Reducing Severe Maternal Morbidity Opportunities and Challenges

Larry Shields, MD
Medical Director for Perinatal Safety
Dignity Health

Maternal Mortality USA

Critical Pathway to Poor Outcome

Severe Maternal Morbidity: USA 1998-2013

J. Women’s Health 2014;23:3-9
Critical Pathway to Poor Outcome

Symptoms Not Recognized
Assumption Symptoms Are Not Significant
Delayed Diagnosis
Delayed Treatment

Selected Maternal Mortality Rates 2010-2013
Source: www.smfm.org/data/mortality-map

California PMAR Racial Disparity

Selected Maternal Mortality Rates 2010-2013
State | Mat Mort | White | Black | Hispanic | Asian
--- | --- | --- | --- | --- | ---
Tennessee | 12.9 | 73% | 17% | 6% | 2%
Alabama | 11.3 | 65% | 27% | 4% | NA
Illinois | 19.3% | 63% | 11% | 16% | 0%
Indiana | 34.1% | 80% | 9% | 8% | 2%
Texas | 10.3% | 64% | 12% | 22% | 2%
Calif | 6.5% | 59% | 6% | 38% | 15%

Mortality v. ICU Admission

<table>
<thead>
<tr>
<th></th>
<th>Mortality 1979-99</th>
<th>Mortality Ca PMAR</th>
<th>Morbidity 1:Crit Care Med 2013 41;1844</th>
<th>Morbidity 3:Ill Mat Child Health databook</th>
</tr>
</thead>
<tbody>
<tr>
<td>Preeclampsia</td>
<td>19.6%</td>
<td>17%</td>
<td>30%</td>
<td>16%</td>
</tr>
<tr>
<td>Hemorrhage</td>
<td>15.9%</td>
<td>11%</td>
<td>19%</td>
<td>35%</td>
</tr>
<tr>
<td>Sepsis</td>
<td>33%</td>
<td>7%</td>
<td>33%</td>
<td>33%</td>
</tr>
<tr>
<td>Cardiovascular</td>
<td>5.2%</td>
<td>19%</td>
<td>9%</td>
<td>8%</td>
</tr>
<tr>
<td>DVT/PE*</td>
<td>24.9%</td>
<td>10%</td>
<td>3%</td>
<td>N/A</td>
</tr>
<tr>
<td>AFE</td>
<td>↑↑</td>
<td>10%</td>
<td>1%</td>
<td></td>
</tr>
</tbody>
</table>

1: Crit Care Med 2013 41;1844  
2: Dignity Health  
3: Ill. Mat Child Health databook

Mortality v. ICU Admission

<table>
<thead>
<tr>
<th></th>
<th>Mortality 1979-99</th>
<th>Mortality Ca PMAR</th>
<th>Morbidity 1:Crit Care Med 2013 41;1844</th>
<th>Morbidity 3:Ill Mat Child Health databook</th>
</tr>
</thead>
<tbody>
<tr>
<td>Preeclampsia</td>
<td>17%</td>
<td>7%</td>
<td>30%</td>
<td>16%</td>
</tr>
<tr>
<td>Hemorrhage</td>
<td>11%</td>
<td>15%</td>
<td>19%</td>
<td>35%</td>
</tr>
<tr>
<td>Sepsis</td>
<td>7%</td>
<td>33%</td>
<td>33%</td>
<td>33%</td>
</tr>
<tr>
<td>Cardiovascular</td>
<td>19%</td>
<td>18%</td>
<td>9%</td>
<td>8%</td>
</tr>
<tr>
<td>DVT/PE*</td>
<td>10%</td>
<td>3%</td>
<td>3%</td>
<td>N/A</td>
</tr>
<tr>
<td>AFE</td>
<td>10%</td>
<td></td>
<td>1%</td>
<td></td>
</tr>
</tbody>
</table>

1: Crit Care Med 2013 41;1844  
2: Dignity Health  
3: Ill. Mat Child Health databook

California PMAR – Healthcare Providers

Identify specific triggers for responding to changes in the mother’s vital signs and clinical condition and use protocols for responding to these changes.
Early Warning Systems

- Essential criteria:
  - High sensitivity, PPV, NPV,
  - Alarm rate must be low enough to prevent alarm fatigue
  - Use should be associated with reduced morbidity

- UK Modified Obstetric Early Warning System (MOEWS)
- National Partnership for Patient Safety:
  - Maternal Early Warning Criteria (MERC)
  - Maternal Early Warning Trigger Tool (MEWT)

Early Warning Systems

- Essential criteria:
  - High sensitivity, PPV, NPV,
  - Alarm rate must be low enough to prevent alarm fatigue
  - Use is associated with reduced morbidity

- UK Modified Obstetric Early Warning System (MOEWS)
- National Partnership for Patient Safety: (MERC)
  - Maternal Early Warning Criteria
  - Maternal Early Warning Trigger Tool (MEWT)

MOEWS

- 94% cases from hemorrhage, preeclampsia, & infection
- High sensitivity 89%
- Negative predictive value 98%
- Alarm rate: 30%
- No evidence that will reduce morbidity
- Recommendations: not part of system

Current Commentary

The Maternal Early Warning Criteria
A Proposal from the National Partnership for Maternal Safety

Singh et al. 2012 Anaesthesia 67:12-18

Current Commentary

The Maternal Early Warning Criteria
A Proposal from the National Partnership for Maternal Safety

Obstet Gynecol 2014;124:782–6
Current Commentary

The Maternal Early Warning Criteria
A Proposal From the National Partnership for Maternal Safety

- No prospective or retrospective data
- Similar to MOEWS it is activated with any abnormal value
- No time duration for presence of abnormal value
- No specific action or treatment path recommended
- Alarm rate: unknown

Persistent Trigger: > 20 min

Comparison of two or more extant and two or more persistent MEWTs.

<table>
<thead>
<tr>
<th>Predictor</th>
<th>ICU group (n = 50)*</th>
<th>Control group (n = 50)*</th>
<th>Odds ratio (95% CI)</th>
<th>P value</th>
</tr>
</thead>
<tbody>
<tr>
<td>≤ 2 MEWTs</td>
<td>36 (72)</td>
<td>10 (20)</td>
<td>0.3 (0.40–2.60)</td>
<td>&lt;0.001</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Sensitivity, %</th>
<th>Specificity, %</th>
<th>PPV, %</th>
<th>NPV, %</th>
</tr>
</thead>
<tbody>
<tr>
<td>72 (57–83)</td>
<td>80 (66–90)</td>
<td>78 (63–89)</td>
<td>74 (60–85)</td>
</tr>
</tbody>
</table>

Two or More Sustained Maternal Triggers
Temp: ≥ 100.4°F or ≤ 96.9°F
O₂ Sat: < 94%
RR: > 24/min or < 12/min
HR > 110 bpm
Sys BP < 80 mmHg or < 45 mmHg
Sys BP > 160 or Dia BP > 110 mmHg
FHR > 160 (infection only)

Abnormal Value – Repeat in 15-20 min.

Sustained Maternal Triggers
O₂ Sat: < 90%
RR: > 30/min or < 12/min
HR > 130 bpm
MAP < 55 mmHg
Sys BP > 160 or Dia BP > 110 mmHg
Nurse clinically uncomfortable with patient status

Nurse clinically uncomfortable with patient status

Maternal Early Warning Tool (MEWT)

Persistent Trigger - > 20 min

Comparison of two or more extant and two or more persistent MEWTs.

<table>
<thead>
<tr>
<th>Predictor</th>
<th>ICU group (n = 50)*</th>
<th>Control group (n = 50)*</th>
<th>Odds ratio (95% CI)</th>
<th>P value</th>
</tr>
</thead>
<tbody>
<tr>
<td>≤ 2 MEWTs</td>
<td>36 (72)</td>
<td>10 (20)</td>
<td>0.3 (0.40–2.60)</td>
<td>&lt;0.001</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Sensitivity, %</th>
<th>Specificity, %</th>
<th>PPV, %</th>
<th>NPV, %</th>
</tr>
</thead>
<tbody>
<tr>
<td>72 (57–83)</td>
<td>80 (66–90)</td>
<td>78 (63–89)</td>
<td>74 (60–85)</td>
</tr>
</tbody>
</table>

Maternal Early Warning Tool (MEWT)

Single Sustained Maternal Triggers
O₂ Sat: < 90%
RR: > 24/min or < 12/min
HR > 110 bpm
MAP < 55 mmHg
Sys BP > 160 or Dia BP > 110 mmHg
FHR > 160 (infection only)
Maternal Early Warning Tool (MEWT)

- Maternal Assessment
  - Vital Signs
    - HR >110 bpm
    - BP <85/45 mmHg
    - O2 sat <94%

- Clinical Symptoms
  - Addresses FOUR “Ds” of Hemorrhage
    - Denial of degree of blood loss
    - Delay in diagnosis of “hemorrhage”
    - Denial that she needs more than 1 unit of PRBC
    - Delay in treatment

- Verify Critical BP in 15 min.

- CHTN = GHTN = Severe Preeclampsia

- Treat Critical BP Within 1 hr.
Verify Critical BP in 15 min.

Treat Critical BP Within 1 hr.

Start Magnesium

Verify Critical BP in 15 min.

Treat Critical BP Within 1 hr.

Start Magnesium

Preeclampsia Bundle Compliance

Treatment Changes

Rate of Eclampsia / 1,000 births and SMM / 100 births

Rate of Eclampsia / 1,000 Births

Data Source: Midas+ Perinatal Quality Profile, 2011 – July 2016
**Maternal Early Warning Tool (MEWT)**

- **Maternal Triggers**
  - Temp: ≥ 100.4°F or ≤ 96.9°F
  - O2 Sat: < 94%
  - RR: > 24/min or < 12/min
  - Sys. BP > 160 or < 80 mmHg
  - Dia. BP > 110 or < 45 mmHg
  - HR > 110 bpm
  - FHR > 160 (infection only)

**Infection – Sepsis**

- Temp: ≥ 100.4°F or ≤ 96.9°F
- O2 Sat: < 94%
- RR: > 24/min or < 12/min
- HR > 110 bpm
- Sys. BP < 80 mmHg or < 45 mmHg
- FHR > 160 (infection only)

**EMR Sepsis Screening: Cerner BioS v. MEWT**

- **Cerner BioS**
  - Based on 3 of 4 abnormal values
  - HR > 90**
  - RR > 20
  - WBC > 12,000**
  - BP

- **MEWT**
  - Based on 2 abnormal values
  - HR > 110
  - RR > 24
  - BP < 85/45
  - O2 Sat < 9%
  - FHR > 160
  - Altered mental status

* WBC average in labor 11.4
** HR average in labor 90 bpm

**Sepsis Screening Parameters**

<table>
<thead>
<tr>
<th>Cerner BioS</th>
<th>MEWT</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total Encounters: 2524</td>
<td>10,016 patients screened</td>
</tr>
<tr>
<td>Screen Positive: 95</td>
<td>Infection Positive: 158</td>
</tr>
<tr>
<td>Alert Frequency: 3.8%</td>
<td>Sepsis Sensitivity: 1.6%</td>
</tr>
<tr>
<td>Sepsis Sensitivity: 80%</td>
<td>Sepsis Sensitivity: 100%</td>
</tr>
<tr>
<td>Alerts BioS per MEWT: 2.4</td>
<td>“Ideal screen remains elusive”</td>
</tr>
</tbody>
</table>

**Pilot Sites for Data Collection**

- Marian Regional Medical Center
- Mercy Hospital of Folsom
- Mercy General Hospital
- Mercy San Juan Medical Center
- Sequoia Hospital
- St. Joseph’s Stockton

**Maternal Early Warning Trigger (MEWT) Screening**

- MEWT Pilot Implemented September 2014
MEWT Performance:

- Screen Positive: 2.3%
- ICU Admission:
  - Sensitivity: 96.7%
  - Specificity: 99.9%
  - PPV: 12% → 1:8
  - NPV: 99.99%
- Recommendations followed: 82.3%
- Physician intervention <60 min: 83%

MEWT Performance:

### Summary

- Reversing the trend in maternal mortality is relatively simple
- Standardization of treatment for 4 most common morbidities provides a straightforward and successful approach
- Hospital size varied from 800-3000 annual births
- Review and compliance monitoring is essential for improved outcomes

**Tennessee:** Assume SMM at 3% with 80,000 births

- 2400 case of SMM
- 20% reduction → 480 cases per year
Other Logistical Issues:

- Administrative “buy-in”
- Physician “buy-in”
- “Full meal deal” or “a la carte”
- Collection of data
- Moving to EMR
- Nursing to physician notification
- Physician Non-compliance

Other Logistical Issues: Administrative “buy-in”

High Risk / High Cost Areas (Rolling 5 Years, $MM)

<table>
<thead>
<tr>
<th>Prior</th>
<th>Post</th>
</tr>
</thead>
<tbody>
<tr>
<td>Perinatal $63.7 31%</td>
<td>Perinatal $33.0</td>
</tr>
</tbody>
</table>

Other Logistical Issues: Nurse and Physician “buy-in”

Other Logistical Issues: Collection of Data

Eastside Medical Center Snellville Ga. 1,200 Annual Births

Mary Campbell, MD
Presentation for Scientific Session on Patient Safety and Quality SMFM 2017
Needed to Increase Functionality of EMR

- Built in “timer” that is unique to the patient for missing routine or required repeat values
  - Would improve timeliness of treatment and “end of shift” effects
- Linkage between activation of alert and either:
  - Desired algorithm
  - Order sets for treatment
- Alert and compliance monitor report
  - Would allow tracking of nursing and physician adherence to management and treatment guidelines

Other Logistical Issues: Nursing Communication

- Nurse knows they should call the physician— but do not
  - “Improved willingness to call if part of standardize process”
- Hypertension pathway:
  - “Dr. Smith Ms. Jane’s BP is 170/105 and on repeat was 175/108, her HR is 85 and she is afebrile”
  - “Do you want me to give her labetalol or hydralazine”?
  - “Labs and Mag per protocol”?
  - “I will call if the creatinine is above 0.9”

Other Logistical Issues: Physician Reluctance

- Algorithms and standard treatment plans
  - May not follow standard evidenced based process …but must:
    - 1) examine the patient and put a note in the chart detailing rationale
    - 2) have presented at peer review to see if “peers” agree with decision as well as tract and trend

Table 2: Logon model for a multidisciplinary education program for recognizing and managing the compromised obstetric patient

<table>
<thead>
<tr>
<th>Objective</th>
<th>Activity</th>
<th>Outcomes</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Develop a multidisciplinary education program that incorporates evidenced-based practice and standard treatment plans</td>
<td>• Identify an appropriate care plan</td>
<td>• Implement the program</td>
</tr>
<tr>
<td>2. Develop an electronic healthcare provider’s guidebook, tools, and resources for recognizing and managing the compromised obstetric patient</td>
<td>• Curriculum development with stakeholders</td>
<td>• Evidence-based practice guidelines</td>
</tr>
<tr>
<td>3. Ensure electronic healthcare provider’s guidebook, tools, and resources for recognizing and managing the compromised obstetric patient</td>
<td>• EBM/EBP</td>
<td>• Knowledge outcomes</td>
</tr>
</tbody>
</table>

Severe Maternal Morbidity: USA 1998-2013

- 1-4% of Deliveries
- 1 year

Severe Morbidity Rate per 10,000 Delivery Hospitalizations

- 0 20 40 60 80 100 120 140 160 180 200

J. Women’s Health 2014;23:3-9
Reducing Severe Maternal Morbidity: USA 2017

- Must have a robust approach to hemorrhage
- Must treat hypertension
- Inclusion of a Maternal Early Warning System appears to help
- Refocus of providers that not everyone is young and healthy
- Administrative “buy-in” critical for nursing education and training
- Must monitor compliance with recommendations!
- Reductions in maternal mortality will follow

Thank You and Questions?