Multidisciplinary Approach to the Recognition and Management of Maternal Sepsis

March Of Dimes
March 17, 2016

Tamera Hatfield MD, PhD
Learning Objective

- Discuss epidemiology and pathophysiology of maternal sepsis
- Define sepsis continuum
- Discuss limitations in diagnosing maternal sepsis
- Review sepsis management
- Review sepsis bundles
Racial Disparities
Maternal Mortality

- 11.8 deaths/100,000 births - Caucasian
- 41.1 deaths/100,000 births - Black
- 15.7 deaths/100,000 births - other races

- Non-cardiovascular disease: 15.3%
- Cardiovascular disease: 14.7%
- Infection/sepsis: 12.7%
- Hemorrhage: 11.3%
- Cardiomyopathy: 10.8%
- Thrombotic pulmonary embolism: 9.0%
- Hypertensive disorder of pregnancy: 7.6%
- Cerebrovascular accident: 6.5%
- Amniotic fluid embolism: 5.7%
- Anesthesia complications: 0.2%

Note: The cause of death is unknown for 6.2% of all pregnancy-related deaths.
Maternal Sepsis Mortality and Morbidity During Hospitalization for Delivery: Temporal Trends and Independent Associations for Severe Sepsis


Maternal Sepsis

- A leading cause of preventable morbidity and mortality
- Absolute risk of maternal death remains low however incidence and severity has increased
- Physiologic changes of pregnancy can mask the biomarkers of sirs/sepsis
- Recognition may be delayed as a result leading to severe sepsis
Epidemiology: Maternal Sepsis
Acosta Et Al 2013

• Retrospective cohort designed to evaluate Incidence and risk factors of uncomplicated maternal sepsis, severe sepsis and septic shock
• Probability of progression
• Used California birth data 2005-2007
Results

- 1,622,474 live births
- 1598 developed sepsis
- 807 uncomplicated sepsis
- 735 severe sepsis
- 56 septic shock
- 4.9/10,000 severe or septic shock
- 14 maternal deaths (11.5% of mat death over study period)
14.3% of women with septic shock died.

**Risk Factors Sepsis**
- Age > 25
- High school or less education
- Public or no health insurance
- Cesarean delivery

**Risk Factors Severe or SS**
- Race
- Public or Non-insured
- Diabetes
- Hypertension
- Low volume hospital
- Primiparous
- Multiple Gestation
Risk by # of Risk Factors

Figure 1. Absolute risk (95% CI) of all sepsis and severe sepsis/septic shock as a function of the number of a priori risk factors. doi:10.1371/journal.pone.0067175.g001
Study Conclusions

- Risk of severe sepsis twice the estimated national rate
- Significant socioeconomic disparities exist
### Table 4. Most Common Concurrent Infectious Diagnoses in Maternal Severe Sepsis Patients During 1998 to 2008 in the United States

<table>
<thead>
<tr>
<th>Diagnosis</th>
<th>n (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pneumonia</td>
<td>945 (29.7)</td>
</tr>
<tr>
<td>Genitourinary infection</td>
<td>945 (29.7)</td>
</tr>
<tr>
<td>Chorioamnionitis</td>
<td>585 (18.4)</td>
</tr>
<tr>
<td>Endometritis</td>
<td>274 (8.6)</td>
</tr>
<tr>
<td>Pyelonephritis</td>
<td>184 (5.8)</td>
</tr>
<tr>
<td>Wound infection</td>
<td>148 (4.7)</td>
</tr>
<tr>
<td>Endocarditis</td>
<td>72 (2.3)</td>
</tr>
<tr>
<td>Meningitis</td>
<td>15 (0.5)</td>
</tr>
<tr>
<td>Central line–associated bloodstream infection</td>
<td>NR</td>
</tr>
<tr>
<td>Mastitis</td>
<td>NR</td>
</tr>
</tbody>
</table>

NR = not reported due to number ≤10.
Non Pregnant Sepsis

• Clearly defined parameters
• Targeted strategies demonstrated in RCT to improve outcomes
• Generalizable to the OB population?
Sepsis Continuum

SIRS
Sepsis
Severe Sepsis
Septic Shock
A non-specific clinical response including > 2 of the following:

- Temperature >38°C or <36°C
- Heart rate >90 beats/min
- Respiratory rate >20/min
- White blood cell count >12,000/mm³ or <4,000/mm³ or >10% immature neutrophils
SIRS + Presumed or Confirmed Infectious Process
SIRS
Sepsis
Severe Sepsis
Septic Shock

Sepsis + Organ Failure
Surviving Sepsis Campaign

3 Hour Resuscitation Bundle

6 Hour Management Bundle
Bundles

• Group of interventions
  • initiated together
  • better patient outcomes than if the interventions are implemented separate from one another

• All bundle elements have to be implemented together to be effective
3 Hour Bundle

Obtain Cultures
Antibiotics
Lactate Levels
Volume Resuscitation

Suspect Sepsis

Discover • Teach • Heal
Obtain Cultures Prior to Starting Antibiotics

Goal is to initiate antibiotics within first hour of recognizing severe sepsis or septic shock.
3 Hour Bundle
Volume Resuscitation goals

- CVP ≥ 8-12 mm Hg
- MAP ≥ 65 mmHg
- ScVO2 ≥ 70%
- Normal lactate level
- Urine output >0.5 mL/kg/hour
6 Hour Bundle

Hemodynamic Monitoring
CVP
ScvO2

Re-measure Lactate if elevated

Vasopressors

With Severe Sepsis
Lactate >4 or Organ Dysfunction
What about Pregnancy? Same Rules Apply?

SIRS Criteria
- Temperature >38°C or <36°C
- Heart rate >90 beats/min
- Respiratory rate >20/min
- White blood cell count >12,000/mm³ or <4,000/mm³ or >10% immature neutrophils

Normal Pregnancy
- Temperature Same
- Heart rate ↑
- Respiratory Rate Same/
- White blood cell count ↑
SIRS criteria in pregnancy
What is normal?

• Systematic Review/Meta-analysis
• 87 studies met inclusion criteria and included 8,834 patients
  – Temperature-No overlap
  – Respiratory rate – Overlap 2\textsuperscript{nd}, 3\textsuperscript{rd}, labor, 48 hr pp
  – Heart rate –Overlap 1\textsuperscript{st}, 2\textsuperscript{nd}, 3\textsuperscript{rd}, labor
  – White blood cell count –Overlap 2\textsuperscript{nd}, 3\textsuperscript{rd}, labor, 48 hr pp

• CONCLUSION: Current SIRS criteria often overlap with normal physiologic parameters during pregnancy and the immediate postpartum period; thus, alternative criteria must be developed to diagnose maternal sepsis.

Scoring Systems In Pregnancy

- Sepsis screening tools under investigation for obstetrics (some have customized obstetric parameters)
  - Irish Maternity Early Warning System
  - Modified Early Warning System (MEWS)
  - Maternal Early Warning Trigger
  - Sepsis in Obstetrics Score
MEWS and SIRS criteria in pregnancy

TABLE 4
Test characteristics of the SIRS and MEWS

<table>
<thead>
<tr>
<th>Variable</th>
<th>Sensitivity, %</th>
<th>Specificity, %</th>
<th>Negative predictive value, %</th>
<th>Positive predictive value, %</th>
</tr>
</thead>
<tbody>
<tr>
<td>SIRS&lt;sup&gt;a&lt;/sup&gt;</td>
<td>100</td>
<td>17.6</td>
<td>100</td>
<td>1.7</td>
</tr>
<tr>
<td>SIRS&lt;sup&gt;b&lt;/sup&gt;</td>
<td>100</td>
<td>37.2</td>
<td>100</td>
<td>0.9</td>
</tr>
<tr>
<td>MEWS ≥ 5</td>
<td>100</td>
<td>90.4</td>
<td>100</td>
<td>0.05</td>
</tr>
</tbody>
</table>

<sup>a</sup> Calculated with complete vital sign and laboratory data (n = 363 patients); <sup>b</sup> Calculated with missing vital sign and laboratory data assumed to be normal from all study patients (n = 913 women).

MEWS, Modified Early Warning score; SIRS, Systemic Inflammatory Response Syndrome.


MEWS and SIRS criteria do not accurately identify pregnant women with chorioamnionitis at risk for ICU transfer, sepsis or death

Lappen JR et al. Existing models fail to predict sepsis in an obstetric population with intrauterine infection. AJOG 2010;203(6)
<table>
<thead>
<tr>
<th>Variable</th>
<th>High abnormal range</th>
<th>+3</th>
<th>+2</th>
<th>+1</th>
<th>0</th>
<th>+1</th>
<th>+2</th>
<th>+3</th>
<th>+4</th>
</tr>
</thead>
<tbody>
<tr>
<td>Score</td>
<td>+4</td>
<td>+3</td>
<td>+2</td>
<td>+1</td>
<td>0</td>
<td>+1</td>
<td>+2</td>
<td>+3</td>
<td>+4</td>
</tr>
<tr>
<td>Temperature (°C)</td>
<td>&gt;40.9</td>
<td>39-40.9</td>
<td>38.5-38.9</td>
<td>36-38.4</td>
<td>34-35.9</td>
<td>32-33.9</td>
<td>30-31.9</td>
<td>&lt;30</td>
<td></td>
</tr>
<tr>
<td>Systolic Blood Pressure (mmHg)</td>
<td>&gt;90</td>
<td>70-90</td>
<td>60-70</td>
<td>50-60</td>
<td>40-50</td>
<td>30-40</td>
<td>30-31</td>
<td>&lt;30</td>
<td></td>
</tr>
<tr>
<td>Heart Rate (beats per minute)</td>
<td>&gt;179</td>
<td>150-179</td>
<td>130-149</td>
<td>120-129</td>
<td>110-120</td>
<td>100-110</td>
<td>90-100</td>
<td>&lt;90</td>
<td></td>
</tr>
<tr>
<td>Respiratory Rate (breaths per minute)</td>
<td>&gt;49</td>
<td>35-49</td>
<td>25-34</td>
<td>12-24</td>
<td>10-11</td>
<td>6-9</td>
<td>≤5</td>
<td></td>
<td></td>
</tr>
<tr>
<td>SpO₂ (%)</td>
<td>≥92%</td>
<td>90-91%</td>
<td>85-89%</td>
<td>80-85%</td>
<td>75-80%</td>
<td>70-75%</td>
<td>&lt;80%</td>
<td></td>
<td></td>
</tr>
<tr>
<td>White Blood Cell Count (μL)</td>
<td>&gt;39.9</td>
<td>25-39.9</td>
<td>17-24.9</td>
<td>5.7-16.9</td>
<td>3.5-6.0</td>
<td>1.2-3.5</td>
<td>&lt;1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>% Immature Neutrophils</td>
<td>≥10%</td>
<td>&lt;10%</td>
<td>&lt;10%</td>
<td>&lt;10%</td>
<td>&lt;10%</td>
<td>&lt;10%</td>
<td>&lt;10%</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Lactic Acid (mmol/L)</td>
<td>≥4</td>
<td>&lt;4</td>
<td>&lt;4</td>
<td>&lt;4</td>
<td>&lt;4</td>
<td>&lt;4</td>
<td>&lt;4</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**S.O.S ≥ 6** were more likely to have ICU or telemetry unit admit, (+) blood cultures, fetal tachycardia, and longer hospital stay.
Maternal sepsis-What can you do?

• Recognize the factors along the continuum of sepsis morbidity
  – Respond without delay to improve outcomes
• Target preventative strategies in your hospital for obstetric patients
• Acknowledge current limitations from lack of pregnancy specific data
• Develop algorithms and order sets to standardize care
  – Train multidisciplinary teams to include RN’s, OB’s, MFM, Anesthesia and Critical Care associates
Suspected Infection + 2 SIRS Criteria

- \( T \geq 100.4 \text{ or } \leq 97 \) (\( >38 \, ^\circ \text{C} \) or \( < 36 \, ^\circ \text{C} \))
- \( HR \geq 90 \) (P-\( >110 \))
- \( RR \geq 20 \) (P-\( >24 \))
- WBC
  - \( >12,000 \text{ or } < 4000 \)
  - (P-\( >15,000 \text{ or } < 4000 \))
  - or \( > 10\% \) bands

Obtain Lactate from ABG or VBG

If Lactate \( \geq 2.0 \) or
SBP < 90 after 2 L NS
severe sepsis

Transfer to Critical Care

Call MET RN
Lactate is not just for the ICU!

- Normal Lactate Level: 1.0 – 2.0 mmol/dL
- If Lactate 2.0 – 4.0: Diminished perfusion of oxygen to cells
- If Lactate >4.0: Shows complete tissue hypoxia, and will lead to…………………

ORGAN FAILURE
How is my patient doing? Assess Patient Response to Treatment!

Stable patient – good response to fluid therapy:
- SBP > 90
- RR < 30
- Serum lactate < 2mm/L

Unstable Patient – poor response to fluid therapy (Severe Sepsis/Septic Shock)
- SBP < 90
- RR > 30
- Requiring vasopressor to maintain BP
- Serum lactate > 2mm/L

Transfer to Critical Care
Sepsis
Screen your patient every shift

Severe Sepsis

Lactate $\geq 2$
Signs/SX of acute/new organ dysfunction

Septic Shock

Blood Pressure $\downarrow$
Hypotensive
Despite fluid boluses
And/or vasopressors started

Two or more SIRS Criteria
☐ $T \geq 100.4$ or $\leq 97$
($>38^\circ$ or $< 36^\circ$ C)
☐ $HR \geq 90$ (Pregnant $\rightarrow 110$)
☐ $RR \geq 20$ (Pregnant $\rightarrow 24$)
☐ $WBC > 12,000$ or $< 4000$
(Pregnant $> 15,000$ or $< 4000$ or
$> 10\%$ bands)

Call MET Nurse! (Ext. xxxx)

Start and Complete 3 Hour Bundle

SCHOOL OF MEDICINE
UNIVERSITY OF CALIFORNIA • IRVINE
Discover • Teach • Heal
THANK YOU QUESTIONS?