Maternal Mortality and Hemorrhage

Gina M. Brown, MD
NYC Department of Health and Mental Hygiene
Bureau of Maternal, Infant and Reproductive Health
Special Thanks to:
Candace Mulready, MPH
Katrina Manzano, MPH
Vani Bettegowda, MHS
Office of Vital Statistics
Office of the City Medical Examiner
SPARCS

Bureau of Maternal, Infant and Reproductive Health
Maternal Mortality Ratio

Deaths/100,000 live births during pregnancy or within 1 year of termination. A ratio not a rate: cannot count total # pregnancies.

Pregnancy Related OB complications, management, or disease exacerbated by pregnancy

Pregnancy Associated
Not related to pregnancy

Direct
OB diseases or management

Indirect
Preexisting disease aggravated by pregnancy
MMR Industrialized Nations

1990-1994

Source: JAMWA 2001
## US Historical Perspective: Racial Disparities

<table>
<thead>
<tr>
<th>Year</th>
<th>MMR White</th>
<th>MMR Black</th>
<th>Risk Ratio</th>
</tr>
</thead>
<tbody>
<tr>
<td>1915</td>
<td>601.0</td>
<td>1056.0</td>
<td>1.76</td>
</tr>
<tr>
<td>1930</td>
<td>601.0</td>
<td>1174.0</td>
<td>1.95</td>
</tr>
<tr>
<td>1945</td>
<td>172.0</td>
<td>445.0</td>
<td>2.59</td>
</tr>
<tr>
<td>1950</td>
<td>61.0</td>
<td>222.0</td>
<td>3.64</td>
</tr>
<tr>
<td>1990</td>
<td>6.5</td>
<td>26.7</td>
<td>4.11</td>
</tr>
<tr>
<td>1991-1999</td>
<td>8.1</td>
<td>30.0</td>
<td>3.70</td>
</tr>
</tbody>
</table>

Sources: MMWR 2003; JAMWA 57(3), 2002
Trends in Maternal Mortality Ratio
NYC, 1993-2002

Source: NYC DOHMH Office of Vital Statistics
Trends in Maternal Mortality Ratio by Race/Ethnicity
NYC OVS, 1993-2002

Per 100,000 Live Births

Source: NYC DOHMH Office of Vital Statistics
BMIRH MMR Enhanced Surveillance Methods

- **Case ascertainment**
  - Vital Statistics, Medical Examiner, SPARCS
- **Case Review**
  - Medical records, ME reports, maternal death certificates, infant birth certificates
- **Data entry and analysis**
<table>
<thead>
<tr>
<th>Year</th>
<th># Cases OVS</th>
<th># Cases BMIRH (enhanced surveillance including OVS)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1998</td>
<td>25</td>
<td>52 (110%)</td>
</tr>
<tr>
<td>1999</td>
<td>49</td>
<td>63 (30%)</td>
</tr>
<tr>
<td>2000</td>
<td>34</td>
<td>54 (60%)</td>
</tr>
<tr>
<td>Total</td>
<td>108</td>
<td>169 (60%)</td>
</tr>
</tbody>
</table>
# Referral Source of Maternal Deaths

**BMIRH 1998-2000**

<table>
<thead>
<tr>
<th>Source</th>
<th>Direct</th>
<th>Indirect</th>
<th>Not related</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>OVS</td>
<td>67</td>
<td>24</td>
<td>17</td>
<td>108</td>
</tr>
<tr>
<td>OCME</td>
<td>4</td>
<td>6</td>
<td>22</td>
<td>32</td>
</tr>
<tr>
<td>SPARC S</td>
<td>10</td>
<td>8</td>
<td>8</td>
<td>26</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>81</strong></td>
<td><strong>38</strong></td>
<td><strong>47</strong></td>
<td><strong>166</strong>*</td>
</tr>
</tbody>
</table>

* Missing = 3
CDC/ACOG Categorization of Maternal Deaths
BMIRH 1998-2000

- Preg Rel Direct
- Preg Rel Indirect
- Preg not related
Location of Death
BMIRH 1998-2000

Percent

Hospital | EMR | Home | In Transit
---|---|---|---
70% | 10% | 5% | 0%
Percent of Live Births and Maternal Deaths By Race/Ethnicity
BMIRH 1998-2000

Live Births

Maternal Deaths
Concurrent Morbidity: Obesity
BMIRH 1998-2000 (n =169)

- Obese: 24%
- Not Obese: 44%
- Missing: 33%
- Weight > 200 lbs at delivery: 20%
## Comparing Leading Causes of Death (%)

<table>
<thead>
<tr>
<th>Cause</th>
<th>International PRMR*</th>
<th>National PRMR N=4200**</th>
<th>NYC PRMR N=119</th>
</tr>
</thead>
<tbody>
<tr>
<td>Embolism</td>
<td>Negligible</td>
<td>20%</td>
<td>7%</td>
</tr>
<tr>
<td>Hypertensive Disorders</td>
<td>12%</td>
<td>16%</td>
<td>10%</td>
</tr>
<tr>
<td>Hemorrhage</td>
<td>25%</td>
<td>17%</td>
<td>32%</td>
</tr>
<tr>
<td>Infection/Sepsis</td>
<td>15%</td>
<td>13%</td>
<td>7%</td>
</tr>
<tr>
<td>Obstructed Labor</td>
<td>8%</td>
<td>Cardiomyopathy 8%</td>
<td>Cardiomyopathy 8%</td>
</tr>
<tr>
<td>CVA 5.0%</td>
<td>Anesthesia 2%</td>
<td>Anesthesia 7%</td>
<td></td>
</tr>
</tbody>
</table>

*International WHO 1993, JAMWA 2002
**National MMWR 2003
***NYC BMIRH 1998-2000
Hemorrhage Related Deaths
BMIRH 1998-2000

- Black 64%
- Hispanic 21%
- White 8%
- Asian/Pacific Isl. 8%
- In hospital 97%
Hemorrhage Deaths*

% Related Cause
n=39

- Abnormal Coagulation
  - DIC/ Coagulopathy 31%
  - Amniotic Fluid Embolism 13%
  - HELLP syndrome 10%
  - Abruptio placenta 5%

- Active bleeding
  - Uterine atony 28%
  - Placenta other 8%
  - Placenta previa 5%

- Unspecified/Unknown 36%

* Coagulopathy is the final common pathway
## Pregnancy Outcome %
### All Deaths vs. Hemorrhage

<table>
<thead>
<tr>
<th>Pregnancy Outcome</th>
<th>All NYC Maternal Deaths (n=169)</th>
<th>NYC Hemorrhage Deaths (n=39)</th>
<th>US Hemorrhage Deaths (n=470)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Live Birth</td>
<td>44</td>
<td>54</td>
<td>14</td>
</tr>
<tr>
<td>Stillbirth</td>
<td>8</td>
<td>13</td>
<td>12</td>
</tr>
<tr>
<td>Induced Abortion/ miscarriage</td>
<td>13</td>
<td>18</td>
<td>8*</td>
</tr>
<tr>
<td>Ectopic</td>
<td>1</td>
<td>5</td>
<td>47</td>
</tr>
<tr>
<td>Molar</td>
<td>2</td>
<td>5</td>
<td>0.2</td>
</tr>
<tr>
<td>Undelivered</td>
<td>23</td>
<td>3</td>
<td>8</td>
</tr>
<tr>
<td>Unknown</td>
<td>8</td>
<td>3</td>
<td>10</td>
</tr>
</tbody>
</table>

*US data combines abortion and miscarriage
## Obesity: Maternal Mortality Risk From Hemorrhage
### BMIRH 1998-2000

<table>
<thead>
<tr>
<th>Obesity</th>
<th>NYC Live Births 1998-2000 (n=373,554; % of total)</th>
<th>Maternal Deaths (n=169) % of total, OR [CI]</th>
<th>Maternal Hemorrhage Deaths (n=39; % of total) OR [CI]</th>
</tr>
</thead>
<tbody>
<tr>
<td>Yes</td>
<td>17</td>
<td>24</td>
<td>38</td>
</tr>
<tr>
<td></td>
<td></td>
<td>2.24 [1.5, 3.34]</td>
<td>3.88 [1.82, 8.26]</td>
</tr>
<tr>
<td>No</td>
<td>71</td>
<td>44</td>
<td>41</td>
</tr>
<tr>
<td>Missing</td>
<td>12</td>
<td>33</td>
<td>21</td>
</tr>
</tbody>
</table>
Hemorrhage

• 1/1000 deliveries
  • Likely
    • Previa, Abruptio, uterine distension, previous history, Uterine rupture
  • Unanticipated
    • Uterine atony
    • Post partum
<table>
<thead>
<tr>
<th>Physiologic Response to Pregnancy</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Increased vascular volume</strong></td>
</tr>
<tr>
<td><strong>Decreased systemic vascular resistance</strong></td>
</tr>
<tr>
<td><strong>Increased HR</strong></td>
</tr>
<tr>
<td><strong>Increased cardiac output</strong></td>
</tr>
<tr>
<td><strong>Placental blood flow 500-650 cc/minute</strong></td>
</tr>
<tr>
<td><strong>Auto transfusion at delivery</strong></td>
</tr>
</tbody>
</table>
Physiology of Hemorrhage

- **Decreased**
  - MAP, CO, CVP, PCWP, SV, Stroke work, O2 consumption, MVO2
- **Increased**
  - SVR, A-V O2 difference, Catecholamine release, HR, PVR, Myocardial contractility
  - Platelet aggregation
    - Small vessel occlusion
    - Impaired microcirculation
    - Embolization to lungs
Physiology of Hemorrhage

• Adrenergic effect
  • constriction of venules and small veins
    • Increased venous return (preload)
  • Systemic hypotension
  • Decrease capillary hydrostatic pressure
• Fluid mobilization
• Decrease blood viscosity
Physiology of Hemorrhage

- Anaerobic metabolism
  - Metabolic acidosis
  - Hyperventilation
    - Incr. intra-thoracic pressure
    - Incr. venous return
- Vasoconstriction
  - Blood redistribution
Impact of Hemorrhage

- Hypotension
- Oliguria
- Acidosis
- Collapse

- Acute renal failure
- Shock liver, lung
- ARDS
- Pituitary necrosis

- salvage brain, heart, adrenals
- Fetal cerebral blood flow decr.
Mortality Risk

- Hb < 3.5-5 mg/dl (Hct.10.5-15)
- Multi organ failure
<table>
<thead>
<tr>
<th>Class</th>
<th>Blood Loss</th>
<th>Volume Deficit</th>
<th>Spx</th>
<th>Rx</th>
</tr>
</thead>
<tbody>
<tr>
<td>I</td>
<td>≤1000 cc</td>
<td>15%</td>
<td>Orthostatic tachycardia</td>
<td>Crystalloid</td>
</tr>
<tr>
<td>II</td>
<td>1001-1500</td>
<td>15-25%</td>
<td>Incr. HR, orthostasis, mental Decr cap refill</td>
<td>Crystalloid,</td>
</tr>
<tr>
<td>III</td>
<td>1501-2500</td>
<td>25-40%</td>
<td>Incr HR, RR Decr BP, Oliguria</td>
<td>Crystalloid</td>
</tr>
<tr>
<td>IV</td>
<td>&gt; 2500</td>
<td>&gt; 40%</td>
<td>Obtunded Oliguria/anuria CV collapse</td>
<td>RBC, Crystalloid, Colloid</td>
</tr>
</tbody>
</table>

**Spx**: Symptoms and physical examination.
Replacement fluids

- Restore Volume with crystalloid
  - NS preferred
  - 3:1 ratio to blood loss
- Transfuse RBCs
- Signs of O2 deficiency
- Consider colloid
  - Albumen
  - Hetastarch
Transfusion

- NS only
  - D5W – hemolysis
  - RL - neutralizes citrate anticoagulant
- Blood used within 4 hours
- Return to blood bank < 30 minutes
- Blood warming
  - Administered > 100cc/min
  - Cold => arrhythmia, coagulopathy
Transfusion Risks

- Febrile Rxn (> 38C)
- Allergic Rxn
- Acute lung injury
- Septic Rxn (temp increased >2 Deg)
- Blood born infection
  - HIV - 0.9/1million
  - HTLV - 1/641k
- Hep C – 1/103K
- Hep B – 1/250K
- Calcium depletion
- Coagulopathy
- Dilution of clotting factors
# Blood Components

<table>
<thead>
<tr>
<th>Product</th>
<th>Volume</th>
<th>Component</th>
<th>Indication/Utility</th>
</tr>
</thead>
<tbody>
<tr>
<td>Whole blood</td>
<td>450-500 cc</td>
<td>Hct. 36-44%</td>
<td>1u = 1g/dl Hb</td>
</tr>
<tr>
<td>PRBC</td>
<td>200-250 cc</td>
<td>Hct. 70-80%</td>
<td>1u = 1g/dl Hb</td>
</tr>
<tr>
<td>Platelets</td>
<td>30-50cc</td>
<td>Platelets WBC Ag</td>
<td>1u = 5000uL</td>
</tr>
<tr>
<td>FFP</td>
<td>100cc</td>
<td>Fibrinogen, clotting factors</td>
<td>PT, PTT &gt; 1.5 x nl, INR ≥ 1.6</td>
</tr>
<tr>
<td>Cryo precipitate</td>
<td>50-75cc</td>
<td>Factor 8c, VW factor Fibrinogen</td>
<td>Fibrinogen replacement</td>
</tr>
</tbody>
</table>
Other Approaches to Hemorrhage

- Preop donation
- Acute normovolemic hemodilution
- Hemobate (F2 alpha)
- Rectal Misoprostol
- Placental bed suture
- Uterine artery ligation
- Hypogastric artery ligation
- Hysterectomy
Approaches to Hemorrhage

- Hemorrhage drills
  - Ob, Anesthesioloig, Blood Bank, Nursing, other staff
- Experienced operator for anticipated blood loss
- O neg blood available
- Organized response team for unanticipated blood loss
What doesn’t work

- Preop uterine artery stents
- Lack of immediate response
- Crystalloid when blood is needed
- Delayed operative response
- Delayed transfusion response