Maternal Mortality in California: What we know, What we don’t know, and How we are filling in the blanks

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Objectives:
- Describe the ways that maternal mortality is defined and collected and how that impacts the reported numbers.
- Describe the current leading causes of maternal mortality in the US and in California.
- Describe how this measure can be used for political, public health and quality improvement purposes.

Presenter Disclosure(s):
- None

“Maternal mortality is a general report card with regard to the quality of obstetric care in the United States.”

--Jeffrey C. King, MD, Chair of ACOG Maternal Mortality Special Interest Group
Literature review and over 100 in-depth interviews and focus groups
Focus on disparity (esp African American women) and on variation among the states
Scathing indictment of US healthcare system for maternity care
**Transforming Maternity Care**

**UK Triennial Maternal Mortality Review**
- Confidential Enquiry into Maternal and Child Health (CEMCH)
  - Formerly known as: Confidential Enquiry into Maternal Deaths (CEMD)
  - Triennial Report: “Saving Mother’s Lives”
  - Changed to reflect a new emphasis on **Quality Improvement**

**Key Questions:**
- What is a “Maternal Mortality?”
- What are the causes of maternal mortality?
  - Medical (diagnoses)
  - Risk factors (maternal characteristics)
- Is maternal mortality preventable?
- Why is maternal mortality rising?
Key Definitions

**Maternal Mortality Rate**
Number of women who die from pregnancy-related causes within 42 days postpartum/the number of live births in that year x 100,000.
(sometimes referred to as Maternal Mortality Ratio)

**Pregnancy-Related Deaths**
Death of a woman within one year postpartum related to pregnancy or aggravated by the pregnancy or its management.

**Pregnancy-Associated Deaths**
Death of a woman within one year postpartum from any cause.

**Not-Pregnancy-Related Deaths**
Death of a woman within one year postpartum unrelated to pregnancy or its management.

Options for Measuring Maternal Mortality

1. **Vital Statistics/ Death Certificates**
   - ICD-10 Obstetric code, <42 days PP
   - Used for state/national and time comparisons

2. **Enhanced surveillance with chart review**
   - Linked Birth / Death files, <365 days PP
   - Recommended by CDC / ACOG for quality assessment and improvement

3. **Demographic modeling**
   - Used for international comparisons (Lancet)

Pregnancy-Related Mortality in the United States

<table>
<thead>
<tr>
<th>Years</th>
<th>No. of Maternities</th>
<th>Maternities</th>
</tr>
</thead>
<tbody>
<tr>
<td>1994-96</td>
<td>158</td>
<td>2,197,640</td>
</tr>
<tr>
<td>1997-99</td>
<td>128</td>
<td>2,123,614</td>
</tr>
<tr>
<td>2000-02</td>
<td>136</td>
<td>1,997,472</td>
</tr>
<tr>
<td>2003-05</td>
<td>149</td>
<td>2,114,004</td>
</tr>
</tbody>
</table>

Maternal Mortality Rate, California Residents: 1970-2006


HP 2010 Objective – 4.3 Deaths per 100,000 Live Births

Maternal Deaths per 100,000 Live Births

ICD-10

ICD-8

ICD-9

2002-3


This project was supported by federal Title V block grant funds received from the California Department of Public Health; Center for Family Health; Maternal, Child and Adolescent Health Division

CA-PAMR Committee, current

Elliott Main, MD, Chair
Deirdre Anglin, MD, MPH
Conrad Chao, MD
Sheila E. Cohen, MB.Ch.B, FRCA
Patricia Dailey, MD
Maurice Druzin, MD
Michael Fassett, MD
Kristi Gabel, RNC-OB, MSN, CNS
Dodi Gauthier, Med, RNC
Jeffrey B. Gould, MD, MPH

Kimberly Gregory, MD, MPH
Afshan Hameed, MD, FACOG, FACC
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Barbara Murphy, MSN, RN
Larry Newman, MD, FACOG
Larry Shields, MD
Lucy Van Otterloo, RN, MSN
Linda V. Walsh, CNM, PhD, FACNM

Key Steps of CA-PAMR Methodology

STEP 1: Hospital discharge data linked to birth, death certificates
Identifies women who died within one year postpartum from any cause
(Pregnancy-Associated Cohort)

STEP 2: Additional data gathered for each death
Coroner Reports, Autopsy Results, and additional information from the Death Certificate (e.g., multiple causes of death, recent surgeries, etc.) are obtained

STEP 3: Cases selected for PAMR Committee review
Documented (ICD-10 obstetric (“O”) code) and suspected pregnancy-related deaths are prioritized for review

STEP 4: Medical records abstracted and summarized
All available labor and delivery, prenatal, hospitalization, transport, and outpatient and emergency department records are obtained

STEP 5: Case reviewed by PAMR Committee
Committee summarizes whether the death was pregnancy-related, the cause of death, contributing factors and quality improvement opportunities.
Maternal Mortality Rates by Race/Ethnicity, California Residents; 1999-2006

Maternal Deaths per 100,000 Live Births

CA-PAMR Race/Ethnicity of Pregnancy-Related Deaths and All CA Births; 2002-2003 (N=98)

OF all the forms of inequality, injustice in health care is the most shocking and inhumane.”


Causes of Maternal Mortality: Medical Diagnoses
Pregnancy-Related Mortality in the United States

Overall rates per million maternities
UK 2003-2005

Clinical Causes of Death
Pregnancy-related Deaths

What can we prevent?
(And how do we judge that?)
**CDC Determination of Preventable Maternal Mortalities by Cause**

Table 2. Distribution of Causes of Pregnancy-Related Deaths and Percent of Preventable Deaths by Cause, North Carolina, 1995–1999

<table>
<thead>
<tr>
<th>Cause of Death</th>
<th>% of All Pregnancy-Related Deaths</th>
<th>% Preventable</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cardiomyopathy</td>
<td>21</td>
<td>22</td>
</tr>
<tr>
<td>Hemorrhage</td>
<td>14</td>
<td>13</td>
</tr>
<tr>
<td>Pregnancy-induced hypertension</td>
<td>16</td>
<td>60</td>
</tr>
<tr>
<td>Cardiovascular accident</td>
<td>9</td>
<td>0</td>
</tr>
<tr>
<td>Chronic condition</td>
<td>9</td>
<td>89</td>
</tr>
<tr>
<td>Amniotic fluid embolus</td>
<td>7</td>
<td>0</td>
</tr>
<tr>
<td>Infection</td>
<td>7</td>
<td>43</td>
</tr>
<tr>
<td>Pulmonary embolus</td>
<td>6</td>
<td>17</td>
</tr>
<tr>
<td>Micronephric hemolytic syndrome</td>
<td>5</td>
<td>0</td>
</tr>
<tr>
<td>Cardiovascular condition</td>
<td>5</td>
<td>40</td>
</tr>
<tr>
<td>Chorioangiomas</td>
<td>4</td>
<td>25</td>
</tr>
<tr>
<td>Miscellaneous</td>
<td>3</td>
<td>33</td>
</tr>
</tbody>
</table>

Berg et al., Obstet Gynecol 2005;106:1228–34

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**Percentage of deaths due to substandard care; UK 1985 - 2005**


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**CA-PAMR Pregnancy-Related Deaths, Chance to Alter Outcome by Grouped Cause of Death; 2002-2003 (N=98)**

<table>
<thead>
<tr>
<th>Cause of Death</th>
<th>Strong/Good (N)</th>
<th>Strong/Good (%)</th>
<th>Some (N)</th>
<th>None (N)</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Obstetric hemorrhage</td>
<td>7</td>
<td><strong>70</strong></td>
<td>2</td>
<td>1</td>
<td>10</td>
</tr>
<tr>
<td>Sepsis/infection</td>
<td>5</td>
<td><strong>63</strong></td>
<td>3</td>
<td>0</td>
<td>8</td>
</tr>
<tr>
<td>Preeclampsia/eclampsia</td>
<td>9</td>
<td><strong>60</strong></td>
<td>6</td>
<td>0</td>
<td>15</td>
</tr>
<tr>
<td>Deep vein thrombosis/ Pulmonary embolism</td>
<td>3</td>
<td><strong>37</strong></td>
<td>4</td>
<td>1</td>
<td>8</td>
</tr>
<tr>
<td>Cardiomyopathy and other cardiovascular condition</td>
<td>5</td>
<td><strong>29</strong></td>
<td>12</td>
<td>2</td>
<td>19</td>
</tr>
<tr>
<td>Amniotic Fluid Embolism</td>
<td>0</td>
<td><strong>0</strong></td>
<td>12</td>
<td>2</td>
<td>14</td>
</tr>
<tr>
<td>All other causes of death</td>
<td>7</td>
<td><strong>32</strong></td>
<td>8</td>
<td>7</td>
<td>22</td>
</tr>
<tr>
<td>Total (%)</td>
<td>36</td>
<td><strong>38%</strong></td>
<td>47</td>
<td>13</td>
<td>96**</td>
</tr>
</tbody>
</table>

SOURCE: The California Pregnancy-Associated Mortality Review

By definition, all these items represent associations rather than proven cause and effect

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**Why is the MMR Increasing? What has Changed in the Last 10-15 years?**

“Usual Suspects”

- Increasing Maternal Age
- Increasing Obesity
- Increasing Cesarean Birth Rate
- Increasing Underlying Medical Problems
Mean Maternal Age has Risen by One Year Every Decade

Maternal Mortality Rates by Age Group, California Residents; 1999-2006

Maternal Deaths per 100,000 Live Births

CA-PAMR Pregnancy-Related Deaths and CA Birth Cohort, Age of Mother at Death; 2002-2003

Obesity (UK)

- Confidential Enquiry into Maternal and Child Health (CEMACH) (Dec. 2007 Report)
  - More than Half of the almost 300 women who died during childbirth between 2003 and 2005 from pregnancy-related conditions, were overweight or worse:
    - Overweight (BMI 25-30): 25%
    - Obese (BMI 30-35): 12%
    - Morbidly Obese (BMI >35): 15%
Frequency of Obesity in Pregnancy-related Mortalities (2002-3)

- Overweight or Obese: 60%
- Normal: 22%
- Underweight: 8%
- Obese I (BMI = 30.0-34.9): 35.7%
- Obese II (BMI = 35.0-39.9): 5.7%
- Obese III (BMI = 40+): 2.3%

Mode of Delivery for Pregnancy-related Deaths (2002-3)

<table>
<thead>
<tr>
<th>Delivery Type</th>
<th>N=98</th>
</tr>
</thead>
<tbody>
<tr>
<td>Died without delivery</td>
<td>3</td>
</tr>
<tr>
<td>Vaginal birth</td>
<td>29</td>
</tr>
<tr>
<td>Cesarean deliveries</td>
<td>65+1*</td>
</tr>
<tr>
<td>Primary</td>
<td>46 (70%)</td>
</tr>
<tr>
<td>Repeat</td>
<td>19 (30%)</td>
</tr>
</tbody>
</table>

Cesarean Births Have Risen by 50% Over the Last 10 years

Figure 10. Total cesarean delivery rate: United States, 1989-2005

Contribution of Cesarean Births

Cases that the PAMR Committee judged that the current or prior Cesarean birth was a contributing factor

- Post-operative DVT/PE: 5 deaths
- CS Related Hemorrhage: 3 deaths
  - Intra-operative lacerated vessel
  - Accreta from prior Cesarean
  - Uterine rupture from prior Cesarean
- Post-operative sepsis (no chorio): 2 deaths
- Post-operative ARDS with intra-op fluid overload: 1 death
- Spinal anesthesia related severe hypotension with intra-operative cardiac arrest: 4 cases

*Cesarean scar found on autopsy, MR not available
Contribution of Cesarean Births

Cases that the PAMR Committee judged that the current or prior Cesarean birth was a contributing factor

- Cesarean section was a **contributing factor** in 15 of the 65 cesarean births (23%), 15 of all 98 deaths reviewed (15%)
- No DVT prophylaxis of any kind was used in these cases. This represents an opportunity
- The risk of maternal mortality for Cesarean section is small but not zero

Key Findings

1. By all measurement approaches, Maternal Mortality in California has increased
2. Cardiovascular disease has emerged as the #1 category for pregnancy related deaths
3. Deaths from hemorrhage, preeclampsia, infection, and thromboembolism were judged to have good to strong chances to alter outcome
4. Obesity, advanced maternal age, cesarean section and African-American race were recognized contributing factors
5. >95% of cases had “opportunities for improvement” for the facilities and the professionals involved

CA-PAMR Opportunities for Quality Improvement Themes

- Timely diagnosis and standardized, evidence-based management of specific clinical conditions
- Recognition and response to clinical triggers (i.e., warning signs) in clinical status
- Coordination of care issues
- Optimal resuscitation of pregnant women, and earlier consideration of cesarean birth during resuscitation
- Access to care, including timely referrals to, and the availability of medical consultants or subspecialist care
- Maximizing the health of women before and during pregnancy and postpartum

Causes of Maternal Mortality and Morbidity

<table>
<thead>
<tr>
<th>Cause</th>
<th>Mort.</th>
<th>ICU</th>
<th>Serious Morbid</th>
</tr>
</thead>
<tbody>
<tr>
<td>VTE and AFE</td>
<td>10%</td>
<td>5%</td>
<td>2%</td>
</tr>
<tr>
<td>Infection</td>
<td>15%</td>
<td>10%</td>
<td>5%</td>
</tr>
<tr>
<td>Hemorrhage</td>
<td>15%</td>
<td>30%</td>
<td>45%</td>
</tr>
<tr>
<td>Preeclampsia / CVA</td>
<td>20%</td>
<td>30%</td>
<td>30%</td>
</tr>
<tr>
<td>Cardiac Disease</td>
<td>20%</td>
<td>15%</td>
<td>10%</td>
</tr>
</tbody>
</table>
Joint Commission Sentinel Alert: Improvement Opportunities

- Better control of BP in hypertensive women
- Better diagnosis and treatment pulmonary edema in women with preeclampsia
- Better recognition and treatment of hemorrhage especially following Cesarean birth
- Closer attention to vital signs, use of “triggers”
- Greater use of pneumatic compression devices and low molecular weight heparin in high risk patients undergoing a Cesarean birth
- Education of ED staff to complications of pregnancy and the postpartum period

The Joint Commission Sentinel Alert #44, January 26, 2010

What can we do?

- **DVT/PE**: Many California hospital systems now have protocols for VTE-prevention: universal SCDs at CS, Lovenox for high risk patients. ACOG is revising its recommendations.
- **Preeclampsia**: Treat both systolic AND diastolic HTN! ER is an important care setting. ACOG is revising its recommendations this year
- **Hemorrhage**: Carts, protocols, drills, balloons QBL (see www.CMQCC.org)

Open Access Toolkit of Best Practices

- Guidelines, protocols, checklists, sample policies, support materials
- Series of “Best Practice” discussions on all OB hemorrhage topics, from Accreta to Jehovah’s Witness to Uterotonic agents
- www.CMQCC.org

CMQCC: Transforming Maternity Care
### CMQCC California Hemorrhage Guidelines

These are open access tools being utilized across CA and the world.

### New Challenges...

**For 2009, H1N1 will likely raise the MMR by 4.3**

"**Eternal vigilance is the price of maternal safety**"

### Key Questions:

- **What is a “Maternal Mortality?”**
- **What are the causes of maternal mortality?**
  - Medical (diagnoses)
  - Risk factors (maternal characteristics)
- **Is maternal mortality preventable?**
- **Why is maternal mortality rising?**

### What can we do? (2)

- **Cardiovascular / Cardiomyopathy:** 3 “pearls”
  - Obesity + HTN=High Risk for Cardiomyopathy (esp if African American)
  - Known underlying cardiovascular disease: should be followed by a multi-disciplinary team, strongly consider tertiary center
  - 3rd Trimester onset of wheezing: this is not likely to be asthma but rather Cardiac in origin, refer for evaluation

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**Original Article**

### Severe 2009 H1N1 Influenza in Pregnant and Postpartum Women in California

Laverne K. Lavor, M.D., M.P.H., Instructions Automotive, M.P.H.,
Dania Z. Almeida, M.D., M.P.H., and Margaret A. Franch, R.N., M.P.H.,
for the California Pandemic (H1N1) Working Group

**Abstract**

Severe 2009 H1N1 influenza in pregnant and postpartum women: 31 cases, with 12 due to complications of antenatal care, and 19 fulminant cases requiring hospitalization and critical care. After maternal hospitalization, there were 14 cases of pneumonia, 3 cases of sepsis, 2 cases of thrombocytopenia, 8 cases of organ failure, and 3 cases of death. There were 17 cases of miscarriage, 1 case of stillbirth, 1 case of neonatal death, and 1 case of maternal death. There were 12 cases of maternal admission to the intensive care unit, 3 cases of maternal transfer to the intensive care unit, and 1 case of maternal death. There were 11 cases of antenatal care, 3 cases of postpartum care, 1 case of birth, 1 case of neonatal care, and 1 case of death. The median age of maternal hospitalization was 31 years, the median age of maternal death was 39 years, and the median age of infant death was 7 months. The median duration of hospitalization was 14 days, and the median duration of critical care was 12 days. The median duration of antenatal care was 14 days, the median duration of postpartum care was 14 days, and the median duration of neonatal care was 14 days. The median duration of organ failure was 14 days, and the median duration of critical care was 14 days. The median duration of antenatal care was 14 days, the median duration of postpartum care was 14 days, and the median duration of neonatal care was 14 days. The median duration of organ failure was 14 days, and the median duration of critical care was 14 days. The median duration of antenatal care was 14 days, the median duration of postpartum care was 14 days, and the median duration of neonatal care was 14 days. The median duration of organ failure was 14 days, and the median duration of critical care was 14 days. The median duration of antenatal care was 14 days, the median duration of postpartum care was 14 days, and the median duration of neonatal care was 14 days. The median duration of organ failure was 14 days, and the median duration of critical care was 14 days.
Thank You!