What’s New in Obstetric Anesthesia
Publications from 2015

Philip Hess, MD
What’s new in OB anesthesia?

- Mortality and Morbidity
- Cesarean Delivery
- Effects of Anesthesia
Mortality and Morbidity
Maternal Mortality

*Pregnancy-Related Mortality in the United States, 2006-2010.*  
Obstet Gynecol 2015;125:5-12
Maternal Mortality

CDC’s Pregnancy Mortality Surveillance System

Maternal deaths within one (1) year

10 category Cause-of-death coding
  - ACOG and the CDC Maternal Mortality Study Group
Maternal Mortality

20,959,533 live births during 2006–2010

3,358 pregnancy-related (8,645 total deaths)

16.0 deaths per 100,000 live births

- 86.5% within 42 days (13.6 per 100,000)

- 2009: 17.8 deaths per 100,000 live births

  - Obstet Gynecol 2015;126:486-90
  - Increased influenza – related deaths in pregnancy
  - 12 % of all pregnancy-related deaths

Obstet Gynecol 2015;125:5-12
Maternal Mortality

Age

Advanced maternal age (≥35 yr): 27.4%

Obstet Gynecol 2015;125:5-12
Maternal Mortality

1987 – 1990
- Hemorrhage
- Hypertensive disorders
- Infection
- Embolic

2006 – 2010
- Cardiovascular
- Infection
- Cardiomyopathy
- Medical comorbidity

Preexisting → Aquired

Obstet Gynecol 2015;125:5-12
*Factors Associated with Maternal Death from Direct Pregnancy Complications: A UK National Case-Control Study.*  
BJOG 2015;122:653–662
Maternal Mortality – UK

- Life threatening condition
- Death

BJOG 2015;122:653–662
Maternal Mortality – UK

- Unmatched, case-control, retrospective analysis
- Mortality data - MBRRACE-UK database (2009 to 2012) (n=135)

BJOG 2015;122:653–662
## Maternal Mortality – UK

### Table 3. Population-attributable fractions (PAFs) for specific associated factors

<table>
<thead>
<tr>
<th>Risk factors</th>
<th>PAF (%)</th>
<th>95% CI</th>
</tr>
</thead>
<tbody>
<tr>
<td>‘Risk factors’ score</td>
<td>69.8</td>
<td>66.1–73.0</td>
</tr>
<tr>
<td>Specific factors</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Medical comorbidities</td>
<td>48.9</td>
<td>40.5–56.2</td>
</tr>
<tr>
<td>Previous pregnancy problems</td>
<td>21.1</td>
<td>11.7–29.5</td>
</tr>
<tr>
<td>Hypertensive disorders of pregnancy</td>
<td>12.0</td>
<td>7.7–16.1</td>
</tr>
<tr>
<td>Inadequate use of antenatal care</td>
<td>10.5</td>
<td>9.7–11.4</td>
</tr>
<tr>
<td>Indian ethnicity</td>
<td>2.9</td>
<td>0.3–5.5</td>
</tr>
<tr>
<td>Substance misuse</td>
<td>1</td>
<td>0.03–1.4</td>
</tr>
</tbody>
</table>

*BJOG 2015;122:653–662*
Maternal Comorbidity

  - 6% Cardiovascular outcome
Maternal Comorbidity

  - 6% major events (mortality, LVAD, transplant)

  - 10% adverse maternal events (2% mortality)
  - 50% adverse fetal outcomes
Maternal Mortality

Main EK, McCain CL, Morton CH, et al.  
*Pregnancy-Related Mortality in California: Causes, Characteristics, and Improvement Opportunities.*  
Obstet Gynecol 2015;125:938-47
Maternal Mortality

Preventable?

41% of deaths ‘Good to Strong’

- Hemorrhage (70%)
- Preeclampsia (60%)
- Cardiovasc (29%)
- AFE (0%)

Obstet Gynecol 2015;125:938-47
Obstetric Anesthesia

Parturients are older and have more complex medical histories.

Challenge:

How do we improve care?
ICU Admissions

ICU Admissions

- French hospital discharge database
  - (Programme de Médicalisation des Systèmes d’Information)

- 11,824 pregnancy-related ICU admissions in France from 2006 to 2009
  - 3.62 per 1,000 deliveries
### ICU Admissions

<table>
<thead>
<tr>
<th>Diagnosis</th>
<th>% of admissions</th>
<th>Rate / 100,000 deliveries</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hemorrhage</td>
<td>34.2</td>
<td>1.24</td>
</tr>
<tr>
<td>Hypertensive DO</td>
<td>22.3</td>
<td>0.81</td>
</tr>
<tr>
<td>Cardiovascular</td>
<td>8.0</td>
<td>0.29</td>
</tr>
<tr>
<td>Infectious</td>
<td>*</td>
<td>0.13</td>
</tr>
<tr>
<td>Thromboembolic</td>
<td>2.8</td>
<td>0.10</td>
</tr>
<tr>
<td>Anesthesia</td>
<td>*</td>
<td>0.02</td>
</tr>
<tr>
<td>AFE</td>
<td>*</td>
<td>0.02</td>
</tr>
</tbody>
</table>

Crit Care Med 2015;43:78-86
Sepsis

Bauer ME, Lorenz RP, Bauer ST, et al. 
*Maternal Deaths Due to Sepsis in the State of Michigan, 1999-2006.*
Obstet Gynecol 2015;126:747-52
Sepsis

• Maternal Mortality Surveillance records from the Michigan Department of Community Health

• Sepsis identified by:
  • Death certificate cause of death,
  • Maternal Mortality Medical Surveillance Committee, or
  • Specific source of infection leading to organ failure

Obstet Gynecol 2015;126:747-52
Sepsis

558 maternal deaths

• 14 per 100,000 live births

Sepsis:

• 15% of pregnancy – related mortality
• 2.1 deaths/100,000 live births

Obstet Gynecol 2015;126:747-52
Sepsis

- Inadequate care:
  - Delayed identification
  - Delayed treatment
  - Inadequate antibiotic coverage
Cesarean Delivery
Cesarean and Mortality

“There is no justification for any region to have a cesarean delivery rate higher than 10-15%”

World Health Organization

Lancet. 1985;2(8452):436-437
Cesarean and Mortality

Relationship between Cesarean Delivery Rate and Maternal and Neonatal Mortality.
JAMA 2015;314:2263-70
Cesarean and Mortality

<table>
<thead>
<tr>
<th>194 WHO member states</th>
</tr>
</thead>
<tbody>
<tr>
<td>• 54 countries with published rates</td>
</tr>
<tr>
<td>• 118 countries with estimated from previous</td>
</tr>
<tr>
<td>• 22 countries calculated from economic / social factors</td>
</tr>
</tbody>
</table>

2012:

• 22,900,000 cesarean deliveries (est)

JAMA 2015;314:2263-70
Cesarean and Mortality

Maternal Mortality Rate

\[ \geq 19.1\% \ (95\% \text{ CI, } 16.3\% \text{ to } 21.9\%) \]

\[ \geq 20\% \text{ when only high quality data used} \]
Cesarean and Mortality

Neonatal Mortality Rate

≥ 19.4% (95% CI, 18.6% to 20.3%)
≥ 24% when only high quality data used
Cesarean Anesthesia
Conversion to GA

86% of anesthesia-associated mortality during cesarean


Failed airway ~ 1 / 250 parturients


Mortality from anesthesia has decreased

? Improved practice and equipment?
Cesarean Anesthesia
Conversion to GA

Regional >> General

- Mortality
- Side effects
- Participation
Cesarean Anesthesia
Conversion to GA

*Maternal and Fetal Outcomes Following Unplanned Conversion to General Anesthetic at Elective Cesarean Section.*

*J Perinatol* 2015;35:695-9
Cesarean Anesthesia
Conversion to GA

4337 deliveries from 2008 to 2013

- Single center
- Non-emergent

Identified conversion to general anesthesia

J Perinatol 2015;35:695-9
## Cesarean Anesthesia
### Conversion to GA

Rate of general anesthesia: 3.8%

<table>
<thead>
<tr>
<th>Type of Anesthesia</th>
<th>Number planned</th>
<th>Convert to GA</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Epidural</td>
<td>132</td>
<td>15</td>
<td>11.4%</td>
</tr>
<tr>
<td>Spinal</td>
<td>3831</td>
<td>67</td>
<td>1.74%</td>
</tr>
<tr>
<td>CSE</td>
<td>291</td>
<td>0</td>
<td>0%</td>
</tr>
</tbody>
</table>

General anesthesia associated with:
- Delayed neonatal respiration
- Maternal blood loss

J Perinatol 2015;35:695-9
Patient Safety Minute

Obstetric Airway
Guidelines
Obstetric Airway

Three Algorithms:
1. Safe Obstetric General anesthesia
   Planning and preparation, up to second failed attempt
2. Obstetric Failed Tracheal Intubation
3. ‘Can’t Intubate, Can’t Oxygenate’
5 valuable charts to aid decision-making
Poster-ready format

Master algorithm – obstetric general anaesthesia and failed tracheal intubation

Algorithm 1
Safe obstetric general anaesthesia

Pre-induction planning and preparation
Team discussion

Rapid sequence induction
Consider facemask ventilation ($P_{\text{max}}$ 20 cmH$_2$O)

Laryngoscopy
(maximum 2 intubation attempts; 3rd intubation attempt only by experienced colleague)

Success
Verify successful tracheal intubation and proceed
Plan extubation

Fail

Algorithm 2
Obstetric failed tracheal intubation

Declare failed intubation
Call for help
Maintain oxygenation
Supraglottic airway device (maximum 2 attempts) or facemask

Success
Is it essential/safe to proceed with surgery immediately?

No
Wake

Yes
Proceed with surgery

Algorithm 3
Can’t intubate, can’t oxygenate

Declare CICO
Give 100% oxygen
Exclude laryngospasm – ensure neuromuscular blockade
Front-of-neck access

Patient Safety
Visual Aids

Cesarean Delivery

Adverse Events

Anesthesiol 2015;123:1013-23
Cesarean Delivery

Adverse Events

2003 to 2012

Hospital discharge records

785,000 cesarean deliveries

Anesthesiol 2015;123:1013-23
Cesarean Delivery

Adverse Events

Anesthesia events
Rate = 730 / 100,000

Non-anesthesia events
Rate = 890 / 100,000

Anesthesiol 2015;123:1013-23
## Cesarean Delivery

### Adverse Events

<table>
<thead>
<tr>
<th>Anesthesia events</th>
<th>Non-anesthesia events</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Minor – 94% of events</td>
<td>• Myocardial infarction</td>
</tr>
<tr>
<td>• Dural puncture headache</td>
<td>• Heart failure</td>
</tr>
<tr>
<td>• Major (≥ 1% risk of death)</td>
<td>• Respiratory failure</td>
</tr>
<tr>
<td></td>
<td>• PE / DVT</td>
</tr>
<tr>
<td></td>
<td>• DIC</td>
</tr>
<tr>
<td></td>
<td>• Renal failure</td>
</tr>
<tr>
<td></td>
<td>• Sepsis</td>
</tr>
<tr>
<td></td>
<td>• Stroke</td>
</tr>
</tbody>
</table>

*Anesthesiol 2015;123:1013-23*
Cesarean Anesthesia

Hypotension

Aortocaval compression
- Supine hypotension syndrome
- Fetal perfusion decrease

Foundation for lateral tilt

How much tilt is required?
Higuchi H, Takagi S, Zhang K, et al.  
*Effect of Lateral Tilt Angle on the Volume of the Abdominal Aorta and Inferior Vena Cava in Pregnant and Nonpregnant Women Determined by Magnetic Resonance Imaging.*  
Anesthesiol 2015;122:286-93
Cesarean Anesthesia

Hypotension

10 healthy pregnant women (37 – 39 wks)

10 healthy volunteers

MRI performed at 4 positions of tilt

Aortic and vena cava volumes measured (L2-3 and L3-4)
## Cesarean Anesthesia Hypotension

<table>
<thead>
<tr>
<th>Variable</th>
<th>Pregnant (n=10)</th>
<th>Nonpregnant (n=10)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Cardiac output (l/min)</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>0°</td>
<td>5.4±0.9</td>
<td>4.6±0.8</td>
</tr>
<tr>
<td>15°</td>
<td>5.6±0.9</td>
<td>4.7±0.7</td>
</tr>
<tr>
<td>30°</td>
<td>5.3±0.9</td>
<td>4.5±0.6</td>
</tr>
<tr>
<td>45°</td>
<td>5.4±1.1</td>
<td>4.5±0.6</td>
</tr>
<tr>
<td><strong>Mean arterial pressure (mmHg)</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>0°</td>
<td>77±8</td>
<td>76±8</td>
</tr>
<tr>
<td>15°</td>
<td>80±8</td>
<td>77±5</td>
</tr>
<tr>
<td>30°</td>
<td>78±9</td>
<td>76±5</td>
</tr>
<tr>
<td>45°</td>
<td>80±10</td>
<td>75±6</td>
</tr>
<tr>
<td><strong>Heart rate (beats/min)</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>0°</td>
<td>81±14</td>
<td>72±4</td>
</tr>
<tr>
<td>15°</td>
<td>79±13</td>
<td>73±7</td>
</tr>
<tr>
<td>30°</td>
<td>79±14</td>
<td>69±5</td>
</tr>
<tr>
<td>45°</td>
<td>81±14</td>
<td>71±6</td>
</tr>
</tbody>
</table>
Cesarean Anesthesia

Hypotension

Hypotension is potentially bad

- Fluids: Ineffective
- Ephedrine: Tachycardia
  Fetal acidosis
- Phenylephrine: Bradycardia
  Decreased cardiac output
Ngan Kee WD, Lee SW, Ng FF, et al.
Randomized Double-Blinded Comparison of Norepinephrine and Phenylephrine for Maintenance of Blood Pressure During Spinal Anesthesia for Cesarean Delivery.
Anesthesiol 2015;122:736-45
Cesarean Anesthesia

Hypotension

104 parturients
- Scheduled cesarean delivery
- ASA 1 or 2
- Singleton
- Term

Spinal anesthesia
- 11mg bupivacaine (hypobaric) / 15μg fentanyl
- 2 liter IV fluid cohydration
- Hip wedge

Anesthesiol 2015;122:736-45
Cesarean Anesthesia
Hypotension

Randomized to infusion of:
- Norepinephrine
- Phenylephrine

Infusion maintained by computer-controlled, closed-loop feedback system.

Primary outcome: Cardiac Output

Anesthesiol 2015;122:736-45
Postpartum Care

*Elevated Upper Body Position Improves Pregnancy-Related OSA without Impairing Sleep Quality or Sleep Architecture Early after Delivery.*  
Chest 2015;148:936-44
Postpartum Care

Body position alters obstructive sleep apnea (OSA)

~ 5% of parturients

30 postpartum women (day 2)
  • Polysomnography (sleep study)
  • Crossover design
    • Horizontal vs. 45° incline

Chest 2015;148:936-44
Postpartum Care

<table>
<thead>
<tr>
<th>Horizontal</th>
<th>45 Degree Incline</th>
<th>P-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Apnea Hypopnea Index</td>
<td>7.7 ± 2.2 / hr</td>
<td>4.5 ± 1.4 / hr</td>
</tr>
</tbody>
</table>

No differences in sleep quality parameters

Chest 2015;148:936-44
Postpartum Care

IJOA 2015;24:124-30
Postpartum Care

Enhanced recovery / fast tracking

- Cardiac surgery
- Colorectal
- Orthopedic
- Gynecologic
- Urology

Reduced morbidity, faster recovery

IJOA 2015;24:124-30
Postpartum Care

- Select patient population
- Education!
- Sports drink 2h preop
- Active warming in OR
- Spinal anesthesia with diamorph
- Early feeding
- Early mobilization
# Postpartum Care

## Table of Readmissions

<table>
<thead>
<tr>
<th>Day of discharge</th>
<th>Number discharged n (%)</th>
<th>Readmissions n (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Day 1</td>
<td>114 (15%)</td>
<td>5 (4%)</td>
</tr>
<tr>
<td>Day 2</td>
<td>375 (49%)</td>
<td>21 (6%)</td>
</tr>
<tr>
<td>Day 3+</td>
<td>271 (36%)</td>
<td>35 (13%)</td>
</tr>
</tbody>
</table>
*Does the Presence of a Condition-Specific Obstetric Protocol Lead to Detectable Improvements in Pregnancy Outcomes?*
Am J Obstet Gynecol 2015;213:86 e1-6
Protocols and Guidelines

NICHD / MFMU

25 hospitals – 4 years – 115,502 patients

Protocols:

- Hemorrhage
- Shoulder dystocia
- Preeclampsia

Am J Obstet Gyneco 2015;213:86 e1-6
Protocols and Guidelines

No change in outcomes
No change in morbidity

Am J Obstet Gynecol 2015;213:86 e1-6
Guidelines

Guidelines

- American College of Obstetricians and Gynecologists (2013)
- Royal College of Obstetrician and Gynaecologists (2011)
- Society of Obstetricians and Gynaecologists of Canada (2009)
- Royal Australian and New Zealand College of Obstetricians and Gynaecologists (2014)
Guidelines

References # range from 12 to 110

Minimal review of RCT and meta-analyses

- ACOG: NONE!

Few points of agreement

Am J Obstet Gynecol 2015;213:76 e1-10
Points of Agreement

- Definition: Clinical markers > visual EBL
- Active management of 3rd stage
  - Medications in agreement
- Surgical or interventional radiology
  - 2nd line after medications
- Units should have resuscitative equipment
- Internal iliac balloons are +/- in accreta
Placenta Accreta

Placenta Accreta

Nationwide Inpatient Sample

- 2000-2011 data
- Discharges from 1000 hospitals
- 20% sample of the US

Trends in primary and repeat cesarean delivery: Nationwide Inpatient Sample, United States, 2000-2011
FIGURE 2
Percentage rate changes in morbidity associated with cesarean delivery complications: United States, 2000-2011
Placenta Accreta

The Effects of Anesthesia Associations or Causality?

A ≠ B
Spann MN, Serino D, Bansal R, et al.  
*Morphological Features of the Neonatal Brain Following Exposure to Regional Anesthesia During Labor and Delivery.*  
Mag Res Imag 2015;33:213-21
37 healthy infants

- MRI two weeks post delivery

**Anesthesia**

- None $n=13$
- Spinal anesthesia $n=12$
- Epidural analgesia $n=12$

Behavioral testing 12 months

Mag Res Imag 2015;33:213-21
Anesthesia and The Developing Brain

Mag Res Imag 2015;33:213-21
Anesthesia and The Developing Brain

Mag Res Imag 2015;33:213-21
Anesthesia and The Developing Brain

Analgesia ≠ Un-medicated

Cesarean ≠ Vaginal
Anesthesia and The Developing Brain


- Sevoflurane (mice) Long-term learning impairment


- Propofol (rats) TNF-α in the cortex and thalamus


- Morphine (human) behavioral up to 2 years
*Association between Childhood Exposure to Single General Anesthesia and Neurodevelopment: A Systematic Review and Meta-Analysis of Cohort Study.*  
J Anesth 2015;29:749-57
Anesthesia and The Developing Brain

<table>
<thead>
<tr>
<th>Study</th>
<th>HR (95% CI)</th>
<th>Weight</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bartles 2009</td>
<td>1.70 (0.60, 5.00)</td>
<td>0.85</td>
</tr>
<tr>
<td>Dimaggio 2011</td>
<td>1.10 (0.80, 1.40)</td>
<td>12.21</td>
</tr>
<tr>
<td>Flick 2011</td>
<td>1.09 (0.80, 1.48)</td>
<td>10.10</td>
</tr>
<tr>
<td>Hansen 2011</td>
<td>1.13 (0.98, 1.31)</td>
<td>45.39</td>
</tr>
<tr>
<td>IngC 2012</td>
<td>1.73 (1.04, 2.88)</td>
<td>3.69</td>
</tr>
<tr>
<td>IngC 2014</td>
<td>1.35 (1.05, 1.75)</td>
<td>14.65</td>
</tr>
<tr>
<td>Kalkman 2009</td>
<td>1.27 (0.74, 2.16)</td>
<td>3.33</td>
</tr>
<tr>
<td>Ko.WR 2014</td>
<td>0.93 (0.57, 1.53)</td>
<td>3.92</td>
</tr>
<tr>
<td>Sprung 2012</td>
<td>1.35 (0.90, 2.02)</td>
<td>5.85</td>
</tr>
<tr>
<td>Overall (I^2 = 0.0%, p = 0.656)</td>
<td>1.18 (1.07, 1.30)</td>
<td>100.00</td>
</tr>
</tbody>
</table>

J Anesth 2015;29:749-57
Anesthesia and The Developing Brain

Kids who need surgery ≠ Kids who don’t
Epidural “Fever”

- Epidural analgesia
- Inflammation
- Infection
- Neurologic injury

Relations:
- Epidural analgesia to Inflammation
- Inflammation to Infection
- Infection to Neurologic injury
- Neurologic injury to Epidural analgesia
- Epidural analgesia to Neurologic injury
- Inflammation to Epidural analgesia
- Inflammation to Neurologic injury
Epidural “Fever”

Neal JL, Lamp JM, Lowe NK, et al.
Differences in Inflammatory Markers between Nulliparous Women Admitted to Hospitals in Preactive Vs Active Labor.
Am J Obstet Gynecol 2015;212:68 e1-8

Inflammatory biomarkers = active labor
Epidural “Fever”


Inflammatory biomarkers in mom = no injury
Inflammation in fetus = neurologic injury
Epidural “Fever”

*Histological Severity of Fetal Inflammation Is Useful in Predicting Neonatal Outcome.*  
Placenta 2015;36:1490-3

Chorionic (maternal) inflammation  
= no neurologic injury

Funisitus (fetal) inflammation  
= neurologic injury
Stages of ascending intraamniotic infection

- Stage I
- Stage II
- Stage III
- Stage IV
Epidural “Fever”

Low Apgar Score, Neonatal Encephalopathy and Epidural Analgesia During Labour: A Swedish Registry-Based Study.

Epidural “Fever”

Swedish Birth Registry
- 300,000 deliveries
- 10 years
- Nulliparous women with singleton pregnancies at term
- Spontaneous onset of delivery

Epidural analgesia: 44%

Epidural “Fever”

Women who received Epidural Analgesia

• Shorter
• Higher BMI
• Larger fetus

Epidural “Fever”

Women who received Epidural Analgesia

• Dystocia and prolonged labor
• Instrumental delivery
• Chorioamnionitis or other infections

• 6 – fold higher rate of fever
  (1.4% vs. 0.24%)

Epidural “Fever”

<table>
<thead>
<tr>
<th>Multivariate analysis:</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Epidural</td>
<td>No neurologic sequela</td>
</tr>
<tr>
<td>Fever</td>
<td>Convulsions</td>
</tr>
<tr>
<td></td>
<td>Neonatal cerebral ischemia</td>
</tr>
</tbody>
</table>

Epidural “Fever”

Epidural fever ≠ Funisitis = Neurologic Injury
Labor Analgesia
Second Stage

Craig MG, Grant EN, Tao W, et al.
A Randomized Control Trial of Bupivacaine and Fentanyl Versus Fentanyl-Only for Epidural Analgesia During the Second Stage of Labor.
Anesthesiol 2015;122:172-7
Labor Analgesia
Second Stage

310 nulliparous laboring women

Second stage epidural infusion
  • Bupivacaine/fentanyl
  • Fentanyl

Second stage: 75 min vs. 73 min

No difference in labor outcomes
Labor Analgesia

Second Stage

Weak legs ≠ Weak Uterus
Thank you!