Maternal Morbidity and Mortality in the US:
Time To Wake Up and Take the Lead

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We do not have a financial interest or other relationship with any manufacturer/s of any commercial product/s that may be discussed during this presentation.
Objectives

- List suggested criteria to identify severe maternal morbidity
- Name available maternal bundles
- List 2 common causes of maternal death in US
36 YO G1 at 40 Weeks

- Mild preeclampsia at 38 wks
- Induction recommended; patient declined
- Came in with “worst headache of life”
- BP 220/110
  - Hydralazine and magnesium started
- Pt stated she was going to seize
- BP 240/120
- Pt stated she was going to arrest
- Pt had left sided paralysis and became unarousable
• Presents to ER 5 days s/p termination with abd pain
• Afebrile, HR 100
• Many services called to evaluate abd pain, ultrasound done
• 12 hours later gyn called pt taken to or for d+c, antibiotics started
• 2 days later pt dies due to sepsis, multisystem organ failure
US MMR 1915-2003

1915-608/100,000

CDC, vital health stats; 2007;#33
There were 342,900 maternal deaths in 2008 worldwide.

- Global MMR was 251/100,000 in 2008.
- Over half all deaths in India, Nigeria, Pakistan, Afghanistan, Ethiopia, Democratic Republic of Co.

Global numbers improved except in:

Hogan Lancet 2010,375;1609-23
MMR 1980 vs. 2008

California Data: 1991-2006

Maternal Mortality Rate
California Residents and United States: 1991-2006

California Disparities

Maternal Mortality Rates by Race/Ethnicity, California Residents; 1999-2006

25 YO G3P2 37 weeks

- Presented in labor, known fibroids
- Active phase arrest at 8 cm
- Taken for cesarean
  - Difficulty getting into uterus due to fibroids
  - EBL 1500 cc during delivery
  - HR 120’s, BP 110/50
- In RR pt holding baby, became dizzy, hypotensive, tachycardic
- Taken back to OR; large hemoperitoneum; could not be resuscitated
DEADLY DELIVERY

THE MATERNAL HEALTH CARE CRISIS IN THE USA
Amnesty International 2010 Concerns

• Unequal care
  ➢ 51% women without insurance women of color
  ➢ Late or no prenatal care significantly higher in women of color
• Barriers to maternal care
  ➢ Medicaid hard to get
  ➢ Not enough fqhcs
  ➢ Difficulty accessing care
• Barriers to family planning
• Variability of care
  ➢ No national comprehensive guidelines/protocols for obstetric emergencies
• No requirement to report maternal deaths
  ➢ Only 21 states have maternal death review committees

www.amnestyusa.org/demand-dignity/maternal-health-is-a-human-right/the-united-states/page.do?id=1351091
Objective Factors Likely Associated with Increase Maternal Mortality and Morbidity

- Increased maternal age
- Increased obesity rates
- Increased Cesarean delivery rates
- More pregnancies in women with significant chronic medical conditions

- Is it only them?
Why Deaths Plateau then Increase in US?

• Numbers prob not accurate
  ➢ Under-reported
  ➢ Differing definitions

• Complacency
  ➢ Total number really not that big (600 per year)?
  ➢ It only rarely happens to 1 MD

• Actual numbers of too deaths small to study

• Quality evaluations focused on provider
Causes of Death Subtle Change


Berg OG 2010;116:1
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Data are % unless otherwise specified.
* Pregnancy-related mortality ratio indicates pregnancy-related deaths per 100,000 live births.
† Limited to deaths of women with known marital status (n=4,688).
‡ Limited to deaths associated with live birth and known live birth order (n=2,503).
Mexican woman delivers child alone—by Caesarean

Reuters

A woman in Mexico gave birth to a healthy baby boy after performing a Caesarean section on herself with a kitchen knife, doctors said Tuesday.

The unidentified woman, 40, who lives in a rural area without electricity, running water or sanitation and is an eight-hour drive from the nearest hospital, performed the operation when she could not deliver the baby naturally.

“She took three small glasses of hard liquor and, using a kitchen knife, sliced her abdomen in three attempts... and delivered a male infant that breathed immediately and cried,” said Dr R.F. Valle, of the Dr. Manuel Velasco Suarez Hospital in San Pablo, Mexico.

Valle reported the incident in the International Journal of Gynecology and Obstetrics.

Before losing consciousness, the woman told one of her children to call a local nurse for help. After the nurse stitched the wound, the mother and baby were transferred and treated by Valle and his colleagues at the nearest hospital.
Common Things Cause Death

- Remarkable hemorrhage and hypertensive disease are in top 3 causes of maternal death
- Because we see hypertension and blood loss frequently, we may be too complacent
- Because women do well no matter what we get reinforced for wrong behaviors
• Clinical diagnosis and provider related preventable factors sig associated with progression from severe morbidity on (p < .01)

• System and patient factors ns
Preventability

• 37% deaths in Chicago 1992-98 (Kemp AJOG. 2000:182:S164)

• 54% deaths in MA 1990-1999 (Nannini, 2002)

• 40% NC 1995-99 (Berg OG 2005;106:1228-34)

Preventable factors

➤ Providers (41% preventable deaths)
➤ Patients (15%)
➤ Both (15%) (Sachs NEJM, 1987:316:667-72)
Preventability Related to Cause

• High preventability
  ➢ Hemorrhage (93%)
  ➢ Preexisting chronic disease (89%)
  ➢ PIH (60%)
  ➢ Infection (43%)
  ➢ Cardiovascular (40%)

• Less preventability
  ➢ Choriocarcinoma (25%)
  ➢ Cardiomyopathy (22%)
  ➢ CVA (0)
  ➢ AFE (0)

Berg OG 2005;106:1228-34
• Severe maternal morbidity cases
  ➢ 0.5% deliveries 1991-2003
    ▪ 291,000 cases, 464 hospitals, national hospital discharge survey
  ➢ Based on ICD-9 codes most common: transfusion, eclampsia, hysterectomy (75%)
  ➢ 50X more common than death
• What if we studied these?

Callaghan ajog 2008;199:133
The Burden of Maternal Morbidity

• Reviewed Nationwide Inpatient Sample (ICD-9) for 1998-2009
• Severe morbidity 12.9 per 1000 deliveries
  ▪ Increased by 75% and 114% for delivery and postpartum from 1998/99 to 2008/09
  ▪ Increase in shock, ARF, PE, RDS, Acute MI, blood transfusion, aneurysm, cardiac surgery
• No change in delivery mortality (.8/10,000 del)
• Mortality postpartum hosp significantly increased by 66% (.26 to .43/10,000 del)
• Impacts >50,000 women each year

Callaghan OG 2012;120:1029
Why Evaluate Severe Maternal Morbidity?

• Not enough maternal deaths per institution to study 1.7 million women/year have maternal morbidity (Danel, 2003)
• If severe maternal morbidity cases are similar to deaths related to disease diagnoses and preventable issues then we large number to study

Continuum of Morbidity
How Do We Identify Women with Near Miss?

- Began with 11 clinical factors
- Evaluated sensitivity and specificity of all 11 for near miss (clinical assessment = gold standard)
- Weighted factors
- Best model had 5 factors

Geller J clin epi 2004;57:716
5 Factor Model

- Organ failure > 1 system
- Intubation > 12 hours
- ICU admission
- Surgical intervention
- Transfusion > 3 units
- 100% sensitive; 93% specific
- Difficult to use
2 Factor Model

• 2 factors
  - ICU admission and transfusion 4 or more units
  - 100% sensitivity
  - 78% specificity
    ▪ Pick up 36 extra near miss cases
    ▪ Were classified as severe morbidity

• Can use a model to identify and analyze these patients

Geller J clin epi 2004;57:716
Near Miss Identification Repeated

• You et al 2013
• Tested Geller model on 815 cases
  ➢ Point system
  ➢ ICU admit alone: 79% sensitivity, 96% specificity;
  ➢ 4 or more units alone: 63% sensitivity; 99% specificity
• Currently only US 2 papers to test smm identification

Am J Perinatol 2013;30:21-4
Near Miss Preventable Factors

• **40%** deaths preventable factors
• **45%** near misses preventable factors
• **17%** severe morbidities preventable factors \( (p = .01) \)

• Clearly opportunity for slowing progression through the continuum at least from severe morbidity to worse

Geller AJOG 2004;191:939-44
Preventable Events Near Miss

• **Provider (93%)**
  - Failure to identify high risk
  - Incomplete/inappropriate management
  - No referral to tertiary care

• **System (47%)**
  - Communication
  - Policies
  - Equipment
  - Medication

• **Patient (13%)**

Geller AJOG 2004;191:939-44
Provider Preventable Factors

- 87 – 93% of all cases with preventable factors had provider factors
- Failure to ID high risk: 13 – 29%
- Incomplete management: 82 – 93%
- No referral to tertiary: 0 – 7%

Geller AJOG 2004;191:939-44
Prevention or Opportunity to Alter Outcome

• Prevention morbidity: harder concept
  ➢ Reduce eclampsia, DIC, LOS, renal failure, HELLP, stroke etc.

• Identifying opportunities to alter outcome
  ➢ Strong, possible, none
What To Do?

• Obtain data
  ➢ Follow CDC 2001 recommendations for severe morbidity and death

• Utilize multidisciplinary approach

• Identify opportunities to alter outcome

• Implement interventions based on data
  ➢ educational programs on the basics: hemorrhage, hypertensive disease, infection, cardiac disease
Why Bother to Record?

- State pregnancy mortality surveillance
- Identify deaths
- Review medical and nonmedical causes
- Analyze, interpret findings
- Act on the findings

CDC; 2001
• Review all women with 4 or more units of blood products or ICU admission
  ➢ Callaghan, Grobman, Kilpatrick, Main, D’Alton Facility-based identification of women with severe maternal morbidity: It’s time to start. Obstet Gynecol 2014 May

• How to review: paper submitted
  ➢ Based on maternal mortality reviews
  ➢ Abstraction and assessment forms available
    ▪ www.safehealthcareforeverywoman.org
SMM Review: Process

• Identify women with 4 or more units of blood, ICU admission
• Develop multidisciplinary committee
• Encourage debriefing
• Primary data abstracted from record and presented to committee
• Utilize SMM abstraction and assessment form
• Conduct of committee
• Identify whether opportunities to improve outcome
• Have institutional mechanisms to implement change
SMM Review Process cont…

- Trend data internally potentially regionally etc.
- Review timing
- Confidentiality
- Focus on systems

- ICU admission/4 or more units are not markers of quality
We Can Learn

• Systems can change

• Takes organized concerted effort
Maternal Mortality Rate, California and United States; 1999-2010

HP 2020 Objective – 11.4 Deaths per 100,000 Live Births

SOURCE: State of California, Department of Public Health, California Birth and Death Statistical Master Files, 1999-2010. Maternal mortality for California (deaths ≤ 42 days postpartum) was calculated using ICD-10 cause of death classification (codes A34, O00-O95,O98-O99) for 1999-2010. United States data and HP2020 Objective were calculated using the same methods. U.S. maternal mortality data is published by the National Center for Health Statistics (NCHS) through 2007 only. U.S. rates from 2008-2010 were calculated using NCHS Final Death Data (denominator) and CDC Wonder Online Database for maternal deaths (numerator). Accessed at http://wonder.cdc.gov on April 17, 2013. Produced by California Department of Public Health, Center for Family Health, Maternal, Child and Adolescent Health Division, April, 2013.
What Else Have We and Can We Do?

• Multiple multidisciplinary efforts

• Contraception Access

• A national collaborative effort is necessary – The National Partnership for Maternal Safety
Comprehensive National Effort

- Standard protocols
- *Saving Mothers Lives, U.K.*


National confidential enquiry system into maternal deaths published every 3 years

Goal to identify remediable factors to address in guidelines created by national organizations
SMFM Annual Meeting 2012: Objectives

- Organized, national approach to decrease maternal mortality and morbidity in the US
  - Enhance the training in maternal care for residents and fellows
  - Improve medical care and management of pregnant women
  - Address the critical research gaps in maternal medicine

2012 MFM Fellowship Training Requirements

• 12 months clinical rotations
• 18 months research activities
• 6 months elective time

MORE TO LEARN IN LESS TIME
MFM Fellowship Training:
ABOG's Response

Modified in 2013:

- **Clinical rotations** - ↑ 15 months
  - L& D/Inpatient Services rotation - 2 months
  - ICU rotation - 1 month
- **Elective** - ↑ 9 months
- **Research** - ↓ 12 months

Research Recommendations

- Develop standardized methods for national surveillance of maternal mortality
- Define significant maternal morbidity and “near misses”
- Determine appropriate patients for transfer to level III care
- Research impact of adverse pregnancy outcomes on long-term maternal health
Fourteen U.S. university-based clinical centers focus on clinical questions in MFM and obstetrics, in particular the continuing problem of preterm birth.
Pravastatin for the Prevention of Preeclampsia in High-Risk Women: A Pilot Study

Obstetric-Fetal Pharmacology Research Units (OPRU) Network
The National Institute of Child Health and Human Development
Pravastatin for Prevention of Preeclampsia

- NICHD-OPRU (clinicaltrials.gov NCT01717586)
- Pilot, dose escalating, RCT in women at high risk of preeclampsia
  - Pravastatin (10 or 20 mg) vs. placebo
  - 12-16 6/7 till delivery
- Primary aim
  - Pravastatin PK & maternal and fetal safety profiles
- Secondary aims
  - Maternal and neonatal clinical outcomes
  - Biomarkers
- Enrollment of first cohort finished Jan 2014
NuMom2b Follow-Up Study

- NHLBI Funding: “Pregnancy as a Window to Future Health”
- Long-Term Follow-up of Nulliparous Network Women (10,000 women)
- Cardiovascular risk profile will be evaluated in women with history of preeclampsia or adverse pregnancy outcome (APO)
- Underlying mechanisms will be explored by evaluating biochemical markers in stored blood
High risk women:
• Timely identification and referral of patients for tertiary care

Low risk women:
• Comprehensive national effort to educate all providers on the prevention and treatment of obstetrical complications

Annual Birth Volume in U.S. Hospitals, 2008

Simpson KR, JOGNN 40, 2011

NUMBERS OF HOSPITALS

- <500: 1193
- 500-1,000: 696
- 1,000-1,999: 690
- 2,000-2,999: 342
- 3,000-3,999: 177
- 4,000-4,999: 80
- 5,000-5,999: 36
- 6,000-6,999: 23
- 7,000-7,999: 10
- 8,000-8,999: 8
- 9,000-9,999: 3
- >10,000: 5

n = 3,265
Recommended Guidelines

- Urgent development of national management guidelines:
  - Hypertensive disorders in pregnancy
  - Postpartum hemorrhage
  - Prevention of venous thromboembolism
  - Diagnosis and management of placenta accreta
  - Management of the obese obstetrical patient
  - Management of cardiac disease in pregnancy

The Relevance of Protocols

National Protocols for Maternal Medicine

- Should be derived from evidence-based data
- Define the standard of care
- Minimize variability
- Reduce the need to rely on memory
- Enhance patient safety
- Reduce duplication of effort
Building Consensus

- ACOG-CDC Maternal Mortality/Severe Morbidity Action Meeting occurred in Atlanta, November 2012
- Participants identified key priorities:
  - 6 multidisciplinary working groups were formed
  - Work product presented in New Orleans 2013

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<td>Obstetric Hemorrhage</td>
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<td>Severe Hypertension in Pregnancy</td>
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<td>Facility Review</td>
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<td>Family and Staff Support</td>
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## Organizations Represented at May 2013 SMFM-ACOG Meeting

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IHI Evidence-Based Care Bundles

- Concept of bundles developed by Institute for Healthcare Improvement (IHI)
- Goal: to help health care providers more reliably deliver the best care for patients
- Provides a structured way of improving processes of care
- Includes a straightforward set of evidence-based practices
- When performed correctly and consistently there is a noted improvement in patient outcomes

IHI. Evidence–Based Care Bundles. Available at: http://www.ihi.org/topics/bundles/
# Obstetric Hemorrhage Safety Bundle

## Readiness
- Hemorrhage Cart with Procedural Instructions
- Rapid access to hemorrhage medications
- Established response team
- Establish massive transfusion protocols
- Unit education, regular unit-based drills (with debriefs)

## Recognition
- Assessment of hemorrhage risk
- Measurement of CUMMULATIVE blood loss
- Active Management of 3rd Stage of labor

## Response
- Unit-standard, stage-based OB Hemorrhage Emergency Management Plan with checklists
- Support program for patients, families and staff for all significant hemorrhages

## Reporting/Systems Learning
- Establish a culture of Huddle for high risk patients and Post-event Debriefs
- Review all serious hemorrhages for systems issues
- Monitor outcomes and process metrics in Perinatal QI committee

Modified from Elliott Main, M.D.
Preeclampsia/ Severe HTN Safety Bundle

READINESS
- Make severe hypertensive protocol familiar and easy to implement (i.e. Order sets)
- Rapid access to key medications (eliminate need to go to pharmacy)
- Unit education, regular unit-based drills (with debriefs)

RECOGNITION
- Proper blood pressure recording
- Application of the 2013 ACOG hypertension diagnosis categories

RESPONSE
- Unit-standard, Severe Hypertension and Eclampsia Management Plans with checklists
- Delivery planning based on ACOG Hypertension category
- Postpartum and Post discharge planning for close supervision
- Support program for patients, families and staff for all ICU admissions

REPORTING/SYSTEMS LEARNING
- Establish a culture of Huddle for high risk patients and Post-event Debriefs
- Review all Severe Hypertension/ICU cases for systems issues
- Monitor outcomes and process metrics in Perinatal QI committee

Modified from Lynn Simpson, MD, Burton Rochelson, MD and ACOG District II
Venous Thromboembolism (VTE) Prophylaxis

“single cause of death most amenable to reduction by systematic change in practice” – Steven Clark, M.D., Semin Perinatol 2012;36(1):42-7

Direct Deaths per Million Maternities by Cause
UK 1994-2008

- Pregnancy induced hypertension
- Haemorrhage
- Sepsis
- Thromboembolism
- AFE

Saving Mothers’ Lives 2006-2008, National Launch, March 2011 Professor Gwyneth Lewis OBE FRCOG FACOG
VTE Prophylaxis Safety Bundle

- Risk assessment tools
- Protocols for antepartum and postpartum prophylaxis
- Anesthesia recommendations
- Suggested dosing
- Key references
  - International Guidelines
MEOWS: Maternal Early Obstetric Warning Score

- Response initiated for one red or two yellow triggers

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<th>Red Trigger</th>
<th>Yellow Trigger</th>
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<td>35-36</td>
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<td>Systolic BP; mmHg</td>
<td>&lt;90 or &gt;160</td>
<td>150-160</td>
</tr>
<tr>
<td>Diastolic BP; mmHg</td>
<td>&gt;100</td>
<td>90-100</td>
</tr>
<tr>
<td>Heart rate</td>
<td>&lt;40, &gt;120</td>
<td>100-120, 40-50</td>
</tr>
<tr>
<td>Respiratory rate</td>
<td>&lt;10 or &gt;30</td>
<td>21-30</td>
</tr>
<tr>
<td>Oxygen saturation</td>
<td>&lt;95</td>
<td>-</td>
</tr>
<tr>
<td>Pain score</td>
<td>-</td>
<td>2-3</td>
</tr>
<tr>
<td>Neurological response</td>
<td>Unresponsive, pain</td>
<td>Voice</td>
</tr>
</tbody>
</table>

“Contact doctor if one red or two yellow scores at any one time.”
**A Validation System of MEOWS**

<table>
<thead>
<tr>
<th>673 patients scored</th>
</tr>
</thead>
<tbody>
<tr>
<td>200 (30%) triggered an evaluation</td>
</tr>
<tr>
<td>86 (13%) met criteria for morbidity</td>
</tr>
<tr>
<td>Sensitivity 89% (95% CI 81-95%)</td>
</tr>
<tr>
<td>Specificity 79% (95% CI 76-82%)</td>
</tr>
<tr>
<td>PPV 39% (95% CI 32-46%)</td>
</tr>
<tr>
<td>NPV 98% (95% CI 96-99%)</td>
</tr>
</tbody>
</table>

# Maternal Early Warning Signs (MEWS)

<table>
<thead>
<tr>
<th>Vital Sign</th>
<th>Trigger Range</th>
</tr>
</thead>
<tbody>
<tr>
<td>Systolic BP; mmHg</td>
<td>&lt;90 or &gt;160</td>
</tr>
<tr>
<td>Diastolic BP; mmHg</td>
<td>&gt;100</td>
</tr>
<tr>
<td>Heart rate; beats per min</td>
<td>&lt;50 or &gt;120</td>
</tr>
<tr>
<td>Respiratory rate; breaths per min</td>
<td>&lt;10 or &gt;30</td>
</tr>
<tr>
<td>Oxygen saturation; %</td>
<td>&lt;95</td>
</tr>
<tr>
<td>Oliguria; mL/hr for 2 hours</td>
<td>&lt;30</td>
</tr>
<tr>
<td>Neurologic: Maternal agitation, confusion, or unresponsiveness</td>
<td></td>
</tr>
<tr>
<td>Patient with hypertension reporting a non-remitting headache or shortness of breath</td>
<td></td>
</tr>
</tbody>
</table>

ACOG District II

Vital Signs Triggers Committee
Adapted from Singh et al. 2012
Family and Staff Support Bundle

“a sentinel event similar to tossing a pebble into a pond of still water.” - Jeffrey King, Semin Perinatol 2012;36:14–8

• Affects patient’s partner, other children, extended family, colleagues and her community

• Affects physicians, nurses and other members of care team

• Communication, teamwork, debriefing, and grief counseling are important

• Every birthing facility should establish a system of support for patients, family and staff

• A Mother’s Memory, Bereavement and Advanced Care Planning Services: www.bereavementservices.org/maternaldeath
The National Partnership for Maternal Safety
The Council on Patient Safety in Women’s Health Care will:

• provide oversight for the implementation of the 3 safety bundles within 3 years
• track implementation throughout the US using lessons learned from IHI 5 Million Lives Campaign
• provide a platform for facilities to share best practices
• systematically review the impact of these initiatives

www.safehealthcareforeverywoman.org

IHI. 5 Million Lives Campaign. Available at: http://www.ihi.org
Maternal Morbidity and Mortality in the US: Time to Wake Up and Take the Lead

Mary E. D’Alton, M.D.
Willard C. Rappleye Professor and Chair, Department of Obstetrics & Gynecology
Columbia University College of Physicians & Surgeons

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