Preventing the First Cesarean

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Jeanne Sealy Smith Distinguished Chair in Ob-Gyn
Chief of Obstetrics and Maternal Fetal Medicine
The University of Texas Medical Branch
Disclosure

This speaker has no conflicts of interest to disclose relative to the contents of this presentation.
Objectives

At the end of this presentation, participants should be able to:

- Review the evidence on cesarean delivery rates and contributing factors.
- Discuss the recent SMFM and ACOG recommendations regarding prevention of the first cesarean.
- Follow management guidelines to decrease primary cesarean.
Cesarean Delivery Rates in US

Data from National Vital Statistics

The Healthy People Challenge

Percent

Total CD
Primary CD
VBAC

HP2010 VBAC
HP 2010 1-CD

1989 1991 1993 1995 1997 1999 2001 2003 2005 2007 2009
Downstream Consequences of Rising CD Rates

- Decision analysis model
- If primary and repeat cesareans continue to rise at current rates:
  - 2020:
    - CS rate of 56.2%
    - Additional 6,236 previas per year
    - Additional 4,504 accretas per year
    - Additional 130 maternal deaths per year

Solheim et al., J Mat-Fet and Neonat Med 2011;24:1341-6
The Healthy People Challenge

The graph shows trends in VBAC (Vaginal Birth After Cesarean), Primary CD (Cesarean Delivery), and Total CD (All Cesarean Deliveries) from 1989 to 2009.

- VBAC increased from 1989 to 1997, then decreased to 2009.
- Primary CD remained relatively stable from 1989 to 2009.
- Total CD increased steadily from 1989 to 2009.

The graph highlights the Healthy People 2010 VBAC and HP 2010 1-CD targets.

The most effective approach to reducing overall cesarean delivery rates is to prevent the first cesarean.
Preventing the First Cesarean Delivery

Summary of a Joint Eunice Kennedy Shriver National Institute of Child Health and Human Development, Society for Maternal-Fetal Medicine, and American College of Obstetricians and Gynecologists Workshop

Catherine Y. Spong, MD, Vincenzo Berghella, MD, Katharine D. Wenstrom, MD, Brian M. Mercer, MD, and George R. Saade, MD

Safe Prevention of the Primary Cesarean Delivery

Abstract: In 2011, one in three women who gave birth in the United States did so by cesarean delivery. Cesarean birth can be life-saving for the fetus, the mother, or both in certain cases. However, the rapid increase in cesarean birth rates from 1996 to 2011 without clear evidence of concomitant decreases in maternal or neonatal morbidity or mortality raises significant concern that cesarean delivery is overused. Variation in the rates of nulliparous, term, singleton, vertex cesarean births also indicates that clinical practice patterns affect the number of cesarean births performed. The most common indications for primary cesarean delivery include, in order of frequency, labor dystocia, abnormal or indeterminate (formerly, nonreassuring) fetal heart rate tracing, fetal malpresentation, multiple gestation, and suspected fetal macrosomia. Safe reduction of the rate of primary cesarean deliveries will require different approaches for each of these, as well as other, indications. For example, it may be necessary to revisit the definition of labor dystocia because recent data show that contemporary labor progresses at a rate substantially slower than what was historically taught. Additionally, improved and standardized fetal heart rate interpretation and management may have an effect. Increasing women’s access to nonmedical interventions during labor, such as continuous labor and delivery support, also has been shown to reduce cesarean birth rates. External cephalic version for breech presentation and a trial of labor for women with twin gestations when the first twin is in cephalic presentation are other of several examples of interventions that can contribute to the safe lowering of the primary cesarean delivery rate.

Background
Indications Contributing to the Increasing 1° Cesarean Delivery Rate

- Labor arrest: 34%
- Nonreassuring fetal tracing: 23%
- Maternal-Fetal: 5%
- Malpresentation: 17%
- Macrosomia: 4%
- Maternal Request: 3%
- Multiple Gestation: 7%
- Other obstetric indications: 4%
- Preeclampsia: 3%
Potentially Modifiable Obstetric Indications for First CD

- Failed induction
- Arrest of labor
- Multiple gestation
- Preeclampsia
- Prior shoulder dystocia
- Prior myomectomy
- Prior 3/4 degree lacerations
- Marginal/low lying placenta

Detailed in subsequent slides

*Obstet Gynecol* 2012;120:1181-93
Potentially Modifiable *Fetal* Indications for First CD

- Malpresentation
  - ECV
- Nonreassuring FHT
  - Education, confirmatory tests
- Suspected macrosomia
  - 5000/4500 cutoffs, monitor weight gain
- Malformations
  - Education

*Detailed in subsequent slides*

*Obstet Gynecol* 2012;120:1181-93
Potentially Modifiable Maternal Indications for First CD

- Obesity
  - Education, monitor weight gain, preconception weight loss

- Infection
  - Treatment to minimize transmission

- CV disease

- Inadequate pelvis

- Request

*Obstet Gynecol* 2012;120:1181-93
Induction of Labor
Rate of Induction

Martin JA et al National Vital Statistics Reports 2005
Elective Inductions at Term

- 27 hospitals in 14 states, 2007
- 14,955 term births
- 19% of term births were elective inductions
- Rate of elective induction varied (8-40%)

Clark SL et al AJOG 2009
To avoid first CD related to induction:

- Focus on elective labor inductions
  - Avoid
  - Recognize association of CD with cervical status
  - Accept that there is no clinically useful prediction model presently available
  - Allow the induction sufficient time to progress
Key points 1:

- Labor induction for medical indications only
- If no indication, should be 39+wks and cervix should be favorable (Bishop score >8)
Timing of Indicated Late-Preterm and Early-Term Birth

Catherine Y. Spong, MD, Brian M. Mercer, MD, Mary D’Alton, MD, Sarah Kilpatrick, MD, PhD, Sean Blackwell, MD, and George Saade, MD

Obstet Gynecol 2011;118:323–33,
Definitions:
Failed Induction

Failure to generate regular (eg, every 3 min) contractions and cervical change after at least 24 h of oxytocin administration, with artificial membrane rupture if feasible.
Progress of Labor

Progress of Labor

Contemporary Patterns of Spontaneous Labor With Normal Neonatal Outcomes

Jun Zhang, PhD, MD, Helain J. Landy, MD, D. Ware Branch, MD, Ronald Burkman, MD, Shoshana Haberman, MD, PhD, Kimberly D. Gregory, MD, MPH, Christos G. Hatjis, MD, Mildred M. Ramirez, MD, Jennifer L. Bailit, MD, MPH, Victor H. Gonzalez-Quintero, MD, MPH, Judith U. Hibbard, MD, Matthew K. Hoffman, MD, MPH, Michelle Kominarek, MD, Lee A. Learman, MD, PhD, Paul Van Veldhuisen, PhD, James Troendle, PhD, and Uma M. Reddy, MD, MPH, for the Consortium on Safe Labor

Rethinking Friedman: Contemporary Patterns of Spontaneous Labor

- EMR from 19 US hospitals
- 62,415 women at term, spontaneous labor, vaginal delivery, normal outcomes
- Constructed labor curves using the same methods as Friedman

Zhang, *Obstet Gynecol*, 2010
Average Labor Curves

Singleton term gestation, spontaneous onset of labor, vaginal delivery and normal neonatal outcomes

Zhang, Obstet Gynecol, 2010
Average Labor Curves

Singleton term gestation, spontaneous onset of labor, vaginal delivery and normal neonatal outcomes

No deceleration phase

Zhang, *Obstet Gynecol*, 2010
Average Labor Curves

Singleton term gestation, spontaneous onset of labor, vaginal delivery and normal neonatal outcomes

Zhang, Obstet Gynecol, 2010
Average Labor Curves

Singleton term gestation, spontaneous onset of labor, vaginal delivery and normal neonatal outcomes

- Multips: inflection at 6 cm (not 4 cm)
- Nullips: no clear inflection point

Zhang, *Obstet Gynecol*, 2010
Average Labor Curves

Singleton term gestation, spontaneous onset of labor, vaginal delivery and normal neonatal outcomes

Zhang, *Obstet Gynecol*, 2010
Table 2. Duration of Labor in Hours by Parity in Spontaneous Onset of Labor

<table>
<thead>
<tr>
<th>Cervical Dilation (cm)</th>
<th>Parity 0 (n=25,624)</th>
<th>Parity 1 (n=16,755)</th>
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Zhang, *Obstet Gynecol*, 2010
### Median & 95th %iles duration of first stage in nulliparas with spontaneous labor

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<th>Median (h)</th>
<th>95th Percentile (h)</th>
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Median & 95th %iles of second stage duration with and without epidural

As for the second stage of labor, the data from the safe labor consortium showed the median duration (95th percentile) with epidural analgesia to be 1.1 (3.6), 0.4 (2.0), and 0.3 (1.6) hours for nulliparous, primiparous, and multiparous women, respectively, and 0.6 (2.8), 0.2 (1.3), and 0.1 (1.1) hours without an epidural. ²¹
Definitions: Arrest Disorders

First-stage arrest

6 cm or greater dilation* with membrane rupture and no cervical change for
4 h or more of adequate contractions (eg, >200 Montevideo units) or
6 h or more if contractions inadequate

Second-stage arrest

No progress (descent or rotation) for
4 h or more in nulliparous women with an epidural
3 h or more in nulliparous women without an epidural
3 h or more in multiparous women with an epidural
2 h or more in multiparous women without an epidural

*Denotes the lower limit of normal cervical dilation in American obstetric practice.
PATIENCE

"A jug fills drop by drop."
-Buddha
Spontaneous Labor Algorithm

Spontaneous labor*

3–5.9 cm

- No cervical change
  - Supportive care†
  - Cervical change
  - Continue labor

At least 6 cm

- No cervical change
  - Rupture of membranes
    - Continue labor
  - Cervical change
  - Inadequate contractions; no cervical change for at least 6 hours
    - Consider cesarean delivery
- Cervical change
  - No cervical change despite adequate contractions for at least 4 hours
    - Continue labor

*Obstet Gynecol 2012;120:1181-93
†Obstet Gynecol 2012;120:1185-6
Induced Labor Algorithm

Induction
- Oxytocin with regular frequent contractions

Cervical change from baseline
- At least 6 cm
  - Contractions at least every 3 minutes for at least 6 hours, but no further cervical change
    - Rupture of membranes not safe or not feasible
      - Consider cesarean delivery
    - Rupture of membranes safe and feasible
      - Continue labor
  - Less than 6 cm
    - Rupture of membranes not safe or not feasible
      - Administer oxytocin at least 24 hours
    - Rupture of membranes safe and feasible
      - Consider cesarean delivery

No cervical change from baseline
- Rupture of membranes safe and feasible
  - At least 3 cm
    - Options:
      - Mechanical cervical ripening
      - Pharmacologic cervical ripening with alternate agent
      - Consider resting patient overnight
  - Less than 3 cm; fetal heart tracing reassuring; patient stable
    - Consider double setup for attempted rupture of membranes

- Rupture of membranes not safe or not feasible
  - Cervical change despite adequate contractions for at least 4 hours
  - Inadequate contractions; no cervical change for at least 6 hours
  - Rupture of membranes not feasible
    - Continue labor
Continuous Fetal Heart Rate Monitoring: Time for Reevaluation
Background

- 1960s Continuous EFM introduced into obstetrical practice
  - Complicated pregnancies  
    Hon et al, 1958
- 1978: ~66% US women monitored EFM
  Banta & Thacker, 1979
- 2002: >85% US women (3.4M) EFM
  Martin et al, 2003
Continuous Intrapartum Electronic Fetal Heart Rate Monitoring

Intrapartum monitoring

Cesarean delivery rate

% US women cCEFM in labor

66%

85%
C-Section Rates

Source: CDC, Hospital Episode Statistics (UK), Medline, Notzon et al

Fetal Monitoring begins
Trends in CS and CP Rates

Efficacy: Cochrane Review

- 12 clinical trials (n=37,000), 2 of high quality
- No “non monitoring” studies

<table>
<thead>
<tr>
<th></th>
<th>number (trials)</th>
<th>RR</th>
<th>95%CI</th>
</tr>
</thead>
<tbody>
<tr>
<td>Perinatal death</td>
<td>33,513 (11 trials)</td>
<td>0.85</td>
<td>0.59-1.23</td>
</tr>
<tr>
<td>Neonatal seizures</td>
<td>32,386 (9 trials)</td>
<td>0.50</td>
<td>0.31-0.80</td>
</tr>
<tr>
<td>Cerebral palsy</td>
<td>13,252 (2 trials)</td>
<td>1.74</td>
<td>0.97-3.11</td>
</tr>
<tr>
<td>Cesarean delivery</td>
<td>18,761 (10 trials)</td>
<td>1.66</td>
<td>1.30-2.13</td>
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<tr>
<td>Operative VD</td>
<td>18,151 (9 trials)</td>
<td>1.16</td>
<td>1.01-1.32</td>
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Alfirevic et al. Cochrane 2006 (3) #CD006066
# EFM During Labor

## Neonatal Seizure

<table>
<thead>
<tr>
<th>Study</th>
<th>CTG n/N</th>
<th>Auscultation n/N</th>
<th>Relative Risk (Fixed)</th>
<th>Weight (%)</th>
<th>Relative Risk (Fixed) 95% CI</th>
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<tbody>
<tr>
<td><strong>01 Continuous CTG and FBS</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>Copenhagen 1985</td>
<td>0/485</td>
<td>0/493</td>
<td></td>
<td>0.0</td>
<td>Not estimable</td>
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<tr>
<td>Denver 1979</td>
<td>0/230</td>
<td>1/116</td>
<td></td>
<td>3.9</td>
<td>0.17 [ 0.01, 4.11 ]</td>
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<td>Dublin 1985</td>
<td>12/6530</td>
<td>27/6554</td>
<td></td>
<td>53.0</td>
<td>0.45 [ 0.23, 0.88 ]</td>
</tr>
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<td>Melbourne 1976</td>
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<td>4/175</td>
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<td>8.9</td>
<td>0.11 [ 0.01, 2.05 ]</td>
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<td>Seattle 1987</td>
<td>7/122</td>
<td>7/124</td>
<td></td>
<td>13.7</td>
<td>1.02 [ 0.37, 2.81 ]</td>
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<td><strong>Subtotal (95% CI)</strong></td>
<td>7542</td>
<td>7462</td>
<td></td>
<td>79.4</td>
<td>0.49 [ 0.29, 0.84 ]</td>
</tr>
<tr>
<td>Total events: 19 (CTG), 39 (Auscultation)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Test for heterogeneity chi-square=3.46 df=3 p=0.33 P =13.4%</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Test for overall effect z=2.61 p=0.009</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>02 Continuous CTG only</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Athens 1993</td>
<td>0/746</td>
<td>2/682</td>
<td></td>
<td>5.1</td>
<td>0.18 [ 0.01, 3.80 ]</td>
</tr>
<tr>
<td>Dallas 1986</td>
<td>1/7288</td>
<td>3/7330</td>
<td></td>
<td>5.9</td>
<td>0.34 [ 0.03, 3.22 ]</td>
</tr>
<tr>
<td>Denver 1976</td>
<td>2/242</td>
<td>2/241</td>
<td></td>
<td>3.9</td>
<td>1.00 [ 0.14, 7.01 ]</td>
</tr>
<tr>
<td>Denver 1979</td>
<td>2/233</td>
<td>1/116</td>
<td></td>
<td>2.6</td>
<td>1.00 [ 0.09, 10.87 ]</td>
</tr>
<tr>
<td>Sheffield 1978</td>
<td>0/253</td>
<td>1/251</td>
<td></td>
<td>3.0</td>
<td>0.33 [ 0.01, 8.08 ]</td>
</tr>
<tr>
<td><strong>Subtotal (95% CI)</strong></td>
<td>8762</td>
<td>8620</td>
<td></td>
<td>20.6</td>
<td>0.51 [ 0.18, 1.44 ]</td>
</tr>
<tr>
<td>Total events: 5 (CTG), 9 (Auscultation)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Test for heterogeneity chi-square=1.40 df=4 p=0.84 P =0.0%</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Test for overall effect z=1.28 p=0.2</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Continuous Intrapartum Electronic Fetal Heart Rate Monitoring

- No reduction in cerebral palsy
- Dramatic increase in cesarean delivery

US Preventive Task Force Grade: D
- No evidence of benefit
- Evidence of harm

Intrapartum monitoring

Cesarean delivery rate

66% 85%

% US women cEFM in labor

% Cesarean delivery rate


0 5 10 15 20 25 30 35

- Continuous Intrapartum Electronic Fetal Heart Rate Monitoring

- No evidence of benefit
- Evidence of harm

- US Preventive Task Force Grade: D

- 66% US women cEFM in labor

- 85% US women cEFM in labor

- Cesarean delivery rate
Most FHR abnormalities do not result in fetal acidosis!

Intrapartum Fetal Heart Rate Monitoring and Cerebral Palsy

Multiple Late Decelerations and/or Decreased Variability in Prediction of Cerebral Palsy in Singleton Children with Birth Weights ≥ 2500 g, According to Risk Group

<table>
<thead>
<tr>
<th>Risk Group</th>
<th>% of Population</th>
<th>Prevalence of Cerebral Palsy (per 10,000)</th>
<th>Sensitivity (%)</th>
<th>Specificity (%)</th>
<th>Positive Predictive Value (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Low</td>
<td>69</td>
<td>3.6</td>
<td>13.8</td>
<td>91.3</td>
<td>0.05</td>
</tr>
<tr>
<td>High</td>
<td>31</td>
<td>13.8</td>
<td>34.7</td>
<td>89.1</td>
<td>0.25</td>
</tr>
<tr>
<td>Total</td>
<td>100</td>
<td>6.8</td>
<td>26.9</td>
<td>90.7</td>
<td>0.14</td>
</tr>
<tr>
<td>Agreement</td>
<td>Kappa coefficient</td>
<td>Early labor&lt;sup&gt;a&lt;/sup&gt;</td>
<td>Before delivery&lt;sup&gt;b&lt;/sup&gt;</td>
<td></td>
<td></td>
</tr>
<tr>
<td>-----------------</td>
<td>-------------------</td>
<td>-----------------------------------------------</td>
<td>-----------------------------------------------</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Poor</td>
<td>0.00-0.19</td>
<td>Baseline</td>
<td>Baseline</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Accelerations</td>
<td>Accelerations</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Bradycardia</td>
<td>Bradycardia</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Beat-to-beat variability, decreased</td>
<td>Beat-to-beat variability, decreased</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Beat-to-beat variability, absent</td>
<td>—</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Recurrent prolonged decelerations</td>
<td>Recurrent prolonged decelerations</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Variable deceleration with slow return</td>
<td>Variable deceleration with slow return</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>—</td>
<td>Recurrent late decelerations</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Fair</td>
<td>0.20-0.29</td>
<td>Recurrent late decelerations</td>
<td>Beat-to-beat variability, absent</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Recurrent severe variable decelerations</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Moderate</td>
<td>0.30-0.43</td>
<td>—</td>
<td>Recurrent severe variable decelerations</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Good</td>
<td>0.44-0.59</td>
<td>Tachycardia</td>
<td>Tachycardia</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Substantial</td>
<td>0.60-0.80</td>
<td>—</td>
<td>—</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Almost perfect</td>
<td>0.81-1.00</td>
<td>—</td>
<td>—</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<sup>a</sup>FHR tracing of 1-hour duration, before the onset of periodic decelerations.  
<sup>b</sup>FHR tracing of 1-hour before birth.
Intrapartum FHR Evaluation
Intraobserver Agreement
Westerhuis et al. BJOG 2009;116:545-51

Kappa Values = Moderate 0.4-0.75

<table>
<thead>
<tr>
<th></th>
<th>A1</th>
<th>A2</th>
<th>B1</th>
<th>B2</th>
<th>C1</th>
<th>C2</th>
</tr>
</thead>
<tbody>
<tr>
<td>CTG classification</td>
<td>0.64</td>
<td>0.59</td>
<td>0.67</td>
<td>0.52</td>
<td>0.62</td>
<td>0.54</td>
</tr>
<tr>
<td>Decision to intervene</td>
<td>0.72</td>
<td>0.68</td>
<td>0.75</td>
<td>0.61</td>
<td>0.62</td>
<td>0.64</td>
</tr>
</tbody>
</table>
Let us just go back to IA
Continuous EFM

- Meconium-stained liquor (see page 15)
- FHR less than 110 or greater than 160 bpm; decelerations after a contraction
- Maternal pyrexia (38.0°C once or 37.5°C twice 2 hours apart)
- Fresh bleeding in labour
- Oxytocin for augmentation

Other risk factors present
- Previous CS
- Pre-eclampsia
- Pregnancy > 42 weeks
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- Other maternal medical disease
- Fetal growth restriction
- Prematurity
- Oligohydramnios
- Abnormal Doppler artery velocimetry
- Multiple pregnancies
- Breech presentation

Inform that EFM will restrict woman’s mobility
Every hour take documented systematic assessment based on tables 1 and 2, page 18

Normal trace with oxytocin
Continue oxytocin until 4 or 5 contractions every 10 min. Reduce if fewer than 5 in 10 min.

low-risk women
Intermittent Auscultation for Intrapartum Fetal Heart Rate Surveillance (replaces ACNM Clinical Bulletin #9, March 2007)
### Table 3. Frequency of Fetal Heart Rate Auscultation for Women Who Are Low Risk<sup>a</sup> During Labor

<table>
<thead>
<tr>
<th>Organization</th>
<th>Latent Phase</th>
<th>Active Phase Minutes</th>
<th>Second Stage Minutes</th>
</tr>
</thead>
<tbody>
<tr>
<td>AWHONN</td>
<td></td>
<td>15–30</td>
<td>5–15</td>
</tr>
<tr>
<td>ACOG&lt;sup&gt;b&lt;/sup&gt;</td>
<td></td>
<td>15</td>
<td>5</td>
</tr>
<tr>
<td>SOGC&lt;sup&gt;c&lt;/sup&gt;</td>
<td>At time of assessment and approximately every hour</td>
<td>15–30</td>
<td>5&lt;sup&gt;d&lt;/sup&gt;</td>
</tr>
<tr>
<td>RCOG</td>
<td></td>
<td>15&lt;sup&gt;e&lt;/sup&gt;</td>
<td>5&lt;sup&gt;e&lt;/sup&gt;</td>
</tr>
<tr>
<td>ACNM</td>
<td></td>
<td>15–30</td>
<td>5</td>
</tr>
</tbody>
</table>
Table 3. Frequency of Fetal Heart Rate Auscultation for Women Who Are Low Riska During Labor

<table>
<thead>
<tr>
<th>Organization</th>
<th>Latent Phase</th>
<th>Active Phase Minutes</th>
<th>Second Stage Minutes</th>
</tr>
</thead>
<tbody>
<tr>
<td>AWHONN</td>
<td></td>
<td>15–30</td>
<td>5–15</td>
</tr>
<tr>
<td>ACOGb</td>
<td>15</td>
<td>5</td>
<td></td>
</tr>
<tr>
<td>SOGCc</td>
<td>At time of assessment and approximately every hour</td>
<td>15–30</td>
<td>5d</td>
</tr>
<tr>
<td>RCOG</td>
<td>15e</td>
<td>5e</td>
<td></td>
</tr>
<tr>
<td>ACNM</td>
<td>15–30</td>
<td>5</td>
<td></td>
</tr>
</tbody>
</table>

aNone of the professional organization guidelines specifically define “low risk.” For the purpose of this bulletin, “low risk” refers to women who have no medical or obstetric conditions that are associated with uteroplacental insufficiency, and/or conditions
Let us fix variability in interpretation and subjectivity
The 2008 National Institute of Child Health and Human Development Workshop Report on Electronic Fetal Monitoring

Update on Definitions, Interpretation, and Research Guidelines

George A. Macones, MD, Gary D. V. Hankins, MD, Catherine Y. Spong, MD, John Hauth, MD, and Thomas Moore, MD

In April 2008, the Eunice Kennedy Shriver National Institute of Child Health and Human Development, the American College of Obstetricians and Gynecologists, and the Society for Maternal-Fetal Medicine partnered to sponsor a 2-day workshop to revisit nomenclature, interpretation, and research recommendations for intrapartum electronic fetal heart rate monitoring. Participants included obstetric experts and representatives from relevant stakeholder groups and organizations. This article provides a summary of the findings from the workshop.
Intrapartum Fetal Heart Rate Monitoring: Nomenclature, Interpretation, and General Management Principles
Category II

Category II FHR tracings include all FHR tracings not categorized as Category I or Category III. Category II tracings may represent an appreciable fraction of those encountered in clinical care. Examples of Category II FHR tracings include any of the following:

**Baseline rate**
- Bradycardia not accompanied by absent baseline variability
- Tachycardia

**Baseline FHR variability**
- Minimal baseline variability
- Absent baseline variability not accompanied by recurrent decelerations
- Marked baseline variability

**Accelerations**
- Absence of induced accelerations after fetal stimulation

**Periodic or episodic decelerations**
- Recurrent variable decelerations accompanied by minimal or moderate baseline variability
- Prolonged deceleration $\geq 2$ minutes but $< 10$ minutes
- Recurrent late decelerations with moderate baseline variability
- Variable decelerations with other characteristics, such as slow return to baseline, “overshoots,” or “shoulders”
Category II: Indeterminate

Meaning & Management

- Continued reevaluation
- Additional tests
- Non surgical interventions
Preventing the First Cesarean Delivery

Summary of a Joint Eunice Kennedy Shriver National Institute of Child Health and Human Development, Society for Maternal-Fetal Medicine, and American College of Obstetricians and Gynecologists Workshop

Catherine Y. Spong, MD, Vincenzo Berghella, MD, Katharine D. Wenstrom, MD, Brian M. Mercer, MD, and George R. Saade, MD

Obstet Gynecol 2012;120:1181–93
SMFM Preventing the First Cesarean
Obstet Gynecol 2012;120:1181-93

Assessment of intrapartum FHR tracing

Category I
Routine management

Category II*
Evaluation and surveillance; confirmatory test (for example, scalp stimulation)

FHR accelerations or moderate FHR variability
Continue surveillance and intrauterine resuscitative measures†

Absent FHR accelerations and absent or minimal FHR variability
Intrauterine resuscitative measures†
If not improved or FHR tracing progresses to Category III, consider delivery‡

Category III
Prepare for delivery and intrauterine resuscitative measures†
If not improved, consider prompt delivery‡
Assessment of intrapartum FHR tracing

- Category I
  - Routine management

- Category II*
  - Evaluation and surveillance; confirmatory test (for example, scalp stimulation)
    - FHR accelerations or moderate FHR variability
      - Continue surveillance and intrauterine resuscitative measures†
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SMFM Preventing the First Cesarean
Obstet Gynecol 2012;120:1181-93

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Category I
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Category II*
- Evaluation and surveillance; confirmatory test (for example, scalp stimulation)
  - FHR accelerations or moderate FHR variability
    - Continue surveillance and intrauterine resuscitative measures†
  - Absent FHR accelerations and absent or minimal FHR variability
    - Intrauterine resuscitative measures†
      - If not improved or FHR tracing progresses to Category III, consider delivery‡

Category III
- Prepare for delivery and intrauterine resuscitative measures†
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Continuous EFM

- Meconium-stained liquor (see page 15)
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- Other maternal medical disease
- Fetal growth restriction
- Prematurity
- Oligohydramnios
- Abnormal Doppler artery velocimetry
- Multiple pregnancies
- Breech presentation

Other risk factors present
- Continuous EFM

Inform that EFM will restrict woman's mobility
Every hour take documented systematic assessment based on tables 1 and 2, page 18

Normal trace with oxytocin
- Continue oxytocin until 4 or 5 contractions every 10 min.
- Reduce if more than 5 in 10 min

Abnormal trace

Pathological trace
- If uterine hypercontractility, consider 0.25 mg terbutaline subcutaneously

With oxytocin
- Suspicious trace: review; continue to increase oxytocin till 4 or 5 contractions every 10 min
- Pathological trace: stop oxytocin; full assessment by obstetrician before recommencing

FBS, see page 19. If result abnormal

Real-time ultrasound assessment

Urgent birth
Problem with EFM
Problem with EFM

It is a screening test that involves interpretation
Problem with EFM

It is a screening test that involves interpretation
Prediction of Acidemia: Computerized Assessment
Prediction of Acidemia: Computerized Assessment

Likelihood Ratio (LR)

<table>
<thead>
<tr>
<th></th>
<th>Condition +</th>
<th>Condition -</th>
</tr>
</thead>
<tbody>
<tr>
<td>Test +</td>
<td>1</td>
<td>800</td>
</tr>
<tr>
<td>Test -</td>
<td>0</td>
<td>200</td>
</tr>
</tbody>
</table>

LR\(+\) = \(\frac{\text{sensitivity}}{1-\text{specificity}}\) = \(\frac{1}{0.8} = 1.25\)

LR\((-\) = \(\frac{1-\text{sensitivity}}{\text{specificity}}\) = \(\frac{0}{0.2} = \text{NC}\)

NNT = 801

For outcome rate of 1 per 1000 assuming all prevented by CD
Prediction of Acidemia: Computerized Assessment
Likelihood Ratio (LR)

<table>
<thead>
<tr>
<th></th>
<th>Condition +</th>
<th>Condition -</th>
</tr>
</thead>
<tbody>
<tr>
<td>Test +</td>
<td>8</td>
<td>2000</td>
</tr>
<tr>
<td>Test -</td>
<td>2</td>
<td>8000</td>
</tr>
</tbody>
</table>

\[ LR^+ = \frac{\text{sensitivity}}{1-\text{specificity}} = \frac{0.8}{0.2} = 4 \]

\[ LR^- = \frac{1-\text{sensitivity}}{\text{specificity}} = \frac{0.2}{0.8} = 0.25 \]

\[ \text{NNT} = \frac{2008}{8} = 251 \]

For outcome rate of 1 per 1000 assuming all prevented by CD
# Likelihood Ratio (LR)

<table>
<thead>
<tr>
<th>Condition +</th>
<th>Condition -</th>
</tr>
</thead>
<tbody>
<tr>
<td>Test +</td>
<td>16</td>
</tr>
<tr>
<td>Test -</td>
<td>4</td>
</tr>
</tbody>
</table>

\[
\text{LR}^+ = \frac{\text{sensitivity}}{(1-\text{specificity})} = \frac{0.8}{0.2} = 4
\]

\[
\text{LR}^- = \frac{(1-\text{sensitivity})}{\text{specificity}} = \frac{0.2}{0.8} = 0.25
\]

\[
\text{NNT} = \frac{2016}{16} = 126
\]

For outcome rate of 2 per 1000 assuming all prevented by CD
Likelihood Ratio (LR)

<table>
<thead>
<tr>
<th></th>
<th>Condition +</th>
<th>Condition -</th>
</tr>
</thead>
<tbody>
<tr>
<td>Test +</td>
<td>32</td>
<td>2000</td>
</tr>
<tr>
<td>Test -</td>
<td>8</td>
<td>8000</td>
</tr>
</tbody>
</table>

\[ LR^+ = \frac{\text{sensitivity}}{1-\text{specificity}} = \frac{0.8}{0.2} = 4 \]

\[ LR^- = \frac{1-\text{sensitivity}}{\text{specificity}} = \frac{0.2}{0.8} = 0.25 \]

\[ \text{NNT} = \frac{2032}{32} = 63.5 \]

For outcome rate of 4 per 1000 assuming all prevented by CD
Risk Factors for Newborn Encephalopathy

Abnormal Placental Appearance: 2.07
Emergency C/S: 2.17
Instrumental Delivery: 2.23
Family Hx Seizure: 2.55
Family Hx Neurological Disorder: 2.73
Viral Illness: 2.97
Mod/Severe Antepartum Bleeding: 3.57
Intrapartum Fever: 3.82

Badawi, BMJ 317:1549
Risk Factors for Newborn Encephalopathy

- **OP Presentation**: 4.29
- **IUGR 3-9%tile**: 4.37
- **Infertility Treatment**: 4.43
- **Acute Intrapartum Event**: 4.44
- **Severe Preeclampsia**: 6.3
- **Maternal Thyroid Disease**: 9.7

Badawi, BMJ 317:1549
Prediction of Acidemia: Computerized Assessment

[Graph showing a Receiver Operating Characteristic (ROC) curve]
Prediction of Acidemia: Computerized Assessment
Sensitivity of GLT
Sensitivity of GLT
We Need to Minimize Human Interpretation
Comparison of 5 experts and computer analysis in rule-based fetal heart rate interpretation

Julian T. Parer, MD, PhD; Emily F. Hamilton, MD

OBJECTIVE: The purpose of this study was to measure agreement among 5 expert clinicians and a computerized method with the use of a strict fetal heart rate classification method.

STUDY DESIGN: Five providers independently scored 769 8-minute segments from the last 3 hours of 30 tracings with the use of a 5-tier color-coded framework that contains pattern descriptions and proposals for management. Computer analysis was performed with PeriCALM Patterns (PeriGen, Princeton, NJ) to detect and classify patterns.

RESULTS: The clinicians agreed exactly with the majority opinion in 57% (95% confidence interval [CI], 49–64%) of the segments and were within 1 color code in 89% (95% CI, 81–96%). The average proportion of agreement was 0.83 (95% CI, 0.73–0.94). Weighted Kappa scores averaged 0.58 (range, 0.48–0.68). The computer-based results were not statistically different: 0.87 and 0.52, respectively.

CONCLUSION: These 5 clinicians achieved moderate-to-substantial levels of agreement overall using a strictly defined method to classify fetal heart rate tracings. The result of the computerized method was similar to the conclusions of these clinicians.

Key words: computer, electronic fetal heart rate monitoring, interobserver agreement

PeriCALM® Tracings™
Using Pattern Recognition Software to Evaluate Intrapartum Fetal Heart Rate Tracings

<table>
<thead>
<tr>
<th>Outcome present (N=109)</th>
<th>Outcome absent (N=4,099)</th>
<th>P-value‡</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Proportion of time baseline variability &lt;5 bpm</strong></td>
<td>0 (0, 0.04)</td>
<td>0 (0, 0.02)</td>
</tr>
<tr>
<td><strong>Average baseline variability (bpm) over the last 15 mins</strong></td>
<td>13.8 ± 4.8</td>
<td>15.4 ± 5.1</td>
</tr>
<tr>
<td><strong>Average baseline variability over the last 30 mins</strong></td>
<td>13.5 ± 4.2</td>
<td>14.4 ± 4.3</td>
</tr>
<tr>
<td><strong>Acceleration present</strong></td>
<td>54 (49.5%)</td>
<td>2,795 (68.2%)</td>
</tr>
<tr>
<td><strong>Number of accelerations per patient per hour</strong></td>
<td>0 (0, 2.7)</td>
<td>2.8 (0, 4.1)</td>
</tr>
<tr>
<td><strong>Percent of tracing time as accelerations</strong></td>
<td>2.5 ± 4.5</td>
<td>3.7 ± 4.8</td>
</tr>
<tr>
<td><strong>Late deceleration present</strong></td>
<td>58 (53.2%)</td>
<td>1,970 (48.6%)</td>
</tr>
<tr>
<td><strong>Number of late decelerations per patient per hour</strong></td>
<td>1.0 (0, 2.1)</td>
<td>0 (0, 2.0)</td>
</tr>
<tr>
<td><strong>Percent of tracing time as late decelerations</strong></td>
<td>3.4 ± 5.0</td>
<td>2.8 ± 4.6</td>
</tr>
<tr>
<td><strong>Variable deceleration present</strong></td>
<td>100 (91.7%)</td>
<td>3928 (95.8%)</td>
</tr>
<tr>
<td><strong>Number of variables per patient per hour</strong></td>
<td>10.1 (4.7, 21.1)</td>
<td>13.5 (7.0, 20.8)</td>
</tr>
<tr>
<td><strong>Percent of tracing time as variables</strong></td>
<td>20.9 ± 15.8</td>
<td>20.7 ± 13.8</td>
</tr>
<tr>
<td><strong>Prolonged deceleration present</strong></td>
<td>54 (49.5%)</td>
<td>1,570 (38.3%)</td>
</tr>
<tr>
<td><strong>Number of prolonged decelerations per patient per hour</strong></td>
<td>0 (0, 1.2)</td>
<td>0 (0, 1)</td>
</tr>
<tr>
<td><strong>Percent of tracing time as prolonged decelerations</strong></td>
<td>4.6 ± 6.4</td>
<td>2.8 ± 4.7</td>
</tr>
</tbody>
</table>
Automated Fetal ECG Analysis

ST Analysis - STAN System
Example of STAN recording: Category II tracing with ST events

Log function that automatically identifies significant ST changes, information about the type and degree of abnormality.

30 heartbeats = T/QRS ratio = X

ST Event - significant change
NICHD’s MFMU Network centers 2011-16

- 14 Clinical sites
- Data center
- NICHD

- ~140,000 deliveries/yr
- Re-competition: 5 yrs

- Columbia
- Case Western
- Duke
- Northwestern
- Ohio State
- Stanford
- U Alabama
- U Colorado
- U North Carolina
- U Texas-Houston
- U Texas SW-Dallas
- U Utah
- UTMB Galveston
- Women and Infants
A Randomized Trial of Intrapartum Fetal ECG ST-Segment Analysis

## Neonatal Outcomes

<table>
<thead>
<tr>
<th>Outcome</th>
<th>Open Group (N = 5532)</th>
<th>Masked Group (N = 5576)</th>
<th>Relative Risk (95% CI)</th>
<th>P Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Primary composite outcome†</td>
<td>52 (0.94)</td>
<td>40 (0.72)</td>
<td>1.31 (0.87–1.98)</td>
<td>0.20</td>
</tr>
<tr>
<td>Intrapartum fetal death</td>
<td>0</td>
<td>0</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Neonatal death</td>
<td>3 (0.05)</td>
<td>1 (0.02)</td>
<td>3.02 (0.31–29.1)</td>
<td>0.37</td>
</tr>
<tr>
<td>Apgar score ≤3 at 5 min</td>
<td>17 (0.31)</td>
<td>6 (0.11)</td>
<td>2.86 (1.13–7.24)</td>
<td>0.02</td>
</tr>
<tr>
<td>Neonatal seizure</td>
<td>3 (0.05)</td>
<td>4 (0.07)</td>
<td>0.76 (0.17–3.38)</td>
<td>1.0</td>
</tr>
<tr>
<td>Umbilical-artery blood pH ≤7.05 and base deficit in extracellular fluid ≥12 mmol/liter‡</td>
<td>3 (0.06)</td>
<td>8 (0.15)</td>
<td>0.37 (0.10–1.41)</td>
<td>0.13</td>
</tr>
<tr>
<td>Intubation for ventilation at delivery</td>
<td>42 (0.76)</td>
<td>27 (0.48)</td>
<td>1.57 (0.97–2.54)</td>
<td>0.07</td>
</tr>
<tr>
<td>Neonatal encephalopathy</td>
<td>4 (0.07)</td>
<td>5 (0.09)</td>
<td>0.81 (0.22–3.00)</td>
<td>1.0</td>
</tr>
</tbody>
</table>
Quality Measures

- Rate of nonmedically indicated cesarean delivery
- Rate of nonmedically indicated induction
- Rate of labor arrest or failed induction diagnosed without meeting accepted criteria
- Rate of cesarean deliveries for nonreassuring fetal heart rate by *Eunice Kennedy Shriver National Institute of Child Health and Human Development category*\(^{14}\)

*For singleton gestation, vertex presentation, at 37 0/7 to 41 6/7 weeks of gestation.*
Saade Quality Measures

- Rate of cesarean for failure to progress before 6 cm
- Rate of cesarean for non-reassuring fetal status with 1 min Apgar >7
Change in Primary Cesarean 2009-2012

NOTES: Data reflect singletons only. See Table A for 2009 revised reporting area.
Induction of Labor In Singletons

CDC/NCHS, National Vital Statistics System

Gestational age (completed weeks)

Percent

2006  2007  2008  2009  2010  2011  2012

Late preterm

34  35  36

Early term

37  38

CDC/NCHS, National Vital Statistics System
We Deliver!
THROUGH STORM, AND RAIN, AND HURRICANE!

Department of Obstetrics & Gynecology
The University of Texas Medical Branch at Galveston