2019 Sol Shnider, M.D.
Obstetric Anesthesia Meeting

The premier review meeting for clinical obstetric anesthesia, established in 1976

March 14-17, 2019
Grand Hyatt Hotel on Union Square
San Francisco, California

Jointly provided by the American Society of Anesthesiologists and the Society for Obstetric Anesthesia and Perinatology
Welcome to the SOAP 2019 Sol Shnider, M.D. Obstetric Anesthesia Meeting

On behalf of the leadership of the Society for Obstetric Anesthesia and Perinatology (SOAP), I would like to welcome you to the SOAP Sol Shnider 2019 Obstetric Anesthesia Meeting. This outstanding meeting has an extraordinarily rich history and an outstanding track record. The meeting was founded by Drs. Sol Shnider, Sam Hughes and Mark Rosen in 1976, and remains one of the premier refresher course programs for obstetric anesthesia in the world.

The goal for this meeting is to provide practical, high quality educational content for those who practice clinical obstetric anesthesia. We have carefully structured the program based on solicited feedback from practitioners and previous meeting attendees to cover all key aspects in the field of obstetric anesthesia in a clinically-focused program. The meeting presentations will be given by SOAP’s best speakers and content experts, as well as accomplished obstetric anesthesiologists in the Bay Area.

I am proud to present what we hope for you will be a highly enriching program, a comprehensive update on current optimal practice, and a meaningful professional experience for all those that attend. I look forward to seeing and interacting with you at the SOAP Sol Shnider 2019 Obstetric Anesthesia Meeting.

Sincerely,

Brendan Carvalho MBBCh, FRCA
Chair, Program Committee
SOAP Sol Shnider 2019 Meeting

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Exhibits Information

Exhibits will be open during the following times:

Friday, March 15, 2019:
7:00 - 8:00 a.m.
9:45 - 10:30 a.m.
3:15 - 4:00 p.m.

Saturday, March 16, 2019:
7:00 - 8:00 a.m.
9:45 - 10:30 a.m.
3:15 - 4:00 p.m.

Learning Objectives

At the conclusion of this learning activity, the participant will be able to answer these questions:

• Apply the latest medical, surgical and pharmacological advances in obstetrical hemorrhage management
• Integrate cutting-edge neuraxial techniques including programmed intermittent epidural bolus (PIEB) and dural puncture epidural (DPE) to optimize labor analgesia
• List the recent publications that will most impact your obstetric anesthesia practice
• Construct and implement an enhanced recovery after surgery (ERAS) program for cesarean delivery
• Evaluate point of care ultrasound to enhance your obstetric anesthesia care
• Implement the latest pre-eclampsia management and care bundles
• Identify how to prevent and treat side effects of neuraxial opioids
• Distinguish how to manage pregnant patients with chronic pain and opioid addiction
• Apply best practice for the management of post-dural puncture headaches
• Recognize how to provide optimal anesthesia for non-obstetric surgery during pregnancy and postpartum tubal ligation
Mission of SOAP
The mission of this Society is to improve the pregnancy-related outcomes of women and neonates through the support of obstetric anesthesiology research, the provision of education to its members, other providers, and pregnant women, and the promotion of excellence in clinical anesthetic care.

ACCME Accreditation
This activity has been planned and implemented in accordance with the accreditation requirements and policies of the Accreditation Council for Continuing Medical Education (ACCME) through the joint providership of the American Society of Anesthesiologists and the Society for Obstetric Anesthesia and Perinatology. The American Society of Anesthesiologists is accredited by the ACCME to provide continuing medical education for physicians.

The American Society of Anesthesiologists designates this live activity for a maximum of 17 AMA PRA Category 1 Credits™. Physicians should claim only the credit commensurate with the extent of their participation in the activity.

AANA Credits (Program offering Friday through Sunday)
This program has been prior approved by the American Association of Nurse Anesthetists for 17 Class A CE credits; Code Number 1036961; Expiration Date 3/17/2019.

Hands-on Ultrasound for the Obstetric Anesthesia Provider: Cardiac Ultrasound, Hemodynamic Exam, Pulmonary Evaluation, Ultrasound Guided TAP Blocks & Neuraxial Techniques and Basic Fetal Ultrasound
This program has been prior approved by the American Association of Nurse Anesthetists for 4.00 Class A CE credits; Code Number 1036960; Expiration Date 3/14/2019.

The American Society of Anesthesiologists designates this live activity for a maximum of 4 AMA PRA Category 1 Credits™. Physicians should claim only the credit commensurate with the extent of their participation in the activity.

CEP Number
Provider approved by the California Board of Registered Nursing, Provider #CEP16975, for 17 Contact Hours.

Target Audience
This meeting is intended for specialists in anesthesiology to include anesthesiologists, nurse anesthetists, residents and fellows. Pediatricians, neonatologists, perinatologists, obstetricians, general practitioners, delivery room nurses, nurse midwives, and clinical pharmacologists may also find educational benefit. The program is generated from member requests and an assessment of need by the program committee. Attendance at this meeting does not guarantee competency or proficiency in the performance of any procedures which may be discussed or taught during the meeting.

Educational Format
CME activities may include the following formats: plenary sessions, debates, lectures, problem-based learning, and skill-set workshops.

Mission of SOAP Program Committee
The mission of the Society’s Program Committee is to provide anesthesiologists, obstetricians, and other physicians and members of related allied health specialties with the knowledge that will reinforce past learning as well as disseminate new concepts, practices, and skills involving anesthesia and analgesia for the pregnant woman.

Participation in the SOAP 2019 Sol Shnider, M.D.
Obstetric Anesthesia Meeting
Attendance shall be open to all health practitioners, provided that they have registered for the meeting. CME credit will only be offered to M.D.s, D.O.s, and AAs or the equivalent. CE credit will be offered to CRNAs.

Evaluations
Electronic evaluations by questionnaire will address program content, presentations, and possible bias.

Special Needs Statement
The Society for Obstetric Anesthesia and Perinatology is committed to making its activities accessible to all individuals and fully complies with the legal requirements of the Americans with Disabilities Act and the rules and regulations thereof. If you are in need of an accommodation, please do not hesitate to call the SOAP office at 414-389-8611 and/or submit a description of your needs in writing to soap@soap.org.

Statement of Need
The SOAP Sol Shnider, M.D. Obstetric Anesthesia Meeting provides a forum devoted exclusively to obstetric anesthesia at which leaders in the field present recent clinical updates and other relevant clinical information.

Commercial Support Acknowledgement
This activity is supported by educational grants. A complete list of supporters will be available in the course syllabus.

Disclosure
The American Society of Anesthesiologists remains strongly committed to providing the best available evidence-based clinical information to participants of this educational activity and requires an open disclosure of any potential conflict of interest identified by our faculty members. It is not the intent of the American Society of Anesthesiologists to eliminate all situations of potential conflict of interest, but rather to enable those who are working with the American Society of Anesthesiologists to recognize situations that may be subject to question by others. All disclosed conflicts of interest are reviewed by the educational activity course director/chair to ensure that such situations are properly evaluated and, if necessary, resolved. The American Society of Anesthesiologists educational standards pertaining to conflict of interest are intended to maintain the professional autonomy of the clinical experts inherent in promoting a balanced presentation of science. Through our review process, all American Society of Anesthesiologists activities are ensured of independent, objective, scientifically balanced presentations of information. Disclosure of any or no relationships will be made available for all educational activities.

Disclaimer
The information provided at this CME activity is for continuing education purposes only and is not meant to substitute for the independent medical judgment of a healthcare provider relative to diagnostic and treatment options of a specific patient’s medical condition.
Thursday, March 14, 2019

SOAP is offering the Hands-on Ultrasound for the Obstetric Anesthesia Provider: Cardiac Ultrasound, Hemodynamic Exam, Pulmonary Evaluation, Ultrasound Guided TAP Blocks & Neuraxial Techniques and Basic Fetal Ultrasound Workshop the day before the full 2019 SOAP Sol Shnider, M.D. Obstetric Anesthesia Meeting begins.

Meeting attendees are encouraged to register for these events early. Please note that registration for the workshops requires a separate, additional fee from the full SOAP 2019 Sol Shnider, M.D. Obstetric Anesthesia Meeting registration.

Hands-on Ultrasound for the Obstetric Anesthesia Provider:
Cardiac Ultrasound, Hemodynamic Exam, Pulmonary Evaluation, Ultrasound Guided TAP Blocks & Neuraxial Techniques and Basic Fetal Ultrasound

**Co-Directors:**
Kristine E. W. Breyer, MD and Lindsey Huddleston, MD, PhD

**1:00 p.m. – 5:00 p.m.**

**LOCATION**
Grand Hyatt Hotel

#### Disclosures

Each presenter is required to disclose the existence of any financial interest and/or other relationship(s) (e.g. employee, consultant, grant recipient/research support) he/she might have with a.) the manufacturer(s) of any commercial product(s) to be discussed during his/her presentation and/or b.) the commercial contributor(s) of the activity.

**Planner/Faculty Disclosures**

The following planning committee members and/or faculty have indicated that they have relevant financial relationships with commercial interests.

- **Alexander Butwick:** Honoraria, Consulting
- **Ashraf Habib:** Funded Research, Consulting, Honoraria
- **Brendan Carvalho:** Funded Research

All other faculty, planners and staff have reported no relevant financial relationships with commercial interests.
Thursday, March 14, 2019

1:00-5:00pm  Workshops: Ultrasound
Co-Directors: Kristine Breyer, M.D.
& Lindsey Huddleston, M.D., Ph.D.

Friday, March 15, 2019

7:00 – 7:45 a.m.  Registration and Continental Breakfast
7:45 – 8:00 a.m.  Opening Welcome

Session I: Optimizing Labor Analgesia
Moderator: Alexander Butwick, M.B.,B.S., FRCA, M.S.
8:00 – 8:30 a.m.  CSE, DPE, Epidural: Is there an Optimal Labor Analgesia Insertion Technique?
Lawrence Tsen, M.D.
8:30 – 9:00 a.m.  PIEB, CEI, PCEA: Is there an Optimal Labor Analgesic Maintenance Technique?
Brendan Carvalho, M.B., B.Ch., FRCA
9:00 – 9:30 a.m.  Alternatives to Neuraxial Analgesia for Labor Pain Management
Jennifer M. Lucero, M.D., M.S.
9:30 – 9:45 a.m.  Panel Discussion
9:45 – 10:30 a.m.  Coffee Break

Session II: Comorbidities and High-Risk Patients
Moderator: Lawrence Tsen, M.D.
10:30 – 11:00 a.m.  Management of Parturients with Cardiac Disease
Ronald Pearl, M.D., Ph.D.
11:00 – 11:30 a.m.  Latest on Pre-Eclampsia Management and Care Bundles
Gillian Abir, M.B., Ch.B., FRCA
11:30 – 12:00 p.m.  Anesthetic Management of Invasive Placental Disease
John C. Markley, M.D., Ph.D.
12:00 – 12:15 p.m.  Coffee Break
12:15 – 1:30 p.m.  Lunch (hosted)

Session III: Enhanced Recovery and Cesarean Anesthesia
Moderator: Brendan Carvalho, M.B., B.Ch., FRCA
1:30 – 2:00 p.m.  Recommended ERAS Protocols for Cesarean Delivery
Ashraf S. Habib, M.B.,B.Ch., M.Sc., M.S.N., FRCA
2:00 – 2:30 p.m.  Setting up and Evaluation of a Successful ERAS Pathway for Cesarean Delivery
Eric J. Hunt, M.D., Ph.D.
2:30 – 3:00 p.m.  Regional Blocks for Cesarean Delivery Analgesia: TAP, QL and Beyond
Pedram Alesihi, M.D.
3:00 – 3:15 p.m.  Panel Discussion
3:15 – 4:00 p.m.  Coffee Break

Session IV: Tips and Techniques
Moderator: Pamela D. Flood, M.D., M.A.
4:00 – 4:30 p.m.  Trouble-Shooting Labor Epidurals and Failed Top-ups
Jalal A. Nanji, B.Sc., M.D., FRCPC
4:30 – 5:00 p.m.  Reducing Obstetric General Anesthesia: 10 Practical, Tested Tips
Lawrence Tsen, M.D.
5:00 – 5:30 p.m.  Preventing and Treating Side Effects of Neuraxial Opioids
Ashraf S. Habib, M.B.,B.Ch., M.Sc., M.S.N., FRCA
5:30 – 5:45 p.m.  Panel Discussion
6:00 – 7:30 p.m.  Reception

Saturday March 16, 2019

7:00 – 8:00 a.m.  Registration and Continental Breakfast

Session V: Obstetric Anesthesia Safety Session
(ABA Part 2 MOCA Patient Safety Credit)
Moderator: Gillian Abir, M.B., Ch.B., FRCA
8:00 – 8:30 a.m.  Current Evidence for the Prevention and Treatment of Spinal Hypotension
Mark D. Rollins, M.D., Ph.D.

Program continued on next page
### Saturday March 16, 2019 cont.

<table>
<thead>
<tr>
<th>Time</th>
<th>Session</th>
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| 8:30 – 9:00 a.m. | Pregnant Patient with Chronic Pain and Opioid Addiction  
Pamela D. Flood, M.D., M.A. |
| 9:00 – 9:30 a.m. | OSA in the Parturient: Implications for Peri and Post-Operative Period  
Jeremy Collins, FRCA, M.B.,Ch.B. |
| 9:30 – 9:45 a.m. | Panel Discussion                                                        |
| 9:45 – 10:30 a.m. | Coffee Break                                                            |

**Session VI: New Developments and Concepts**  
Moderator: Jennifer M. Lucero, M.D., M.S.

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<thead>
<tr>
<th>Time</th>
<th>Session</th>
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| 10:30 – 10:55 a.m. | Point of Care Ultrasound in Obstetric Anesthesia  
Clemens M. Ortner, M.D., M.S., DESA |
| 10:55 – 11:15 a.m. | Neuraxial Ultrasound: Practical Guide to Adoption  
Katherine M. Seligman, M.D. |
| 11:15 – 12:00 p.m. | Sam Hughes Lecture: Obstetric Anesthesia Year in Review  
Ashraf S. Habib, M.B.,B.Ch., M.Sc., M.S.N., FRCA |
| 12:00 – 12:15 p.m. | Panel Discussion                                                        |
| 12:15 – 1:30 p.m. | Lunch on your own                                                        |

**Session VII: Obstetrical Hemorrhage Update**  
Moderator: Andrea Traynor

<table>
<thead>
<tr>
<th>Time</th>
<th>Session</th>
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| 1:30 – 1:50 p.m. | Optimal Uterotonic Administration to Prevent and Treat Uterine Atony  
Lawrence Tsen, M.D. |
| 1:50 – 2:10 p.m. | Obstetrical Management of Post-Partum Hemorrhage  
Maurice L. Druzin, M.D. |
| 2:10 – 2:30 p.m. | Transfusion Practices for Obstetric Hemorrhage: What’s the latest?  
Anil K Panigrahi, M.D., Ph.D. |
| 2:30 – 2:50 p.m. | Pharmacological Management of Obstetric Hemorrhage  
Alexander Butwick, M.B.,B.S., FRCA, M.S. |
| 2:50 – 3:15 p.m. | Panel Discussion                                                        |
| 3:15 – 4:00 p.m. | Coffee Break                                                            |

### Sunday March 17, 2019

<table>
<thead>
<tr>
<th>Time</th>
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<tbody>
<tr>
<td>7:00 – 8:00 a.m.</td>
<td>Registration and Continental Breakfast</td>
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</table>

**Session IX: Management Updates Safety**  
Session (ABA Part 2 MOCA Patient Safety Credit)  
Moderator: Mark D. Rollins, M.D., Ph.D.

<table>
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<tr>
<th>Time</th>
<th>Session</th>
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| 8:00 – 8:30 a.m. | Anesthesia for Non-Obstetric Surgery During Pregnancy  
Gillian Abir, M.B., Ch.B., FRCA |
| 8:30 – 9:00 a.m. | Eating During Labor and the “Full Stomach” Pre and Post-Delivery  
Atisa B Britton, M.D. |
| 9:00 – 9:30 a.m. | Post-Partum Tubal Ligation: Optimal Anesthetic Technique and Timing  
Andrea J. Traynor, M.D. |
| 9:30 – 9:45 a.m. | Panel Discussion                                                        |
| 9:45 – 10:30 a.m. | Coffee Break                                                            |

**Session X: Complications and Uncommon Occurrences**  
Moderator: Brendan Carvalho, M.B., B.Ch., FRCA

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<tr>
<th>Time</th>
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| 10:30 – 11:00 a.m. | Ethical Dilemmas in Obstetric Anesthesia  
Caitlin D. Sutton, B.S., M.D. |
| 11:00 – 11:30 a.m. | Management of Postpartum Headaches  
Jessica Ansari, M.D. |
| 11:30 – 12:00 a.m. | The Diagnosis and Management of Peripartum Neurologic Complications  
Mark D. Rollins, M.D., Ph.D. |
| 12:00 – 12:15 p.m. | Panel Discussion                                                        |
| 12:15 p.m. | Adjourn                                                                 |
Universal Anesthesia is looking for anesthesiologists who like to practice OB Anesthesia, are compassionate and empathetic physicians. Universal Anesthesia is a privately owned anesthesia company in Louisville, Kentucky, which provides anesthesia services for Norton Healthcare at two locations: Norton downtown and Norton Women’s and Children’s Hospital. Norton offers inpatient and outpatient medical/surgical care, full diagnostic services and 24-hour emergency care for men, women and children. Labor and Delivery services include 33 labor and delivery rooms, 59 mother-baby rooms, 5 ORs on the Labor and Delivery units in addition to 16 rooms in the main OR and the lithotripsy unit. OB Emergency Departments care for 16+ weeks’ gestation patients. 24/7 OB anesthesiologists, hospitalists and neonatologists provide support. Norton has been designated Blue Distinction Center + Maternity Care, 4-Star Kentucky Infants Safe and Strong (KISS) designation and has a 44 bed Level III Neonatal Intensive Care Unit. Obstetric Anesthesia Consultants is the company under the Universal Anesthesia umbrella providing OB Anesthesia Services to Norton Healthcare.

The Society for Obstetric Anesthesia and Perinatology would like to thank the following supporters and exhibitors of the 2019 Sol Shnider, M.D. Obstetric Anesthesia Meeting:

**Platinum Supporter**

**Gold Supporter**

**Bronze Supporters**

Gauss Surgical is a medical technology company using Artificial Intelligence to make surgery and childbirth safer and more cost-effective. Gauss’s flagship product, Triton, uses the iPad to monitor blood loss from digital images of sponges and canisters, with the goal of recognizing hemorrhage early, optimizing transfusion decisions, and assisting with sponge management. Triton has been adopted by a wide network of hospitals covering over 100,000 surgeries annually, and has been clinically proven to improve patient outcomes and reduce cost. Learn more at www.gausssurgical.com.

Norton offers inpatient and outpatient medical/surgical care, full diagnostic services and 24-hour emergency care for men, women and children. Labor and Delivery services include 33 labor and delivery rooms, 59 mother-baby rooms, 5 ORs on the Labor and Delivery units in addition to 16 rooms in the main OR and the lithotripsy unit. OB Emergency Departments care for 16+ weeks’ gestation patients. 24/7 OB anesthesiologists, hospitalists and neonatologists provide support. Norton has been designated Blue Distinction Center + Maternity Care, 4-Star Kentucky Infants Safe and Strong (KISS) designation and has a 44 bed Level III Neonatal Intensive Care Unit. Obstetric Anesthesia Consultants is the company under the Universal Anesthesia umbrella providing OB Anesthesia Services to Norton Healthcare.

Accuro® by RIVANNA® is the world’s first spinal navigation device designed to improve the safety, speed, and efficiency of epidural and spinal anesthesia. The revolutionary platform features BoneEnhance®, which visualization of bony versus soft tissue anatomy, and SpineNav3D™, which automates measurements of the spinal midline, epidural depth and trajectory. Accuro was engineered and commercialized by RIVANNA, an innovative medical device company headquartered in Charlottesville, VA. For anesthesia providers, certainty can be effortless with Accuro. For more information, visit rivannamedical.com.

Cerus Corporation is a biomedical company focused in the field of blood safety. Cerus markets and sells the INTERCEPT Blood System for platelets and plasma in the United States and around the world. The INTERCEPT Blood System reduces the risk of transfusion-transmitted infections by inactivating a broad range of pathogens such as viruses, bacteria, parasites and leukocytes that may be present in donated blood products. The INTERCEPT red blood cell system is in clinical development.

IMD, Inc. offers the famous Gertie Marx needle and full line of spinal and epidural needles for Labor and Delivery, Pediatric, Myelograms and Lumbar Puncture. Needles range from 50mm to 215mm. CSE sets with 3.5/5”/6”/7” epidural needles are matched with Gertie Marx spinal Needle. We are proud to say we are NEVER on backorder. IMD also has new Fenestrated Needle for Peripheral Nerve Block to be used for post-operative pain relief after total knee replacement with excellent results. This unique needle has multiple side ports giving exceptional distribution of anesthetic.
Session I: Optimizing Labor Analgesia
Moderator: Alexander Butwick, M.B., B.S., FRCA, M.S.

CSE, DPE, Epidural: Is there an Optimal Labor Analgesia Insertion Technique?
Lawrence Tsen, M.D.

PIEB, CEI, PCEA: Is there an Optimal Labor Analgesic Maintenance Technique?
Brendan Carvalho, M.B., B.Ch., FRCA

Alternatives to Neuraxial Analgesia for Labor Pain Management
Jennifer M. Lucero, M.D., M.S.
The CSE, DPE, and Epidural Technique
Is there an Optimal Labour Analgesia Technique?

SOAP Sol Shnider Obstetric Anesthesia Meeting, 2019

Lawrence C. Tsen, MD
Director, Center for Reproductive Medicine, Department of Anesthesiology, Perioperative & Pain Medicine, Brigham & Women’s Hospital
Associate Professor in Anaesthesia
Harvard Medical School

No Disclosures

“...from so simple a beginning, endless forms most beautiful and most wonderful have been and are being evolved”

Origin of the Species
Darwin

A Darwinian Adventure

1809
• Shrewsbury

1825
• Edinburgh
• Limb amputation
• Cambridge

1831
• HMS Beagle

A Darwinian Adventure

DPE CSE EPIDURAL

TECHNIQUES
Neuraxial Techniques

“Variability is not actually caused by man...but man can and does select the variations given to him by nature.”

Origin of the Species
Darwin

Neuraxial Techniques

“Ideal Technique”

Quick Onset, Predictable Spread & Quality, Adjustable Depth & Duration, Minimal Motor Block, Minimal Maternal and Fetal Side Effects

Origin of the Species
Darwin

Neuraxial Techniques

Epidural Technique

Spinal Epidural Subcutaneous

Dura Ligamentum Flavum Skin

Epidural Technique

CSE Technique

Spinal Epidural Subcutaneous

Dura Ligamentum Flavum Skin
### CSE Technique

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<th>Epidural</th>
<th>Subcutaneous</th>
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<tbody>
<tr>
<td>Dura</td>
<td>Ligamentum Flavum</td>
<td>Skin</td>
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### DPE Technique

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<th>Spinal</th>
<th>Epidural</th>
<th>Subcutaneous</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dura</td>
<td>Ligamentum Flavum</td>
<td>Skin</td>
</tr>
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</table>

### Study

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<th>Study</th>
<th>Needle</th>
<th>Anesthetic</th>
<th>Effect</th>
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<tbody>
<tr>
<td>Thomas</td>
<td>27G</td>
<td>2% Lido 10 mL</td>
<td>No</td>
</tr>
<tr>
<td>Suzuki</td>
<td>26G</td>
<td>2% Mepiv 18 mL</td>
<td>Yes</td>
</tr>
<tr>
<td>Wilson</td>
<td>26G</td>
<td>0.125% Bup 12 mL</td>
<td>Yes</td>
</tr>
<tr>
<td>Cappiello, Tsen</td>
<td>25G</td>
<td>0.25% Bup 12 mL</td>
<td>Yes</td>
</tr>
<tr>
<td>Chau, Tsen</td>
<td>25G</td>
<td>0.125% Bup 20 mL</td>
<td>Yes</td>
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<tr>
<td>Chau, Tsen</td>
<td>25G</td>
<td>0.1% Bup 16 mL</td>
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Faster, Greater Sacral Spread  
No Difference Hypotension, Highest Sensory or PDPH

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<table>
<thead>
<tr>
<th>Study</th>
<th>Needle</th>
<th>Anesthetic</th>
<th>Effect</th>
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<tr>
<td>Chau, Tsen</td>
<td>25G</td>
<td>0.1% Bup 16 mL</td>
<td>Yes</td>
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</table>

No Difference Inadequate, Sacral, Bilateral  
No Difference Hypotension, Highest Sensory or PDPH

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### DPE Technique

#### Study | Needle | Anesthetic | Effect
---|---|---|---
Thomas | 27G | 2% Lido 10 mL | No
Suzuki | 26G | 2% Mepiv 18 mL | Yes
Wilson | 26G | 0.125% Bup 12 mL | Yes
Cappiello, Tsen | 25G | 0.25% Bup 12 mL | Yes
Chau, Tsen | 25G | 0.125% Bup 20 mL | Yes
Chau, Tsen | 25G | 0.1% Bup 16 mL | Yes

Faster, Greater Sacral Spread, Bilateral
No Difference Hypotension, Highest Sensory or PDPH


### Technique Advantages

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>CSE</th>
<th>DPE</th>
<th>Epidural</th>
</tr>
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<tbody>
<tr>
<td>Location Confirmation</td>
<td>X</td>
<td>X</td>
<td></td>
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</table>

Cappiello E, O’Rourke N, Segal S, Tsen LC. Anes Analg 2008; 107:1646-51
Chau A, Bibbo C, Huang CC, Ettnerman KG, Cappiello E, Tsen LC. Anesthesiology 2017
## Location Confirmation

### CSE + DPE Techniques

<table>
<thead>
<tr>
<th>Technique Advantages</th>
<th>Characteristic</th>
<th>CSE</th>
<th>DPE</th>
<th>Epidural</th>
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<tr>
<td>Onset</td>
<td>X</td>
<td>X</td>
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<td></td>
</tr>
</tbody>
</table>

**Median Onset**

- **CSE**: 3-5 min
- **Epidural**: 10-20 min

- **Chau A, Bibbo C, Huang CC, Ellerman KG, Cappiello E, Tsen LC. Anesth Analg 2017**

**Sacral Spread**

<table>
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<td>X</td>
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**CSE**: 3-5 min

**Epidural**: 10-20 min

- **Chau A, Bibbo C, Huang CC, Ellerman KG, Cappiello E, Tsen LC. Anesth Analg 2017**

**Sacral Spread**

- **Sacral Fibers Harder to Block**
- **Nerve Roots**: Larger in Diameter, Thicker Dura Mater
- **Spread**: Farther from Epidural Catheter, Sacral Resistance

**Chau A, Bibbo C, Huang CC, Ellerman KG, Cappiello E, Tsen LC. Anesth Analg 2017**
Sacral Spread

<table>
<thead>
<tr>
<th></th>
<th>DPE/EPL</th>
<th>CSE/EPL</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>RR</td>
<td>95% CI</td>
</tr>
<tr>
<td>BS2 @ 10 min</td>
<td>2.13</td>
<td>1.39-3.28</td>
</tr>
<tr>
<td>BS2 @ 20 min</td>
<td>1.60</td>
<td>1.26-2.03</td>
</tr>
<tr>
<td>BS2 @ 30 min</td>
<td>1.18</td>
<td>1.01-1.30</td>
</tr>
</tbody>
</table>

Sacral Fibers Harder to Block
Nerve Roots-Larger in Diameter, Thicker Dura Mater; Spread-Farther from Epidural Catheter, Sacral Resistance

Chau A, Bibbo C, Huang CC, Elterman KG, Cappiello E, Tsen LC. Anesth Analg 2017

Technique Advantages

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<td>X</td>
<td></td>
</tr>
<tr>
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<td>X</td>
<td>X</td>
<td></td>
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<tr>
<td>Bilateral Spread</td>
<td>X</td>
<td>X</td>
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</tr>
<tr>
<td>Tested Catheter</td>
<td>X</td>
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Chau A, Bibbo C, Huang CC, Elterman KG, Cappiello E, Tsen LC. Anesth Analg 2017

Bilateral Spread

Discontinuous, Heterogenous, Potential Space with Escape Routes


Patchy, One Sided: 5-8%

Pan PH, Bogard TD, Owen MD. IJOA 2004;13:227-233

Chau A, Bibbo C, Huang CC, Elterman KG, Cappiello E, Tsen LC. Anesth Analg 2017

Technique Advantages

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<tbody>
<tr>
<td>Failed Blocks</td>
<td></td>
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<td></td>
</tr>
<tr>
<td>Eappen n = 4240</td>
<td>13.1%</td>
<td>7.2%</td>
<td>25G</td>
</tr>
<tr>
<td>Norris n = 1660</td>
<td>1.3%</td>
<td>0.2%</td>
<td>25G</td>
</tr>
<tr>
<td>Van de Velde n = 661/2075</td>
<td>3.18%</td>
<td>1.49%</td>
<td>27, 29G</td>
</tr>
<tr>
<td>Thomas n = 248</td>
<td>9.3%</td>
<td>8%</td>
<td>27G</td>
</tr>
<tr>
<td>Groden n = 1507/3980</td>
<td>3.9%</td>
<td>2.1%</td>
<td>27G</td>
</tr>
<tr>
<td>Booth n = 955/1440</td>
<td>11.6%</td>
<td>6.6%</td>
<td>27G</td>
</tr>
</tbody>
</table>

Eappen, IJOA 1998; Norris, IJOA 2000; Van de Velde, Anaesth Intens Care 2001
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<td>X</td>
<td>X</td>
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<td></td>
<td>X</td>
</tr>
<tr>
<td>Progress of Labor</td>
<td>X</td>
<td>X (?)</td>
<td></td>
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Cappiello E, O’Rourke N, Segal S, Tsen LC. Anes Analg 2008;107:1646-51
Chau A, Bibbo C, Huang CC, Ellerman KG, Cappiello E, Tsen LC. Anesth Analg 2017

### Progress of Labor

**CSE vs Epidural; Bolus**
- Lower instrumental delivery; Technique matters?

**CSE vs Epidural; CEI**
- 100 Nulliparous < 3 cm
- CSE: Shorter labor; Delivery 30 min faster

**CSE vs Parenteral Opioids; CEI**
- 750 Nulliparous < 4 cm
- CSE: Shorter labor; Delivery 80 min faster

Collis, Lancet 1995; Tsen, Anesthesiology 1999; Wong, NEJM 2005

### DISADVANTAGES

#### Technique Disadvantages

<table>
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<tr>
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<th>DPE</th>
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<tbody>
<tr>
<td>Fetal Bradycardia</td>
<td>X</td>
<td></td>
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#### Fetal Bradycardia

<table>
<thead>
<tr>
<th></th>
<th>CSE</th>
<th>EPIDURAL</th>
<th>RR</th>
<th>NNH</th>
</tr>
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<tbody>
<tr>
<td>FHR abnl</td>
<td>7.7%</td>
<td>6.7%</td>
<td>1.17</td>
<td>75</td>
</tr>
<tr>
<td>FHR brady</td>
<td>7.3%</td>
<td>4.8%</td>
<td>1.81</td>
<td>28</td>
</tr>
<tr>
<td>CS FHR</td>
<td>6%</td>
<td>7.8%</td>
<td>0.86</td>
<td>-87</td>
</tr>
<tr>
<td>CS Any</td>
<td>17%</td>
<td>16.6%</td>
<td>1.03</td>
<td>208</td>
</tr>
<tr>
<td>Apgar &lt; 7</td>
<td>1%</td>
<td>0.9%</td>
<td>1.17</td>
<td>623</td>
</tr>
</tbody>
</table>

Mardirosoff. Meta-analysis: 24 Trials (n=3513) Intrathecal Opioids, BJOG 2002

**Minimize Effect:** Fentanyl (<50 mcg), Sufentanil (<7.5 mcg)
Van de Velde RAPM 2001, Fun Minerva Anesthesiol 2008

<table>
<thead>
<tr>
<th></th>
<th>CSE</th>
<th>DPE</th>
<th>EPIDURAL</th>
</tr>
</thead>
<tbody>
<tr>
<td>FHR decelerations</td>
<td>52.5%</td>
<td>45%</td>
<td>42.5%</td>
</tr>
<tr>
<td>NICHD I to II</td>
<td>32.5%</td>
<td>12.5%</td>
<td>12.5%</td>
</tr>
</tbody>
</table>

National Institute of Child Health and Human Development (NICHD) Classifications
Chau A, Bibbo C, Huang CC, Ellerman KG, Cappiello E, Tsen LC. Anesth Analg 2017

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*“What a trifling difference must often determine which should survive...and which perish”*  
Darwin
## Technique Disadvantages

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<td></td>
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## Uterine Hypertonus

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<thead>
<tr>
<th></th>
<th>CSE</th>
<th>DPE</th>
<th>EPIDURAL</th>
</tr>
</thead>
<tbody>
<tr>
<td>PRE UT/HT</td>
<td>5 (15%)</td>
<td>8 (20%)</td>
<td>8 (20%)</td>
</tr>
<tr>
<td>POST UT/HT</td>
<td>18 (45%)</td>
<td>4 (10%)</td>
<td>5 (12.5%)</td>
</tr>
<tr>
<td>Tocolysis</td>
<td>2 (5%)</td>
<td>0 (0%)</td>
<td>1 (2.5%)</td>
</tr>
</tbody>
</table>

1 Hour UT/UH: Uterine Tachysystole; Uterine Hypertonus

National Institute of Child Health and Human Development (NICHD) Classifications
Chau A, Bibbo C, Huang CC, Elterman KG, Cappiello E, Tsen LC. Anesth Analg 2017

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<td></td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>Workload</td>
<td></td>
<td></td>
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## Workload

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<th></th>
<th>CSE</th>
<th>DPE</th>
<th>EPIDURAL</th>
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<tr>
<td>NONE</td>
<td>20 (50%)</td>
<td>31 (77.5%)</td>
<td>20 (50%)</td>
</tr>
<tr>
<td>ONE or MORE</td>
<td>20 (50%)</td>
<td>9 (22.5%)</td>
<td>20 (50%)</td>
</tr>
<tr>
<td>TIME TO TOP-UP</td>
<td>132 ± 85</td>
<td>250 ± 163</td>
<td>207 ± 133</td>
</tr>
<tr>
<td>Catheter Manipulation</td>
<td>3 (7.5%)</td>
<td>2 (5%)</td>
<td>4 (10%)</td>
</tr>
<tr>
<td>Catheter Replacement</td>
<td>0 (0%)</td>
<td>0 (0%)</td>
<td>0 (0%)</td>
</tr>
</tbody>
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## Adverse Events

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<th>CSE</th>
<th>DPE</th>
<th>EPIDURAL</th>
</tr>
</thead>
<tbody>
<tr>
<td>NAUSEA</td>
<td>1 (2.5%)</td>
<td>1 (2.5%)</td>
<td>4 (10%)</td>
</tr>
<tr>
<td>PRURITUS</td>
<td>27 (87.5%)</td>
<td>4 (10%)</td>
<td>4 (10%)</td>
</tr>
<tr>
<td>HYPOTENSION</td>
<td>13 (32.5%)</td>
<td>5 (12.5%)</td>
<td>5 (12.5%)</td>
</tr>
</tbody>
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Technique Disadvantages

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<tr>
<td>Adverse Events</td>
<td>X</td>
<td></td>
<td></td>
</tr>
<tr>
<td>High Spinal Motor Block</td>
<td>X</td>
<td></td>
<td></td>
</tr>
<tr>
<td>PDPH</td>
<td>X (?)</td>
<td>X (?)</td>
<td></td>
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<tbody>
<tr>
<td>HIGHEST LEVEL</td>
<td>T4 [T2-T6]</td>
<td>T4 [T2-T8]</td>
<td>T4 [T2-T8]</td>
</tr>
<tr>
<td>MOTOR BLOCKADE</td>
<td>3 (7.5%)</td>
<td>6 (15%)</td>
<td>15 (37.5%)</td>
</tr>
<tr>
<td>PDPH</td>
<td>0 (0%)</td>
<td>0 (0%)</td>
<td>0 (0%)</td>
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Chau A, Bibbo C, Huang CC, Elterman KG, Cappiello E, Tsen LC. Anesthesiol 2017

Optimal Neuraxial Technique?

“Natural selection is daily and hourly scrutinizing, rejecting those that are bad, preserving all that are good”

“We see nothing of these slow changes in progress, until the hand of time has marked the lapse of ages”  
Darwin

CONCLUSIONS

Neuraxial Techniques

- 50 years
- 40 years
- 20 years

Workforce Surveys

- 1300 hospitals in United States
- Geography
- #births: 3 strata

Gibbs et al. Anesthesiology 1986
Hawkins et al. Anesthesiology 1997
Bucklin et al. Anesthesiology 2005
Traynor et al. Anes Analg 2016

Neuraxial Techniques
### Technique Advantages

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<td>X</td>
<td>X</td>
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<td></td>
<td>X</td>
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<tr>
<td>Progress of Labor</td>
<td>X</td>
<td>X</td>
<td>(?)</td>
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The CSE, DPE, and Epidural Technique

**Is there an Optimal Labour Analgesia Technique?**

SOAP Sol Shnider
Obstetric Anesthesia Meeting, 2019

**Lawrence C. Tsen, MD**  
Director, Center for Reproductive Medicine, Department of Anesthesiology, Perioperative & Pain Medicine, Brigham & Women’s Hospital  
Associate Professor in Anaesthesia  
Harvard Medical School

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Questions?
PIEB, CEI, PCEA: Is there an Optimal Labor Analgesic Maintenance Technique?

Brendan Carvalho MBBCh, FRCA, MDCH
Professor, Chief Obstetric Anesthesia Division
Stanford University School of Medicine
Immediate Past President, Society for Obstetric Anesthesia and Perinatology

Disclosures
No relevant financial relationships or funding to disclose
All investigational products and off-labeled use will be disclosed

Optimal Maintenance of Labor Neuraxial Analgesia
Lecture Outline
• Patient-controlled epidural analgesia (PCEA)
• Programmed intermittent epidural boluses (PIEB)
• Local anesthetic solutions
• Epidural pump settings

Labor Epidural Maintenance Techniques

1930s Epidural for Childbirth

1970s Manually bolus epidural
1980s Continuous epidural infusion CEI
1988 Patient-controlled PCEA
2004 Programmed intermittent PIEB

Manual Intermittent Epidural Boluses
• Workload
• Drug errors / Sterility
• Analgesic delays
• Third party pain interpretation
• Over or under treatment

Continuous Epidural Infusion (CEI)
• Fewer manual boluses
• Less hypotension
• No analgesic control
• Doesn’t adapt to labor pain or women’s needs
• More local anesthetic use
PCEA vs. CEI

Halpern, Douglas (Eds) Evidence-Based Obstetric Anesthesia BMJ 2006

↓ Local anesthetic use (24-45%)
↓ Motor block

↑ Analgesic, Maternal Satisfaction
Control, autonomy, no analgesic delays
Less motor block

Workload: ↓19% in clinician top-ups

PCEA: Potential Safety Concerns

• Local anesthetic overdose from excessive self-administration
  • Poor understanding of the PCEA technique
  • Family member "trying to be helpful"
• Literature and clinical experience: Labor PCEA is very safe
• Potential harm with all techniques (CEI, manual boluses, PIEB)

Labor PCEA Usage


Background CEI with PCEA

• Improved labor pain relief
• ↓ Clinician interventions
• ↑ Local anesthetic consumption
• Sleep uninterrupted
• Less active patient involvement

CEI + PCEA

PIEB + PCEA
Programmed Intermittent Epidural Bolus (PIEB) vs. Automated Mandatory Bolus (AMB)

- Most uniform spread:
  - Large volumes
  - Correspondingly high injectate pressures

Dyed solution: 10.5 mL/h vs. 3.5 mL (delivered over 1 min) every 20 mins
  - Kagral. Anesth Analg 1999;88:534

PIEB vs. CEI Spread

- Porcine model: Extent of dye spread 1 ml bolus vs. 1 ml over 30 min
  - Infusion: 9 cm (3.1 levels)
  - Bolus: 15 cm (5.5 levels)
  - Greater segmental spread
  - Injection pressure: 314 mmHg (bolus) vs. 24 mmHg (infusion)

PIEB Mechanisms

- Infusion rates office recruitment
  - 1 orifice (<80 mL/h) → 3 orifices (>300 mL/h) ¹

- Opioid bolus spinal effect
  - Epidural fentanyl bolus 30 mcg vs. infusion (30 mcg/h) → segmental analgesia (leg>head) ²

PIEB vs. CEI

- Longer duration of analgesia (239 vs. 181 min)
- Higher sensory block to cold
- Less labor pain
- No difference in blood pressure

PIEB + PCEA vs. CEI + PCEA

- Less bupivacaine consumption
- Fewer rescue boluses (↓22%)
- Higher maternal satisfaction

PIEB 10 ml every hour

- Continuous infusion

PIEB vs. CEI Spread


PIEB

- 10 ml/h

PIEB Mechanisms

Porcine model: Extent of dye spread 1 ml bolus vs. 1 ml over 30 min

- Infusion: 9 cm (3.1 levels)
- Bolus: 15 cm (5.5 levels)
- Greater segmental spread
- Injection pressure: 314 mmHg (bolus) vs. 24 mmHg (infusion)
### PIEB vs. CEI (+/- PCEA)

<table>
<thead>
<tr>
<th>Meta-Analysis Data Outcomes</th>
<th>PIEB vs. CEI</th>
<th>P-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Local Anesthetic Consumption</td>
<td>-1.2 mg/h</td>
<td>0.01</td>
</tr>
<tr>
<td>Maternal Satisfaction Scores</td>
<td>7.0 mm</td>
<td>&lt;0.00001</td>
</tr>
<tr>
<td>Duration of 2nd Stage of Labor</td>
<td>-12 min</td>
<td>0.04</td>
</tr>
<tr>
<td>Mode of Delivery</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cesarean Delivery</td>
<td>OR 0.87</td>
<td>0.54</td>
</tr>
<tr>
<td>Instrumented Delivery</td>
<td>OR 0.59</td>
<td>0.05</td>
</tr>
<tr>
<td>Anesthesia Interventions</td>
<td>OR 0.56</td>
<td>0.08</td>
</tr>
</tbody>
</table>

George RB. Anesth Analg 2013; 133 - 144

### PIEB + PCEA vs. PCEA + CEI

- 145 patients; Levobupivacaine 0.0625% + sufentanil 0.5 mcg/mL
- CEI (10 mL/h) vs. PIEB (10 mL q 1h)
- PCEA levobupivacaine 0.125%
- PCEA boluses needed: 40% vs. 8%
- Motor block: 37% CEI vs. 3% PIEB
- Instrumented delivery: 20% vs. 7%

Capogna G. Anesth Analg 2011;113:926–31

### PIEB/AMB vs. CEI

- Meta-Analysis; 12 studies (1121 women)
- ↓ Breakthrough pain (33% → 20%; RR 0.60)
- ↓ Local anesthetic use (MD -1.1 mg/h)
- 5/7 studies ↓ maternal satisfaction
- Instrumental delivery (12% vs. 9%; RR 0.75; 95%CI 0.5-1.1)
- Duration of labor (MD ~10 min; 95%CI ~27 to 6)
- No difference cesarean delivery

Sng. Cochrane Database of Systematic Reviews 2018, Issue 5. Art. No.: CD011344

### CEI + PCEA → PIEB + PCEA

- Bupivacaine 0.0625% + fentanyl 2 mcg/ml
- CEI 12 ml/h vs PIEB 9 ml q45 min
- ↓ Clinician rescue boluses: 19 vs 12%
- ↓ Unilateral block: 5 vs. 2%
- ↓ Peak pain: 2 [0–5] vs. 0 [0–4]
- Similar obstetric outcomes


### CEI + PCEA → PIEB + PCEA

- UW:
  - Bupivacaine 0.0625% + fentanyl 2 mcg/ml
  - CEI 10 ml/h vs. PIEB 10 ml q 45, 45HF, 60 min
  - PIEB (10 ml q 45 min) vs. CEI: ↓ physician bolus requests
- Duke:
  - Bupivacaine 0.125% + fentanyl 2 mcg/mL
  - CEI 5 mL/h vs. PIEB 5 mL/60 min or 3 mL/30 min
  - PIEB vs. CEI: ↑ PCEA attempts/given ratios


CEI → PIEB + PCEA
Clinical Practice Change

- CEI (ropivacaine 0.2% + fentanyl 2 mcg/ml) vs. PIEB + PCEA (ropivacaine 0.1% + fentanyl 2 mcg/ml)
- Decreased ropivacaine use
- Less motor block (31-fold difference)
- Shorter 2nd stage of labor

Bullingham. British J Anaesth 2018; 121(2): 432e437

Optimal PIEB + PCEA Settings

- Many recipes reported in literature
  - Bolus: 2-20 ml; lockout intervals: 5-60 min
- PCEA settings
  - No ideal settings
  - Larger less frequent boluses preferable
- PIEB settings
  - 10 mL bupivacaine 0.0625% + fentanyl 2 mcg/mL
  - Lockout ED90 ~40 min
  - Volume ED90 ~11 ml
  - 45% >T6, no motor block

Carvalho. Anesth Analg. 2016;1123:965-71
Kanczuk ME. Anesth Analg 2017;124:537-41
Zaker. Anaesthesia 2018;73, 459-465

PIEB and PCEA interactions

- In-vitro study:
  - Pressures by delivery speeds: 100, 175, 300, 400 mL/h
  - 2 single-orifice + 2 multi-orifice epidural catheters
  - Peak pressure ↑ with ↑ delivery speeds
- Clinical efficacy:
  - 100 ml/h vs. 300 ml/h PIEB: No difference analgesia quality
  - Standard set (250 mL/h) → high-flow tubing (500 mL/h)
  - Downstream occlusion alarms!

Krupner TT. J Clin Anesth. 2016;34:837
Lange. Anesthesiology 2018; 128:745-53
PIEB: Potential Safety Concerns

- Unwitnessed first bolus due to delay start of PIEB
- Occlusion alarm
- Respiratory depression (opioid bolus)
- Hypotension (local anesthetic bolus)
- Untested catheter (unrecognized intrathecal or intravascular)
- Inopportune bolus timing
  - Bolus during second stage labor in woman with motor block or difficulty pushing

Recommended Epidural Settings

**Stanford University**

- **Loading:**
  - Epidural: 15 ml 0.125% bupivacaine + 10 mcg sufentanil
  - CSE: 2.5 mg bupivacaine + 2.5 mcg sufentanil
- **Maintenance Solution:**
  - 0.0625% bupivacaine + 0.4 mcg/ml sufentanil
- **PCEA + PIEB Settings:**
  - PIEB 9 ml every 45 min
  - 10 ml PCEA
  - 10 min lockout
  - Delay 30 min

Dilute Local Anesthetic Solutions

**Reduce Motor Block**

- Bupivacaine
  - 0.0625% with fentanyl
  - Bupivacaine 0.25%

Light (≤ 0.1% Bupivacaine) vs. Heavy (> 0.1%) Meta-analysis:

- Assisted vaginal delivery
- Second stage duration, motor blockade, ambulation
- No difference with analgesia

Low dose epidural vs. Non-epidural analgesia

Meta-analysis:

- No difference assisted vaginal or cesarean delivery or duration of labor

Second Stage of Labor Duration: 400 patients

- Epidural 0.08% ropivacaine + 0.4 mcg/mL sufentanil
- Epidural 0.02 min vs. saline 51 min
- Spontaneous vaginal delivery rate similar (97% vs. 99%)

Despite 30% less local anesthetic consumption

Dilute Local Anesthetic Solutions

- Group 0.1%
- Group 0.1%
**Volume vs. Concentration**

<table>
<thead>
<tr>
<th>Bupivacaine 0.125%/L</th>
<th>Bupivacaine 0.25%/L</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Patient Number</strong></td>
<td><strong>Patient Number</strong></td>
</tr>
<tr>
<td>0 to 10</td>
<td>0 to 10</td>
</tr>
<tr>
<td>10 to 20</td>
<td>20 to 30</td>
</tr>
<tr>
<td>30 to 40</td>
<td>40 to 50</td>
</tr>
</tbody>
</table>

MLAV = 14 mL (17 mg)  
MLAV = 9 mL (23 mg)

Equivalent analgesia with 25% dose reduction

---

**Opioid + Local Anesthetics**

- ↓ LA requirement by 2-4 fold

**Fentanyl vs. Sufentanil**

- Fentanyl most popular option
- Many studies: Equivalent efficacy
- Sufentanil may be preferable (↓ pain, ↓ LA use, ↑ satisfaction, breastfeeding)1-4
- ↑ Cost, dosing errors with sufentanil


**Ropivacaine vs. Bupivacaine**

- MLAC potency ratios: 0.6 : 1.0
- Ropivacaine is 40% less potent

**PCEA Labor Analgesia**

- Systematic review; 11 studies
- Concentration range: 0.05% to 0.20%
- Labor analgesia similar
- Increased motor block with bupivacaine (5 studies, most did not account for potency)
- “Both ropivacaine and bupivacaine are well suited for PCEA in labor”

**Neuraxial Adjuvants**

**Clonidine and/or Neostigmine**

- Modest analgesic effect
- ↓ LA use (~30%) and opioid use
- ↓ Breakthrough pain
- Maternal side-effects and fetal concerns
- Bolus (Clonidine 50-75 mcg, Neostigmine 500 mcg)
- Infusion (Clonidine 1-2 mcg/ml)

---

**Labor Epidural Primary Aim**

- Reduce Labor Epidural Local Anesthetic Use
- Increase volume
- Add an opioid
- Minimize background
- Use bolus technique

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- Polley. Anesthesiology. 1998;89(3):626-32

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**Back to Table of Contents**
Labor Epidural Analgesic Maintenance Techniques

Summary

• Modern neuraxial techniques provides excellent analgesia
• PCEA offers many advantages over CEI
• PCEA+PIEB more effective than PCEA+CEI
• Dilute local anesthetic epidural solutions facilitate effective analgesia with minimal obstetric effects
• Optimal settings PIEB + PCEA uncertain

Epidural Labor Analgesia

• Overall rate neuraxial labor analgesia use:
  • 82% (>1500 deliveries/year)
  • 66% (<500) to 74% (500-1499)

### Objectives

- Review Current Contraindications for Neuraxial Techniques
- Discuss Maternal Diseases for Consideration of Alternatives to Neuraxial
- Discuss the Evidence for Remifentanil and Fentanyl PCA
- Discuss and Review Nitrous Oxide

### Gold Standard: Labor Epidural

- Catheter based technique utilized in early 1930’s
- Advances made in early 80’s with use of local anesthetics and opioids
- Techniques advanced: CSE and patient-controlled pumps
- Widely used in the U.S. with some centers up to 80% laboring women
- Survey of Women epidurals are the most common form of labor analgesia

### Contraindications to Epidural & Spinal Anesthesia

- Patient Refusal or Inability to Cooperate
- Increased ICP from Mass Lesion
- Skin or Tissue Infection at Needle Placement Site
- Frank Coagulopathy
- Uncorrected Maternal Hypovolemia
- Inadequate Experience with Technique

### Table 24

<table>
<thead>
<tr>
<th>Survey Item</th>
<th>LTM I 2000-02</th>
<th>LTM II 2005</th>
<th>LTM III 2011-12</th>
</tr>
</thead>
<tbody>
<tr>
<td>Used epidural or spinal analgesia for pain relief</td>
<td>83%</td>
<td>95%</td>
<td>67%</td>
</tr>
<tr>
<td>Had nitrous oxide intravenous drip for pain relief</td>
<td>80%</td>
<td>83%</td>
<td>76%</td>
</tr>
<tr>
<td>Used nitrous oxide for pain relief</td>
<td>3%</td>
<td>3%</td>
<td>3%</td>
</tr>
<tr>
<td>Used in pain medications</td>
<td>85%</td>
<td>50%</td>
<td>33%</td>
</tr>
</tbody>
</table>

*Emanuel’s Obstetric Anesthesia, 4th Edition, pg. 491*
Labor Analgesia Consumption and Time to Neuraxial Catheter Placement in Women with a History of Surgical Correction for Scoliosis: A Case-Matched Study

Jeanette R. Bauchat, MD,* Robert J. McCarthy, PharmD,* Tyler R. Kovic, MD,t and Cynthia A. Wong, MD

• 41 women with surgical correction and 41 controls subjects requesting neuraxial labor analgesia
• Neuraxial failure occurred in 12% of women with spinal instrumentation and none in control
• Mean time to complete the procedure was 41% longer
• More redirects and more experienced proceduralist was required

Neuraxial Techniques in Obstetric and Non-Obstetric Patients with Common Bleeding Diatheses

Systematic Review of 326 Neuraxial techniques on ITP patient
94 patient > 100k
204 patient had Pit count 75-100k
19 patient had Pit counts between 50-75k
9 patient Pit < 50k

No reports of hemorrhagic complications

38 y.o. G6P1 at 37w2d who presents to OB fellow clinic for hx of SLE presumed lupus nephritis & presumed ITP
• Pt has had a successful vaginal delivery in 2016 (due to thrombocytopenia was not a candidate for neuraxial but used nitrous and remifentanil)
• Her post partum course was complicated by severe thrombocytopenia, pre-eclampsia, and post-partum bleeding requiring transfusion
• During this pregnancy, she is on low dose plaquenil, 2-ASA per day
• Thrombocytopenia presumed to be immune-mediated complicated from her SLE, Goal pts > 50K

32 y G3P0 at 35w0d who presents to OB Anesthesia clinic for history of spinal fusion
(Mid Thoracic to Sacral Scar) in Florida at the age of 17
A) Offer Epidural
B) Offer her a Continuous Spinal
C) Offer her Nitrous
D) Offer her nothing and hope for the best

32 y G3P0 at 35w0d who presents to OB Anesthesia clinic for history of spinal fusion (Mid Thoracic to Sacral Scar) in Florida at the age of 17
• Initial epidural placement difficult for fellow and attending. No CSF with DPE and no level after testing. Decision made to replace epidural after discussing with patient
• Pre-scanning with ultrasound revealed L- Harrington rod deep to scar and midline 2-3 cm lateral. Epidural placed easily with DPE and threaded easily
• Repeat epidural placement functioned
• Underwent cesarean delivery with functioning epidural

38 y.o. G6P1 at 37w2d who presents to OB Anesthesia for history of SLE
• Neuraxial labor analgesia should provide multiple benefits

© 2009 International Anesthesia Research Society
38 y.o. G6P1 at 37w2d who presents to OB fellow clinic for hx of SLE presumed lupus nephritis & presumed immune mediated thrombocytopenia

After discussion patient opted for a remifentanil PCA and delivered quickly without complication

**Opioids**

- Bind to specific receptors in CNS
- 4 major opioid receptors= mu (μ), kappa, delta, sigma
- Modulated through descending inhibitory pathway from periaqueductal gray matter to dorsal horn of spinal cord

**Remifentanil**

- Ester structure
- Metabolized into inactive metabolite by non-specific esterases in plasma
- Metabolism allows for lack of accumulation
- Context sensitive half-life = 3.5 min, respiratory depression half-life = 2.5 min
- Rapid onset of analgesia = 30-60 sec; Peak at 2.5 min
- Crosses placenta and metabolized by placental and fetal nonspecific esterases
- F/M ratio = .50

**Fentanyl**

- High protein binding
- Lipid soluble
- No active metabolites when crossing the placenta
- Metabolized by the cytochrome P system via liver
- Reversed by naloxone
- Slows gastric emptying
- Respiratory depression
- Crosses placenta quickly to fetal F/M = .50

**Labor PCA**

Is it a viable alternative to labor epidural?

Intravenous remifentanil vs. epidural levobupivacaine with fentanyl for pain relief in early labour: a randomised, controlled, double-blinded study

Pain scores were lower in epidural group, which indicates epidural was superior for pain control

However, pain relief scores were no different between the groups
Remifentanil and Labor:


A.A. Melber, Y. Joling, M. Huber, D. Koller, A. Dullnkoepfl, T. Girardi, P. Kreita

Department of Anaesthesiology, Spital Frauenfeld, Frauenfeld, Switzerland
Department of Anaesthesiology, University Hospital Basel, University of Basel, Switzerland
Institute for Anaesthesia and Intensive Care Medicine, Spital Thurgau Frauenfeld, Frauenfeld, Switzerland
Department of Anaesthesiology, University Hospital Basel, University of Basel, Switzerland

Table 3: Summary of Remifentanil Studies for Labor Analgesia

Table 2: Changes to the standard operating procedure

Table 3: Maternal side effects

Routinely Available Remifentanil?

- Retrospective study in Ireland performed in 2007
- In 2005 remifentanil PCA for labor analgesia was routinely available
- During the two year period:
  - 28% opted for remifentanil
  - 22% opted for epidural
- Conversion from remifentanil to epidural was 10%

Remifentanil vs Fentanyl

Remifentanil versus fentanyl for intravenous patient-controlled labour analgesia: an observational study

Rémifentanil versus fentanyl pour l’analgésie intraveineuse contrôlée par les patientes en travail: étude observationnelle

Ratika Merwitz, MD · Somik Hoon, MD
Jen C. A. Carvalho, MD · Minakshi Kahi, MD

There is no difference in pain scores between Remifentanil and Fentanyl PCA. Both provide a moderate amount of pain relief. Pick your poison...

- Remifentanil: more maternal oxygen desaturation
- Fentanyl: associated with higher need for neonatal resuscitation
Labour pain with remifentanil patient-controlled analgesia versus epidural analgesia: a randomised equivalence trial

OWHM, Schuitemaker N, van Woerkens ECSM, Hostijn I, Middeldorp JM, van der Post JA, Mol BW. Labour pain with remifentanil patient-controlled analgesia, with well over 500 American birth centers and hospitals sources only

Main outcome measures

A total of 408 pregnant women at low risk for obstetric complications were randomised to receive remifentanil patient-controlled analgesia (IVPCA) or epidural analgesia, with well over 500 American birth centers and hospitals sources only.

Secondary Outcome - overall satisfaction with pain relief, Pain intensity scores during labor mode of delivery, and maternal and neonatal outcomes

Satisfaction with pain relief during labor with Remi/PCA and Epidural

Lower satisfaction with analgesia in Remi-PCA group

Higher pain intensity in the Remi-PCA group

Conclusions

Nitrous oxide

A qualitative analysis of parturients’ experiences using nitrous oxide for labor analgesia: It is not just about pain relief

Michael G. Richardson MD MD | Brittany L. Raymond MD | Curtis L. Ratliff MD | Bradley T. Kook MD | David H. Chestnut MD

- Qualitative content analysis
- 6507 deliveries 2011-2014
- 12% used nitrous oxide
- Determinants of satisfaction more variable, than previously thought

Any Other Alternatives?

Nitrous oxide

Comparison of remifentanil and nitrous oxide in labour analgesia

P. Vickers1, E. Abrego2, T. Raymond3, P. O'Donnell4, and S. Algeri5

1Department of Anaesthesia and Perioperative Care, St. Vincent's University Hospital, 2Department of Anaesthesia and Perioperative Care, Children's Hospital of Eastern Ontario, 3Department of Anaesthesia and Perioperative Care, and 4Department of Anaesthesia and Perioperative Care, St. Boniface General Hospital, 5Department of Anaesthesia and Perioperative Care, University of Manitoba, Winnipeg, Manitoba

Remifentanil IVPCA provides better labor analgesia compared to nitrous oxide

Satisfaction vs Analgesia

- 90% > 8 satisfaction scores
- 64% intermediate to low analgesia scores
- Women cited benefits of partial analgesia
- Partial analgesia allows for enhanced ability to cope with labor pain
Conclusions

• Epidural analgesia provides overall best pain relief in labor
• PCA opioid options exist, but with certain side effects
• Remifentanil an option for those who contraindicated to neuraxial
• Nitrous is an alternative, but pain scores higher than PCA-opioid
• Nitrous has a role in labor analgesia pain
• Nitrous does not require anesthesia provider to administer
Friday, March 15, 2019

Session II: Comorbidities and High-Risk Patients
Moderator: Lawrence Tsen, M.D.

Management of Parturients with Cardiac Disease
Ronald Pearl, M.D., Ph.D.

Latest on Pre-Eclampsia Management and Care Bundles
Gillian Abir, M.B., Ch.B., FRCA

Anesthetic Management of Invasive Placental Disease
John C. Markley, M.D., Ph.D.
Parturients with Cardiac Disease or Pulmonary Hypertension

Ronald Pearl, MD, PhD, FASA
Professor and Chair
Department of Anesthesiology
Stanford University
Rpearl@stanford.edu

No financial disclosures

• Cardiac anesthesiologist
• Critical care physician
• Expert in pulmonary hypertension

Cardiovascular Disease

• 1-2% of parturients
• Leading cause of maternal mortality in the developed world
• Fetal morbidity (premature labor, IUGR, congenital anomalies)
• Fetal mortality

The 7 Steps to Success

• Recognition of the disorder
• Assessment of its severity
• Perioperative risk assessment
• Preoperative optimization of the patient
• Choice of anesthetic technique
• Choice of monitoring
• Treatment of decompensation

Heterogeneity of Cardiovascular Disease

• Anatomy
  – Cardiomyopathy, valvular disease, congenital heart disease without shunts, CHD with shunts, aortopathy, pulmonary hypertension
• Functional status
  – Maternal mortality 0.4% with NYHA I or II
  – Maternal mortality 6.8% with NYHA III or IV
• Arrhythmias
Cardiovascular Changes of Pregnancy

- 30-50% increase in blood volume

Changes During Labor

- Further increases in CO and SV with labor
- Constructions: Autotransfusion of 300-500 ml; 30-50% increase in CO
- Painful contractions: Increased SVR, increased PVR
- Valsalva: Decreased venous return
- After delivery, preload increases 30% due to relief of aortocaval compression and uterine autotransfusion; CO increases 50%; SVR increases over days

Interactions with Cardiovascular Disease

- Obstructive lesions (mitral stenosis, aortic stenosis, pulmonary hypertension)
  - Increased flow results in increased gradient
  - Tachycardia increases mitral gradient in MS
  - Decreased preload results in decreased cardiac output
- Shunting lesions (VSD, complex congenital heart disease)
  - Decreased SVR or increased PVR increases right-to-left shunt
  - Increased SVR or decreased PVR increases left-to-right shunt
- Aortopathy (Marfan syndrome, bicuspid aortic valve)
  - Hypertension results in aortic dissection or rupture
  - Increased blood volume results in pulmonary edema
  - High incidence of arrhythmias
  - Need for increased cardiac output in pregnancy
  - ACEIs, ARBs, and aldosterone antagonists require discontinuation

Risk Assessment

- History, pathology, ECG, functional status, TTE, BNP, aortic diameter, arrhythmias
- Progression of disease during pregnancy
- Formal risk assessment systems
  - CARPREG
  - ZAHARA
  - WHO risk stratification model

WHO Classification

- Risk Categories
  1. No changes or minimal increase in maternal morbidity or short-term mortality in maternal and perinatal outcomes
  2. Small increased risk of maternal morbidity or limited increase in mortality
  3. Small increased risk of maternal morbidity and/or increased perinatal morbidity
  4. Moderate risk of maternal morbidity
  5. Pregnancy is contraindicated

Balci, Heart 2014; 100(17):1373

WHO Classification

- Risk Categories
  1. No changes or minimal increase in maternal morbidity or short-term mortality in maternal and perinatal outcomes
  2. Small increased risk of maternal morbidity or limited increase in mortality
  3. Small increased risk of maternal morbidity and/or increased perinatal morbidity
  4. Moderate risk of maternal morbidity
  5. Pregnancy is contraindicated

Balci, Heart 2014; 100(17):1373
WHO Classification

- Class 1: Mitral valve prolapse with trivial MR, successfully repaired ASD
- Class 2: Unrepaired ASD; repaired tetralogy of Fallot
- Class 3: Cyanotic heart disease; Fontan circulation; mechanical valve; systemic right ventricle; bicuspid aortic valve with aorta 45-50 mm; Marfan with aorta 40-45 mm
- Class 4: Pulmonary hypertension; severe AS; Marfan syndrome with aorta > 45 mm; severe LV dysfunction

CARPREG II Risk Score

<table>
<thead>
<tr>
<th>Predictor</th>
<th>Points</th>
</tr>
</thead>
<tbody>
<tr>
<td>Prior cardiac events or arrhythmias</td>
<td>3</td>
</tr>
<tr>
<td>Baseline NYHA II-IV or cyanosis</td>
<td>3</td>
</tr>
<tr>
<td>Mechanical valve</td>
<td>3</td>
</tr>
<tr>
<td>Ventricular dysfunction</td>
<td>2</td>
</tr>
<tr>
<td>High risk left-sided valve disease/ LV outflow tract obstruction</td>
<td>2</td>
</tr>
<tr>
<td>Pulmonary hypertension</td>
<td>2</td>
</tr>
<tr>
<td>Coronary artery disease</td>
<td>2</td>
</tr>
<tr>
<td>High risk aortopathy</td>
<td>2</td>
</tr>
<tr>
<td>No prior cardiac intervention</td>
<td>1</td>
</tr>
<tr>
<td>Late pregnancy assessment</td>
<td>1</td>
</tr>
</tbody>
</table>

CARPREG II Risk Score:

The 7 Steps

- Recognition of the disorder
- Assessment of its severity
- Perioperative risk assessment
- Preoperative optimization of the patient
- Choice of anesthetic technique
- Choice of monitoring
- Treatment of decompensation

Multidisciplinary Planning

- Cardiologist
- Obstetrician/MFM
- Anesthesiologist
- Neonatologist
- Additional providers
- Consideration of intervention such as balloon valvuloplasty for MS/AS or medications for pulmonary hypertension
The 7 Steps

• Recognition of the disorder
• Assessment of its severity
• Perioperative risk assessment
• Preoperative optimization of the patient
• Choice of anesthetic technique (and of delivery)
• Choice of monitoring
• Treatment of decompensation

Key Points

• Pregnancy not recommended in patients with pulmonary arterial hypertension, a systemic RV with decreased function, after Fontan operation, with dilated aorta, severe MS, or severely decreased LV ejection fraction
• Weight-based LMWH with anti-Xa monitoring rather than UFH
• WHO 2-3 or higher should be managed in specialized centers by a multidisciplinary team
• Induction of labor at 40 weeks
• Vaginal delivery recommended except for aggressive aortic pathology, acute intractable heart failure, severe pulmonary hypertension, or patients presenting in labor on oral anticoagulants

Method of Delivery

• Ruys, Heart 2015; 101:530
  – Analysis of ROPAC (Registry on Pregnancy and Cardiac Disease) registry
  – Compared planned vaginal delivery with planned Cesarean delivery
  – Similar perinatal mortality and Apgar scores
  – Planned section had decreased gestational age and birth weight
  – No difference in outcome with emergency vs. planned Cesarean
Method of Delivery

- Vaginal delivery in absence of obstetric indications
- “Cardiac vaginal delivery”
  -- Avoids pushing
  -- Requires forceps or vacuum-assisted delivery
- Cesarean delivery when pregnancy would have been contraindicated
  -- Severe aortopathy
  -- Severe pulmonary hypertension

The 7 Steps to Success

- Recognition of the disorder
- Assessment of its severity
- Perioperative risk assessment
- Preoperative optimization of the patient
- Choice of anesthetic technique
- Choice of monitoring
- Treatment of decompensation

Hemodynamic Goals

- Preload
- Afterload (SVR)
  - Blood pressure
  - Contractility
  - Heart rate
  - Rhythm
  - PVR
- Which are critical to the patient?
- Which are likely to change?

Interactions with Cardiovascular Disease

- Obstructive lesions (mitral stenosis, aortic stenosis, pulmonary hypertension)
  -- Increased flow results in increased gradient
  -- Tachycardia increases mitral gradient in MS
  -- Decreased preload results in decreased cardiac output
- Shunting lesions (VSD, complex congenital heart disease)
  -- Decreased SVR increases right-to-left shunt
  -- Increased SVR increases left-to-right shunt
- Aortopathy (Marfan syndrome, bicuspid aortic valve)
  -- Hypertension results in aortic dissection or rupture
- Cardiomyopathy
  -- Increased blood volume results in pulmonary edema
  -- High incidence of arrhythmias
  -- Need for increased cardiac output in pregnancy
  -- ACEIs, ARBs, and aldosterone antagonists require discontinuation

Monitoring

- 5-lead ECG
- NIBP ± arterial line
- Baseline TTE and availability if clinical change
- Fetal monitoring
- Consider CVP for drug administration and volume assessment
- Rarely PA catheter

Labor Analgesia

- Avoid painful labor: Increased HR, BP, CO, VO2
Method of Delivery

- Epidural when BP control is important (aortopathy, cardiomyopathy, regurgitant lesions)

Labor Analgesia

- Avoid painful labor: Increased HR, BP, CO, VO2
  - Early analgesia
  - Perineal coverage in later stages
- Epidural
- CSE with intrathecal opioid only
- LOR technique with no air in the syringe

Cesarean Delivery

- Neuraxial anesthesia (SAB, epidural, CSE)
  - Decreased preload, decreased SVR
  - Avoid rapid changes in hemodynamics
    - Slow epidural
    - CSE with low dose intrathecal bupivacaine (2.5 – 5 mg) and sequential epidural boluses
- General anesthesia
  - Sympathetic response to intubation
    - Consider lidocaine plus fentanyl or remifentanil
    - Etomidate in potentially unstable patient
    - Consider TEE monitoring

Postpartum Period

- Increased preload and afterload
- Requires ICU monitoring

Drugs and Cardiovascular Disease

- Terbutaline and ritodrine: ↑inotropy/chronotropy, ↓SVR
- Oxytocin: ↑SVR
- PGF2-alpha: ↑PVR
- Methylergonovine: Coronary vasospasm, ↑PVR

Pulmonary Hypertension

- One-third have a cardiac event
- 20% have a thromboembolic complication
- Half have premature delivery
- Increased fetal mortality
- Maternal mortality 25% but case series in specialized centers of 10-12%
- Neonatal mortality 1-4%; complications 18-30%
Risk of Surgery in Patients with Pulmonary Hypertension

- Depends on etiology of pulmonary hypertension, severity of pulmonary hypertension, and adequacy of compensatory mechanisms (RAP, CO, SvO₂, RV function, functional status)

The 7 Steps

- Recognition of pulmonary hypertension
- Assessment of severity of pulmonary hypertension
- Perioperative risk assessment
- Preoperative optimization of the patient
- Choice of anesthetic technique
- Choice of monitoring
- Treatment of decompensated pulmonary hypertension
Therapy of Pulmonary Hypertension

- Inhaled prostanoids
- Sildenafil
- Deliver at 34 weeks to avoid emergency situation – Cesarean delivery to avoid prolonged labor

The 7 Steps

- Recognition of pulmonary hypertension
- Assessment of severity of pulmonary hypertension
- Perioperative risk assessment
- Preoperative optimization of the patient
- Choice of anesthetic technique
- Choice of monitoring
- Treatment of decompensated pulmonary hypertension

Hemodynamic Goals in PH

- Maintain preload
- Maintain SVR (systemic afterload)
- Maintain contractility
- Maintain heart rate and sinus rhythm
- Avoid increased PVR

Anesthetic Techniques

- General anesthesia
  - ↓preload, ↓afterload, ↓contractility
- Neuraxial blocks
  - ↓Sympathetic tone, ↓preload, ↓afterload
- Regional anesthesia
  - Ideal for peripheral procedures and for postoperative pain

Induction Techniques

- Propofol: ↓preload, ↓afterload, ↓contractility
- Ketamine: ↑PVR
- Etomidate: Ideal agent
### Maintenance of Anesthesia
- **Nitrous oxide:** \( \uparrow \) PVR
- **High-dose narcotics:** Hypercarbia with emergence
- **Isoflurane/sevoflurane:** \( \downarrow \) SVR
- **Combined narcotic-volatile agent techniques** work well
- **Increasing role** for dexmedetomidine
  - Avoid bradycardia

### The 7 Steps
- **Recognition of pulmonary hypertension**
- **Assessment of severity of pulmonary hypertension**
- **Perioperative risk assessment**
- **Preoperative optimization of the patient**
- **Choice of anesthetic technique**
- **Choice of monitoring**
- **Treatment of decompensated pulmonary hypertension**

### Ventilation and PVR

![Graph showing Vascular Resistance (mmHg/min) vs. Flow (L/min)]

### The 7 Steps
- **Recognition of pulmonary hypertension**
- **Assessment of severity of pulmonary hypertension**
- **Perioperative risk assessment**
- **Preoperative optimization of the patient**
- **Choice of anesthetic technique**
- **Choice of monitoring**
- **Treatment of decompensated pulmonary hypertension**

### Intraoperative Monitoring
- **Arterial catheter**
- **Intraoperative TEE**
  - RV function, RV volume, LV volume
- **Pulmonary artery catheter**
  - Assess for progression of pulmonary hypertension
  - Guide surgical and anesthetic decision making
  - Treatment of systemic hypotension
  - Not used for wedge pressure measurement
  - Risk of pulmonary artery rupture

### Treatment of RV Failure
- Molloy, Am Rev Respir Dis 1984; 130:870
- Right ventricular failure model in dogs due to pulmonary hypertension from pulmonary embolism
- Resuscitation with
  - **Volume:** 0% survival
  - **Isoproterenol:** 0% survival
  - **Norepinephrine:** 100% survival
Hypotension and RV Decompensation

- **RV ischemia**
  - RV coronary flow normally in systole and diastole; in pulmonary hypertension, only in diastole
  - Increased oxygen consumption
  - Cycle of ischemia and failure
- **Role of the interventricular septum**
  - High LV pressure normally pushes the septum towards the RV free wall, producing RV ejection

Etiologies of Hypotension

<table>
<thead>
<tr>
<th>Etiology</th>
<th>CVP</th>
<th>PAP</th>
<th>CO</th>
</tr>
</thead>
<tbody>
<tr>
<td>Decreased preload</td>
<td>↓↓</td>
<td>↓</td>
<td>↓</td>
</tr>
<tr>
<td>Decreased contractility</td>
<td>↑↑</td>
<td>↓</td>
<td>↓</td>
</tr>
<tr>
<td>Decreased SVR</td>
<td>→</td>
<td>→</td>
<td>↑ or →</td>
</tr>
<tr>
<td>Increased PVR</td>
<td>↑↑</td>
<td>↑</td>
<td>↓</td>
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</table>

Management of Hypotension

<table>
<thead>
<tr>
<th>Is CVP decreased?</th>
<th>Yes</th>
<th>Volume</th>
</tr>
</thead>
<tbody>
<tr>
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<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Is PAP decreased?</th>
<th>Yes</th>
<th>Inotropes</th>
</tr>
</thead>
<tbody>
<tr>
<td>No</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Are there reversible causes of increased PVR?  
| No | Yes |

Is cardiac output decreased?  
| No | Yes |

Systemic vasoconstrictors  
| Inotropes and/or Pulmonary vasodilators |

Management of Hypotension

<table>
<thead>
<tr>
<th>Is CVP decreased?</th>
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<tr>
<th>Is PAP decreased?</th>
<th>Yes</th>
<th>Inotropes/ Vasoconstrictors</th>
</tr>
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</tr>
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<td>No</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Are there reversible causes of increased PVR?  
| No | Yes |

Is cardiac output decreased?  
| No | Yes |

Systemic vasoconstrictors  
| Inotropes and/or Pulmonary vasodilators |
**Active Pulmonary Vasoconstriction**

- Hypoxia
- Hypercarbia
- Acidosis
- Sympathetic tone

**Management of Hypotension**

<table>
<thead>
<tr>
<th>Question</th>
<th>Yes</th>
<th>No</th>
</tr>
</thead>
<tbody>
<tr>
<td>Is CVP decreased?</td>
<td>Volume</td>
<td>↓</td>
</tr>
<tr>
<td>Is PAP decreased?</td>
<td>Inotropes/</td>
<td>↓</td>
</tr>
<tr>
<td>Are there reversible causes of increased PVR?</td>
<td>Vasoconstrictors</td>
<td>↓</td>
</tr>
<tr>
<td>Is cardiac output decreased?</td>
<td>Treatment</td>
<td>↓</td>
</tr>
</tbody>
</table>

- Systemic Inotropes and/or vasoconstrictors
- Pulmonary vasodilators

**Vasopressors in Pulmonary Hypertension**

- Siehr, Pediatr Crit Care Med 2016; 17:428
  - 15 pediatric patients with pulmonary hypertension undergoing elective cardiac catheterization with general anesthesia
  - Received
    - Phenylephrine 1 mcg/kg (n = 5)
    - Epinephrine 1 mcg/kg (n = 5)
    - Vasopressin 0.03 U/kg over 5 minutes (n = 5)
  - Hemodynamic measurements at peak systemic pressure

**Management of Hypotension**

- Systemic Inotropes and/or vasoconstrictors
- Pulmonary vasodilators

**Inovasodilators**

<table>
<thead>
<tr>
<th></th>
<th>Control</th>
<th>Milrinone (1 hour)</th>
<th>Milrinone (2 hours)</th>
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</thead>
<tbody>
<tr>
<td>MPAP</td>
<td>34</td>
<td>28</td>
<td>27</td>
</tr>
<tr>
<td>CI</td>
<td>2.6</td>
<td>2.8</td>
<td>3.1</td>
</tr>
<tr>
<td>PVR</td>
<td>701</td>
<td>462</td>
<td>379</td>
</tr>
<tr>
<td>MAP</td>
<td>78</td>
<td>75</td>
<td>74</td>
</tr>
</tbody>
</table>

Wang, Adv Ther 2009; 26:46
MANAGEMENT OF HYPOTENSION

Is CVP decreased? Yes Volume
↓No
Is PAP decreased? Yes Inotropes
↓No
Are there reversible causes of increased PVR?
↓No  ↓Yes
Is cardiac output decreased? Treatment
↓No  ↓Yes
Systemic Pulmonary vasodilators
vasoconstrictors

MANAGEMENT OF HYPOTENSION

Is CVP decreased? Yes Volume
↓No
Is PAP decreased? Yes Inotropes/
↓No Vasoconstrictors
Are there reversible causes of increased PVR?
↓No  ↓Yes
Is cardiac output decreased? Treatment
↓No  ↓Yes
Systemic Pulmonary vasodilators
vasoconstrictors  Inhaled

Inhaled Vasodilators

• Nitric oxide
• Epoprostenol (Flolan, Veletri)

Postoperative Management

• Most challenging aspect of the case
• Emergence issues
  – Dexmedetomidine
• Post-delivery pulmonary hypertensive crisis due to hormonal vasoconstriction
• ICU monitoring
• Continue chronic pulmonary vasodilator therapy throughout the perioperative period

When All Else Fails

• Right ventricular assist device (RVAD)
• V-A ECMO

The 7 Steps to Success

• Recognition of the disorder
• Assessment of its severity
• Perioperative risk assessment
• Preoperative optimization of the patient
• Choice of anesthetic technique
• Choice of monitoring
• Treatment of decompensation

• Call a friend: Rpearl@Stanford.edu
THANK YOU!

Rpearl@Stanford.edu
The Latest on Preeclampsia Management and Care Bundles

Dr. Gillian Abir, MBChB, FRCA
Clinical Associate Professor
Department of Anesthesiology, Perioperative and Pain Medicine

Disclosures
Nothing to declare

Objectives
- Compare current practice with best evidence to identify areas of improvement
- Discuss the role of the obstetric anesthesiologist in management planning for patients with preeclampsia
- Review the concept of care bundles and describe ways to incorporate them in your practice

Incidence

- Preeclampsia ↑ 25%
- Gestational HTN ↑ 186%
- Eclampsia ↓ 22%

Maternal morbidity

- ↑ Risk of CVS disease
  - RR: HTN 3.7 after 14.1 yr (95% CI 2.7 – 5.05)
  - IHD 2.16 after 11.7 yr (95% CI 1.86 – 2.52)
  - CVA 1.81 after 10.4 yr (95% CI 1.45 – 2.27)
  - VTE 1.79 after 4.7 yr (95% CI 1.37 – 2.33)
- No associated ↑ risk of cancer

Maternal mortality

- RR of women dying within 12 months of delivery (preeclampsia/eclampsia vs. normotensive) = 5.1
- Overall mortality RR = 1.49 after 14.5 yr

Cause of death
(preeclampsia + eclampsia)
Seizure occurrence

- Antepartum: 25.1%
- During labor: 44.1%
- Postpartum: 26.3%
- Not specified: 4.5%


Medically indicated preterm delivery (<35 weeks)

- 22.3/1000 - eclampsia
- 10.7/1000 - preeclampsia
- 7.9/1000 - normotensive

Neonatal mortality rate

- 22.3/1000 - eclampsia
- 10.7/1000 - preeclampsia
- 7.9/1000 - normotensive


Neonatal morbidity + mortality

- Seizure occurrence
- Medically indicated preterm delivery (<35 weeks)
- Neonatal mortality rate


Cause-specific pregnancy-related mortality (US)

- Preeclampsia-eclampsia
- Chronic hypertension
- Chronic hypertension with superimposed PreE
- Gestational hypertension

Obstet Gynecol 2013;122:1122-31

Diagnostic criteria for preeclampsia

- SBP ≥ 160 or DBP ≥ 110 mm Hg (min)
- or
- SBP ≥ 140 or DBP ≥ 90 mm Hg (4 h apart)

- Proteinuria ≥ 300 mg/24 h
- or
- Prot/creat ≥ 0.3

1. Platelets < 100,000/µL
2. Serum creatinine > 1.1 mg/dL or [x2]
3. AST, ALT x2
4. Pulmonary edema
5. Cerebral or visual symptoms

Obstet Gynecol 2019;133:e1–25
Objectives

- Compare current practice with best evidence to identify areas of improvement
- Discuss the role of the obstetric anesthesiologist in management planning for patients with pre eclampsia
- Review the concept of care bundles and describe ways to incorporate them in your practice

How we can help

- Anesthetic risk assessment
- Blood pressure control
- Fluid management
- Eclampsia prophylaxis
- Analgesia + anesthesia planning

Treatment for acute-onset, severe range hypertension

<table>
<thead>
<tr>
<th>BP</th>
<th>Pres - CVA</th>
</tr>
</thead>
<tbody>
<tr>
<td>SBP &gt;155 mm Hg</td>
<td>(100%)</td>
</tr>
<tr>
<td>SBP ≥160 mm Hg</td>
<td>(96%)</td>
</tr>
<tr>
<td>DBP ≥110 mm Hg</td>
<td>(13%)</td>
</tr>
</tbody>
</table>

Pre-CVA

- SBP > 155 mm Hg (100%)
- SBP ≥160 mm Hg (96%)
- DBP ≥110 mm Hg (13%)

Call OB Stat

Monitor maternal vital signs

Airway/Breathing

- 100% O₂ via non-rebreather face mask + suction available
- Open airway:
  - Jaw thrust/ head-tilt chin-lift
- If airway obstructed gently insert an oral airway (if able)
- If not able to insert oral airway + patient is obstructed + sats < 94% gently insert a nasal airway
- If apneic, ventilate with an ambu bag
- After airway control obtained turn to left lateral position + trendelenburg

Circulation

- See other side for meds

Seizure Control

- If not on magnesium administer 6 g bolus IV (over 20 mins)
- If already on magnesium administer 2nd bolus dose of 2 g IV (over 3 - 5 mins)
- Magnesium maintenance dose 1 - 2 g/hr
- If seizure not terminating administer midazolam 2 mg IV (lorazepam 4 mg IV is an alternative)
- Anesthesiologist to consider small dose of propofol (i.e. 20 - 40 mg)
- If seizure continues consider intubation (modified RSI)

Monitor FHR

OB and Anesthesia to discuss if/when delivery is required.

Try and avoid immediate delivery, allow time for FHR to return to baseline.

Deliver only for prolonged bradycardia after termination of seizure.

ONLY INTUBATE PATIENT IF:
1) Remains unconscious post-seizure
2) Non-terminating seizure
3) Signs of aspiration
4) Is hypoxic

Dr G Abir and colleagues (2015) – Stanford Children’s Health

Management of eclampsia

Acute/bradycardia

- Ensure intubation has been established
- Put patient on sophisticated ECG/monitor
- Titrated sedation 
- Optimize ventilation

Circulation

- One goal: control BP
- Use propofol and magnesium to decrease blood pressure
- Consider oral/nasal airway
- Consider intubation

Seizure Control

- If not on magnesium administer a bolus of 2g
- Midazolam 2mg IV or an alternative

Molecular PCD

- If intubation needed then paralyze
- Use propofol for sedation
- Titrated sedation

AOG - 2nd line

Esmolol infusion or Nicardipine infusion

Extreme emergency:

Sodium nitroprusside

Dr G Abir and colleagues (2015) – Stanford Children’s Health
RSI modification - Indications

- Preeclampsia
- Eclampsia
- Increased intracranial pressure:
  - Tumor
  - Head injury
  - Hemorrhage
  - Meningoencephalitis
  - Hydrocephalus
  - Cerebral edema
  - Status epilepticus
  - PRES

Cardiovascular changes at intubation

**Unmodified**

**Modified**

SBP = Systolic blood pressure (mm Hg)
HR = Heart rate (bpm)

Intracerebral hemorrhage

- Intraparenchymal hemorrhage
- Midline shift

http://wenpathology-web.org/chapter2/chapter2/3Cerebralhemorrhage.html

RSI drugs

**Modified**

- Esmolol 1-2 mg/kg
- Remifentanil 1 mcg/kg

**Induction agent**

- Propofol

**Muscle relaxant**

- Succinylcholine

**Maintenance**

- O₂ + Volatile ± N₂O

Ocular Ultrasound

- Optic nerve sheath diameter >5.8 mm ➤ ↑ ICP (90% sensitivity, 84% specificity)
- Optic disc height ≥1 mm ➤ ↑ ICP (73% sensitivity, 100% specificity)
Preeclampsia with severe features vs. control group

<table>
<thead>
<tr>
<th></th>
<th>Optic nerve sheath diameter ≥5.8 mm</th>
<th>Optic disc height &gt;1 mm</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Severe preeclampsia (n=30)</td>
<td>Control (n=30)</td>
</tr>
<tr>
<td>Antepartum</td>
<td>13 (43%)†</td>
<td>0</td>
</tr>
<tr>
<td>Day 1 postpartum</td>
<td>13 (43%)†</td>
<td>23 (77%)†</td>
</tr>
<tr>
<td>Day 4 postpartum</td>
<td>3 (10%)†</td>
<td>6 (20%)†</td>
</tr>
</tbody>
</table>

* P<0.001
† P=0.66

Please note...

- **81 mg aspirin** (PreE prophylaxis)
  - Neuraxial anesthesia not contraindicated
- **Magnesium infusion** (PreE with severe features)
  - Continue infusion during cesarean delivery
- **NSAIDs**
  - Safe use in postpartum patients with BP issues

Objectives

- Compare current practice with best evidence to identify areas of improvement
- Discuss the role of the obstetric anesthesiologist in management planning for patients with preeclampsia
- Review the concept of care bundles and describe ways to incorporate them in your practice

Care Bundles

“A patient safety bundle is a set of evidence-based guidelines, to be adapted for local circumstances, to optimally manage a medical condition and thus improve patient outcomes.”

Maternal Safety Bundle for Severe Hypertension in Pregnancy
§ Standard diagnostic criteria, monitoring + treatment
§ Unit team education, reinforced with drills with debriefs
§ Timely triage
§ Rapid access to medications
§ System plan for escalation

Bernstein et al. Obstet Gynecol 2017;130:347–57

§ Standard protocol and measurement of blood pressure + urine protein
§ Standard response to MEWS
§ Facility-wide standards for educating women on symptoms + signs

Bernstein et al. Obstet Gynecol 2017;130:347–57

§ Facility-wide standard protocols with checklists + escalation protocols for management + treatment
§ Minimum requirements for protocol
§ Support plan for patients, families + staff for ICU admissions + serious complications

Bernstein et al. Obstet Gynecol 2017;130:347–57

In summary
✓ Current practice
✓ Role of the anesthesiologist
✓ Care bundles

gabir@stanford.edu
Anesthetic Management of Invasive Placental Disease

John C. Markley, MD, PhD
Department of Anesthesia and Perioperative Care
University of California San Francisco
Director of Obstetric Anesthesia, Zuckerberg San Francisco General

No Financial Disclosures

This presentation will address off-label use of medications

Placenta Accreta Spectrum (PAS)
aka Morbidly Adherent Placenta (MAP)
aka Invasive Placental Disease

Figure 1.
Placenta Accreta, Increta, and Percreta.

The New England Journal of Medicine
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Silver et al.
NEJM.
2018

Bladder muscularis

Increta involving anterior (A), posterior (P), left (L), and right (R) lower uterine segments

Gross images courtesy of Dr. J. Rabban, UCSF Department of Pathology

Cervix

Fundus

Gross images courtesy of Dr. J. Rabban, UCSF Department of Pathology
Not all accretas are the same (hence the term placenta accreta spectrum)

- Small area of accrete
- Not necessarily associated with cesarean wound
- If films, uterus may contract well
- Hypertrophy not typically noted

![Image](https://example.com/image1.png)

Placenta Accreta Spectrum: Hemorrhage

- Because placenta is “stuck,” a gravid hysterectomy may be needed.
- Gravid hysterectomy is not at all like a Non-Gravid hysterectomy
  - 700 vs. 50 mL/min blood flow
  - Many collateral vessels
  - Much larger organ
  - Open procedure
  - Fetal(s)

![Image](https://example.com/image2.png)

Previa + Prior Cesarean Delivery → Accreta

- Risk of PAS increases with # of prior cesareans in the presence of previa

<table>
<thead>
<tr>
<th>Cesarean Delivery</th>
<th>Previa</th>
<th>None/Cesarean</th>
<th>No Previous/Cesarean</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total</td>
<td>35</td>
<td>25</td>
<td>10</td>
</tr>
<tr>
<td>Sec + Prior</td>
<td>10</td>
<td>5</td>
<td>5</td>
</tr>
<tr>
<td>Total + Prior</td>
<td>20</td>
<td>15</td>
<td>5</td>
</tr>
<tr>
<td>Diagnosis</td>
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<tr>
<td>Placenta previa</td>
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<td></td>
<td></td>
</tr>
<tr>
<td>Placenta previa resection</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Placenta previa total hysterectomy</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

![Image](https://example.com/image3.png)

Role of the Anesthesiologist in C-Hyst Planning

- Opportunities for involvement of the Obstetric Anesthesia service

- Identification of exact location of delivery (surgical suite and its associated capabilities)
- Assurance that critical care services are engaged and available for postoperative care
- Verification of appropriate complement of surgical expertise involved or available, or both
- Preoperative evaluation of need for maternal/fetal monitoring (eg, continuous umbilical cord blood flow monitoring, intrauterine antibiotic exposure)
- Identification of need for abdominal or thoracic surgery
- Intraoperative availability of resources to optimize each case
- Identification of need for maternal or fetal intensive care services
- Preparation for and availability of critical care services required to stabilize mother and fetus
- Postoperative evaluation of need for critical care services

![Image](https://example.com/image4.png)

Accreta Center of Excellence: Criteria


- Level of Maternal Care

<table>
<thead>
<tr>
<th>Required Service</th>
<th>Level 1</th>
<th>Level 2</th>
<th>Level 3</th>
<th>Level 4</th>
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</thead>
<tbody>
<tr>
<td>Anesthesia</td>
<td>Anesthesia service available at all times</td>
<td>Anesthesia service available at all times</td>
<td>Anesthesia service available at all times</td>
<td>Anesthesia service available at all times</td>
</tr>
<tr>
<td>Labor &amp; delivery</td>
<td>Obstetric service available with special training in obstetrics, available for consultation</td>
<td>Obstetric service available with special training in obstetrics, available for consultation</td>
<td>Obstetric service available with special training in obstetrics, available for consultation</td>
<td>Obstetric service available with special training in obstetrics, available for consultation</td>
</tr>
</tbody>
</table>

![Image](https://example.com/image5.png)
Obstetric Management of PAS

- Cesarean hysterectomy – typical treatment
- Conservative/Preservative management
  - Placental tissue removed, no hysterectomy
- Expectant management
  - Placenta remains in situ, no hysterectomy

General Surgical Plan for PAS C-Hyst

- Delivery at 34-36 weeks
- +/- Preoperative ureteral stent placement
- +/- Arterial balloon catheters
- Low lithotomy vs. supine positioning
- Vertical midline vs. Pfannenstiel incision
- Hysterotomy site dependent on placenta position
- Delivery of neonate(s)
- Placenta left in situ
- Closure of hysterotomy
- Gravid hysterectomy
- +/- Cystoscopy
- +/- Arterial embolization
- +/- Intensive care unit

Planning for the PAS Case

- Multidisciplinary team
  - Obstetrics
  - Obstetric Anesthesia
  - Perfusion Medicine (autologous blood salvage)
  - Neonatology
  - Gynecologic-Oncology
  - OR Nursing
  - Main OR Nursing
  - Anesthesia Technicians
  - Radiology
  - Intervventional Radiology
  - Transfusion Medicine (Blood Bank)
  - General/Thoracic Surgery
  - Ultrasound
  - Critical Care

PAS C-Hyst Perioperative Checklist

- In an unplanned Cesarean hysterectomy, these resources may need to be activated intraoperatively.

Transfusion Strategy

- Prepare for massive transfusion
- RBC:Plasma:Platelets
  - No equivalent of the randomized PROPPR trial done for obstetric hemorrhage
  - Higher Plasma/RBC ratio assoc. w/ decr. need for advanced interventional procedures
  - CMQCC recommends 6:4:1 or 4:4:1
- Aim for fibrinogen > 250 mg/dL
  - Cryoprecipitate
  - Fibrinogen concentrate (ReStAP)

Vascular Access: Poiseuille Equation c. 1840

\[ Q = \frac{\pi}{8} \cdot r^4 \cdot \frac{P_1 - P_2}{\eta \cdot L} \]
**Peripheral vs. Central Access**

- "Exchange Set" means you can exchange a 20G catheter with this set.

**Pressurized Flow Rates Through Different Catheters**

- **Belmont rapid infuser**
  - Maximum rate: 1000 mL/min
  - Pressure limiter set to 300 mm Hg
  - Extension tubing attached

- **Massive Transfusion Products (PRBC:FFP 1:1)**

**Uterotonics During C-Hyst for PAS?**

- No data to support their use OR non-use

- Controversy:
  - **PRO argument**
    - Myometrial contraction will occlude blood vessels
  - **CON argument**
    - Uterotonics will cause placental separation and lead to hemorrhage.

  Side effects of uterotonic agents.

**Anesthetic Modality Options for PAS**

- **Primary neuraxial anesthesia (NA)**
  - What type of neuraxial?
  - Sedation plan?

- **Primary general anesthesia (GA)**
  - Place neuraxial for post-operative analgesia?
  - NA to GA conversion after delivery
    - Electively after delivery?
    - Electively after hysterectomy confirmed?
    - Convert only if needed (non-elective)?
Comparison of Anesthesia Modalities

<table>
<thead>
<tr>
<th>Anesthetic Modality</th>
<th>Patient awake</th>
<th>Bonding/Breastfeeding possible</th>
<th>Lower incidence of Apgar &lt;7</th>
<th>Possibly lower EBL</th>
<th>Reduced ICU admission</th>
<th>Possible need for emergent conversion to GA</th>
<th>Inferior operative conditions</th>
<th>Intraoperative N/V</th>
<th>Possible need for supplemental sedation</th>
<th>Sym pathetic</th>
<th>Need in the setting of potential coagulopathy</th>
<th>Neuraxial sympathectomy + GA induction at onset of hemodynamic instability</th>
<th>Patient can see/bond with neonate</th>
<th>Airway secured during resuscitation</th>
<th>Reduced fetal exposure to anesthetics</th>
</tr>
</thead>
<tbody>
<tr>
<td>Neuraxial anesthesia (NA)</td>
<td>•</td>
<td>•</td>
<td>•</td>
<td>•</td>
<td>•</td>
<td>•</td>
<td>•</td>
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<td>•</td>
<td>•</td>
<td>•</td>
<td>•</td>
<td>•</td>
</tr>
<tr>
<td>General Anesthesia (GA)</td>
<td>•</td>
<td>•</td>
<td>•</td>
<td>•</td>
<td>•</td>
<td>•</td>
<td>•</td>
<td>•</td>
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<td>•</td>
<td>•</td>
<td>•</td>
<td>•</td>
<td>•</td>
</tr>
<tr>
<td>NA-to-GA conversion after delivery</td>
<td>•</td>
<td>•</td>
<td>•</td>
<td>•</td>
<td>•</td>
<td>•</td>
<td>•</td>
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<td>•</td>
<td>•</td>
<td>•</td>
<td>•</td>
<td>•</td>
</tr>
</tbody>
</table>


No prospective studies.
No consensus on a superior anesthe sia modality.

Not Realistic to Plan Based on Path-Confirmed PAS

- Problem: When planning a case, the Obstetric Anesthesiologist is not given the patient’s pathology results.
- Our plan relies on clinical and radiological suspicion for PAS.
- For example, what is your anesthetic plan for this scenario?
  - Clinical: “Current placenta previa with history of two prior cesarean deliveries.”
  - Radiological findings: “Low suspicion for increta.”
  - Ultrasound – 54% sensitivity, 88% specificity
  - MRI – 77% sensitivity, 50% specificity
  - Ultrasound & MRI – 68% concordance

Anesthesia for Suspected PAS

Resuscitative Endovascular Balloon Occlusion of the Aorta (REBOA) for PAS

- **Prophylaxis:** Meta-analysis of 4 studies
  - N = 128 control, N = 313 balloon
  - Balloon = -1.4 L EBL, 2-5 units transfused
  - 2 balloon-related complications
- **Treatment:** Largest case series: N = 36
  - Balloon placed for hemodynamically unstable severe PPH
  - All cases resulted in return of hemodynamic stability
  - 6 balloon-related complications
  - Of note, procedure performed by IR, but not with fluoroscopy


Conclusions

- ACOG strongly recommends that patients with suspected PAS be delivered at a Level III or IV Maternal Care institution
- The multi-disciplinary team approach is essential for successful outcomes
- No prospective trials exist comparing anesthesia modalities for cesarean delivery for PAS
- Primary neuraxial anesthesia may have advantages over primary general anesthesia including reduced fetal exposure to anesthetics
  - Starting with neuraxial anesthesia may prevent the unnecessary conversion and avoid maternal hypotension during GA induction.
- Immediate availability of vasopressors may avoid maternal hypotension during GA induction.
- Attention to hemodynamic stabilization and immediate availability of vasopressors may avoid maternal hypotension during GA induction.
- Noting a 21% conversion rate from NA to GA following the decision to perform gravid hysterectomy can be the patient's surgical outcome variable.

PAS C-Hyst: NA-Only vs. NA-to-GA

<table>
<thead>
<tr>
<th>Outcome Variable</th>
<th>NA-Only (N = 15)</th>
<th>NA-to-GA (N = 15)</th>
<th>p-Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Vasoconstrictor (1.5 U PRBC)</td>
<td>4 (66.7%)</td>
<td>9 (60%)</td>
<td>0.01</td>
</tr>
<tr>
<td>Total products IV</td>
<td>2 (0-24)</td>
<td>8 (0-34)</td>
<td>0.033</td>
</tr>
<tr>
<td>Preoperative duration</td>
<td>25 (9-58)</td>
<td>20 (10-43)</td>
<td>0.033</td>
</tr>
<tr>
<td>Perioperative Acuity</td>
<td>2 (1.6%)</td>
<td>7 (4.7%)</td>
<td>0.009</td>
</tr>
<tr>
<td>Pathological diagnosis</td>
<td>1 (6.7%)</td>
<td>1 (6.7%)</td>
<td>0.07</td>
</tr>
<tr>
<td>No invasion</td>
<td>4 (26.7%)</td>
<td>0 (0%)</td>
<td>0.007</td>
</tr>
<tr>
<td>Severe</td>
<td>4 (26.7%)</td>
<td>0 (0%)</td>
<td>0.007</td>
</tr>
<tr>
<td>Severe</td>
<td>4 (26.7%)</td>
<td>0 (0%)</td>
<td>0.007</td>
</tr>
</tbody>
</table>

Data shown as n (%) or median (IQR). Asterisk: *Need for ICU admission, arterial embolization, immediate availability of vasopressors may avoid maternal hypotension during GA induction.

Session III: Enhanced Recovery and Cesarean Anesthesia
Moderator: Brendan Carvalho, M.B., B.Ch., FRCA

Recommended ERAS Protocols for Cesarean Delivery
Ashraf S. Habib, M.B., B.Ch., M.Sc., M.S.N., FRCA

Setting up and Evaluation of a Successful ERAS Pathway for Cesarean Delivery
Eric J. Hunt, M.D., Ph.D.

Regional Blocks for Cesarean Delivery Analgesia: TAP, QL and Beyond
Pedram Aleshi, M.D.
Recommended ERAS Protocols for Cesarean Delivery

Ashraf S Habib, MBChB, MSc, MHSc, FRCA
Professor of Anesthesiology
Professor in Obstetrics and Gynecology
Chief, Division of Women’s Anesthesia

Disclosures

- Research Support
  - Trevena Inc.
  - Pacira Pharmaceuticals
  - BioQ Pharma
  - Haylard Health

- Advisory Board
  - Trevena Inc
  - Health Decisions

Objectives

- Identify Quality of Recovery Indicators following Cesarean Delivery
- Provide an Overview of essential elements of an ERAS protocol for CD
- Focus on the Anesthesiologist role in ERAS protocols
Objectives

- Identify Quality of Recovery Indicators following Cesarean Delivery
- Provide an Overview of essential elements of an ERAS protocol for CD
- Focus on the Anesthesiologist role in ERAS protocols
Anesthesiologist Role

- Prevention of hypotension
- Prevention of hypothermia
- Nausea and vomiting prophylaxis
- Postoperative analgesia

Fluids for Spinal Induced Hypotension

<table>
<thead>
<tr>
<th>Study</th>
<th>Method</th>
<th>Ephedrine</th>
<th>Phenylephrine</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ngan Kee 2008</td>
<td>Bolus</td>
<td>13%</td>
<td>0%</td>
</tr>
<tr>
<td>Prakash 2010</td>
<td>Bolus</td>
<td>13%</td>
<td>4%</td>
</tr>
<tr>
<td>Ngan Kee 2009</td>
<td>Infusion</td>
<td>35%</td>
<td>2%</td>
</tr>
<tr>
<td>Ngan Kee 2008</td>
<td>Infusion</td>
<td>40%</td>
<td>0%</td>
</tr>
<tr>
<td>Cooper 2002</td>
<td>Infusion</td>
<td>66%</td>
<td>17%</td>
</tr>
</tbody>
</table>

Table 1

<table>
<thead>
<tr>
<th>Study</th>
<th>APGAR 1 min</th>
<th>APGAR 5 min</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ephedrine</td>
<td>Phenylephrine</td>
<td>Significance</td>
</tr>
<tr>
<td>Ayorinde et al., 2001</td>
<td>14</td>
<td>9 (9–10)</td>
</tr>
<tr>
<td>Adigun et al., 2010</td>
<td>20*</td>
<td>8.0</td>
</tr>
<tr>
<td>Guillon et al., 2010</td>
<td>23</td>
<td>9 (5–10)</td>
</tr>
<tr>
<td>Prakash et al., 2010</td>
<td>24</td>
<td>8 (7–9)</td>
</tr>
<tr>
<td>Dyer et al., 2009</td>
<td>4</td>
<td>9 (7–10)</td>
</tr>
<tr>
<td>Hennebry et al., 2009</td>
<td>26</td>
<td>9 (8–10)</td>
</tr>
<tr>
<td>Cooper et al., 2002</td>
<td>22</td>
<td>9 (9–9)</td>
</tr>
</tbody>
</table>

Data are given as median and range.

*Standard deviation.
n.s., not significant.

IONV with Ephedrine vs. Phenylephrine

Prophylactic Phenylephrine Infusion

- Prevention of hypotension
- Prevention of hypothermia
- Nausea and vomiting prophylaxis
- Postoperative analgesia
Impact of Hypothermia

- Increased blood loss
- Increased wound infection
- Myocardial ischemia
- Prolonged drug action
- Prolonged recovery and hospital stay/ increased costs

Incidence of Hypothermia

- 91% No warming
- 64% Warming

Frank SM. JAMA 1997;277;1127-34.
KurzA. NEJM 1996; 334;1209-15
LenhardtR. Anesthesiology 1997;87:1318-23

Magnitude and Duration of Temperature Drop

Active Warming

<table>
<thead>
<tr>
<th>Outcome (n studies)</th>
<th>MD, RR or SMD (95% CI)</th>
</tr>
</thead>
<tbody>
<tr>
<td>End of surgery temperature (10)</td>
<td>0.43 (0.27, 0.59)</td>
</tr>
<tr>
<td>Shivering (12)</td>
<td>0.58 (0.43, 0.79)</td>
</tr>
<tr>
<td>Thermal Comfort (4)</td>
<td>0.96 (0.36, 1.45)</td>
</tr>
<tr>
<td>Hypothermia (5)</td>
<td>0.66 (0.50, 0.87)</td>
</tr>
<tr>
<td>Umbilical artery pH (3)</td>
<td>0.02 (0.00, 0.06)</td>
</tr>
</tbody>
</table>

Anesthesiologist Role

- Prevention of hypotension
- Prevention of hypothermia
- Nausea and vomiting prophylaxis
- Postoperative analgesia
Prevention of IONV

- **Anesthetic factors:**
  - Prevention of hypotension (PE Infusion)
  - Good quality block (ITF)
  - RR (95% CI) = 0.41 (0.24 - 0.70), NNT = 6.5
  - Combination Antiemetics
  - Metoclopramide + ondansetron
  - 23% vs. 49% with placebo

- **Surgical factors:** Exteriorization and irrigation

Exteriorization of the Uterus and Bowel Function

<table>
<thead>
<tr>
<th>Return of bowel function</th>
<th>Irrigation</th>
<th>No Irrigation</th>
</tr>
</thead>
<tbody>
<tr>
<td>%</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Intraoperative Nausea</td>
<td>18%</td>
<td></td>
</tr>
<tr>
<td>Postoperative Vomiting</td>
<td></td>
<td>28%</td>
</tr>
<tr>
<td>Prevention of PONV</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Irrigation</td>
<td>1.68, 95% CI: 1.36 - 2.06</td>
<td></td>
</tr>
<tr>
<td>No Irrigation</td>
<td>0.95, 95% CI: 0.64 - 1.40</td>
<td></td>
</tr>
</tbody>
</table>

Exteriorization of the Uterus and Intra-abdominal Irrigation and IONV

Intra-abdominal saline irrigation at cesarean section: a systematic review and meta-analysis

Prevention of PONV

- **Combination Antiemetic Therapy**
- **Analgesia**
  - Dose of ITM
  - Opioid sparing techniques
Anesthesiologist Role

- Prevention of hypotension
- Prevention of hypothermia
- Nausea and vomiting prophylaxis
- Postoperative analgesia

Modalities for Post-Cesarean Analgesia

- Opioids
- Systemic Adjuncts
- Local Anesthetic Techniques
- Neuraxial Adjuncts

Neuraxial vs. Parenteral Opioids

- Meta-analysis (10 studies):
  - \(\uparrow\) time to first analgesia
  - \(\downarrow\) pain scores
  - \(\uparrow\) pruritus (RR=2.7) and nausea (RR=2)
  - \(\uparrow\) sedation with parenteral opioids

Dose Response of Neuraxial Morphine

<table>
<thead>
<tr>
<th>Epidural Morphine</th>
<th>Intrathecal Morphine</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>70</td>
</tr>
<tr>
<td>1.25</td>
<td>60</td>
</tr>
<tr>
<td>2.5</td>
<td>50</td>
</tr>
<tr>
<td>3.75</td>
<td>40</td>
</tr>
<tr>
<td>5</td>
<td>30</td>
</tr>
</tbody>
</table>

ITM Dose and Pruritus/PONV

<table>
<thead>
<tr>
<th>Outcomes</th>
<th>No. studies</th>
<th>No. patients (low dose, high dose)</th>
<th>MD/CR</th>
<th>OR (95% CI)</th>
<th>P</th>
<th>P</th>
<th>NNT/NNH</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pain scores at 24 h</td>
<td>2</td>
<td>74, 72</td>
<td>MD</td>
<td>2.54 (1.59 to 4.04)</td>
<td>0.03</td>
<td>16</td>
<td></td>
</tr>
<tr>
<td>Pain scores at 36 h</td>
<td>1</td>
<td>18, 13</td>
<td>MD</td>
<td>1.83 (0.91 to 3.67)</td>
<td>0.08</td>
<td>14</td>
<td>16</td>
</tr>
<tr>
<td>Pruritus</td>
<td>8</td>
<td>256, 152</td>
<td>OR</td>
<td>0.34 (0.23 to 0.52)</td>
<td>0.0001</td>
<td>0</td>
<td>5.9</td>
</tr>
<tr>
<td>Severe pruritus</td>
<td>5</td>
<td>204, 131</td>
<td>OR</td>
<td>0.32 (0.16 to 0.69)</td>
<td>0.025</td>
<td>0</td>
<td>11.5</td>
</tr>
<tr>
<td>Vomiting</td>
<td>7</td>
<td>186, 124</td>
<td>CR</td>
<td>0.44 (0.27 to 0.73)</td>
<td>0.021</td>
<td>0</td>
<td>8.3</td>
</tr>
<tr>
<td>Nausea or vomiting</td>
<td>7</td>
<td>196, 174</td>
<td>OR</td>
<td>0.44 (0.27 to 0.73)</td>
<td>0.021</td>
<td>0</td>
<td>8.3</td>
</tr>
<tr>
<td>Antiemetics</td>
<td>2</td>
<td>79, 75</td>
<td>OR</td>
<td>0.69 (0.32 to 1.53)</td>
<td>0.37</td>
<td>0</td>
<td>NA</td>
</tr>
</tbody>
</table>

CI = confidence interval; MD = weighted mean difference; OR = odds ratio; CR = count ratio; NNT = numbers needed to treat; NNH = numbers needed to harmed; CR = odds ratio.
Combination of NSAIDs and Acetaminophen

- Combination > acetaminophen alone in 85% of studies
- Combination > NSAIDs alone in 64% of studies
- Pain scores reduced by 35%/37% over acetaminophen/NSAIDs
- Analgesic needs reduced by 39%/31% over acetaminophen/NSAIDs

Gabapentin

Mean VAS pain scores

Sedation: 55% vs. 38%, P = 0.03
Severe Sedation: 8% vs. 2%, P = 0.02

Dexamethasone

Early Pain (0-6 h)
Late Pain (24 h)
Need for rescue analgesics

Scheduled Acetaminophen vs. PRN Percocet

Ketamine

10 mg IV following Delivery

0.5mg/kg IM followed by 2 μg/kg/min for 12 h

Modalities for Post-Cesarean Analgesia

- Opioids
- Systemic Adjuncts
- Local Anesthetic Techniques
- Neuraxial Adjuncts
Modalities for Post-Cesarean Analgesia

- Opioids
- Systemic Adjuncts
- Local Anesthetic Techniques
- Neuraxial Adjuncts

Duke ERAS Protocol

Before Hospital Arrival
- Only apple juice or Gatorade up to 12 oz 2 hours before hospital arrival
- "Please note time"
- No solid food after midnight

Preoperative
- Aspiration/Antiemetic prophylaxis: IV ondansetron 8 mg + metoclopramide 10 mg before OR
- Oral recovery food
- IV LR 120 mL/h

Intraoperative
- Nonopioid: OR temp > 32°C (89°F), Fluid warmer, forced air warmer
- Spinal/CSE with bupivacaine: 12 mg + F 15 mcg + M 100-150 mcg
- Arterial: Dexamethasone 4 mg prior to incision. Diclofenac 50 mg after delivery
- Premedication: IV ondansetron 4 mg
- Pain: Neuraxial opioids: PR-Actavis epidural 15 mg and ketorolac 30 mg unless contraindicated
- Fluid management: Co-loaded with 1000-2000 cc
- IV lock: 18 G
- Gastro-oesophageal: Airway with clear drapes, mask skin-to-skin time

Postoperative
- IV twice
- Double lock 5-10 mg of hour PRN
- Premedication: Mesalamine, Diphenhydramine PRN
- Nasal spray 2% PRN
### Duke ERAS Protocol

<table>
<thead>
<tr>
<th>Postop</th>
<th>Ketorolac 15mg for 24 hours + Ibuprofen 800mg q6h and Discontinue IV Acetaminophen 975mg q6 hours Oxycodone 5-10mg titrate PRN Nalbuphine 2.5mg titrate PRN Remove Foley at 6h Consider: Epidural for postoperative analgesia TAP Block Neuraxial Clonidine Gabapentin Ketamine Post-discharge Opioids 15 tablets oxycodone 5 mg</th>
</tr>
</thead>
<tbody>
<tr>
<td>Opioid Nondependent Patient</td>
<td>Consider: Epidural for postoperative analgesia TAP Block Neuraxial Clonidine Gabapentin Ketamine</td>
</tr>
</tbody>
</table>
Setting Up & Evaluation of a Successful ERAS Pathway for Cesarean Delivery

Eric J. Hunt, MD, PhD
Chair Obstetric Anesthesia
Permanente Medical Group
Kaiser Northern California

DISCLOSURE: I have no financial relationships with commercial support to disclose.

Learning Objectives

At the conclusion of this activity, participants should be able to:

1. Recognize how implementing an ERAS pathway for cesarean delivery requires multidisciplinary coordination between anesthesia, obstetrics, neonatology, perinatology, and nursing.
2. Appreciate the importance of developing documentation that tracks adoption of pathway steps and results.
3. Understand the effect of an ERAS pathway for cesarean delivery on opioid usage.

Kaiser Permanente Northern California

4.1 Million Members

The Permanente Medical Group, multidisciplinary physician led
established 1948
- 9,000 Physicians
- 16,000 Nurses
- ~43,000 deliveries in 2019
- ~11,000 Cesarean deliveries
- 15 Hospitals with maternity services

24 X 7 OB coverage in house at each hospital:
- Two anesthesia providers: one exclusively dedicated to OB, at least one anesthesiologist in house
- Obstetrician and surgical assist
- Midwifery care in 14 of the 15 hospitals

Enhanced Recovery after Cesarean Delivery: Initial Efforts

Obstetric Anesthesia Chiefs/Directors
Represent all 15 maternity hospitals in system
Mission: evidence-based practice, standardize care, & coordinate patient centered care improvement with the perinatal care team.

Difficulty with initial efforts
- Created pathway for preop, intraop & post partum care, however,
  - Difficult to coordinate with OB, perinatology, neonatology...
  - Challenged to rein in variation in anesthesia care
  - Impossible to coordinate with nursing without order sets.
  - No documentation tools.

Enhanced Recovery After Cesarean Delivery fell into regionwide plan

Integrate Cesarean care with other regional objectives.

Framework for Creating Pathway Recommendations & Metrics
ERAS for Cesarean Delivery Resources

Increasingly robust literature regarding ERAS in general, as well as ERAS for Cesarean delivery.

Anesthesia literature
Obstetric literature
Perioperative Surgical Home for Cesarean Delivery

ERAS Society Recommendations

Special Reports


Part 1 focuses on Antenatal and Preoperative care (AUG 2018; 219: 523-32)
Part 2 focuses on Intraoperative Care (AUG 2018; 219: 533-44)

Recommended ERAS protocols for Cesarean delivery

Excellent resource on Cesarean ERAS with additional details regarding anesthetic considerations.

Developing a Cesarean ERAS Pathway

Develop your ERAS pathway from literature reviews and expert opinion. Reviews describe many dimensions of enhanced recovery goals that have the most value to your practice.

ERAS for cesarean delivery must engage the continuum of care

- Preconception outreach with comorbidity mitigation including weight management,
- Antepartum care involving education, diet, exercise, diabetes management
- Intrapartum care including the anesthetic
- Postpartum Inpatient & outpatient care

Multidisciplinary perinatal team develops ERAS consensus.

Obstetrician and anesthesia leaders and hospital administration align
Obstetrician
Midwife
L&D nursing
PACU nursing
Postpartum nursing
Anesthesia
Pediatrics
Neonatology and perinatology

Tracking ERAS implementation

Engage IT early in the process
Track implementation using the electronic medical record (EMR)
Process measures
Outcome measures
Define discrete data fields, nurse documentation, and anesthesia if record is part of the EMR
Pharmacy (MAR)
Coding associated with delivery including elective vs non-elective
**Nursing Documentation Challenges**

IT can develop as many new discrete data fields as your Cesarean ERAS team requests. However, smart IT design is essential for success. In this example, a single nursing documentation required opening eight windows.

**Invest in Cesarean ERAS education**

*Change is not easy.*

Enhanced recovery requires the perinatal team to adopt new protocols and procedures to support the new pathway.

ERAS “champions” socialize the concept then introduce specific ERAS elements:
- Presentations to perinatal staff
- Nurse education time
- Department wide presentations with expectations for each team

**Overcoming resistance to Cesarean ERAS**

Overcoming resistance of anesthesia providers
- “I trained with Sol Shnider, and when I trained, we did it…”

Counter by presenting cesarean ERAS anesthesia protocols in the context of:
- Evidenced based medicine
- Improved care experience
- Opioid sparing
- and
- Sol Shnider, Gertie Marx, Gerald Ostheimer…practiced, and taught, cutting-edge evidence-based anesthesia, not decades behind the time.

**Align Cesarean Order-sets to Support ERAS**

ERAS requires new protocols, supported by updated order-sets
- Multimodal analgesia (MMA) is a cornerstone of ERAS
  - Supported by orders that assure around the clock dosing
  - Prevent accidental overdosing
  - Anesthesia orders must align with obstetrician orders
- Preop PACU orders for MMA, PRN opioids, diet
- Anesthesia neuraxial opioid orders with MMA and
  - PRN non-combined PO opioids

**Potentially Controversial Cesarean ERAS protocols**

Additional time may be required to get agreement on protocol involving:
- Carbohydrate drink
- Skin-to-skin in operating room
- Active warming throughout delivery
- Evidence based Pitocin dosing
- Evidence based neuraxial opioid dosing
- Avoiding exteriorization of the uterus
- Pressor infusion to maintain maternal blood pressure
- Avoiding prescription of PRN PO opioids with analgesia additives, eg prescribe oxycodone rather than oxycodone combined with acetaminophen

**Data not tracked by process or outcome measure**

Requires chart audits to verify compliance with protocol

If the anesthesia record is not integrated into the EMR, check:
- Opioid dosing
- Pitocin dosing
- Pressor infusion
- Verify that acetaminophen and NSAID are not being administered in both the OR and PACU
Tracking Implementation of Cesarean ERAS

A product of IT involvement and Administrative resolve.

Monthly reports

Each facility has an ERAS champion who provides feedback to leaders and frontline staff.

Cesarean ERAS intramural reports

Current process and outcome data is shared for every facility

Performance is benchmarked relative to all hospitals in the region.

Local Infrastructure to Rollout OB Enhanced Recovery

Hospital Executive Leadership

Senior Operational Leaders for Physician, Nursing, Continuum, & Quality

Local Physician Lead

Local Nursing Lead

Project Manager

Multidisciplinary Implementation Team

OB, Women’s Clinic, Anesthesia, Nursing, Pharmacy, Perinatology, Perioperative Services, Dietary, Lactation Services, Technology, Performance Improvement

Enhanced Recovery after Cesarean Delivery

Optimize blood count prior to delivery

Early Nutrition and ambulation

Multidisciplinary Pain Management

What’s New for OB Anesthesia?

- Guideline-based NPO instruction
- Active warming
- National anesthesiology guidelines
- Prevention of hypotension
- Multimodal Analgesia
- Minimizing drain to skin neurobehavioral support
- Standard NG/Enteral Nutrition
- Optimize electronic administration
- Support Early nutrition and ambulation

Feedback at Pilot sites

1. RN feedback: “Patients reach their goal of comfort while decreasing opioid usage”
2. Lactation Consultant stated that “Patients are more alert and retaining more of what we teach”
3. OB and CNSM feedback: patients are more alert, engaged with the recovery process
4. Anesthesia feedback: patients experience less postoperative nausea and are more comfortable post op
5. All: The Enhanced Recovery after Cesarean Delivery Pathway allows us to follow the “same plan” for our Cesarean delivery patients

Expanded to all 15 hospitals Oct. 1, 2016, now with 6 months of experience...
Enhanced Recovery after Cesarean Delivery:
- Provides women with preoperative fluids and nutritional support.
- Provides multimodal analgesia for post Cesarean analgesia (IV acetaminophen and ketorolac was administered after OR).
- Improved nutritional support for mothers after delivery. (Meal eaten within 12 hr of OR departure.)
- Increased sustained ambulation after delivery. (Ambulated at least once in 16 hr, at least twice at >16 hr.)
- Reduced opioid use by 50%.
- Reduced pain scores while simultaneously reducing opioid use. (Sum of delta pain scores form OR exit to POD #3.)
Enhanced Recovery after Cesarean Delivery:
Has little impact on the length of stay. (Days from OR arrival to discharge.)

Enhanced Recovery after Cesarean Delivery
Pilot at 2 hospitals

Obstetric Enhanced Recovery pathways are now incorporated in the care plan for all maternity patients!

Steps to set-up & evaluate ERAS for Cesarean delivery
1. Ally with obstetric leaders.
2. Develop support from medical group and hospital administration.
3. Form a multidisciplinary group of nursing, obstetrics, neonatology, perinatology, and anesthesia to develop agreement on ERAS steps.
4. Harness the electronic medical record to track process and outcome measures.
5. Invest in your staff through education, feedback and reinforcement.
6. Follow your measures to continuously improve care and prevent drift.
7. Celebrate your results with patients, staff and your administrative sponsors,
REGIONAL ANESTHESIA BLOCKS FOR CESAREAN DELIVERY ANALGESIA: TAP, QL AND BEYOND

PEDRAM ALESHI MD
ASSOCIATE CLINICAL PROFESSOR
UCSF
SOAP SOL SPINNER MEETING, MARCH 2019

DISCLOSURES

OBJECTIVES

• Gold standard for post-cesarean analgesia

• Regional anesthesia techniques for providing post-cesarean analgesia

• Landmark and sono-anatomy, nuts and bolts of performing TAP, Quadratus Lumborum (QL) and Erector Spinae Plane (ESP) blocks

POST CESAREAN DELIVERY PAIN

• Incisional/pelvic/visceral pain after cesarean

• Persistent pain reported from 1% to 18% based on studies

• At least 13,000 patients/year in the US

• Risk Factors:
  • Post-operative pain, genetics, history of chronic pain
  • Psychological risk factors include anxiety, depression, catastrophizing pain
  • Sleep deprivation and stress

Carvalho B., Butwick A. Best Pract Res Clin Anaesthesiol. 2017

CONSEQUENCES OF PERSISTENT PAIN

• Chronic pain/opioid tolerance, dependence and addiction

• Societal costs of opioid prescriptions

• Depression/anxiety

• Disability/impaired quality of life

• Impaired maternal-neonatal bonding, decreased breast feeding

THE GOLD STANDARD

• Neuraxial opioids
  • Intrathecal morphine 100-150mcg
  • Epidural morphine 2-3mg

• Both help with postop pain

• Reduce opioid consumption

• Neuraxial fentanyl helps with intraop analgesia

• NSAIDs and acetaminophen scheduled around the clock

Dahl et al. Anesthesiology, 1999
WHEN TO USE REGIONAL ANESTHESIA

- Absence of neuraxial block
- Cesarean under GA without neuraxial access
- Contraindications to neuraxial anesthesia
- High risk patients
- Chronic pain
- Opioid dependent/tolerant/addiction
- High pain levels despite use of neuraxial opioids

REGIONAL ANESTHESIA OPTIONS

- Transversus abdominis plane block (TAP)
- Quadratus lumborum block (QL)
  - At least 4 different types of QL blocks
- Erector spinae block (ESP)

TOPIC COVERED FOR EACH BLOCK

- Level of difficulty
- Advantages/disadvantages
- Area of coverage
- Scanning technique
- What to inject
- Tips and trouble shooting

TRANSVERSUS ABDOMINIS PLANE (TAP) BLOCK

- Level of difficulty: basic to intermediate depending on body habitus
- Advantages
  - Easiest of 3 blocks to perform
  - Good sono-anatomy landmarks
  - Can be performed supine
- Disadvantages
  - No visceral coverage

TAP BLOCK COVERAGE

- Terminal branches of the intercostal nerve at T10-L1 innervating skin, muscle, and peritoneum
- Covers peritoneal and subcutaneous abdominal wall

TAP BLOCK SCANNING/BLOCK TECHNIQUE

- Probe placed in transverse position in the intercostal fat between lower axial and costal margin
- Skin, subcutaneous tissue, external oblique, internal oblique, transversus abdominis muscles, peritoneum
- 5-10cm needle inserted in the anterior axillary line/in-plane approach
- Local anesthetic spread between internal oblique and transversus abdominis muscles
**TAP INJECTATE**

- Typically 20-40ml, 0.25-0.5% bupivacaine or ropivacaine bilaterally
- Larger volume helps spread of local anesthetic
- May need to use lower concentrations to keep total dose acceptable in smaller patients
- Liposomal bupivacaine is now FDA approved for TAP blocks (cost v. benefit)
- Can only combine liposomal bupivacaine with isotonic solutions and bupivacaine

**TAP TIPS AND TROUBLE SHOOTING**

- As probe is moved posteriorly, transversus abdominis muscle ends into transversalis fascia (3 muscle layers to 2 muscle layers)
- The nerves travel deep to the fascial plane between the internal oblique and transversus abdominis muscle (when in doubt, inject into TAM rather than IOM)
- T6-T9 nerves enter the plane more medially, so TAP will not reliably cover above the umbilicus. (Subcostal TAP can cover above the umbilicus, or QL block)

**QUADRATUS LUMBARUM BLOCK**

- Quadratus lumborum muscle
  - posterolateral abdominal wall
  - "Drapes" between 12" rib and Eoc crease
  - Medial connection to transverse processes of L1-L4

**QUADRATUS LUMBARUM BLOCK**

- Level of difficulty: Intermediate to advanced depending on body habitus
- Advantages
  - QLB 1 can be done supine in most patients, may need a bump under the hip
  - QLB 1 easier than QLB 2 and QLB 3
- Some visceral pain coverage

- Disadvantages
  - Technically challenging to image and block with QLB 2 and QLB 3
  - Lateral positioning needed for QLB 3
  - Not recommended for novice ultrasound practitioners
  - Close to kidneys/paranephric fat
**QL BLOCK COVERAGE**

- T6-L1 skin incisions
- Abdominal wall and viscera
- Works through connection of thoracolumbar fascia into the paravertebral space
- More dermatomal coverage compared to TAP block with same volume of injectate

---

**QLB 1 SCANNING/BLOCK TECHNIQUE**

- **Probe placed:** Transverse position in the posterior axillary line
- **Skin, subcutaneous tissue, external oblique, transversus abdominis muscle, QL muscle, psoas major, erector spinae muscles**
- **5-10 cm needle inserted in the mid-axillary line/in-plane approach**
- **Local anesthetic injected lateral to QL deep to transversus abdominis muscle and superficial to transversalis fascia**

---

**QLB 2 SCANNING/BLOCK TECHNIQUE**

- **Probe placed:** Transverse position in the posterior axillary line
- **Skin, subcutaneous tissue, external oblique, transversus abdominis muscle, QL muscle, psoas major, erector spinae muscles**
- **5-10 cm needle inserted in the mid-axillary line/in-plane approach**
- **Local anesthetic injected between QL muscle and erector spinae/latissimus muscles (posterior to QL muscle)**

---

**QLB 3 SCANNING/BLOCK TECHNIQUE**

- **Probe placed:** Transverse position in the posterior axillary line
- **Skin, subcutaneous tissue, external oblique, transversus abdominis muscle, QL muscle, psoas major, erector spinae muscles**
- **5-10 cm needle inserted posteriorly/in-plane approach**
- **Local anesthetic injected between QL muscle and psoas muscle (anterior to QL muscle)**

---

QUADRATUS LUMBO RUM INJECTATE  
- Typically 20-40ml, 0.25-0.5% bupivacaine or ropivacaine bilaterally
- Larger volume helps spread of local anesthetic
- May need to use lower concentrations to keep total dose acceptable in smaller patients

QUADRATUS LUMBO RUM TIPS AND TROUBLE SHOOTING  
- For QL1 block, avoid injecting into retroperitoneal space/perinephric fat, injectate is placed superficial to the transversalis fascia
- For QL2 block, it’s important to inject between QL and erector spinae muscles
- For QL3 block, injection must be done deep to the QL muscle, between QL muscle and the psoas muscle. Injection into the psoas muscle can block the lumbar plexus and cause more significant lower extremity weakness.
- There is conflicting evidence if QL blocks cause lower extremity weakness

ERECTOR SPINA E PLANE BLOCK  
- Erector spinae muscles  
  - 3 muscles:  
    - Iliocostalis, longissimus, spinalis  
- Erector spinae plane is the plane between the erector spinae muscles and transverse processes

ERECTOR SPINA E PLANE BLOCK COVERAGE  
- Diffusion of local anesthetics  
  - Paravertebral, dorsal and lateral rami of thoracic and lumbosacral nerves, back, spinal, skin, muscle, periosteum, visceral organs
- Anterior spread up and down the spine

ERECTOR SPINA E PLANE BLOCK LEVEL OF DIFFICULTY: INTERMEDIATE
- Advantages  
  - Extensive cephalad and caudad coverage
  - Bones are easy to visualize on ultrasound
  - Can easily thread a catheter for prolonged analgesia

ERECTOR SPINA E PLANE BLOCK DISADVANTAGES  
- Patient positioning (lateral, sitting or prone)
- Needle visualization may be hard
- Single shot injection does not last very long

ESP BLOCK COVERAGE  
- Diffusion of local anesthetics  
  - Paravertebral, dorsal and lateral rami of thoracic and lumbosacral nerves, back, spinal, skin, muscle, periosteum, visceral organs
- Anterior spread up and down the spine

ESP BLOCK ADVANTAGES  
- Extensive cephalad and caudad coverage
- Bones are easy to visualize on ultrasound
- Can easily thread a catheter for prolonged analgesia

ESP BLOCK DISADVANTAGES  
- Patient positioning (lateral, sitting or prone)
- Needle visualization may be hard
- Single shot injection does not last very long
ESP BLOCK SCANNING/BLOCK TECHNIQUE

• Probe placed in parasagittal position, 4cm away from midline
• Sacrum, L5, L4 visualized
• 2-5 cm needle traversed transversely, cephalad or caudad until it touches transverse process
• Local anesthetic injected deep to the erector spinae muscles, between erector spinae muscle and transverse process

ESP BLOCK INJECTATE

• Typically 20-30ml, 0.25% bupivacaine or ropivacaine bilaterally
• Larger volume helps spread of local anesthetic
• May need to use lower concentrations to keep total dose acceptable in smaller patients
• For catheter technique, can use 0.2% ropivacaine or bupivacaine
• Use programmed-intermittent-bolus (PIB) if available on your pumps

ESP BLOCK TIPS AND TROUBLE SHOOTING

• Make sure the needle is touching the bone when injecting
• If you encounter high pressure, you may not be fully under the erector spinae muscles, can walk cephalad or caudad on the transverse process
• In some patients, it's hard to detect a level but they are usually pretty comfortable

GOLD STANDARD FOR POST-CESAREAN ANALGESIA IS NEURAXIAL OPIOIDS

ALTERNATIVE TECHNIQUES:
• TRANSVERSUS ABDOMINS PLANE BLOCK
• QUADRATUS LUMBORUM BLOCK
• ERECTOR SPINAE PLANE BLOCK

THANK YOU

Thanks to all the experts, artists/illustrators for making all the amazing images and cartoons available for our learning.
Session IV: Tips and Techniques
Moderator: Pamela D. Flood, M.D., M.A.

Trouble-Shooting Labor Epidurals and Failed Top-ups
Jalal A. Nanji, B.Sc., M.D., FRCPC

Reducing Obstetric General Anesthesia: 10 Practical, Tested Tips
Lawrence Tsen, M.D.

Preventing and Treating Side Effects of Neuraxial Opioids
Ashraf S. Habib, M.B.,B.Ch., M.Sc., M.S.N., FRCA
Troubleshooting Labour Epidurals & Failed Top-ups

2019 Sol Shnider M.D. Obstetric Anesthesia Meeting
Mar 15, 2019

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Edmonton, AB

Relationships with financial interests: None

Objectives

At the end of this lecture, attendees will be able to:
1. Identify common causes of inadequate neuraxial analgesia
2. Discuss risk factors for failed conversion of neuraxial analgesia to surgical anesthesia (e.g. for cesarean delivery)
3. Develop a systematic approach in order to troubleshoot an ineffective labour epidural

Defining the Problem

1. Never gets comfortable, vs.
2. Previously comfortable but now in pain during labour, vs.
3. Experiences pain during cesarean delivery (CD) with in situ epidural catheter (+/- comfortable during labour)

Statistics

- Retrospective review of > 12,000 cases of obstetric neuraxial analgesia/anesthesia (> 19,000 deliveries)
- Overall failure rate of 12%
- 5.6% required direct replacement
  - 1.5% required multiple replacements
- 98.8% reported adequate labour analgesia


A Word on Prevention…

- Prevention is the cure!
- Optimize insertion, initiation, and maintenance to best avoid issues later on
- Consider early replacement if issues persist despite corrective attempts
- “Plant the seed” during consent process AND if issues arise later during maintenance
Why Do Epidural Catheters Fail?

1. Inadequate Initiation
2. Inadequate Maintenance
3. Incorrect Catheter Location
   A. Initial Placement
   B. Subsequent Migration

Inadequate Initiation

- Need adequate volumes of epidural solution (usually dilute LA + opioid) to establish epidural block
- Traditional epidural may never “catch up” in patient with advanced and/or rapidly-progressing labour
- Consider CSE in these cases for quicker onset
- Will also help improve sacral coverage

Combined Spinal-Epidural (CSE)

- Quicker onset of pain relief
- Better subsequent analgesia
- Sacral coverage
- Bilateral coverage
- Fewer boluses/top-ups
- Fewer catheter failures (despite the myth of the “untested epidural”)

Catheter Failures

- 2395 neuraxial procedures for labour
- Failures: 6.6% (CSE) vs. 11.6% (epidural)
- More failed catheters recognized within ½ hour:
  • 48% (CSE) vs. 31% epidural

CSE vs. Epidural for Labour


- 2395 neuraxial procedures for labour
- Failures: 6.6% (CSE) vs. 11.6% (epidural)
- More failed catheters recognized within ½ hour:
  • 48% (CSE) vs. 31% epidural

Failed Blocks: CSE vs. Epidural

- Catheter placed despite no CSF obtained during CSE
  • Replacement rate 29% vs. 4% if CSF obtained
  • Failed top-up for Cesarean after labour
  • OR 5.5 epidural vs. CSE

Inadequate Maintenance

- Optimal maintenance technique is a background regimen (either continuous infusion [CEI] or intermittent bolus [PIEB]) with a patient-controlled epidural analgesia (PCEA) option.

Programmed Intermittent Epidural Bolus (PIEB)

- Instead of giving the “background” as a slow-infusion, why not give it as a bolus as well?
- Models of spread
  - Large volumes
  - Concomitant high injectate pressures
    - E.g. 10.5 mL/h vs. 3.5 mL q20 minutes (each delivered over 1 minute)

PIEB vs. CEI

<table>
<thead>
<tr>
<th>Meta-Analysis Data Outcomes</th>
<th>PIEB vs. CEI</th>
<th>P-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Local Anesthetic Consumption</td>
<td>-1.2 mg/h</td>
<td>0.01</td>
</tr>
<tr>
<td>Maternal Satisfaction Scores</td>
<td>7.0 mm</td>
<td>&lt;0.00001</td>
</tr>
<tr>
<td>Duration of 2nd Stage of Labor</td>
<td>-12 min</td>
<td>0.04</td>
</tr>
<tr>
<td>Mode of Delivery</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cesarean Delivery</td>
<td>OR 0.87</td>
<td>0.54</td>
</tr>
<tr>
<td>Instrumented Delivery</td>
<td>OR 0.59</td>
<td>0.05</td>
</tr>
<tr>
<td>Anesthesia Interventions</td>
<td>OR 0.56</td>
<td>0.08</td>
</tr>
</tbody>
</table>


Incorrect Catheter Location

- Initial Placement
  - Subcutaneous (complete block failure)
  - Subdural (variable presentation)
  - Intrathecal
  - Intravascular (stiff catheters)
- Subsequent Migration
  - Neural foramina (if > 5 cm into epidural space)
  - Intrathecal/Subdural
  - Subcutaneous (especially obese patients)
  - Intravascular


Ultrasound Assistance

- Accurate identification of interspace
- Establishment of midline
- Estimation of depth to epidural space
- Determination of optimal interspace and insertion point
- Angulation of epidural needle between spinous processes
- Benefits may not apply to experienced providers or patients with easily palpable landmarks

Ultrasound vs. Palpation/Landmarking
- Reduced technical failure (RR 0.51)
- Less traumatic procedure (RR 0.27)
- Reduced needle punctures and redirections
- Shorter procedure time (but increased setup time!)
- Decreased block failures
- Higher satisfaction
- Better analgesia


Preventing Migration of Catheter
- Optimal amount of catheter in epidural space 4-5 cm at most (beyond tip of epidural needle)
- Higher incidence of subcutaneous migration if < 3 cm left in epidural space, unilateral block if > 5 cm
- In obese patients, consider having patient sit upright (i.e. not “slouched” or to lie lateral prior to taping/fixating


Changes in Position

<table>
<thead>
<tr>
<th></th>
<th>Obese Habitus</th>
<th>Normal Habitus</th>
</tr>
</thead>
<tbody>
<tr>
<td>Change FLEX to LAT (cm)</td>
<td>1.27 ± 0.77*</td>
<td>0.75 ± 0.49</td>
</tr>
<tr>
<td>Distance to ES (cm)</td>
<td>5.3 ± 0.84*</td>
<td>4.2 ± 0.71</td>
</tr>
</tbody>
</table>

Values are mean ± SD.
*P < 0.05.
FLEX = flexed; LAT = lateral; ES = epidural space.


Technical Factors
- LOR technique with Air vs. Saline (debatable)
- Multi-orifice epidural catheter vs. single orifice
- Catheter with flexible tip vs. stiff tip

Miscellaneous

• Patient expectations
• Bands/septae in epidural space?
  • Dorsal Median Connective Tissue Band (DMCTB)
  • May just be an artifact of how the space was studied

Approach to Inadequate Labour Analgesia

Initial Assessment

• Examine the patient!
  • Catheter site
  • Testing of motor + sensory blockade
  • Review recent OB examination:
    - Cervical dilatation
    - Station
    - Bladder (full vs. empty)
    - Position of presenting part (e.g. occiput posterior, occiput transverse)

Next Steps

• Assess response to bolus administration of epidural solution
  • May elect to use a higher concentration of local anesthetic
  • Consider addition of supplemental epidural opioid

Clinician “Top-up”

• Generally successful (~70% of cases)
• Larger volume of dilute (e.g. 10 mL of 0.125% bupivacaine) or smaller volume of more concentrated (e.g. 5 mL of 0.25%) local anesthetic can be considered
• Depends on whether spread or density is required

Catheter Manipulation

• Sterile withdrawal of catheter 1-2 cm +/- additional clinician top-up dose can improve analgesia in 77% of cases
  • Especially if block is unilateral to begin with
• Useful to use a clear dressing to compare initial documented insertion depth with current catheter location
• Securement devices may prevent migration > 2 cm of labour epidurals
Expectation Management

• Not the patient’s fault!
• Pressure/tightening is normal during contractions if epidural is working
• Significant pain is NOT normal prior to 2nd stage
• This process starts with consent prior to procedure
  • Explanation of failure rate and risk of needing to redo block

Catheter Replacement

• If more than 2 clinician top-ups are required and inadequate analgesia persists, replace the epidural catheter
• Consider performing a CSE in this case
  • Does NOT increase risk of unrecognized catheter failure
    • Actually reduced risk of failure
  • Quick-onset respite for patient with unexpected breakthrough pain
  • Confirmation of epidural space by obtaining CSF through spinal needle
    • More likely to thread catheter into a midline position

Conversion to Surgical Anesthesia

• Active management of labour epidurals is important for successful conversion
• Attempting to use an inadequately-functioning catheter risks both failure (and need for general anesthesia) as well as toxicity/high spinal

Risk Factors

• Increasing number of clinician boluses (OR = 3.2)
• Urgency of delivery (OR = 40.4)
• Care by non-obstetric anesthesiologist (OR = 4.6)

Sage Advice

• Every time you enter a patient room, ask yourself:
  • Is the catheter functioning like it’s in the epidural space?
  • Do you have confidence in being able to use it for cesarean delivery?
  • If the answer to either of these questions is no…
    • DO SOMETHING about it!

Summary

• Prevention is the cure!
• Epidurals can fail for myriad reasons
• Certain interventions during initiation and/or maintenance of a labour epidural can improve analgesic success
• Inadequate analgesia can usually be fixed with simple manoeuvres
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Twitter: @jalalnanji

UNIVERSITY OF
ALBERTA

SOAP
Society for Obstetric Anesthesia and Perinatology
Reducing General Anesthesia for Cesarean Delivery: 10 Practical Tested Tips!

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Director of Anesthesia, Center for Reproductive Medicine,
Department of Anesthesiology, Perioperative and Pain Medicine
Associate Director, Center for Professionalism and Peer Support
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Reducing GA for Cesarean: Learning Objectives

Upon Completion of this Learning Activity, Participants Should Be Able To:

Appropriate?

Not Possible?

Tips!

No Disclosures-Pixar

A Fable

The Grasshopper’s summer was squandered with singing,
Now without a morsel, found winter most stinging.
Off he went to the house of the Ant, his neighbor,
To ask for a meager share of the fruits of her labor.
Alas, he discovered, after an arduous journey through blinding ice and heavy snow,
A sign, tacked firmly to her door:

“Wintering in Maui…with all of my dough”.

No Disclosures-

Reducing GA for Cesarean: Appropriate?

• 38 yo, G3P0 at 36 weeks, 5’4”, 280#, (BMI 48.1), MP IV

• Preeclampsia (BP 168/88), gDiabetes,
gThrombocytopenia (Plt 98)

• Anterior Placenta Previa

• Surgical History: Cholecystectomy, Appendectomy, Jaw Reconstruction

• Fetus: Large for Gestational Age

No Disclosures-
Reducing GA for Cesarean: Appropriate?

38 yo, G3P0 at 36 wks, 5’4”, 280#, (BMI 48.1), MP IV

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- Surgical History: Cholecystectomy, Appendectomy, Jaw Reconstruction
- Anterior Placenta Previa
- Fetus: Large for Gestational Age

Maternal Airway Changes

Capillary Engorgement
- Increased Class IV, Facial Edema & Swollen Tongue
- Further Engorgement with Labor and Active Pushing

Maternal Thoracic & Respiratory Changes

- Increased Thoracic Chest Diameter/Breast Mass
- Faster Desaturation (FRC -30%, O2 Demand +60%)

Maternal Gastrointestinal Changes

Uterine Encroachment
- Anatomic Stomach Compression

Hormonal Changes
- LES Sphincter Tone

Gastric Emptying

Maternal Mortality Higher with GA

Wong et al., A&A 2007
Nimmo et al., Lancet 1975
Pinkington et al., BJA 1995; Rocke et al., Anesth 1992; Kodali et al., Anesth 2008
McClelland SH et al. Anaesthesia 2009
Maternal Mortality Higher with GA

Case fatality ratio 2.3:1 to 16.7:1 to 1.7:1

- 1979-1984: 70% Regional, 30% General
- 1985-1990: 94% Regional, 6% General
- 1991-2002: 63% Regional, 37% General


Fetal Morbidity Worse with GA

Elective

- UA pH <7.20
- Apgar <8
- Intubation

- Gale '82: R, GA worse
- Marx '84: P, GA worse
- Ong '89: R, GA worse

Emergent

- UA pH <7.20
- Apgar <8
- Intubation

- Evans '89: R, RA worse
- Dick '92: P, GA worse, RA worse
- Ratcliffe '93: R, GA worse
- Roberts '95: R, RA worse, GA worse
- Mueller '97: R, RA worse, GA worse
- Sendag '99: R, RA worse, GA worse
- Kolatat '99: P, GA worse, GA worse

Jevtovic-Todorovic V, J Neurosci 2003
Soriano S, Anesthesiology 2005

Reducing GA for Cesarean: Not Possible?

Co-Morbidities

Time

Reducing GA for Cesarean: Not Possible?

Lack of Time/Contraindications/Refusal?

- Contraindicated or Lack of Time
- Failed Epidural
- Failed Spinal
- Patient Refusal

Time: Decision to Incision

Time: Decision to Incision

30 minutes: ACOG, RCOG, ACP, ISOG, CNCC

Time: Decision to Incision

30 minutes: ACOG, RCOG, ACP, ISOG, CNCC

20 minutes: GSGO

15 minutes: ACOG
High Risk

15 minutes?

Obstetric Decision

15 minutes?

Obstetric Decision
Anesthesia Contact

15 minutes?

Obstetric Decision
Anesthesia Contact
Anesthesia Provision

ACOG Standards for Obstetric Services, 6th edition 1988
ACOG + AAP Guidelines for Perinatal Care, 2nd edition 1988
Time: Decision to Incision

15 minutes?
- Obstetric Decision
- Anesthesia Contact
- Anesthesia Provision
- Incision

Time: Decision to Incision

5 minutes:
- Complete Fetal Anoxia
  - Maternal Cardiac Arrest
  - Total Placental Abruption
  - Complete Cord Prolapse
  - Uterine Rupture


Reducing GA for Cesarean: Tips

Anesthesia Selection for Cesarean Delivery

Incidence of Cesarean and Obstetric GA

Incidence of Cesarean and Obstetric GA

Rahman et al., Anaesthesia 2005

Tsen L et al. IJOA 1998; Palanisamy A, Tsen LC Anesth Analg 2011

Chang LY, Tsen LC. Anesth Analg 2013
**Tip #1: Develop a “Core Team” with QA/QI**

Uncommon, Unlikely, but a Possible Goal?

- Shared Mental Models, Expectations
- Similar Methods, Management Styles

---

**Tip #2: Institute “High Risk” Consult System-Need**

Optimizes significant disease

- Creates a multispecialty plan: BACH
- Establishes expectations by patient and providers
- Allays anxiety in patient (and provider!)
- Generates referrals & revenue ($n = 519; 7.8\%$)
- Creates stakeholder in perioperative medical home
- Reduces maternal mortality (CMACE-counsel/referral)

---

**Tip #2: Institute “High Risk” Consult System-Value**

Antenatal Mandatory
  - France-’98, 8th Month
Antenatal Recommended
  - UK
Antenatal Significant Dz
  - USA, Belgium

---

**Tip #2: Institute “High Risk” Consult System-How**

- Distribute Guidelines
- On Call “Clinic” in Triage
- Hours 9:00 am-2:00 pm
- Send Consult Note + Bill
- Audit Cases/Remind

---

**Tip #3: Mandate Ability to see all Parturients**

BWH Anesthesia Clinic
612 Patients/2.5 yrs
Average: 2 pts/wk

30% Management Change
Request Consultant
Order Test
Request Outside Info
Review Novel Info

---


Moffit D, Tsen LC, Farber M: SOAP Abstracts 2016
Tip #3: Mandate Ability to see all Parturients

- Parturient Birth Plans

The Gold Standard Natural Child Birth: Midwife-Attended, Home Birth, Intervention-Free (No IV, Epidural or CS)

Reime B et al. BJOG 2004;111:1388-93

Tip #4: Deputize an “Early Warning System”

- Obstetricians, Nurses, and Unit Clerks

  - “Head’s up” on Physiology/Anatomy, including Airway

<table>
<thead>
<tr>
<th>OB</th>
<th>Pre</th>
<th>Post</th>
<th>P</th>
</tr>
</thead>
<tbody>
<tr>
<td>Airway</td>
<td>59%</td>
<td>60%</td>
<td>NS</td>
</tr>
<tr>
<td>Consult</td>
<td>47%</td>
<td>50%</td>
<td>NS</td>
</tr>
</tbody>
</table>


- Providers influence Timing and Patient’s Selection of Analgesia/Anesthesia, as well as Delivery Mode

Tip #5: Insert “Early Epidural” Catheters

- Before Requested or Required

- Consider Dural Puncture Epidural (DPE) Technique

- Dose Epidural Catheter (5-6 mL)

- Test Sensory Band

Tip #5: Insert “Early Epidural” Catheters

Dural Puncture Epidural (DPE) Technique

- Greater Bilateral and Sacral Block
- Faster Onset
- No Higher Sensory Spread
- No FHR Brady or PDPH


Tip #6: Confirm “Functional” Epidural Catheter

Does the Initial Technique matter? MAYBE

Lower GA with CSE

Bauer, Kountanis, Tsen, Greenfield, Mhyre. IJOA 2012

Tip #5: Insert “Early Epidural” Catheters

Dural Puncture Epidural (DPE) Technique

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>CSE</th>
<th>DPE</th>
<th>Epidural</th>
</tr>
</thead>
<tbody>
<tr>
<td>Location Confirmation</td>
<td>X</td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>Onset</td>
<td>X</td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>Sacral Spread</td>
<td>X</td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>Bilateral Spread</td>
<td>X</td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>Tested Catheter</td>
<td>X</td>
<td>X</td>
<td>(?)</td>
</tr>
<tr>
<td>Progress of Labor</td>
<td>X</td>
<td>X</td>
<td>(?)</td>
</tr>
</tbody>
</table>

Cappiello E, O’Rourke N, Segal S, Tsen LC. Anes Analg 2008;107:1646-51
Chau A, Tsen LC. Anesth Analg 2017

Tip #6: Confirm “Functional” Epidural Catheter

Does the number of Top-up’s matter? YES

Adequate Analgesia?

Patchy?

Increasing Local +Opioid

Higher GA with More Top-ups

Bauer, Kountanis, Tsen, Greenfield, Mhyre. IJOA 2012

Tip #5: Insert “Early Epidural” Catheters

<table>
<thead>
<tr>
<th>Failed Blocks</th>
<th>Epidural</th>
<th>CSE</th>
<th>Needle</th>
</tr>
</thead>
<tbody>
<tr>
<td>Eappen n=4240</td>
<td>13.1%</td>
<td>7.2%</td>
<td>25G</td>
</tr>
<tr>
<td>Norris n=1660</td>
<td>1.3%</td>
<td>0.2%</td>
<td>25G</td>
</tr>
<tr>
<td>van de Velde</td>
<td>3.1%</td>
<td>1.5%</td>
<td>27G, 29G</td>
</tr>
<tr>
<td>Thomas n=248</td>
<td>9.3%</td>
<td>8%</td>
<td>27G</td>
</tr>
</tbody>
</table>

Bauer, Tsen, Mhyre. IJOA 2012; Thomas, Anesth 2005
Van de Velde, Anaesth Intens Care 2001; Norris, IJOA 2000; Eappen, IJOA 1998
Tip #6: Confirm “Functional” Epidural Catheter

Does the Duration of epidural analgesia matter? **NO**

![Duration of Epidural Analgesia](image)

Bauer, Kountanis, Tsai, Greenfield, Myhre. IJOA 2012

Tip #7: Reaffirm No “Emergent” Cesarean

Emergent Cesarean = 23%

Acidosis with Decelerations

- Initially Normal to Late: 115 Minutes
- Initially Normal to Variable: 145 Minutes

CDC, National Center for Vital Statistics; Fleisher AJOG 1982

Tip #8: Implement “Fastest” Anesthesia Combo

### General or Spinal

- Obstetric Decision
- Transport to Room
- Anesthesia Provision
- Incision

### Epidural In-Situ

- Obstetric Decision
- Anesthesia Provision
- Incision

**Tip #8: Implement “Fastest” Anesthesia Combo**

<table>
<thead>
<tr>
<th>Study</th>
<th>Agent</th>
<th>Time</th>
<th>Comment</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gaiser, IJOA 1998;7:27-31</td>
<td>Chloro 3% + Bicarb</td>
<td>3.1 min</td>
<td>Extension T4</td>
</tr>
<tr>
<td></td>
<td>Lido 1.5% + Bicarb</td>
<td>4.4 min</td>
<td>Extension T4</td>
</tr>
<tr>
<td>Lam, Anaes 2001;56:790-4</td>
<td>Lido 2% + Epi+Bicarb</td>
<td>5.2 min</td>
<td>Extension T6</td>
</tr>
<tr>
<td></td>
<td>Lido 2% + Epi</td>
<td>9.7 min</td>
<td>Extension T6</td>
</tr>
</tbody>
</table>

**Tip #8: Implement “Fastest” Anesthesia Combo**

**Study**

- **Agent**
  - Lidocaine or Chloroprocaine
  - Bicarbonate

**Time**

- **Comment**
  - Extension T4
  - Extension T6

Bicarbonate 8.4% 1 mL
4.8% 2 mL

Peterfreund, Datta, Ostheimer. Reg Anesth 1989
Tip #9: Affirm “Neuraxial Technique” Commitment

- 6393 Cesarean/8 years (2005-2013)
- 851 General Anesthetics
- Not just Emergent Cases

<table>
<thead>
<tr>
<th>Anesthesia Technique</th>
<th>Start to Cut</th>
</tr>
</thead>
<tbody>
<tr>
<td>General Anesthesia</td>
<td>5 (3-11) min</td>
</tr>
<tr>
<td>Spinal</td>
<td>20 (16-28) min</td>
</tr>
<tr>
<td>Epidural in Situ</td>
<td>22 (18-24) min</td>
</tr>
<tr>
<td>General Anesthesia + Prior Neuraxial</td>
<td>26 (18-35) min</td>
</tr>
</tbody>
</table>


Tip #9: Affirm “Neuraxial Technique” Commitment

Epidural Technique:
- Anticipated, Perceived, Actual Technique Time
  - Placement Duration: 4.2 ± 3.5 min
  - 7% > 10 min; 21 min
  - Placement to Comfort: 12.6 ± 8 min
  - Total Time to Comfort: 16.8 ± 11.5 min

Clark A, Holck B, Mahoney B, Farber MK, Liu X, Tsen LC; IJOA 2015

Tip #9: Affirm “Neuraxial Technique” Commitment

Epidural Technique:
- 1200 Placements
- 12 Attendings/Fellows
- Placement: SQ Local Needle to Epidural Needle Removal
- Placement Duration: 53.2 (51.2-55.5) sec
- 99% Comfort at 30 min

Carabuena JM, Mitani AM, Xiaoxia L, Kodal BS, Tsen LC; A&A 2013

Tip #9: Affirm “Neuraxial Technique” Commitment

Are you faster than converting epidural analgesia?

<table>
<thead>
<tr>
<th>Study</th>
<th>Agent</th>
<th>Time</th>
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</tr>
</thead>
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<td>5.2 min</td>
<td>Extension T6</td>
</tr>
<tr>
<td></td>
<td>Lido 2% + Epi</td>
<td>9.7 min</td>
<td>Extension T6</td>
</tr>
</tbody>
</table>

Are you facile with a lateral placement?

What about difficult spinal placements? (10-14%)


Tip #10: Trouble-Shoot Neuraxial Technique

Scenario #1
- Urgent Cesarean, Patchy Labor Epidural

Solution
- Examine Epidural Analgesia History
- Give 6-10 mL Bolus Epidural Local Anesthetic
- Consider Spinal (Reduced Dose?)
Tip #10: Trouble-Shoot Neuraxial Technique

Epidural Space Fills…
- Compresses Dural Sac
- Makes Spinal Difficult
- Spreads Spinal Higher
- Dural Puncture Assists

Griffiths et al., Br J Anaesth 1993
Lee et al., Spine 2001
Higuchi et al., Anesthesiology 2005

Scenario #2: Urgent Cesarean, Spinal Failed

Solution
- Consider Repeat Spinal (Reduced Dose?)
  Initial: bupivacaine 12-15 mg, fentanyl 10-20 µg (T8)
  Repeat: bupivacaine 10 mg, fentanyl 10-20 µg (T3)
- Consider Continuous Spinal Catheter

Dadarkar/Vadhera et al. Anesthesiology 2002;96:suppl 1
Stocks, GM; Wilson MJ. Pro-Con. IJOA 2005;14(1):53-7

Tip #10: Trouble-Shoot Neuraxial Technique

- Head-Up Positioning (Semi-Fowler’s)
- Limit Cephalad Spread
- Spinal Bupivacaine: Mobile up to 45 min

Tip #10: Trouble-Shoot Neuraxial Technique

Scenario #3: Urgent Cesarean, Intraop Pain

Solution
- Consider Epidural Options
  - Somatic: Chloroprocaine or Lidocaine (+ Bicarb)
  - Visceral: Sufentanil/Fentanyl  20-50% to 5-10%
- Consider Analgesia/Anesthesia
  - IV: Ketamine + Midazolam; Induction GA
  - Inhaled: 50% Nitrous


Reducing GA for Cesarean: Summary

<table>
<thead>
<tr>
<th>Appropriate</th>
<th>Not Possible?</th>
<th>Tips</th>
</tr>
</thead>
</table>
Disclosures

- Research Support
  - Trevena Inc.
  - Pacira Pharmaceuticals
  - BioQ Pharma
  - Haylard Health

- Advisory Board
  - Trevena Inc
  - Health Decisions

Preventing and Treating Side Effects of Neuraxial Opioids

Ashraf S Habib, MBCh, MSc, MHSc, FRCA
Professor of Anesthesiology
Professor in Obstetrics and Gynecology
Chief, Division of Women's Anesthesia

Patient Preferences for Anesthesia

Outcomes: Associated with CD

<table>
<thead>
<tr>
<th>Outcome During Cesarean</th>
<th>Rank</th>
<th>Relative Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pain</td>
<td>5.4 ± 2.2</td>
<td>27 ± 13</td>
</tr>
<tr>
<td>Vomiting</td>
<td>8.3 ± 1.8</td>
<td>18 ± 10</td>
</tr>
<tr>
<td>Nausea</td>
<td>1.6 ± 1.7</td>
<td>11 ± 7</td>
</tr>
<tr>
<td>Pruritus</td>
<td>6.0 ± 1.9</td>
<td>10 ± 8</td>
</tr>
<tr>
<td>Hypothermia</td>
<td>4.8 ± 1.7</td>
<td>6 ± 6</td>
</tr>
<tr>
<td>Urinary Retention</td>
<td>4.1 ± 1.9</td>
<td>5 ± 4</td>
</tr>
<tr>
<td>Somnolence</td>
<td>2.9 ± 1.4</td>
<td>3 ± 3</td>
</tr>
</tbody>
</table>

Epi vs. parenteral opioids

Neuraxial Opioids

Discussions

- Risk factors
- Prophylaxis
- Treatment
- Monitoring

Side Effects of Neuraxial Opioids

- Pruritus (40-90%)
- PONV (30-50%)
- Respiratory Depression (0-0.9%)
- Urinary Retention (22-58%)
- Hypothermia (6-7%)
Other Risk Factors for Pruritus

- Epinephrine
- Pregnancy
- Spinal administration

Pruritus

- NOT histamine release

Possible mechanisms:
- μ receptors
- Itch center (Trigeminal nucleus)
- Dorsal or ventral horn neurons
- Other (D₂, 5HT₃, GABA, Glycine, PG)
Prophylaxis Against Pruritus

- Opioid Receptor Antagonists
- Antihistamines
- 5HT3 RAs
- Dexamethasone
- Other

Prophylaxis Against Pruritus

- Opioid Antagonists

Prophylaxis Against Pruritus

- 5HT3 Receptor Antagonists

Prophylaxis Against Pruritus

- Naloxone:
  - Single dose not effective (0.4 mg SC)
  - Continuous infusion effective (50-100 μg/h)
  - NNT 3.5 (0.25-2.4 μg/kg/h)

Prophylaxis Against Pruritus

- Placebo
- Diphenhydramine 30 mg
- Nalbuphine 10 mg

Prophylaxis Against Pruritus

- Epidural Naloxone Infusion following Epidural Morphine (4 mg bolus + 6 mg infusion)

Prophylaxis Against Pruritus

- IV Ondansetron
- Epidural Ondansetron

Prophylaxis Against Pruritus

- Need for treatment for pruritus: NNT =13

Prophylaxis Against Pruritus

- IV Ondansetron
- Epidural Ondansetron

Prophylaxis Against Pruritus

- Placebo
- Epidural morphine 1.5 mg every 12h
- Diphenhydramine 30 mg
- Nalbuphine 10 mg

Prophylaxis Against Pruritus

- Epidural morphine 1.5 mg every 12h
- Placebo
- Diphenhydramine 30 mg
- Nalbuphine 10 mg

Prophylaxis Against Pruritus

- Epidural Naloxone Infusion following Epidural Morphine (4 mg bolus + 6 mg infusion)

Prophylaxis Against Pruritus

- Epidural Naloxone Infusion following Epidural Morphine (4 mg bolus + 6 mg infusion)
Prophylaxis Against Pruritus

**Dexamethasone**

<table>
<thead>
<tr>
<th>Study or Subgroup</th>
<th>Dexamethasone</th>
<th>Control</th>
<th>Total</th>
<th>SMD (95% CI)</th>
<th>Risk Ratios (95% CI)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Yeung 2009</td>
<td>18</td>
<td>15</td>
<td>16.3</td>
<td>0.09 (0.01, 0.80)</td>
<td>0.51 (0.20, 1.28)</td>
</tr>
<tr>
<td>Wang 2001</td>
<td>17</td>
<td>15</td>
<td>16.3</td>
<td>0.19 (0.02, 1.56)</td>
<td>0.51 (0.20, 1.28)</td>
</tr>
<tr>
<td>Weng 2005</td>
<td>17</td>
<td>16</td>
<td>16.4</td>
<td>0.28 (0.03, 2.33)</td>
<td>0.46 (0.19, 1.12)</td>
</tr>
<tr>
<td>Li 2011</td>
<td>24</td>
<td>25</td>
<td>19.2</td>
<td>0.02 (0.00, 0.30)</td>
<td>0.73 (0.28, 2.01)</td>
</tr>
<tr>
<td>Total 2013</td>
<td>396</td>
<td>296</td>
<td>22.8</td>
<td>0.88 (0.84, 0.93)</td>
<td>NNT=4</td>
</tr>
</tbody>
</table>

Other Prophylactic Therapies

- Droperidol (1.25-2.5 mg, epidural 1.25-5 mg)
- Propofol (20 mg)
- Alizapride (50-100 mg)
- NSAIDs

Treatment of Pruritus

- **Opioid Antagonists**
- **5HT₃ Receptor Antagonists**
- **Antihistamines**
- **Propofol**

Treatment of Pruritus

**Opioid Antagonists**

- **Nalbuphine**
  - 2-5 mg (optimal dose 2-3 mg)
  - More effective than:
    - Propofol 10 mg
    - Diphenhydramine 25-50 mg
- **Butorphanol**
  - 1 mg followed by 0.2 mg/h

**5HT₃ Receptor Antagonists**

- Ondansetron 4 mg vs. Placebo
  - More effective (80% vs. 36% success)
- Ondansetron 4mg vs. other agents
  - Less effective than pentazocine (96.1% vs. 80.8%)
  - Not effective (no difference in pruritus scores before or after treatment)
  - As effective as diphenhydramine 25 mg (70% success with both agents)
PONV Risk Factors

<table>
<thead>
<tr>
<th>Patient Factors</th>
<th>Anesthesia Factors</th>
<th>Surgical Factors</th>
</tr>
</thead>
<tbody>
<tr>
<td>Female Gender</td>
<td>GA</td>
<td>Type of surgery</td>
</tr>
<tr>
<td>Non-smoker</td>
<td>Inhaled agents</td>
<td></td>
</tr>
<tr>
<td>History of PONV</td>
<td>N2O</td>
<td></td>
</tr>
<tr>
<td>History of motion sickness</td>
<td>Duration of anesthesia</td>
<td>Postoperative opioids</td>
</tr>
<tr>
<td>Young age</td>
<td>Postoperative opioids</td>
<td></td>
</tr>
</tbody>
</table>

Risk Factors For PONV Following CD

Post hoc analysis of data from 2 RCTs with IONV/PONV as primary outcomes
n=460, PONV= 54.4%

<table>
<thead>
<tr>
<th>Apfel Risk Factors</th>
<th>Additional Risk Factors</th>
</tr>
</thead>
<tbody>
<tr>
<td>History of PONV or motion sickness</td>
<td>History of morning sickness</td>
</tr>
<tr>
<td>Non-smoking status</td>
<td>History of hyperemesis gravidarum</td>
</tr>
<tr>
<td>Female gender</td>
<td>Preoperative nausea</td>
</tr>
<tr>
<td>Postoperative opioids</td>
<td>PONV/ Need for rescue antiemetics</td>
</tr>
<tr>
<td>Exteriorization of the uterus</td>
<td>Intraoperative Hypotension</td>
</tr>
</tbody>
</table>

Risk Factors For PONV Following CD

<table>
<thead>
<tr>
<th>Risk Factors</th>
<th>OR (95 % CI)</th>
<th>p = 460 PONV = 54.4%</th>
</tr>
</thead>
<tbody>
<tr>
<td>History of PONV after previous CD</td>
<td>1.7 (1.0, 2.8)</td>
<td></td>
</tr>
<tr>
<td>Never smoked</td>
<td>2.0 (1.1, 3.8)</td>
<td></td>
</tr>
</tbody>
</table>

Factors Not Associated with Increased Risk

- History of PONV after other surgeries
- History of motion sickness
- History of morning sickness (p = 0.08)
- Preoperative nausea
- PONV/ Intraoperative rescue
- Exteriorization of the uterus
- Intraoperative hypotension/ Use of PE infusion

Apfel Score vs. Duke Score

Apfel Score

- 1 point: History of PONV after CD or history of motion sickness
- 1 point: Non-smoker during pregnancy
- 1 point: never smoked

Duke Score

- 1 point: History of PONV after previous CD
- 1 point: Non-smoker during pregnancy

Antiemetics

- Dexamethasone
- Metoclopramide
- Promethazine
- Scopolamine
- Ondansetron
- Granisetron
- Dimenhydrinate
- Prochlorperazine
- Cyclizine
Interventions for Preventing NV During CD Under Regional Anesthesia

**Effective Interventions**

<table>
<thead>
<tr>
<th>Intervention</th>
<th>(n studies)</th>
<th>Postoperative Nausea RR (95% CI)</th>
<th>Postoperative Vomiting RR (95% CI)</th>
</tr>
</thead>
<tbody>
<tr>
<td>5HT3 RAs (5)</td>
<td></td>
<td>0.40 (0.25, 0.64) (466)</td>
<td>0.50 (0.32, 0.77) (665)</td>
</tr>
<tr>
<td>Dopamine-Antagonists (6)</td>
<td></td>
<td>0.60 (0.40, 0.91) (412)</td>
<td>0.57 (0.36, 0.91) (472)</td>
</tr>
<tr>
<td>Antihistamines (3)</td>
<td></td>
<td>0.38 (0.26, 0.59) (365)</td>
<td>0.50 (0.30, 0.86) (184)</td>
</tr>
<tr>
<td>Anticholinergics (1)</td>
<td></td>
<td></td>
<td>0.55 (0.41, 0.74) (161)</td>
</tr>
</tbody>
</table>

Griffiths JD. Cochrane Database Syst Rev. 2012;(9):CD007579

**Ineffective Interventions**

<table>
<thead>
<tr>
<th>Intervention</th>
<th>(n studies)</th>
<th>Postoperative Nausea RR (95% CI)</th>
<th>Postoperative Vomiting RR (95% CI)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dexamethasone (3)</td>
<td></td>
<td>0.75 (0.52, 1.07) (235)</td>
<td>0.78 (0.54, 1.12) (295)</td>
</tr>
<tr>
<td>Nalbuphine (1)</td>
<td></td>
<td>0.75 (0.39, 1.45) (120)</td>
<td>1.25 (0.35, 4.43) (120)</td>
</tr>
<tr>
<td>Supplemental Oxygen (1)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>P6 Stimulation (3)</td>
<td></td>
<td>0.83 (0.68, 1.16) (429)</td>
<td>0.69 (0.45, 1.06) (429)</td>
</tr>
</tbody>
</table>

Griffiths JD. Cochrane Database Syst Rev. 2012;(9):CD007579

**PONV Prophylaxis**

**Metoclopramide**

- Placebo
- Metoclopramide 10 mg

Intrathecal Morphine 0.15 mg

n=100/group


**PONV Prophylaxis**

**Dexamethasone**

- Placebo
- Dexamethasone 8 mg
- Droperidol 1.25 mg
- Dexamethasone 4 mg + Droperidol 0.625 mg


**Combination Antiemetic Therapy**

P<0.05 vs. other groups

NNT=7

NNT=8

Allen TK. Anesth Analg 2012;114:813-22

Treatment of Established PONV

Ondansetron Retreatment Study

Not Significantly Different From Placebo


Treatment of established PONV

Rescue Following Failure of Ondansetron Prophylaxis

Respiratory Depression

Respiratory Depression

• Early (30-90 min), late (6-18 h)

• 0-0.9%

• Clinically significant respiratory depression:
  – 78 studies (n = 18,455)
  – All doses: 5.96-8.67 per 10,000 cases
  – Contemporary doses: 1.08-1.63 per 10,000 cases
Hypothermia

- Hypothermia with diaphoresis and feeling hot
- Not responsive to active warming
- Persists for about 6 hrs
- Lorazepam and naloxone

Conclusions

- Pruritus and PONV common after neuraxial opioid administration
- Respiratory depression rare
- Minimal effective dose of neuraxial morphine
Conclusions

- **Pruritus**
  - Naloxone 0.25 μg/kg/h
  - Nalbuphine 2.5 mg

- **PONV**
  - 5 HT$_3$ RAs
  - Dexamethasone
  - Anticholinergics
  - Antihistaminergics
  - Combination Antiemetics
Saturday, March 16, 2019

Session V: Obstetric Anesthesia Safety Session
(ABA Part 2 MOCA Patient Safety Credit)
Moderator: Gillian Abir, M.B., Ch.B., FRCA

Current Evidence for the Prevention and Treatment of Spinal Hypotension
Mark D. Rollins, M.D., Ph.D.

Pregnant Patient with Chronic Pain and Opioid Addiction
Pamela D. Flood, M.D., M.A.

OSA in the Parturient: Implications for Peri and Post-Operative Period
Jeremy Collins, FRCA, M.B., Ch.B.
Objectives

Participants should be able to discuss the impact of the following to prevent & treat spinal hypotension:

- Fluid Management
- Vasopressors
- Uterine Displacement

Definition of Hypotension

Two most common definitions...

1) A decrease below 80% of baseline

OR

2) Either a blood pressure below 100mmHg or a decrease below 80% of baseline


Why The Concern?

- Maternal
  - Nausea and vomiting
  - Dizziness

- Fetal
  - Acidosis
  - Bradycardia

- Ngan Kee et al. BJA 2004, 92 (4): 469-74
**IV Coload?**

1) 2004 study by Dyer et al. noted benefit of coload over preload
2) 2010 Meta-analysis by Banerjee et al. found no benefit of coload over preload
3) 2012 Analysis suggests may be some minimal benefit with vasopressor use
4) 2017 Meta-analysis by Ni et al. suggests benefit of colading over preload

**A significant decrease in hypotension associated with spinal anesthesia was observed with the use of colloids compared to crystalloids**

\( \text{RR [95% CI]} 0.70 \ [0.53-0.92], P=0.01 \)

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**Prophylactic Ephedrine Preceding Spinal Analgesia for Cesarean Section**

**HORRIT B. GUTSCHE, M.D.**

Hypotension frequently occurs in parturients undergoing cesarean section with high subarachnoid block, due to decreased cardiac output from inferior vena caval compression by the gravid uterus, compounded by vasodilatation and bradycardia. In normotensive parturients, central blood pressure before 100 mmHg was associated with fetal bradycardia, indicating fetal distress in utero as well as indicating neonatal depression at birth. Acetazolamide (Diamox), which produced little attention. The purpose of this study was to determine the need for and effects of prophylactic intravenous administration of ephedrine when both left uterine displacement and maternal hydration are employed. Results indicated that left uterine displacement and maternal hydration alone were not sufficient, and that addition of prophylactic intravenous administration of ephedrine was efficacious.


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**Results:**

1) Ephedrine crosses the placenta to a greater extent and undergoes less early metabolism / redistribution
2) The overall effect of vasopressors on fetal oxygen supply and demand favors phenylephrine
Norepinephrine was effective for maintaining blood pressure and was associated with greater heart rate and cardiac output compared with phenylephrine.

Optimal Infusion Rate?
A 25 - 50 mcg/min infusion rate may be a preferable starting point for prophylactic phenylephrine compared with an initial infusion of 100 mcg/min.

Infusion vs Bolus Dosing?
Less hypotension and less nausea and vomiting with a phenylephrine infusion compared to bolus dosing.

Randomized Double-blinded Comparison of Norepinephrine and Phenylephrine for Maintenance of Blood Pressure during Spinal Anesthesia for Cesarean Delivery
(Anesthesiology 2015; 122:736-45)
Shara W, Y. Lee, B.Sc(Hons), M.Sc., Ph.D., Fiona F. Ng, R.N., B.A.Sc.,

Prophylactic Norepinephrine Infusion for Preventing Hypotension During Spinal Anesthesia for Cesarean Delivery

An open-label randomized controlled clinical trial for comparison of continuous phenylephrine versus norepinephrine infusion in prevention of spinal hypotension during cesarean delivery
UJOA 2017. 29: 18-25
Is LUD Beneficial?

Left Lateral Table Tilt for Elective Cesarean Delivery under Spinal Anesthesia Has No Effect on Neonatal Acid–Base Status

A Randomized Controlled Trial

(Aneesthesia 2017; 127:241-9)

Is LUD Beneficial?

Left Lateral Table Tilt for Elective Cesarean Delivery under Spinal Anesthesia Has No Effect on Neonatal Acid–Base Status

A Randomized Controlled Trial

(Aneesthesia 2017; 127:241-9)

Recommendations

1) Hypotension following spinal or combined spinal-epidural anesthesia at caesarean section causes both maternal and fetal/neonatal adverse effects.

2) Hypotension is frequent and vasopressors should be used routinely and preferably prophylactically.

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1) Hypotension following spinal or combined spinal-epidural anesthesia at caesarean section causes both maternal and fetal/neonatal adverse effects.

2) Hypotension is frequent and vasopressors should be used routinely and preferably prophylactically.

3) Alpha-agonist drugs are the most appropriate agents to treat or prevent hypotension following spinal anaesthesia. Although drugs with some beta activity may have the best profile phenylephrine is currently recommended due to the amount of supporting data.

4) Left lateral uterine displacement and intravenous colloid preloading or crystalloid coloading, should be used in addition to vasopressors.

Lee et al. Anesthesiology 2017; 127:241-9

Lee et al. Anesthesiology 2017; 127:241-9

Guidelines

International consensus statement on the management of hypotension with vasopressors during caesarean section under spinal anaesthesia


Anesthesiology 2018, 73, 71-92
doi:10.1097/ANES.0000000000002340

Recommendations

5) The aim should be to maintain systolic arterial pressure (SAP) at ≥ 90% of an accurate baseline obtained before spinal anesthesia, and avoid a decrease to < 80% baseline. We recommend a variable rate prophylactic infusion of phenylephrine using a syringe pump. This should be started at 25–50 mcg/min immediately after the intrathecal injection, and titrated to blood pressure and pulse rate.

Recommendations

6) Maternal HR can be used as a surrogate for CO if the latter is not being monitored; both tachycardia and bradycardia should be avoided.

7) When using an alpha-agonist as the first-line vasopressor, ephedrine is suitable to manage SAP < 90% of baseline combined with a low heart rate. For bradycardia with hypotension, an anticholinergic drug may be required. Epinephrine should be used for circulatory collapse.
Pregnant Patient with Chronic Pain and Opioid Use Disorder

Pamela Flood, MD, MA
Professor of Anesthesiology,
Perioperative and Pain Medicine
Stanford University

As if that is not complicated enough!

Pain is Common – Pregnancy is Common

- 4 million term pregnancies each year in the United States
- 25% of young adults 20-44 report chronic pain that interferes with their life
- Twice as common in women (33%)
- Any chronic pain syndrome that occurs in young women can superimposed upon pregnancy

http://www.cdc.gov/nchs/fastats/births.htm

2010 US Census
4 million
Pregnancies
60 million
18-45 y with chronic pain
1.3 million
pregnant with chronic pain

- > 2 hours lost productive time per week
- Headache most common
  5%
- Back pain 2%
- Arthritis 1.5%
- Other 1%
  - Fibromyalgia
  - Pelvic Pain


• Some Conditions Get Worse:
  - Low back Pain 2% before pregnancy, 60% of pregnant women report low back pain during pregnancy
  - 20% of pregnant women report pelvic girdle pain during pregnancy, 50% is treated with medication

• Some Conditions Improve (but have exacerbations after delivery):
  - Headache
  - Autoimmune arthritis
  - Multiple Sclerosis


Curr Neurol Neurosci Rep (2016) 16: 40

Preparation is key for women with chronic pain and analgesic use

- Any chronic pain syndrome that occurs in young women can superimposed upon pregnancy
- Pre-conceptual counseling about expected impact of pregnancy on pain condition and safe treatment
- Pharamcology:
  - Reduced symptoms with physical therapy, medication
  - Reduce dosages
  - Limited interventions are possible during pregnancy
  - No fluoroscopy
  - Limited steroids
  - Can do some blocks with ultrasound
  - Physical therapy: maximizes core strength and weight loss
  - Pain psychology: maximize coping skills

Preparation is key but… Unanticipated Pregnancy ~ 50%
(in women who do not abuse drugs)

Common Comorbidities

- Depression
- Anxiety
  - May have had difficulty with previous procedures and providers
  - Often feel negatively judged
- Sleep disorders
- Hyperalgesia – Difficult IV placement
- Allodynia- tourniquet is painful
- Good time to gain trust

Principles of Chronic Pain Management: Biopsychosocial Model

- Medications – Buprenorphine Induction
- Procedures
  - Ultrasound guided injections
  - Acupuncture
- Physical Therapy
  - Core strengthening
  - Yoga for flexibility
- Pain psychology
  - Coping skills
  - Biofeedback
  - Cognitive Behavioral therapy
  - Mindfulness Meditation

Back Pain in Pregnancy: Management

2% before pregnancy
60% during pregnancy
Post Partum prevalence is 25%
Relapse rate is high in subsequent pregnancies

Back Pain in Pregnancy and After:

etiology for onset of chronic back pain in young women?

- Risk Factors
  - Increased Weight
  - History of low back pain
  - Low Job Satisfaction
- Etiology
  - Increased lumbar lordosis
  - Inefficient neuromuscular control

Pennick V1, Liddle SD. Interventions for preventing and treating pelvic and back pain in pregnancy. Cochrane Database Syst Rev. 2013

Back Pain In Pregnancy

- Management
  - Acetaminophen
  - Topical Analgesic Patches
  - Gabapentin
  - Mineral Salicylate
  - Acupuncture
  - TENS (better than exercise or acetaminophen)
  - Any land based exercise
    - Pain -0.64 (-1.03 to -0.25) SD
    - Functional disability -0.56 (-0.89 to -0.23) SD
  - Music Based Relaxation
  - No evidence for pelvic support belt

Pelvic Girdle and Lumbar Pain

- The joints in the pelvis are held together by thick ligaments and normally don’t allow much motion.
  - Sacroiliac and Public Symphysis
- Increasing estrogen and progesterone soften ligaments and allow a greater degree of motion as early as the first trimester
- During the second and third trimester the growing fetus results in increased lordosis and widening of the hips increasing pelvic girdle and lumbar pain
Ultrasound guided Injections
- Trigger point injections
- Occipital nerve blocks
- Facet joints
- Sacroiliac joints
- Injections during pregnancy to facilitate physical therapy

The elephant in the room
Are drugs commonly used for pain conditions safe in pregnancy and during lactation?

WHO Guidelines in Pregnancy?

Summary: NSAIDS and Acetaminophen During Pregnancy
- Aspiring OK
- Acetaminophen likely OK
- Non-steroidals
  - Risk of miscarriage first trimester
  - Multiple studies suggest small increase in risk of cardiac defects
  - Risk of closure of the ductus arteriosus third trimester

Commonly Used Drugs During Pregnancy: Drugs for Migraine
Occurs in 5% of women and commonly recurs post-partum
Migraine

- History of migraine is associated with an increased risk of pregnancy complications
  - preclampsia,
  - low birthweight infants,
  - ischemic stroke
- Myocardial infarction
- DVT
- PE

Migraine Treatment Options in Pregnancy

- Non-pharmacological
  - Behavioral (relaxation, cognitive behavioral, biofeedback, stress management)
  - Mind-body (meditation, yoga)
  - Dietary (limit caffeine, hydrate, avoid known food triggers)
- Ablative Drugs - Triptans
- Physical therapy
- Acupuncture
- Nerve blocks
- Botox

Abnormal Drug for Migraine Teratogenicity

<table>
<thead>
<tr>
<th>Drug</th>
<th>Species</th>
<th>Sample size</th>
<th>Study design</th>
<th>No. of cases</th>
<th>Risk compared</th>
<th>Risk ratio</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ergotamine</td>
<td>Female</td>
<td>17 cases</td>
<td>Pregnancy registry</td>
<td>2.0</td>
<td>13.6 (3.1-50)</td>
<td>1.0 (0.1-10)</td>
<td>Data restricted to women with migraine.</td>
</tr>
<tr>
<td>Ketorolac</td>
<td>Male</td>
<td>100 cases</td>
<td>Double-blind, placebo-controlled study</td>
<td>0.9</td>
<td>0.9 (0.1-9.5)</td>
<td>0.9 (0.1-9.5)</td>
<td>Data restricted to women with migraine.</td>
</tr>
<tr>
<td>Naproxen</td>
<td>Female</td>
<td>100 cases</td>
<td>Double-blind, placebo-controlled study</td>
<td>0.8</td>
<td>0.8 (0.1-9.5)</td>
<td>0.8 (0.1-9.5)</td>
<td>Data restricted to women with migraine.</td>
</tr>
<tr>
<td>Ibuprofen</td>
<td>Female</td>
<td>100 cases</td>
<td>Double-blind, placebo-controlled study</td>
<td>0.7</td>
<td>0.7 (0.1-9.5)</td>
<td>0.7 (0.1-9.5)</td>
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</tr>
<tr>
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<td>Double-blind, placebo-controlled study</td>
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<td>0.4</td>
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<td>Data restricted to women with migraine.</td>
</tr>
</tbody>
</table>

Concerns about blood pressure

- Many studies, very clean, but most cases with sumatriptan

Prophylactic Drugs for Migraine

- Magnesium dietary supplement 200-500 mg at night
- Topiramate used in epilepsy may or may not have a higher risk than no treatment
- Propranolol, nadolol, metoprolol beta-blockers have been used safely for hypertension
- Gabapentin – No increased risk has been found in several registries

Newer-Generation Antiepileptic Drugs and the Risk of Major Birth Defects. JAMA, May 18, 2011—Vol 305, No. 19

Summary: Migraine Management

- Triptans are likely safe, the best data is with sumatriptan
- Migraine prophylactics
  - Start with the more familiar in pregnancy
    - Magnesium citrate
    - Beta blockers
  - Emphasis on lifestyle changes

Opioid Use in Pregnancy

Long Acting Opioids Prescribed by State
- The likelihood of your patient being on chronic opioids depends on where you practice (2012 data)
- This is decreasing due to regulation and increased consciousness, but still very common
- For your state up to 2015: https://ppsg-chart.medicine.wisc.edu/

Are there neurodevelopmental risks? Is it the chicken or the egg?
- Opioids
  - Prenatal exposure is associated with developmental delay
  - Only when the infants are raised by the opioid using mother
  - Not when fostered with non-opioid using parents

Opioid Use is Common – Pregnancy is Common
- 4 million term pregnancies each year in the United States
- Private Insurance 28% of women of reproductive age filled an opioid prescription
- Medicaid 39% of women of reproductive age filled an opioid prescription
- Opioid use increased from 1 to 6/1000 births between 2000 - 2006
- All pregnant women should be screened for opioid use at first prenatal visit

Summary: Opioid Prescription During Pregnancy
- Avoid synthetic opioids during the first trimester
- Opioids should be weaned before conception or (?) during the second trimester
- Increase in incidence of miscarriage if withdrawal in the first trimester
- Increase in preterm birth if withdrawal in the third trimester
- Avoid codeine during lactation
  - Codeine is a prodrug metabolized to morphine
  - The amount and rate of metabolism is highly variable from none to producing very high fast peaks
  - Neonatal deaths have been attributed to mismatch between ultrarapid metabolizing moms and slow and infants with immature morphine metabolism
Methadone – gold standard since 1974,
- Daily dispensing with psychological support
- 86% of women need dose increase during pregnancy, and many need split dose
- Dose reduction after 6 weeks
- No increase in NAS (neonatal abstinence syndrome)

Carter LC1, Read MA, Read L, Nicholas JS, Schmidt E.

Buprenorphine
- Fewer preterm births
- Lower risk or NAS
- Can be prescribed in the office weekly or biweekly (4-32 mg)
- Ceiling effect?
- Increased adherence
- New long acting forms
- Monthly injection
- Implantable


Buprenorphine – Naloxone (Suboxone)
- Cannot be injected
- No difference in outcome between buprenorphine or methadone
- Lower APGAR scores


Partial Agonist – binds tightly
- Regional analgesia
- Other analgesics
- Low doses <2 mg can be overcome by a full agonist


Re assure –
- Patients with chronic pain may fear the impact of vaginal delivery or surgery
- They may be hyperalgesic
- Patients taking pain medications may have had adverse experience medical personnel who judge their use of medication during pregnancy

Opioids need to be continued even with regional analgesia
- Need to prevent withdrawal
- Pre delivery daily requirement should be given in divided doses for pain patients and usually split dose for methadone
- Emphasize regional analgesia whenever possible


- It is the one treatment that a patient won’t be tolerant to
- Consider adjuvant analgesics
  - additive or synergistic when opiates are used
• Hyperalgesia
  • Chronic pain patients, even if not taking opioids, may have higher sensitivity to pain. Plan enhanced pain care in advance.
  • Regional analgesia is a mainstay and should be continued as long as possible, even in the setting of vaginal delivery.
  • Consider other adjuvants.

• Tolerance
  • Baseline daily dose is a minimum and increased opioids and other adjuvant medications are required.
  • >100 MED difficult.

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**OK to Breast Feed? – YES!**

- Consider this excerpt from *The American Academy of Pediatrics Clinical Report*:
  - “Many mothers are inappropriately advised to discontinue breastfeeding or avoid taking essential medications because of fears of adverse effects on their infants. This cautious approach may be unnecessary in many cases, because only a small proportion of medications are contraindicated in breastfeeding mothers or associated with adverse effects on their infants.”

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You can use your:
- Knowledge of pharmacology
- Understanding of maternal and fetal physiology
- Human kindness
OSA in the Parturient Implications for Peri- and Postoperative Period

Jeremy Collins MB ChB FRCA
Clinical Associate Professor, Stanford University

Local OSA guideline?

Limited enthusiasm for diagnosis and treatment
- Limited number of studies showing merits of intervention
- Limitation of sleep medicine referrals
- Limited patient compliance with treatment
- Expense of Dx and Rx in an uninsured population

No conflicts of interest
• OSA in 10% in first trimester
• OSA in 26% in third trimester
• Risk factors are BMI, gestational wt gain and maternal age

Pregnancy and OSA

Distant effect of visceral obesity
• Waist circumference: strong correlation with OSA

• Reduced activity of genioglossus with increased lung volume

Obstructive sleep apnea in pregnancy is associated with adverse maternal outcomes: a national cohort

G. Bourjeily et al. / Sleep Medicine 38 (2017) 50-57


OR ~ 2.5-3.5

OR ~ 1.86-2.11
Forest plots showing A, unadjusted and B, adjusted ORs for SDB and gestational diabetes. Weights are from random-effects analysis and are shown by gray-shaded boxes.


OR ~ 1.86–2.11

Hypertensive disorders of pregnancy and OSA

Diagnosis of OSA in pregnancy

- Men: excessive daytime sleepiness
- Women: fatigue, insomnia, tension

Screening questionnaires for OSA in pregnancy

- STOP-BANG (age>50, NC, gender)
- EPWORTH
- BERLIN
- Sensitivity/specificity: 35% / 63%

Specificity improved by adding serum bicarbonate >28mmol/L.
Home sleep studies

<table>
<thead>
<tr>
<th>Traditional Model</th>
<th>Home Testing Model</th>
</tr>
</thead>
<tbody>
<tr>
<td>In-laboratory PSG</td>
<td>Home portable monitor</td>
</tr>
<tr>
<td>CPAP prescription</td>
<td>CPAP prescription based on 95th percentile NIV/pressure</td>
</tr>
</tbody>
</table>

Expense

- Inexpensive
- Convenient
- Available

Portable home monitors

WatchPAT

Correlates with PSG (r=0.889)

Apnea Risk Evaluation System monitor

Screening: clinical judgement

- Morbid obesity
- Neck Circumference > 40cm
- H/O difficult airway
- CHF/H or GHTN
- Loud snoring
- Observed apneas
- Daytime somnolence

OSA increases risk for Cesarean delivery

Forest plots of the association between OSA and cesarean delivery

Xu, T et al. Scientific Reports volume 4, Article number: 6982 (2014)
Peri-operative management guidelines for OSA in the parturient

- Suspect and optimize early
- CPAP
- Position
- (Mandibular advancement devices)
- (Weight loss & sleep surgery)
- Opioids and multimodal analgesia

Consensus driven vs evidence driven guidelines

Practice Guidelines for the Perioperative Management of Patients with Obstructive Sleep Apnea
An Updated Report by the American Society of Anesthesiologists Task Force on Perioperative Management of Patients with Obstructive Sleep Apnea

- similar consideration as for surgical patients - optimize early
- CPAP machines should be used during admissions
- studies of bariatric patients suggest CPAP mitigates effect of opioids on OSA

Preoperatively Screened Obstructive Sleep Apnea Is Associated With Worse Postoperative Outcomes Than Previously Diagnosed Obstructive Sleep Apnea

- Adverse respiratory events?
- Respiratory interventions?
- Hospital stay?
- Diagnosis on DOS associated with more interventions and longer stay

CPAP - safe

- dry mouth
- aerophagia
- rhinitis
- skin abrasions
Positioning

- AHI supine: 7.7 ± 2.2/h
- AHI 45° elevation: 4.5 ± 1.4/h
- CSA upper airway supine: 1.35 ± 0.14
- CSA upper airway 45° elevation: 1.54 ± 0.14

- avoid sedating anti-emetics, sleeping aids, sedatives
- judicious use of systemic opioids
- multi-modal analgesic regimes
- SpO2 monitoring - oxygen pm until return to baseline
- CPAP during sleep periods
Challenge

OPIOIDS!

Respiratory effects of opioids

- Reduced airway tone
- Reduced central drive
- Less response to hypoxia
- Change in sleep architecture

Challenges

- Common
- Pk/PD in obesity more complex
- Heterogenous nature of obese population
- Limited resources for postoperative observation
- Associated co-morbidities

Adequate pain control

- Early ambulation offsets risk of DVT
- Increased satisfaction
- Maintenance of lung volumes

MO + OSA

- More uncertainty in dosing
- Greater sensitivity to opioid
- Greater level of hypoxia as a result of those effects
Transcranial Magnetic stimulation

- 20 gastric bypass patients
- randomized to sham or 20 min session of rTMS
- mix of open and closed surgery
- measured morphine consumption via PCA

Thank you
Session VI: New Developments and Concepts
Moderator: Jennifer M. Lucero, M.D., M.S.

Point of Care Ultrasound in Obstetric Anesthesia
Clemens M. Ortner, M.D., M.S., DESA

Neuraxial Ultrasound: Practical Guide to Adoption
Katherine M. Seligman, M.D.

Sam Hughes Lecture: Obstetric Anesthesia Year in Review
Ashraf S. Habib, M.B.,B.Ch., M.Sc., M.S.N., FRCA
Point-of-Care Ultrasound in Obstetric Anesthesiology

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March 22, 2019

APPLICATIONS OF FOCUSED HEART AND LUNG ULTRASOUND IN OBSTETRIC ANESTHESIOLOGY

Case #1

- 38 yo G2P1
- 48hrs post D&E
- Fever (Chorioamnitiis?)
- Severe dyspnea

Conflicts of interest: none


Case #1

- SaO2 88%
- HR 140 bpm
- NIBP?
- PANIC in the room
- OBGYN resident staring at ECG
DD: Sepsis? Occult hemorrhage? PE? Heart failure?

"Why wasn’t it being used more widely in OBA?"

Learning Objectives:

- Definition & Goals of Focused Cardiac Ultrasound
- Applications of Lung Ultrasound in Obstetric Anesthesiology
- Ocular Sonography in Preeclampsia
- Gastric Ultrasound in the Obstetric Patient

Focused Cardiac Ultrasound (FOCUS)

1. Why is this patient hypotensive?
2. Might this patient benefit from fluid loading?
3. Is major LV-dysfunction responsible for the shock state?

LV failure  Hypovolemia  Tamponade
Pleural effusion  Pulmonary embolus  LV hypertrophy

Inotropes  Fluids  Drain
Drain  Embolectomy  ????

Focused Cardiac Ultrasound (FOCUS)

- Rapid
- Bedside
- At Point of Care
- Repeatable

Targeted diagnostic test (Yes/No)
FOCUS Diagnostic Targets:

1. LV-Dimension / systolic function
2. RV-systolic Function
3. Volume Status
4. Pericardial Effusion
5. Gross signs of chronic cardiac Dx
6. Gross valvular Dx

FOCUS: How is it done?

Anatomic changes in Pregnancy:
- Anterior and left displacement of the heart
- Elevated diaphragm
- Partial left lateral tilt (LUD)

Ideal for parasternal and apical views

Can you do a Focused-Scan?

Novice / Non-cardiologist diagnose hypotension 2/2:
- Systolic dysfunction 1,4,5
- Significant hypovolemia 1,3
- RV-failure 1
- Pericardial effusion/Tamponade 1,2
- Gross valvular pathology 1,4
- LVH 1,4

84-95% level of agreement to level I/II specialist

International expert statement on training standards for critical care ultrasonography

1. Minimum 10hr lectures + image based training
2. ~30 TTEs under supervision (milestone achievement)
3. Didactic cases / interactive image interpretation
4. Logbook
5. Special Competence in Critical Care Echocardiography Exam (CCEeXAM: www.echoboards.org)
Case #2

31yo G2P1 @ 36wks
PMH: moderate to severe Asthma, ASD II
Previous uncomplicated pregnancy
Now dyspnea on minimal exertion
Admitted on L&D with SOB
Started on duonebs + diuresis

APPLICATION FOR POCUS IN OBSTETRIC ANESTHESIOLOGY 24

Initial improvement of symptoms,
IOL for PreE and severe features
Dyspnea + expiratory wheezing with labor
Oliguria, plasma creatinine
Ob: "Is this related to hypovolemia or worsening PreE?"
Fluid bolus?
Cardiology: Yes
Pulmonology: No
CXR ordered

APPLICATION FOR POCUS IN OBSTETRIC ANESTHESIOLOGY 25

US-guided management of acute breathlessness

.........and then came Paul..........
§ B-lines increase with progressing ALI
§ Before PaO2/FiO2↓

3/22/19 APPLICATIONS FOR POCUS IN OBSTETRIC ANESTHESIOLOGY 30
Experimental evidence to Lung ultrasound

§ B-lines correlate with wet-dry ratio

3/22/19 APPLICATIONS FOR POCUS IN OBSTETRIC ANESTHESIOLOGY 31
Experimental evidence to Lung ultrasound

Lung-US: Short Learning Curve

1 hr training module sufficient to train physicians with/without US-experience to recognize:

- Normal Lungs
- Pulmonary edema
- Pneumothorax

3/22/19 APPLICATIONS FOR POCUS IN OBSTETRIC ANESTHESIOLOGY 32
Lung-US is normal in healthy pregnancy

150 women at 36–38 gest. weeks:

- n=0 interstitial pulmonary syndrome [B-pattern]
- n=0 alveolar consolidation
- n=0 pleural effusion
- n=0 pneumothorax

3/22/19 APPLICATIONS FOR POCUS IN OBSTETRIC ANESTHESIOLOGY 33

US-guided management of acute breathlessness

Case #2

- Initial improvement of symptoms,
- Dyspnea + expiratory wheezing with labor
- Oliguria, plasma creatinine
- OB: fluid bolus?
- Cardiology: Yes
- Pulmonology: No
- CXR ordered

........and then came Paul........
US-guided management of acute breathlessness

Case 2

Zieleskiewicz L., Anaesthesia 2018; Jul 26
Lung-Ultrasound and Preeclampsia

- 25-35% Interstitial pulmonary syndrome present in severe preeclampsia
- 19-20% raised LVEDP on TTE
- B-pattern on Lung-US is associated with raised LVEDP on TTE1,2
  - (Sensitivity 80-100%, Specificity 80-85%)
  - A-pattern on Lung-US excludes raised LVEDP

Interstitial pulmonary syndrome present in severe preeclampsia

Ocular Sonography in Preeclampsia

- Ultrasonographic measurement of the Optic Nerve Sheath Diameter (ONSD)

ONSD measurement to detect raised ICP:
- ONSD Cut-off: 4.8-5.9 mm3
- Sensitivity 90%
  - [95% CI: (0.30-0.95)]1
- Specificity 85%
  - [95% CI: (0.73-0.93)]1
- ROC = 0.9181

A-pattern on Lung-US excludes raised LVEDP

Incidence of raised ONSD in Preeclampsia: 10-43%

- Early and late onset dx +/- SF: 5/24 (19%)
- Late onset dx +/- SF: 28/95 (29%)
- Late and early onset dx +/- SF: 13/70 (43%)
- Back to normal (4.5mm) post partum day 4
- ONSD normal in ALL healthy controls

Late onset dx + SF: 28/95 (29%)

Lung-Ultrasound and Preeclampsia

- 25-35% Interstitial pulmonary syndrome present in severe preeclampsia
- 19-20% raised LVEDP on TTE
- B-pattern on Lung-US is associated with raised LVEDP on TTE1,2
  - (Sensitivity 80-100%, Specificity 80-85%)
- A-pattern on Lung-US excludes raised LVEDP

Incidence of raised ONSD in Preeclampsia: 10-43%

- Early and late onset dx +/- SF: 5/24 (19%)
- Late onset dx +/- SF: 28/95 (29%)
- Early and late onset dx +/- SF: 13/70 (43%)
- Back to normal (4.5mm) post partum day 4
- ONSD normal in ALL healthy controls

Early and late onset dx +/- SF: 5/24 (19%)
Ocular Sonography in Preeclampsia

Challenges in Interpretation:
- No correlation with neurologic symptoms (HA, visual disturbances)
- No comparisons to direct or indirect ICP-measurements
- MRI studies in PreE showing focal swelling only (incidence: 0 - 14.5 %)
- Imaging artefacts? (Lamina cribrosa or Optic disc edema)
- Sign of disease severity?

Gastric Ultrasound in Obstetrics

Case #3
- 34yo G3P2 @ 37wks, ho CDx1 (failed spinal)
- PMH: healthy, BMI 38, Scoliosis
- Pregnancy complicated by ITP (Plts 70 G/l)
- Now contracting q 10-15min, Cervix @ 3cm
- OBGYN wants to proceed
- Coffee+cream and Cornflakes 5-1/2hrs ago

Wait? Proceed? How?
**Gastric Ultrasound**

**STEP 1**
Qualitative examination (both supine and right lateral)
- No content
- Clear fluid
- Solid

**STEP 2**
Volume evaluation (in right lateral decubitus)
- Empty stomach ≤ 1.5ml/kg
- Full stomach ≥ 1.5ml/kg

**Gastric Ultrasound in Obstetrics**

- Gastric ultrasound more challenging, but feasible (83-96%) 1,3
- Right lateral (RL) positioning not well tolerated 4
- Gastric emptying in obstetric women may be delayed (light meals) 2,5
- Traditional Gastric Volume formula not validated in obstetric population
- Variety of antral area cut-offs (SR, RL-position) to predict 1.5ml/kg (large 95% CI) 1,3,7

**Validation Study in Obstetric Women:**
- N = 34 women, third trimester
- Gastric volume measured in MRI and compared to Gastric-US
- Composite scale using 505mm² antral CSA in semirecumbent position to predict 1.5ml/kg

Sensitivity: 85% (95% CI: 51-99)
Specificity: 87% (95% CI: 59-98)
PPV: 93% (95% CI: 64-99)
NPV: 80% (95% CI: 44-96)
Gastric Ultrasound in Obstetrics

- 1 transducer = function of 13 piezo electric probes!
- Costs go down (2000 $ / Transducer)
- Artificial intelligence for imaging acquisition
- Images interpreted via telemedicine

The Future of POCUS

Conclusion: Consensus Statement

"...the use of FOCUS for the evaluation of hemodynamic instability of uncertain or suspected cardiac etiology meets Class I recommendation according to American and European Guidelines..."
Disclosures

- No Financial Disclosures
- Researched/Published on Rivanna-Accuro

Content Outline

- Benefits of Neuraxial Ultrasound
- Machine Types & Equipment
- Neuraxial Anatomy
- Scanning Technique
- How to implement

Benefits of Neuraxial Ultrasound

- Midline Identification
- Accurate identification of lumbar interspaces
- Increased success rates
- Identification of angle of entry
- Accurate estimation of depth to epidural space
- Decreased time to access neuraxial space
Ability of anaesthetists to identify a marked lumbar interspace

C. E. Broadbent, W. B. Maxwell, R. Peris, D. J. Wilson, M. Gavino-Cain and R. Ramsevich

- 100 Patients, level assessed in flexed lateral & sitting position
- MRU assessed where the marker was placed
- Experienced providers appropriately identified the correct interspace by palpation alone 29% of the time
- In 51% of cases, marker was one or more levels higher than predicted

Ultrasonic Assessment of the Vertebral Level of the Interosseous Line in Pregnancy

William J. Lee, MD, MD; Sholana A. Alarcon, MD; Juan Maria Chehade, MD; Kris A. Auerbach, DDS
Duke S. Salzman, MD, Donald R. Fleming, MD, FACP, and David J. Brinter, MD, MPH

- 51 term pregnant patients
- 2 experience anesthesiologists palpated “intercostal line”
- 3rd anesthesiologist ultrasound for vertebral level
- Only 14% agreement between palpation & ultrasound
- Palpation One level higher than estimate - 23%
- Palpation more than one level higher - 25%

Ultrasonic Imaging Provides Reliable Landmarks for Labor Epidurals

Karin E. McKee, MD, FACP, FASID

- 61 pregnant patients enrolled
- Curved Array probe identified midline, intervertebral space & estimate depth (UD) to epidural space
- Needle depth (ND) at loss of resistance was recorded
- Results
  - UD estimate within mean 0.68 cm
  - 91.8% success at ultrasound identified insertion point
  - 1st pass success rate 73.8% (no redirects)

Lumbar Neuraxial Ultrasound for Spinal and Epidural Anesthesia

A Systematic Review and Meta-Analysis

Audrieta Delis, MD, FRCP, FACP; Latif E. Chaparro, MD; and Elison Chen, MD, FRCP

- Systematic Review including 31 studies
- Ultrasonic depth estimates to epidural space correlate well with needle depth
- Ultrasonogaphy resulted in increased success and ease of performance
  - Pooled data showed a 79% reduction in the risk of failed lumbar puncture
  - Neuraxial ultrasound reduced risk of traumatic procedure

Pre-puncture ultrasound guided epidural insertion before vaginal delivery

Malaklal Nour - Babak A. Alshehri

- 110 randomized to palpation vs. Ultrasound before CSE
- 67.27% 1st pass success in Ultrasound vs. 40% Palpation
- Ultrasonographic Group
  - Decreased Puncture Attempts (1.2 vs. 2.3)
  - Decreased Redirects (1.4 vs. 2.8)
  - Palpation Group
  - 2 accidental dural punctures in palpation
- Mean time to identify puncture site longer in ultrasound group (9.1 min vs. 6.2 min)

120 Ortho pts. undergoing spinal anesthesia

- BMI > 35 and poorly palpable spinous process
- Previous Spine surgery
- Severe lumbar scoliosis

Results
- First attempt success 65% vs. 32% in palpation
- Significantly decreased # of needle insertions
- Significantly decreased # of needle passes
Content Outline

- Benefits of Neuraxial Ultrasound
- Machine Types & Equipment
- Neuraxial Anatomy
- Scanning Technique
- How to implement

Equipment Needed

- Ultrasound (Portable or Consult)
- Curvilinear Probe
- Ultrasound Gel
- Marking Pen

Ultrasound Equipment

- Traditional Consult
- Low Frequency (2-5MHz) Curved Probe

Portable Ultrasound

- Accuvo
- Lumify
- Clarus
- Butterfly IQ

Diagram of vertebral anatomy with labels for various structures such as Laminas, Spinal processes, and Ligamentum flavum.
Ultrasound Anatomy

- What you can see on ultrasound
  - Soft Tissue
  - Bone – Bright white with dropout
  - Ligament – Bright white
  - Dura - Moderate white signal

---

Content Outline

- Benefits of Neuraxial Ultrasound
- Machine Types & Equipment
- Neuraxial Anatomy
- Scanning Technique
- How to implement

---

Pre-Procedural Scanning

- Transverse Axis (Horizontal)
- Sagittal Axis (Longitudinal)

---

Sagittal Plane - Transverse Process

---

Sagittal Plane - Facet Joint

---

Sagittal Plane - Lamina
### Scanning Steps

- **Parasagittal Oblique**
  - Start at Sacrum & Scan Up to Identify Interspace
  - Identify & Mark: L3/4, L4/5, L5/S1

- **Transverse Midline**
  - Identify Midline Interlaminar View
  - Adjust probe for correct angle and rotation
  - Mark Midline
  - Estimate Depth to Epidural Space
Novell Handheld Ultrasound

- **Accuru**
  - Automated Bony landmark identification
  - Automated estimated Depth to epidural space
  - Small & Portable

- Decreased time to spinal placement compared to landmark technique (Pawlick et al)
- Estimated depth to Epidural space within 6.6mm (Selzman et al)

---

Practical Application

- Learning curve can be steep
  - Scan normal to familiarize yourself to anatomy
  - Practice without time pressure

- Use what you have
  - Curvilinear probe
  - Marking Pen
  - Ultrasound Gel

- Handheld Ultrasounds are portable & convenient

---

References

1. Robinson CR, Ultrasound in Obstetric and Gynecologic Practice, 2005

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Thank You

- Email: kselzman@salud.unm.edu
The 2019 Sam Hughes Lecture: Obstetric Anesthesia Year in Review

Ashraf S. Habib, MBBCh, MSc, MHSc, FRCA
Professor
Chief, Division of Women's Anesthesia
Duke University School of Medicine

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• Research Support
  – Pacira Pharmaceuticals, Inc
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  – Trevena, Inc

• Advisory Board
  – Trevena, Inc
  – Health Decisions

Literature Search

• Table of contents of major journals
  – Obstetric anesthesia
  – Obstetrics
  – Perinatology
  – Health services research

• Search engines

• Media sources

Subject

Maternal Mortality
Maternal Morbidity
Cesarean Delivery & Postpartum Pain
Labor Analgesia
Global Health

Maternal Mortality in the USA 2011-2013

• Observational Study
  – CDC Pregnancy Mortality Surveillance System

• 2,009 pregnancy related deaths (death of a woman while pregnant or within 1 year of pregnancy termination)

• Pregnancy Related Mortality Ratio
  – 17.100,000 live births

Creanga AA. Obstet Gynecol 2017;130:366-373
Maternal Mortality in the USA 2011-2013

- **Age**
  - 30% of pregnancy related deaths among women ≥ 35 years old

- **Race**
  - Non-Hispanic black women had 3.4 times higher risk of death than non-Hispanic white women

- **Obesity**
  - 1:6 women who died were obese

Maternal Cardiovascular Mortality in Illinois 2002-2011

- **Retrospective Study**
  - Pregnancy related deaths in Illinois from 2002 to 2011
  - 140/636 (22.2%) died of cardiovascular causes (8.2:100,000 live births)

- **Aims**
  - Estimate the role of specific CV diseases, examine demographics and estimate preventable mortality

<table>
<thead>
<tr>
<th>Cause of Death</th>
<th>Number (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cardiomyopathy</td>
<td>39 (27.9%)</td>
</tr>
<tr>
<td>Stroke</td>
<td>33 (22.9%)</td>
</tr>
<tr>
<td>Hypertension</td>
<td>18 (12.8%)</td>
</tr>
<tr>
<td>Arrhythmias</td>
<td>15 (10.7%)</td>
</tr>
<tr>
<td>Coronary Artery Disease</td>
<td>13 (9.2%)</td>
</tr>
<tr>
<td>Vascular Heart Disease</td>
<td>6 (4.3%)</td>
</tr>
<tr>
<td>Aortic Dissection</td>
<td>4 (2.8%)</td>
</tr>
<tr>
<td>Congenital Heart Disease</td>
<td>4 (2.8%)</td>
</tr>
</tbody>
</table>

Maternal Cardiovascular Mortality in Illinois Demographics, Timing & Preventability

- **Age (vs. 20-29 years old)**
  - 30-39 years old: RR 1.67
  - > 40 years old: RR 3.78

- **Time of Death**
  - Antepartum: 13.2%
  - 0-6 days: 29.4%
  - 7-42 days: 21.1%
  - 43-365 days: 34.6%

- **28.1% Preventable**
  - **Patient Factors**
    - Non-compliance
    - Smoking
    - Obesity
  - **Healthcare Provider Factors**
    - Incomplete/delayed treatment
    - No referral
Maternal Mortality

Maternal Morbidity

Cesarean Delivery & Postpartum Pain

Labor Analgesia

Global Health

Maternal Morbidity

• Cardiovascular disease
• Hemorrhage
• Pre-eclampsia
• Cardiac arrest

Bromocriptine for Peripartum Cardiomyopathy

RCT

• **Background**
  – **Pathophysiology:** High levels of prolactin and the production of a cleaved 16kDa N-terminal fragment of prolactin

• **RCT** (n = 63)
  – Short-term (1 week, 2.5 mg, 7 days) or long-term (8 weeks: 5 mg for 2 weeks followed by 2.5 mg for 6 weeks) + standard heart failure therapy

• **Primary Outcome:** LVEF change from baseline to 6 months

Hilfiker-Kleiner D. Eur Heart J 2017;38:2671-2679

Tranexamic Acid for Postpartum Hemorrhage

What we know

• Tranexamic acid (TXA) reduces surgical blood loss

• **CRASH-2 Trial:** TXA reduced death due to bleeding (early treatment within 3 h)

• In 2012, WHO recommended TXA for PPH

Kerk K. BMJ 2012;344:e3054

CRASH-2 Collaborators. Lancet 2010;376:23-32
Tranexamic Acid for Postpartum Hemorrhage
The WOMAN Trial - Design

- **RCT** (n = 20,021, 193 hospitals, 21 countries)
  - Women with PPH received 1 gram TXA or placebo
  - Second dose: bleeding continued after 30 min or restarted within 24 h

- **Primary Outcome**: Death from all causes or hysterectomy within 42 days of randomization

- **Sample Size**: 15,000 → 20,000

**Background**
- **RCT** (n = 20,021, 193 hospitals, 21 countries)
- **Quality Improvement, Before-After Model**
- **ROTEM Guided Fibrinogen Concentrate for PPH**

**Primary Outcome:** Number of allogeneic blood products

**FibTEM A5 prior to study medication**
- Fibrinogen prior to study medication
- (g litre−1)
  - ≤ 12 mm
  - > 12 mm

**Blood loss after study medication**
- ml

**Number of allogeneic blood products**
- RBC units

**Incidence**
- < 200 mg/dL
  - > 200 mg/dL
- (0.13, 2.16)

**Effect of FibTEM A5 and fibrinogen level at the time of randomization on transfusion and blood loss after study medication.**

**Tranexamic Acid for Postpartum Hemorrhage**
The WOMAN Trial - Results

**Death due to bleeding by time since delivery**
- < 3 hrs: RR (95% CI) = 0.69 (0.53, 0.90)
- > 3 hrs: RR (96% CI) = 1.07 (0.76, 1.51)

**Reduction in laparotomy due to bleeding (0.8% vs. 1.3%, p = 0.002)**

**No difference in thrombo-embolic events (0.3% both groups)**

**Safety Bundles and Hemorrhage Morbidity**
State Quality Collaborative

**Background**
- The California Maternal Quality Care Collaborative (CMQCC)
  - Developed obstetric hemorrhage tool kit
  - Established the California Partnership for Maternal Safety Collaborative

**Quality Improvement, Before-After Model**
- Baseline (01/2011-12/2014), Post-intervention (10/2015-03/2016)

**Primary Outcome**: Severe maternal morbidity in patients with obstetric hemorrhage
Maternal Morbidity

- Cardiovascular disease
- Hemorrhage
- Pre-eclampsia
- Cardiac arrest

Association between OSA and Pre-eclampsia

What we know

- OSA is a risk factor for hypertensive disorders of pregnancy (HDP) and gestational diabetes (GDM)
  - Cross-sectional and retrospective studies
  - Self-reported symptoms
  - Inadequate adjustment for BMI
  - Small prospective observational cohorts
  - Conflicting results
- OSA could be a modifiable risk factor

Study Design

- Prospective Cohort Study (n = 3705)
  - Nulliparous women enrolled at 6-13 6/7 weeks
  - Level 3 Home Sleep Test at 6-15 weeks and 22-31 weeks (results blinded)
- Primary Outcome: Pre-eclampsia (PE)
- Secondary Outcomes: HDP and GDM

Facco FL. Obstet Gynecol 2017;129:31-41

Results

- Early Pregnancy: 3.6%
- Mid-Pregnancy: 8.3%
- Pre-eclampsia: 13.1% (PE: 6%), GDM: 4.1%

OR adjusted for age, BMI, chronic hypertension and gestational weight gain

Facco FL. Obstet Gynecol 2017;129:31-41

Bundle on Severe Hypertension

Pregnancy and Postpartum

- Readiness (Every Unit)
  - Diagnostic criteria/monitoring/escalation
  - Education: access to medication titration
- Recognition and Prevention (Every Patient)
  - Protocols for BP and urine protein assessment
  - Reactions to EWS/patient education
- Response (Every case)
  - Standard protocols/checklists/escalation policies
  - Support plan for avoid complications
- Reporting and Systems Learning (Every Unit)
  - Culture of huddles/Debriefs
  - Multidisciplinary reviews


Maternal Morbidity

- Cardiovascular disease
- Hemorrhage
- Pre-eclampsia
- Cardiac arrest
Cardiac Arrest in Pregnancy (CAPS) Study Incidence and Outcomes (2011-2014)

- Prospective Descriptive Study
  - Cardiac arrest and perimortem cesarean delivery (PMCD)
- 66 cardiac arrests (2011-2014): 1:36,000 during pregnancy
- Survival: Mothers: 58%, babies: 71%
- Median (range) time to PMCD (n = 49)
  - Survived (median [IQR]): 3 (0-39) vs. died: 12 (0-67) min, p<0.01

Beckett VA. BJOG 2017;124:1374 -1381

Causes

- Anesthetic Causes
  - 12/17 obese
  - Intubation problems (3)
  - CVS collapse post epidural top up (3)
  - Total spinal after de novo spinal (10)
  - Other causes (1)

- Other Causes
  - AFE
  - Hypovolemia
  - Thromboembolic
  - Hypoxia
  - Cardiac cause
    - Vessel bleed/rupture
    - Intracerebral bleed
    - Other
  - Other
    - Aortic dissection
    - Cardiomyopathy

Survived (n = 37)
Died (n = 22)

<table>
<thead>
<tr>
<th>Cause</th>
<th>Survived</th>
<th>Died</th>
</tr>
</thead>
<tbody>
<tr>
<td>AFE</td>
<td>17</td>
<td>1</td>
</tr>
<tr>
<td>Hypovolemia</td>
<td>15</td>
<td>6</td>
</tr>
<tr>
<td>Hypoxia</td>
<td>4</td>
<td>1</td>
</tr>
<tr>
<td>Cardiac</td>
<td>5</td>
<td>1</td>
</tr>
<tr>
<td>Vessel bleed/rupture</td>
<td>0</td>
<td>6</td>
</tr>
<tr>
<td>Intracerebral bleed</td>
<td>0</td>
<td>3</td>
</tr>
<tr>
<td>Other</td>
<td>2</td>
<td>5</td>
</tr>
<tr>
<td>Aortic dissection</td>
<td>0</td>
<td>2</td>
</tr>
<tr>
<td>Cardiomyopathy</td>
<td>0</td>
<td>2</td>
</tr>
</tbody>
</table>

Opoid Prescription and Use after Cesarean

- Leftover opioid could be diverted, abused or accidentally ingested
- Little information on patterns of opioid prescription and use after cesarean delivery
- Sparse data on pain resolution and functional recovery

Recovery after Nulliparous Birth Analgesia and Functional Recovery

- Prospective Observational Study (n = 213)
  - Nulliparous women attempting vaginal delivery
- Primary Outcome
  - Time to pain- and opioid-free functional recovery
  - Functional recovery to pre-delivery level
    - First of 5 days of no pain
    - First of 5 days of no opioid use

Komatsu R. Anesthesiology 2017;127:684 -694

<table>
<thead>
<tr>
<th></th>
<th>Vaginal Delivery (n = 88)</th>
<th>Cesarean Delivery (n = 35)</th>
<th>P value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Time to pain and opioid-free functional recovery</td>
<td>19 (5-77)</td>
<td>27 (10-45)</td>
<td>0.0003</td>
</tr>
<tr>
<td>Time to opioid cessation</td>
<td>0 (0-14)</td>
<td>9 (0-36)</td>
<td>&lt; 0.0001</td>
</tr>
</tbody>
</table>
Opioid Prescription and Use after Cesarean Survey

- **Phone Survey (n = 720):** 2 weeks after CD at 6 academic centers
  - 85.4% filled opioid prescription (higher pain scores)
  - Median dispensed: 40, consumed: 20 tablets, 95.3% did not dispose of opioids

<table>
<thead>
<tr>
<th>Pills Dispensed</th>
<th>Pills Consumed</th>
<th>Satisfied/Very Satisfied</th>
<th>Pain Score (Median IQR)</th>
<th>Need for Refills</th>
<th>Side Effects</th>
</tr>
</thead>
<tbody>
<tr>
<td>≤ 30</td>
<td>15 (5-24)</td>
<td>84%</td>
<td>4 (3-5)</td>
<td>5.0%</td>
<td>47%</td>
</tr>
<tr>
<td>31-40</td>
<td>20 (10-32)</td>
<td>84%</td>
<td>4 (2-5)</td>
<td>5.0%</td>
<td>62%</td>
</tr>
<tr>
<td>≥ 40</td>
<td>32 (16-50)</td>
<td>81%</td>
<td>4 (2-5)</td>
<td>5.8%</td>
<td>71%</td>
</tr>
</tbody>
</table>

Bateman BT. Obstet Gynecol 2017;130:29 -35

Opioid Prescription and Use after Cesarean Survey

- **Survey (n = 179):** Phone or email survey on day 1 and 2 weeks after discharge following CD
  - 83% used opioids, median dispensed 30 (8-84), median use 8 days
  - 75% had unused tablets, median 10 tablets, 93% did not dispose of opioids

<table>
<thead>
<tr>
<th>Top Opioid Quartile (n = 44)</th>
<th>Average Opioid Quartile (n = 135)</th>
<th>RR/OR (99% CI)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Public insurance</td>
<td>66%</td>
<td>46%</td>
</tr>
<tr>
<td>Smoking</td>
<td>18%</td>
<td>5%</td>
</tr>
<tr>
<td>In hospital median morphine</td>
<td>1.6 mg</td>
<td>1.0 mg</td>
</tr>
<tr>
<td></td>
<td>(mg equivalents)</td>
<td>(mg equivalents)</td>
</tr>
<tr>
<td></td>
<td>2.05 (1.01, 4.17)</td>
<td>2.59 (1.35, 9.12)</td>
</tr>
</tbody>
</table>

Osmundson SS. Obstet Gynecol 2017;130:36- 41

Opioid Prescription and Use after Cesarean Survey

**Shared Decision Making**

- **Shared Decision Making Session (n = 50)**
  - Anticipated patterns of pain
  - Expected outpatient opioid use
  - Risks and benefits of analgesics
  - How to dispose and refill opioids

Prabhu M. Obstet Gynecol 2017;130:42 -46

Patient Choice for Intrathecal Morphine Dose Does it Reflect Opioid Consumption?

- **Background**
  - Significant inter-individual in pain and preferences
  - One size fits all approach

- **RCT (n = 120)**
  - Randomized to perceived choice or no choice
  - All randomized to 100 or 200 µg intrathecal morphine

- **Primary Aim:** Is patient’s choice for intrathecal morphine dose reflective of pain and postoperative opioid analgesic use?

Prabhu M. Obstet Gynecol 2017;130:42-46

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Carvalho B. Br J Anaesth 2017;118:762-771

Carvalho B. Br J Anaesth 2017;118:762-771
Left Lateral Tilt for Elective Cesarean Delivery
Effect on Neonatal Acid-Base Status

- **Background**
  - Earlier studies suggested better neonatal clinical and acid base status with left lateral tilt
  - Improved BP control with phenylephrine infusion and fluid co-load

- **RCT (n = 100)**
  - 15 degrees left table tilt or horizontal position, BMI ≤ 40 kg/m²

- **Primary Outcome:** Umbilical artery base excess

### Spinal Bupivacaine Dose and Success of ECV

#### What we know

- **Neuraxial Techniques**
  - Increase ECV success (58% vs. 43%)
  - Lower CD rate (48% vs. 55%)

#### RCT (n = 239)

- CSE with 4 doses of isobaric bupivacaine (2.5, 5, 7.5 and 10 mg) + fentanyl 15 μg
- Patient, obstetrician, research nurse blinded

#### Primary Outcome: ECV success

### Spinal Bupivacaine Dose and Success of ECV

#### Results

- Higher sensory level with 7.5 and 10 mg
- More hypotension with 5, 7.5 and 10 mg
- More pain with 2.5 mg vs. 7.5 and 10 mg but no difference in satisfaction
- Delayed discharge with 7.5-10 mg
  - 77 min for 7.5, 106 min for 10 mg vs. 2.5 mg
  - 56 min for 7.5 mg, 85 min for 10 mg vs. 5 mg
**Dural Puncture Epidural Technique**

**Study Design**

- **Background**
  - DPE with 25-26 G Whitacre needle improved sacral spread and reduced asymmetric block but no benefit with 27 G needle

- **RCT (n = 120): EPL vs. DPE vs. CSE**
  - EPL/DPE: 20 ml bupivacaine 0.125%
  - CSE: bupivacaine 1.7 mg with fentanyl 17 µg
  - PCEA + CEI: bupivacaine 0.125% + fentanyl 2 µg/ml

- **Primary Outcome:** Time to pain score ≤ 1 between DPE and EPL

**Onset Time and Sacral Spread**

<table>
<thead>
<tr>
<th></th>
<th>EPL (n = 40)</th>
<th>DPE (n = 40)</th>
<th>CSE (n = 40)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Assymmetric block</td>
<td>52.5%*</td>
<td>10%</td>
<td>10%</td>
</tr>
<tr>
<td>Physician topups</td>
<td>50%*</td>
<td>22.5%</td>
<td>50%*</td>
</tr>
<tr>
<td>Hypotension</td>
<td>12.5%</td>
<td>10%</td>
<td>67.5%*</td>
</tr>
<tr>
<td>Tachycardia/Hypertension</td>
<td>12.5%</td>
<td>12.5%</td>
<td>32.5%*</td>
</tr>
<tr>
<td>Category II-III FHR</td>
<td>12.5%</td>
<td>12.5%</td>
<td>32.5%*</td>
</tr>
<tr>
<td>Cesarean Delivery</td>
<td>27.5%</td>
<td>10%</td>
<td>5%</td>
</tr>
</tbody>
</table>

* P<0.05 vs. DPE

**Block Characteristics and Side Effects**

**Epidural Analgesia during Second Stage**

**What we know**

- Epidural analgesia may be associated with prolonged second stage and increased instrumental deliveries

- Some obstetric providers request discontinuation of epidural analgesia during second stage of labor

**Study Design**

- **RCT (n = 400)**
  - Healthy nulliparous women in spontaneous labor
  - Ropivacaine 0.08% + Sufentanil 0.4 µg/ml (CEI + PCEA)
  - Second stage
    - Randomized to same solution or saline at 8 ml/h

- **Primary Outcome**
  - Duration of the second stage of labor

**Results**

<table>
<thead>
<tr>
<th></th>
<th>Saline (n = 200)</th>
<th>Ropivacaine (n = 200)</th>
<th>P value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Duration of 2nd Stage (min)</td>
<td>55 ±25</td>
<td>52 ±21</td>
<td>0.52</td>
</tr>
<tr>
<td>Cesarean Delivery</td>
<td>0 (0%)</td>
<td>2 (1%)</td>
<td>0.50</td>
</tr>
<tr>
<td>Forceps</td>
<td>2 (1%)</td>
<td>5 (2.5%)</td>
<td>0.25</td>
</tr>
<tr>
<td>Episiotomy</td>
<td>84 (42%)</td>
<td>70 (35%)</td>
<td>0.52</td>
</tr>
<tr>
<td>Satisfaction Score &gt;8/10</td>
<td>81 (30.5%)</td>
<td>32 (16%)</td>
<td>&lt; 0.001</td>
</tr>
</tbody>
</table>
Impact of Epidural Fentanyl on Breastfeeding

What we know

- Synergistic effect between local anesthetics and opioids

Conflicting Data

- Beilin: Epidural fentanyl > 150 µg: more likely to stop breastfeeding at 6 weeks & low neonatal behavioral scores
- Wilson: Labor epidural analgesia (+/- epidural fentanyl): No impact on initiation or duration of breastfeeding
- French: No definitive conclusions

Impact of Epidural Fentanyl on Breastfeeding

Study Design

- RCT (n = 305)
  - Women > 38 weeks (with prior breastfeeding success) randomized to CEI + PCEA with:
    - Bupivacaine 1 mg/ml + Fentanyl 0 µg/ml
    - Bupivacaine 0.8 mg/ml + Fentanyl 1 µg/ml
    - Bupivacaine 0.625 mg/ml + Fentanyl 2 µg/ml

- Primary Outcome: Breastfeeding at 6 weeks

Impact of Epidural Fentanyl on Breastfeeding

Results

<table>
<thead>
<tr>
<th>Fentanyl Dose</th>
<th>Breastfeeding at 6 weeks (%)</th>
<th>Breastfeeding at 3 months (%)</th>
<th>LATCH score (8-9)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0 µg/ml</td>
<td>97%</td>
<td>94%</td>
<td>8.5 (8-9)</td>
</tr>
<tr>
<td>1 µg/ml</td>
<td>98%</td>
<td>96%</td>
<td>8 (8-9)</td>
</tr>
<tr>
<td>2 µg/ml</td>
<td>94%</td>
<td>88%</td>
<td>9 (8-9)</td>
</tr>
</tbody>
</table>

- Only 18% exposed to cumulative fentanyl dose > 150 µg (CSE + short labor)

Global Health

Impact and Cost-Effectiveness

- Background
  - 5 year partnership between Kybele and Ghana health service

- Cost Effectiveness Analysis
  - Incremental cost effectiveness ratio (ICER)

- Results
  - Maternal mortality ratio decreased by 22% (236 deaths averted)
  - Still birth decreased by 52% (129 still births averted)
- ICER: $158 (95% CI: 129, 195)

Things to do..

- Incorporate TXA as an adjunct in your transfusion protocol
- Use bromocriptine for women with peripartum cardiomyopathy
- Institute safety bundles on your unit
- Educate, reduce and individualize post-discharge opioid prescriptions
- Consider (and study) DPE for labor analgesia
- Use neuraxial techniques to facilitate ECV
- Get involved/support Global Health
Extraordinary care through a unique culture of innovation, education, research, and professional growth.
Saturday, March 16, 2019

Session VII: Obstetrical Hemorrhage Update
Moderator: Andrea Traynor

Optimal Uterotonic Administration to Prevent and Treat Uterine Atony
Lawrence Tsen, M.D.

Obstetrical Management of Post-Partum Hemorrhage
Maurice L. Druzin, M.D.

Transfusion Practices for Obstetric Hemorrhage: What’s the latest?
Anil K Panigrahi, M.D., Ph.D.

Pharmacological Management of Obstetric Hemorrhage
Alexander Butwick, M.B.,B.S., FRCA, M.S.
Optimizing Uterotonic Agent Administration to Prevent and Treat Uterine Atony

Upon Completion of this Learning Activity, Participants Should Be Able To:

- Evaluate the role of oxytocin and alternative uterotonic agents in promoting uterine tone
- Investigate the mechanisms by which uterine tone is augmented
- Identify an algorithm to optimize uterotic agent use to prevent and treat uterine atony

Theory: Uterotonic Agent Use is Variable

Patterns of Alternative Uterotonic Agents

Premier Database: 2,180,916 Deliveries

Mixed effects, logistic regression

Patient and hospital characteristics

Mean: 7.1% (IQR 5.2-10.8%)

Range: 1.7% (0.12%) to 25% (1.28%)

Use not explained by: patient or hospital characteristics, delivery mode, medical or obstetric conditions, or year


Alternative Uterotonic Agent Use

1. METHERGINE
   - Methylergonovine Maleate 0.2 mg IM

2. HEMABATE
   - Carboprost Tromethamine 0.25 mg IM

3. Cytotec
   - Misoprostol 800 -1000 mcg Rectal or 600 mcg Buccal

No Disclosures
Investigation: Pharmacology

**Oxytocin**

**Natural Nonapeptide**
- Synthesized Hypothalamus, Secreted Posterior Pituitary
- Phospholipase C Pathway leads to Ca²⁺ influx
- Pregnant physiologic levels: 10⁻¹⁰ mol/L

**Synthetic Octapeptide**
- Labor augmentation levels: 10⁻⁸ mol/L
- Response: Dose, Variable

**Receptors**
- Breast, CNS, Heart, Uterus
- 20 & 30 weeks

**Oxytocinase**
- t½ = 3 min
- 30x increase (6x sensitivity) with gestational age
- 200x increase in myometrium; numerous lower segment and cervical

4 Mechanisms for Uterine Contractility
- Inositol Triphosphate (InsP₃; Ca²⁺)
- Voltage Gated Depolarization (Ca²⁺)
- Mitogen-activated Protein Kinase (PG)
- Rho-kinase Protein Kinase (PG)

**Contraction:** Frequency, Amplitude, Duration

Mechanism: Oxytocin

Desensitization with continuous oxytocin exposure
- Occurs via: Phosphorylation, Internalization, Alteration of mRNA levels
- Lasts for hours to days
- Time and Concentration Dependent

<table>
<thead>
<tr>
<th>Study</th>
<th>Model</th>
<th>Time</th>
<th>Concentration</th>
</tr>
</thead>
<tbody>
<tr>
<td>Joyce</td>
<td>Rat</td>
<td>1 hrs</td>
<td>10⁻⁸ mol/L</td>
</tr>
<tr>
<td>Robinson</td>
<td>Human</td>
<td>3 hrs</td>
<td>10⁻⁸ mol/L</td>
</tr>
<tr>
<td>Phaneuf</td>
<td>Human</td>
<td>4, 6 hrs</td>
<td>10⁻⁸ mol/L</td>
</tr>
</tbody>
</table>

**Methylergonovine (Methergine)**

**Natural Ergot Alkaloid**
- Fungus on Rye, Morning Glory
- Chemically similar to LSD

**Receptors**
- Uterus, Blood Vessels
- 5-HT₂a Serotonin
- Dopaminergic, Alpha Adrenergic

**Bioavailability (IM = 78%)**

**Hepatic Metabolism and Excretion**

**Contraindicated**
- Hypertension, Preeclampsia
- HIV+ protease inhibitors

**Carboprost (Hemabate) + Misoprostol (Cytotec)**

**Natural Prostaglandins**
- Synthesized in Most Tissues and Organs
- Nucleated cells produce from arachidonic acid
- All contain 20 Carbon Atoms + 5 Carbon Ring
- Letter (Ring Structure) + Number (Double Bonds)

**Synthetic Prostaglandins**
- F₂a and E₂, Corey, 1969: Japan Prize 1989

**Receptors**
- Platelets, Endothelium, Uterus, Mast Cells
- Platelet Aggregation, Vasodilation, Inflammation

**Paracrine (local active), Autocrine (on cell of synthesis)**
- t½ = short
Carboprost (Hemabate) + Misoprostol (Cytotec)

News Flash: Algorithm for Uterotonic Agent Use

A Stepwise, Standardized Algorithm

Specific guidance
- Laboring & Non-Laboring Women

Emphasis
- Avoid Large & Rapid Bolus Doses
- Initial Infusion + Maintenance
- Early Consideration of Alternatives

Rescue Options
- Methylergonovine Maleate 0.2 mg IM
- Carboprost Tromethamine 0.25 mg IM
- Misoprostol 800 -1000 mcg Rectal

Investigation: Oxytocin is Overdosed

Uterine Tone/Blood Loss Ceiling Effect
- 5 IU = 10, 15, 20 IU
- Dosed 1U/min

EDox Labor Arrest Cesarean
- Oxytocin 9.8 ± 6.3 hrs (10.3 ± 8.2 mIU/min)
- 0.5 IU/mL; initial; up/down increments
- Dosed over 30 secs
- 2.99 IU

EDox Elective Cesarean
- 0.35 IU
- Dosed over 30 secs

More Oxytocin Needed

0% 10% 20% 30% 40% 50%

0 0.5 1 3 5

IV Oxytocin IU over 15 sec

Canavolo JCA, et al. AJOG 2004;104:1005-1010

OXYTOCIN “RULE OF THREES”

- 3 IU Oxytocin Load/30 secs
- 3 minute intervals
- 3 total doses (Load + 2 Rescue)
- 3 IU/hr maintenance (30 IU/L at 100 mL/hr)
- 3 pharmacologic options

Loading
- Non-Laboring < 1 IU (ED90 = 0.35 IU)
- Laboring 3 IU (ED90 = 2.99 IU)

Maintenance
- 0.04 IU/min (20 IU/L at 120 mL/hr) x 8 hrs
- 0.08 IU/min (40 IU/L at 125 mL/hr)

Kovacheva VP, Soens MA, Tsen LC. Anesthesiology 2015;123:92-100

Tsen LC, Balki M. J AM J Obstet Gynecol 2010;192:43-5
Balki M, Tsen LC. Int Anesth Clinics 2014

News Flash: Algorithm for Uterotonic Agent Use

1. METHERGINE
   - Methylergonovine Maleate 0.2 mg IM
   - Ergot Derivative
   - Avoid if Hypertension/Eclampsia
   - 1.5-3.5 hr intervals; total 12 mg, 2 days
   - 20 min interval; repeat to 1 mg

2. HEMABATE
   - Carboprost Tromethamine 0.25 mg IM
   - Prostaglandin F2alpha
   - Avoid if Asthma?
   - 20 min interval; repeat to 1 mg

3. Cytotec
   - Misoprostol 800 -1000 mcg Rectal or 600 mcg Buccal
   - Prostaglandin E1 Analog
   - FDA for NSAID Gastric Ulcer Reduction
   - Terminal Half-life 20-40 min

Summary: Optimizing Uterotonic Agent Use

THEORY
• Uterotonic Agent Use is Variable?

INVESTIGATION
• Mechanisms Assist Overdosed!

NEWS FLASH
• Avoid “rapid IV push” doses
• Rule of Three’s
  • 3 IU doses, 3 min, 3 doses, 3 IU maintenance
  • Limit reliance on single agent

Questions
Learning Objectives

1. To outline a stepwise obstetrical approach to post-partum hemorrhage.
2. To describe minimally invasive techniques to address post-partum hemorrhage.
3. To describe surgical interventions for control of post-partum hemorrhage.

Executive Summary - WHO 2012

- Postpartum Hemorrhage (PPH) is commonly defined as a blood loss of 500 mL or more within 24 hours after birth.
- EBL of > 500 mL an "alert line"
- > 1000 mL an "action line" (Severe PPH)
- PPH is the leading cause of maternal mortality in low-income countries and the primary cause of nearly one quarter of all maternal deaths globally.
- Most deaths resulting from PPH occur during the first 24 hours after birth.
- The majority of these could be avoided through the use of prophylactic uterotonic drugs during the third stage of labour and by timely and appropriate management.
DEFINITION ACOG 2017

Maternal hemorrhage, defined as:

- A cumulative blood loss of greater than or equal to 1,000 ml
- OR
- Blood loss accompanied by signs or symptoms of hypovolemia;
  within 24 hours after the birth process

MORBIDITY FROM HEMORRHAGE

Hemorrhage that leads to blood transfusion is the leading cause of severe maternal morbidity in the United States closely followed by disseminated intravascular coagulation.

In the United States, the rate of postpartum hemorrhage increased 26% between 1994 and 2006 primarily because of increased rates of atony.

MORBIDITY

Additional important secondary sequelae from hemorrhage exist and include:

- Adult respiratory distress syndrome (ARDS)
- Shock
- Disseminated Intravascular Coagulation (DIC)
- Acute renal failure (ARF) (AKI)
- Loss of fertility
- Pituitary necrosis (Sheehan syndrome)

In contrast, maternal mortality from postpartum obstetric hemorrhage has decreased since the late 1980s and accounted for slightly more than 10% of maternal mortalities (approximately 1.7 deaths per 100,000 live births) in 2009.

This observed decrease in mortality is associated with increasing rates of transfusion and peripartum hysterectomy.

Teamwork!!!

- Obstetrics+Nursing+ Anesthesiology
- Mutual respect
- Huddle early and often
- Closed loop communication

Example of Risk Assessment Tool

<table>
<thead>
<tr>
<th>Category</th>
<th>Low Risk</th>
<th>Medium Risk</th>
<th>High Risk</th>
</tr>
</thead>
<tbody>
<tr>
<td>History of previous pregnancy</td>
<td>Prior Cesarean, or Uterine surgery</td>
<td>Previous, current, or planned</td>
<td>Multiple prior deliveries, Cesarean delivery</td>
</tr>
<tr>
<td>Number of previous deliveries</td>
<td>More than four previous deliveries</td>
<td>Less than four previous deliveries</td>
<td>More than four previous deliveries</td>
</tr>
<tr>
<td>Uterine status</td>
<td>Unscarred uterus</td>
<td>Uterus uterine, bicornuate, or septate</td>
<td>Multiple gestation</td>
</tr>
<tr>
<td>History of postpartum hemorrhage</td>
<td>None</td>
<td>Last &gt; 48 hours</td>
<td>History of postpartum hemorrhage</td>
</tr>
<tr>
<td>Chorioamnionitis</td>
<td>None</td>
<td>Last &gt; 48 hours</td>
<td>History of postpartum hemorrhage</td>
</tr>
<tr>
<td>Magnesium sulfate use</td>
<td>None</td>
<td>Last &gt; 48 hours</td>
<td>History of postpartum hemorrhage</td>
</tr>
<tr>
<td>Abnormal vital signs</td>
<td>None</td>
<td>Last &gt; 48 hours</td>
<td>History of postpartum hemorrhage</td>
</tr>
<tr>
<td>Prolonged use of oxytocin</td>
<td>None</td>
<td>Last &gt; 48 hours</td>
<td>History of postpartum hemorrhage</td>
</tr>
</tbody>
</table>

Box 1. Biology of Postpartum Hemorrhage

Maternal Early Warning Criteria

Quantitative Blood Loss (QBL): Vaginal Birth

Quantification of Blood Loss: QBL

DENIAL leads to DELAY
Uterine Atony
Most frequent cause of PPH

- Advanced age
- Multiparity
- Chorioamnionitis
- MgSO₄
- Oxytocin
- Uterine Overdistension
- Abnormal labor

BIMANUAL COMPRESSION

Blood Loss: > 500 ml Vaginal > 1000 ml CS

- Increase IV rate (LR): Increase Oxytocin
- Methergine 0.2 mg IM (if not hypertensive)
- Consider TXA
- Continue fundal massage; Empty bladder, Keep Warm
- Administer O2 to maintain Sat > 95%
- Rule out retained POC, laceration or hematoma
- Order Type and Crossmatch 2 Units PRBC’s if not already done
Blood Loss: > 1000 - 1500 ml or greater

- **CALL FOR EXTRA HELP**
- Hemabate 250 mcg IM
- Misoprostol 800-1000 mcg PR
- Tranexamic Acid within 3 hours
- To OR (if not there):
- Activate Massive Hemorrhage Protocol
  - **TRANSFUSE AGGRESSIVELY**
  - RBC:FFP:Plts 6:4:1 or 4:4:1

Management of Uterine Atony if Bimanual Compression fails

- Tamponade/Packing
- Uterine Artery Ligation
- B-Lynch Suture – (Brace)
- Hypogastric Artery (internal iliac) Ligation
- Hysterectomy
  - Supracervical
  - Total
- Angiography
- Mast suit

**Table 4. Tamponade Techniques for Postpartum Hemorrhage**

<table>
<thead>
<tr>
<th>Technique</th>
<th>Comment</th>
</tr>
</thead>
<tbody>
<tr>
<td>Foley catheter</td>
<td>Inserted transvaginally or through uterine incision; has an end port for blind drainage infused with 300-500 ml of saline.</td>
</tr>
<tr>
<td>Balloon</td>
<td>Balloon tamponade system</td>
</tr>
<tr>
<td>Uterine packing</td>
<td>4-inch gauge, can be soaked with 3,000 ml of saline then inserted into uterine cavity</td>
</tr>
</tbody>
</table>

Ref: ACOG Practice Bulletin #183, October 2017, Replaces Practice Bulletin 78, October 2006

**Uterine Tamponade**
UTERINE CURETTAGE

Surgical Management

<table>
<thead>
<tr>
<th>Technique</th>
<th>Comment</th>
</tr>
</thead>
<tbody>
<tr>
<td>Uterine curettage</td>
<td></td>
</tr>
<tr>
<td>Uterine artery ligation</td>
<td>Bilateral: also can ligate uterovarian vessels</td>
</tr>
<tr>
<td>B-Lynch suture</td>
<td></td>
</tr>
<tr>
<td>Hypogastric artery ligation</td>
<td>Less successful than earlier thought; difficult technique; generally reserved for practitioners experienced in the procedure</td>
</tr>
<tr>
<td>Repair of rupture</td>
<td></td>
</tr>
<tr>
<td>Hysterectomy</td>
<td></td>
</tr>
</tbody>
</table>

UTERINE ARTERY LIGATION—“O’LEARY STITCH”

Perform B-Lynch within an hour

- Among 211 women treated with B-Lynch sutures
- Hysterectomy rate was \(18\%\) if done within 1 hour of delivery
- Hysterectomy rate was \(42\%\) with a delay of 2-6 hours

*Move along a plan*


Hemostatic Suturing Technique for Uterine Bleeding During Cesarean Delivery

American Journal of OBGYN

American Journal of OBGYN
Hypogastric Artery LIGATION

• Performed much less frequently than in the past.

• Purpose is to diminish pulse pressure of blood flow via internal iliac (hypogastric vessels).

• Practitioners are less familiar with this technique, and the procedure has been found to be considerably less successful than previously thought.
• All obstetric care facilities should have guidelines for the \textit{routine administration of uterotonic in the immediate postpartum period.}
• Uterotonic agents should be the \textbf{first-line} treatment for postpartum hemorrhage caused by uterine atony.
• The \textit{specifc agent} selected, outside of recognized contraindications, is at the health care provider’s \textit{discretion} because none has been shown to have greater efficacy than others for the treatment of uterine atony.

\underline{Summary of Recommendations and Conclusions}

\begin{itemize}
\item Management of postpartum hemorrhage should use a \textit{multifaceted} and \textit{comprehensive} approach that involves:
  \begin{itemize}
  \item \textit{Maintaining hemodynamic stability}
  \item \textit{Promptly identifying and treating the cause of blood loss.}
  \item \textit{Generally, in the treatment of postpartum hemorrhage, less invasive methods should be used initially if possible, but if unsuccessful, preservation of life may require more aggressive interventions including hysterectomy.}
  \item \textit{When a massive transfusion protocol is needed, \textbf{blood} includes packed red \textbf{blood} cells, \textbf{fresh frozen plasma}, and \textbf{platelets} should be used.}
  \end{itemize}
\end{itemize}

\textbf{DO NOT DENY THE DIAGNOSIS OF PPH DO NOT DELAY TREATMENT OF PPH}

\begin{tabular}{|c|c|c|c|}
\hline
\textbf{DENIAL} & \textbf{DELAY} & & \\
\hline
\textbf{Maternal early warning criteria} & & & \\
\hline
Systolic BP (mm Hg) & \textbf{<90} or \textbf{>160} & & \\
Diastolic BP (mm Hg) & \textbf{>100} & & \\
Heart rate (beats per min) & \textbf{>100} or \textbf{\(<50\)} & & \\
Respiratory rate (breaths per minute) & \textbf{\(\geq 30\)} & & \\
Oxygen saturation, at sea level, % & \textbf{\(\leq 95\)} & & \\
Oliguria, 60 ml/hr for \textbf{\(\geq 2\)} hours & & & \\
Fetal: \textbf{Deterioration}, \textbf{umbilical arterial} or \textbf{umbilical venous fluid} & & & \\
\textbf{Dysrhythmia}, \textbf{tachycardia} & & & \\
\textbf{Hypoxemia} & & & \\
\textbf{Thrombocytopenia} & & & \\
\textbf{Preeclampsia} & & & \\
\textbf{Fetal distress}, \textbf{non-reassuring} & & & \\
\end{tabular}

\textit{Early warning system proposed by National Partnership for Maternal Safety.}

\textit{3/22/19}
Transfusion Practices for Obstetric Hemorrhage: What’s the latest?

Anji K. Panigrahi, MD, PhD
Clinical Assistant Professor
Departments of Anesthesiology, Perioperative and Pain Medicine and Pathology, Division of Transfusion Medicine

Obstetric Hemorrhage
- Over 11% of US maternal deaths
- 27% of maternal deaths worldwide
- Higher rates in developing countries
- Majority due to postpartum hemorrhage (PPH)
- Increasing incidence of PPH
  - >50% from 1985 to 2005

Disclosures
- None

Treatable Cause of Maternal Mortality
- Highest number of preventable maternal deaths
  - California: 70%
  - North Carolina: 93%
- Most common preventable provider factors
  - Delay in diagnosis
  - Delay in treatment
  - Failure to identify high-risk patients

Outline
- Risk Assessment and Pretransfusion Testing
- Recommendations for Massive Transfusion
- Patient Blood Management in Obstetrics

Obstetric Hemorrhage Safety Bundle
- Equipment for managing obstetric emergencies
  - Hemorrhage Cart
  - Blood bank instructions
  - Telemedicine
  - Rapid access to hemorrhage medications
  - Establish a response team
- Unit-standard obstetric hemorrhage protocols
  - Blood bank orders
  - Telemedicine protocol
  - Mass transfusion protocol
  - Invasive procedures
Risk Assessment

<table>
<thead>
<tr>
<th>Low (0-1%)</th>
<th>Medium (2-4%)</th>
<th>High (5-10%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>No previous Rh immunization</td>
<td>prior cesarean delivery or uterine surgery</td>
<td>Rh immunization during pregnancy</td>
</tr>
<tr>
<td>Singleton pregnancy</td>
<td>Multiple gestation</td>
<td>Suspected placenta accreta, previa, incision</td>
</tr>
<tr>
<td>Uterine or vaginal birth</td>
<td>+4/5 previous vaginal births</td>
<td>Hemorrhage (&lt;500 mL) and other risk factors</td>
</tr>
<tr>
<td>No known Rh disease in family</td>
<td>History of previous Rh sensitization</td>
<td>Active bleeding greater than 500 mL or cardiac</td>
</tr>
<tr>
<td>Large volume transfusion</td>
<td>Known sensitivity</td>
<td>Known sensitivity</td>
</tr>
</tbody>
</table>

*The Rh factor testing strategy should be individualized to fully consider the patient's medical history and the potential for Rh sensitization.*

Pretransfusion Testing

- Incidence of Rh requiring transfusion?
  - Low risk group: 3 ± 3.6
  - Medium risk group: 1.3 ± 1
  - High risk group: 20 ± 5.8

- Suggests type and screen is unnecessary in low and medium risk groups

- Type and screen sufficient in high risk group
  - Requires crossmatching available and antibody screen negative
  - In event of unexpected large volume hemorrhage without type and screen
    - Provide unmatched RBCs
    - Emergency blood availability
    - No higher risk of RBC alloimmunization

Electronic Crossmatch

- ABO-Rh typing alone results in a 99.94% chance of a compatible transfusion, the addition of an antibody screen increases the safety to 99.994%, and a crossmatch increases this to 99.999%

- Negative Antibody Screen
  - Dilution 1:2000 transfusions with negative ABO and Rh screen (Grappe, J., et al. JAMA, 1985)
  - 1% (0.1%) false negative Rh screen
  - No clinical or serologic evidence of hemolysis

- Electronic/Computer crossmatch
  - Ensure ABO compatibility (must be immediate prior to transfusion)
  - Only used if patient has a positive antibody screen & no history of alloantibodies
  - Requires two compatible ABO/Rh blood types (blood type verification)
  - Quickly improves turn-around time
  - Perform serologic (Coombs) crossmatch in select cases
  - Presence of history of RBC alloantibodies

Multiple RBC Alloantibodies

- Time to prepare RBC units depends on the specificity and number of alloantibodies
  - If the antigen is of high prevalence in the general population, then it is more difficult to find compatible units

- Prior preparation is key
  - Provide transfusion service advanced notice (24-48 hrs) in order to locate and crossmatch RBC units
  - Consider adjuncts
    - Cell salvage
    - Umbilical artery embolization
    - Hysterectomy

Insufficient Supply of Compatible RBC Units

- Supporting OB hemorrhage
  - Number of antigen-negative crossmatch-compatible units may be limiting
  - Should not withhold RBC transfusion
  - Issue “least incompatible” RBC units
    - If 2 antibodies present, issue units which do not express the antigen corresponding to the more clinically significant antibody

- If transfusion of incompatible RBC units anticipated
  - Consult with transfusion medicine, hematology, MFM
  - Metyrapone 1 mg/kg/day + IVIG 1 g/kg/day x 3 days prior to procedure

Outline

- Risk Assessment and Pretransfusion Testing
- Recommendations for Massive Transfusion
- Patient Blood Management in Obstetrics
Massive Transfusion Protocols

- Massive Transfusion
  - 10 or more RBC units in 24 hours
  - More than 4 RBC units in 1 hour with anticipated continued need for transfusion
  - Replacement of >50% of blood volume within 24 hours

- MTPs designed to facilitate administration of blood early in resuscitation
  - Pre-defined ratio
  - Avoid excessive crystalloid
  - Prevent dilutional coagulopathy
  - Transfuse plasma and packed cells empirically without waiting for laboratory testing

Benefits of MTPs

- Improved outcomes
- Reduction in multiorgan failure and infection
- Reduction blood product use and cost
- Decreased mortality

MTP for Obstetric Hemorrhage

- Obstetric Hemorrhage Protocols universally endorsed
  - The Joint Commission, ACOG, and the Society of Maternal Fetal Medicine
- Guidelines lack detail about Massive Transfusion Protocols availability
  - Recommended by PANZCOG, NFMS, and an international expert panel
- 98% of US academic obstetric anesthesia units have a MTP available

RBC : Plasma Ratios

- Inconsistency among obstetric societies on MTP composition
  - ACOG recommend fixed product ratios (1:1)
    - “What is more important than the actual ratio is that there is a specific protocol for multi-component therapy in place at each institution.”
  - ACOG
    - Transfusion of FFP
      - If no hemostatic results are available and bleeding is continuing, then, after 4 units of RBCs, FFP should be infused at a dose of 13-15 mL/kg until hemostatic test results are known.
    - Recommendations based upon trauma literature

PROMMTT Data – Early Plasma

- Early plasma transfusion – within first 3-6 blood units and within 2.5 hrs of admission

<table>
<thead>
<tr>
<th>Table 2: Relative Odds Ratio (with 95% Confidence Interval) for Hospital Morality with Early Plasma and Plasma/Plasma Ratios</th>
<th>P &lt; 0.05 &amp; P &lt; 0.01</th>
<th>P &gt; 0.05 &amp; P &gt; 0.01</th>
</tr>
</thead>
<tbody>
<tr>
<td>Early Plasma 947 (0-749) 4.44 0.000</td>
<td>Early Plasma 947 (0-749) 4.44 0.000</td>
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<td></td>
</tr>
</tbody>
</table>

- Decreased 6-hour mortality with increased ratios of:
  - Plasma: RBCs adjusted Ht = 0.35% CI 0.33-0.37
  - Plasma: RBCs adjusted Ht = 0.35% CI 0.33-0.37
  - Plasma: RBCs adjusted Ht = 0.35% CI 0.33-0.37
  - Plasma: RBCs adjusted Ht = 0.35% CI 0.33-0.37
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Plasma Deficit

- Adult trauma admissions receiving >5 RBC units during the first 24 hours (n=438)

- Correlation of survival with RBC and plasma use by hour: ratio and plasma deficit

- Mortality associated with across plasma deficit during the first 2 hours of resuscitation
  - p < 0.001 at 1 hr and p < 0.01 at 2 hr
**PROPRR Trial**
- 1:1 vs. 1:1:2 ratio of plasma, platelets, and red blood cells
- Improved hemostasis and decreased mortality from exsanguination at 24 hours
- Difference: -48.8% (95% CI: -10.4% to -9.2%), P = .02
- No increase in immune-mediated complications in the 1:1:1 group
- Infection, sepsis, acute respiratory distress syndrome, and multi-organ failure
- Suggests relative safety of higher dose plasma transfusion

**MTPs in Non-Trauma Hemorrhage**
- No survival benefit to higher ratios of plasma or platelets to RBC
- Adjusted for age, baseline pH count, Hct, INR, and APACHE II score

**Coagulopathy Varies Based on the Cause of PPH**
- Ultrasound obstetric
  - May be associated with significant placental injury
  - Evidence of placental injury is associated with coagulopathy
- Placental abruption/separation
  - Release of large quantities of TSP into maternal circulation
  - Local hypoxia and cytopathic synergism ( DIC)
  - Increased risk of development of DIC

**Hypofibrinogenemia During PPH**
- Predictive of progression to severe PPH
- Prospective, multicenter, observational study (n = 128)
  - Fibrinogen ≤ 100 mg/dL (71%) vs. 100-150 mg/dL (29%)
  - Fibrinogen ≤ 50 mg/dL (56%) vs. 50-100 mg/dL (44%)
  - Fibrinogen ≤ 25 mg/dL (39%) vs. 25-50 mg/dL (61%)
  - Prospective multicenter analysis of 783 women with PPH
  - Fibrinogen ≤ 50 mg/dL, independent predictor of progression to severe PPH

**Target Fibrinogen Level**
- American Society of Anesthesiologists
  - Fibrinogen concentration < 60-80 mg/dL, in the presence of excessive bleeding
  - Treatment may be indicated in severe or multiple transfusion patients
- European Task Force for Advanced Bleeding Care in Trauma
  - Target fibrinogen level < 150-200 mg/dL
- European Society of Anesthesiology
  - Fibrinogen concentration < 60-80 mg/dL, is considered as hypofibrinogenemia in a severe sepsis patient and is associated with increased mortality
- Hospital of Obstetrics and Gynecology
  - Autologous transfusion level of greater than 25 mg/dL should be maintained for ongoing therapy
- Polymerase chain reaction
  - Not mentioned by ACOG or SCOGP
Outline

- Risk Assessment and Pretransfusion Testing
- Recommendations for Massive Transfusion
- Patient Blood Management in Obstetrics

Consequences of Transfusion

- Risk of transfusion:
  - Transmissible infectious disease
  - Transfusion-transmitted viremia
  - Exposure to unknown viruses (HIV, HGV)
  - Mortal impact of viral contamination
  - Increased morbidity and mortality

- MT for PPH associated with high mortality:
  - Prospective observational study conducted through the UK Obstetric Surveillance System (UKOSS)
  - 95% nontransfused had no recurrence of gestational uterine bleeding (defined as at least one episode of bleeding within six hours of giving birth) (n = 66)
  - Median (IQR) - 6 (3.0) days
  - 45% transfused vs 2% of nontransfused developed significant morbidity (myometrial necrosis and/or pelvic infection)

- Small-volume transfusion associated with poorer outcomes:
  - 5 out of 10 women with severe hemorrhage receiving a transfusion of 1 L RBC units
  - Median (IQR) - 14 (10) days
  - 120% incidence was approached
  - 200% maternal mortality (PMF-1)
  - 80% severe maternal complications
  - 80% of patients died within 5 days (PMF-2)

Patient Blood Management

- Optimise erythropoietins
- Maintain blood loss
- Manage anemia

- Early and vigilant monitoring
- Early and vigorous fluid resuscitation
- Early and aggressive transfusion
- Early and close monitoring

- Optimise erythropoietins
- Maintain blood loss
- Manage anemia

- Nutritional intervention strategies
- Early and close monitoring
- Early and vigorous fluid resuscitation
- Early and aggressive transfusion

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- Nutritional intervention strategies
- Early and close monitoring
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PBM – Anemia Treatment

- WHO estimates that over 1/3 of pregnant women are anemic (Hgb < 11 g/dL)
- Most cases due to iron deficiency

- IV iron better tolerated and more efficacious than oral iron for post-PPH anemia
- Higher hemoglobin at 6 weeks
- Decreased constipation and dyspepsia

PBM – Cell Salvage

- No problems with amniotic fluid contamination given improved filtering techniques
- Endorsed by ACCOG (for cesarean delivery) and AOG
- SWO TriPi?
  - Careful vs standard care in 72% women at risk of hemorrhage
  - Transfusion rates were significantly different in the SWO TriPi group
  - Increased extremities exposure to fetal blood using cell salvage
  - For a decreased hospital stay (95 vs 115 days)

- Does not account for cost from morbidity and mortality risk associated with alloimmune blood transfusions
- Can be useful in patients with persisting allogeneic and limited allogeneic blood

PBM – POC Testing and Pharmacologic Therapy

- Visualized testing for early identification of coagulopathy
- Detecting hypofibrinogenemia
  - Decrease in FIBTEM amplitude - 20% specificity and 88-86% sensitivity to detect fibrinogen concentration < 1.5 g/dL
  - Predicting progression to severe PPH
  - FIBTEM an independent predictor for progression to bleeds > 2500 mL

- Decreasing blood product use
  - ECMO algorithm based on the FIBTEM clot time (CT) and the AUC the number of patients requiring > 5 RBC units

- Pharmacologic Therapy
  - Tranexamic acid
  - Fibrinogen concentrates
  - iNVA
Conclusions
- Type and Screen is sufficient for women at high risk of PPH
  - When electronic crossmatch is available
- In patients with RBC alloantibodies, extra time is required to obtain and prepare cross-match compatible blood
  - Time required is dependent on number and specificity of antibodies
- Massive Transfusion Protocols should be available to all units treating patients with potential PPH
  - The optimal ratio of RBC: plasma unit when treating PPH is unclear
- Hypofibrinogenemia is a strong predictor of severe PPH
  - Studies are ongoing to determine the efficacy of early fibrinogen replacement
- Patient Blood Management initiatives should be employed as part of routine obstetric care to avoid alloimmune blood transfusion and its associated morbidity and mortality risk

Definitions of Postpartum Hemorrhage

<table>
<thead>
<tr>
<th>Organization</th>
<th>PPH Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td>[Organization 1]</td>
<td>Based on 2000 definition by the American College of Obstetricians and Gynecologists (ACOG)</td>
</tr>
<tr>
<td>[Organization 2]</td>
<td>National Institutes of Health (NIH) definition based on the American College of Obstetricians and Gynecologists (ACOG)</td>
</tr>
<tr>
<td>[Organization 4]</td>
<td>Based on the American College of Obstetricians and Gynecologists (ACOG)</td>
</tr>
</tbody>
</table>

Transfusing Crossmatch-Compatible Blood

- What is required?
  - ABO & RhD Type
  - Second confirmatory specimen (Blood Type Verification)
  - Completed RBC alloantibody screen
    - Does not assess presence of "naturally occurring" anti-A and anti-B isoantibodies
    - If RBC alloantibodies present, they must be identified – takes time!

Type and Screen

- 2 separate diagnostic tests
  - Type – Determine ABO and RhD blood type
    - Forward type = Incubate patient RBCs with known reagent antibodies (anti-A, anti-B, anti-RhD)
    - Reverse type = Incubate patient serum with known reagent RBCs (A, B)

RBC Antibody Screen

- Commercially prepared Group O screening cells (ignore anti-A and -B)
  - D, C, E, c, d, M, N, S, s, P1, Le(a), Le(b), K, K, Ky, Fy(a), Fy(b), Jk(a), and Jk(b)

- If antibody screen is positive, then must do additional testing to identify the antibody specificity

Preparing RBC for Transfusion

Requires RBC Crossmatch
- Test patient serum with a cell suspension from a donor RBC unit
- Complete Indirect Antiglobulin Testing crossmatch
  - Involves 37°C incubation and includes anti-human globulin or “Coombs reagent”
  - Identifies if the patient has detectable antibody(ies) to antigen(s) present on a donor RBC’s
  - Positive reaction indicates an incompatible unit and that unit should not be transfused
Acute Hemolytic Transfusion Reactions

- Usually occur during or within 24 hours of transfusion
  - Can be intra- or extravascular
  - Intravascular hemolysis more severe and usually associated with ABO incompatibility
    - Anti-A, anti-B antibodies are IgM and can fix complement

- Signs and symptoms
  - Fever and chills
  - Most common presenting symptom (> 90%)
  - Back or infusion site pain
  - Hypotension/shock
  - Hemoglobinuria (may be first indication of hemolysis in anesthetized patients)
  - DIC (increased bleeding, also important in anesthetized patients)
  - Sense of “impending doom”

AHTR Management

- Stop the transfusion!
- Goal: replace all of the blood of an acute AHTR with the amount of incompatible blood infused

- Initial Transfusion Reaction Workup (Call Transfusion Services)
  - Clinical check
  - Transfusion Service and pharmacy check to ensure correct unit sent to patient
  - Obtain hemoglobin/hematocrit
  - Obtain LUPA blood typing and crossmatch for free hemolysis
  - Obtain RPR, C3, C4, CH50, etc. if clinical suspicion of DIC
  - Repeat ABO typing
  - Free lymphocytes and direct anti-RBC
  - Direct antiglobulin test
  - Coombs test (anti-IgG, anti-C3d)

- IV hydration and diuresis (maintain UOP >3ml/kg/hr)
- Diuretics for DIC
- Consider exchange transfusion for high-volume incompatible transfusion
Pharmacological Management of Obstetric Hemorrhage

2019 Sol Shnider, M.D., Obstetric Anesthesia Meeting

Alexander Butwick MBBS, FRCA, MS
Associate Professor,
Department of Anesthesiology, Perioperative, and Pain Medicine
@aljabut
#SolShnider2019

Disclosures

• Consulting / Honoraria:
  • Instrumentation Laboratory, Cerus Corporation

FIBRINOGEN CONCENTRATE

TRANEXAMIC ACID (TXA)

TXA & Postpartum Hemorrhage

• Treatment
• Prevention

How does TXA work?

Does TXA TREATMENT Improve Outcomes?
**TXA and PPH**

- **4g TXA + 1 g / hr infusion vs. placebo**
  - Intermediate quality studies
  - Low sample sizes
  - Inconsistent results: ↓ / ↔ estimated blood loss with TXA

**BIG STUDY**

- **N = 20,000**
- Randomized: TXA (1 – 2 g) vs. placebo
- Primary outcome = Death from PPH

**Outcomes**

- We don't get death rates this high! (38 deaths per 100,000 PPHs (0.038%) [Marshall AJOG 2017])

**Transfusions:**

- 54% TXA vs. 54% placebo
- Among those transfused: No diff mean number of blood units transfused

**Death from:**

TXA – Should I use it?

- Reasonable option:
  - Prehospital care / Limited resources
- Therapeutic adjunct
- New PPH algorithms → TXA

Does tranexamic acid prevent postpartum haemorrhage? A systematic review of randomised controlled trials
K Ker, H Sheker, J Roberts

Main results We found 26 trials including a total of 4191 women. Examination of the trial reports raised concerns about the quality of the data. Eight trial reports contained identical or similar text, and there were important data inconsistencies in several trials. Two trials did not have ethics committee approval. Meta-analysis of baseline variables suggested that randomisation was inadequate in many trials.

Conclusions There is no reliable evidence that TXA prevents postpartum haemorrhage during childbirth. Many of the trials conducted to date are small, low quality and contain serious flaws.

BJOG 2016;123:1745-1752

Does TXA PROPHYLAXIS Prevent PPH?

Sentilhes L. NEJM 2018;379:731-42

<table>
<thead>
<tr>
<th>TXA</th>
<th>Placebo</th>
<th>RR (95% CI)</th>
</tr>
</thead>
<tbody>
<tr>
<td>PPH</td>
<td>8.1%</td>
<td>9.8%</td>
</tr>
</tbody>
</table>

N = 3891

Final Word of Caution

Neurologic Injury / Death – Intrathecal Injection

3. APSF Newsletter 2010; 25 (1): 9
4. Roy A. SEAJCR 2015; 9: 1210-6

Fibrinogen Concentrate & Postpartum Hemorrhage
### Fibrinogen and Pregnancy

- Fibrinogen Levels and Blood Loss

- Fibrinogen & Severe Blood Loss Progression

- Are Outcomes Improved After Treating a Low Fibrinogen Level?

- What is the Best Product for Fibrinogen Supplementation?

- Fibrinogen Containing Products

#### Fibrinogen Containing Products

<table>
<thead>
<tr>
<th>Product</th>
<th>Fibrinogen Concentration (g/L)</th>
<th>Volume</th>
<th>Amount to ↑ fibrinogen by 100 mg/dl</th>
</tr>
</thead>
<tbody>
<tr>
<td>FFP</td>
<td>1 - 3</td>
<td>1 unit = 250 ml</td>
<td>4 units *</td>
</tr>
<tr>
<td>Cryoprecipitate</td>
<td>3 - 30</td>
<td>2 pools (10 single units) = 400 ml</td>
<td>2 pools</td>
</tr>
<tr>
<td>Fibrinogen Concentrate</td>
<td>20</td>
<td>1 g = 50 ml</td>
<td>2 - 3 g</td>
</tr>
</tbody>
</table>

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**References**


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**Fibrinogen < 200 mg/dl = 100% PPV**→ progression to severe PPH

- Fibrinogen < 200 mg/dl:
  - 2.7 – 12 fold ↑ risk: Worsening blood loss or morbidity
  - Transfusion = 100% PPV

---

**Fibrinogen < 200 mg/dl = 100% PPV** → progression to severe PPH

---

**Are Outcomes Improved After Treating a Low Fibrinogen Level?**

**What is the Best Product for Fibrinogen Supplementation?**

---

**Fibrinogen Levels and Blood Loss**


---

**Fibrinogen & Severe Blood Loss Progression**


---

**Fibrinogen Containing Products**

Fibrinogen Concentrate

- Sterile,
- Preservative-free
- Lyophilized fibrinogen concentrate
- Each Vial: 900 – 1300 mg fibrinogen
- Dilute in 50 ml Sterile Water
- Give IV
- Not exceed 5 ml / min

Fibrinogen Concentrate

Viscoelastic-guided early fibrinogen concentrate replacement during postpartum haemorrhage: OBS2, a double-blind randomised controlled trial

RiaSTAP (weight based dose) vs. Placebo:
Severe PPH with FibTEM A5 ≤ 15 mm

<table>
<thead>
<tr>
<th>RiaSTAP (n=35)</th>
<th>Placebo (n=36)</th>
<th>P</th>
</tr>
</thead>
<tbody>
<tr>
<td>Blood loss at study drug delivery</td>
<td>1950 (1500 – 2290)</td>
<td>2000 (1100 – 2500)</td>
</tr>
<tr>
<td>Transfusion Rate</td>
<td>53%</td>
<td>55%</td>
</tr>
<tr>
<td>Number of units</td>
<td>1 (0 – 2)</td>
<td>1 (0 – 2)</td>
</tr>
<tr>
<td>Blood loss within 24 hr of study medication</td>
<td>225 (100 – 341)</td>
<td>300 (80 – 800)</td>
</tr>
</tbody>
</table>

RiaSTAP vs. Placebo: 2g vs. Placebo

<table>
<thead>
<tr>
<th>RiaSTAP (n=23)</th>
<th>Placebo (n=21)</th>
<th>P</th>
</tr>
</thead>
<tbody>
<tr>
<td>EBL at inclusion (ml)</td>
<td>1493 (489)</td>
<td>1426 (463)</td>
</tr>
<tr>
<td>Baseline fibrinogen (g/L)</td>
<td>4.5 (1.1)</td>
<td>4.5 (1.3)</td>
</tr>
<tr>
<td>Postpartum RBC transfusion</td>
<td>20%</td>
<td>22%</td>
</tr>
<tr>
<td>RBC transfusion within 4 hrs</td>
<td>3%</td>
<td>8%</td>
</tr>
</tbody>
</table>

Introduction of an algorithm for ROTEM-guided fibrinogen concentrate administration in major obstetric haemorrhage

S Fuhre1, T Nielson, C Cherrone2 and B Rode

Suggestions for Use

MAJOR ACTIVE BLEEDING

- Fibrinogen ≤ 250 mg / dl
- ROTEM: FibTEM A5 ≤ 10 mm
- TEG: Alpha Angle < 45°
- Probably if no lab / POC value

Start with 1 – 2 g RiaSTAP
What Are We Doing?

- OB Anesthesia Attending / Fellow / Resident
- MFM Attending / SWC Attending / OB Chief Resident
- Charge Nurse
- If severe PPH (stage 3)
  - GYN
  - Onc / Trauma / Gen Surgery

Atony prophylaxis: IV pitocin (for c/section: 1-2 u; cumulative max dose = 5 u over 3-4 mins) + infusion for maintaining adequate tone

Fundal massage

Measure blood loss – gravimetric + volumetric

All patients:
- Atony Prophylaxis
- Large bore IV x 2
- CBC / PT / PTT / INR / Fibrinogen +/
- POCT (TEG or ROTEM)
- 100% O2 (non-rebreather facemask)
- 2nd line uterotonic (methergine; hemabate; misoprostol)

STAGE 1
- Bleed AND
- Hb<10 or VD or >1500 mL CS
- Activate MTP or use T&Cd blood if immediately available
- Move to OR if PPH post vaginal delivery – repair tear; D&C; IUBT; embolization
- Transfuse (fixed ratio of RBC:FFP:Plt or goal-directed using labs/POCT) + Belmont
- Consider early arterial line + ABG
- Surgical intervention if c/section (inspect broad lig; B Lynch; IUBT; Embolization)

STAGE 2
- Bleed AND
- Hb<10 or VD or >1500 mL CS
- Transfuse (fixed ratio of RBC:FFP:Plt or goal-directed using labs/POCT) + Belmont
- Watch for acidosis / hypocalcemia / hyperkalemia
- Avoid hypothermia (use active warming)
- Surgical intervention (laparotomy; B Lynch; UA ligation; hysterectomy)

STAGE 3
- Bleed AND
- Hb<10 or VD or >1500 mL CS
- Transfuse (fixed ratio of RBC:FFP:Plt or goal-directed using labs/POCT) + Belmont
- Watch for acidosis / hypocalcemia / hyperkalemia
- Avoid hypothermia (use active warming)
- Surgical intervention (laparotomy; B Lynch; UA ligation; hysterectomy)

Pharmacological Adjuncts:
- Rhoimmune concentrate (1-2ig/hr)
- Tranexamic acid (1 g IV then over 10 mins, if bleed after 30 mins, then give 1 g IV over 8h)

Many Thanks

Email = ajbut@stanford.edu
@ aljabut
https://www.facebook.com/obstetricanesthesia
Saturday, March 16, 2019

Session VIII: Clinical Conundrums in Obstetric Anesthesia
Moderator/Lead: Alexander Butwick, M.B.,B.S., FRCA, M.S.

Expert Panel: Lawrence Tsen, MD; Ashraf S. Habib, M.B.,B.Ch., M.Sc., M.S.N., FRCA; Edward T. Riley, M.D.; Jennifer M. Lucero, M.D., M.S.
Clinical Conundrums in Obstetric Anesthesia

ALEXANDER BUTWICK MBBS; FRCA, MS
ASSOCIATE PROFESSOR
DEPARTMENT OF ANESTHESIOLOGY, PERIOPERATIVE, AND PAIN MEDICINE
STANFORD UNIVERSITY SCHOOL OF MEDICINE

Disclosures

Thank you Dr. Katie Arendt MD (Mayo Clinic)

The EXPERTS

- Lawrence Tsen (Brigham and Women’s)
- Ashraf Habib (Duke)
- Edward Riley (Stanford)
- Jennifer Lucero (UCSF)

Guided walk

- Case presentation
- At least 2 courses of action
- Audience vote

# Case 1: ThrombocytoPAINia

- 30 y/o G1P0 – 39 weeks
- Admitted Spontaneous Labor
- BMI 40
- Gestational thrombocytopenia – PLT count today = 50 x 10⁷ / L
- She’s requesting an epidural – no prior anesthesia consultation

What do you do?
1. Perform an Epidural
2. Not Perform an Epidural
Risk of epidural hematoma – Thrombocytopenic patients

- PLT count <100,000 + neuraxial block.
- Systematic Review – 951 patients
- MPOG – 573 patients

1. Lee Anesthesiology 2017

# Case 1: ThrombocytoPAINia

- Epidural @ 3cm
- Ob performs ARM → pain is getting worse
- 3 epidural top-ups
- Pt still c/o right-sided pain
- OB calls c/s for failure to progress (7cm); fetal trace ‘ok’
- Epidural top-up: 20 ml 2% lidocaine + epi + bicarb
  – inadequate block (T7 – Left; L1 – Right)

# Case 1: ThrombocytoPAINia

What do you do?
• Take out catheter & do another block
• GA
• MAC

Case #2: They’re Grrrreeeattt!

25yo G6P5 at 40 wks
- Spont ROM 2 hrs ago, breech position, 1 prior CS
- Cervix unchanged from clinic
- Non-painful regular contractions
- OB wants to go to Cesarean now

Case #2: They’re Grrrreeeattt!

AUDIENCE VOTE:
It is 9pm at night and this patient ate a bowl of Frosted Flakes at 8pm.
Do you delay this case for 6 to 8 hours & do the Cesarean between 2 – 4am?

YES
NO
Case #2: They’re Grrrrreeeattt!

Practice Guidelines for Obstetric Anesthesia
An Updated Report by the American Society of Anesthesiologists Task Force on Obstetric Anesthesia and the Society for Obstetric Anesthesia and Perinatology*

- Solid foods should be avoided in laboring patients
- The patient undergoing elective surgery:
  - Fasting period for solids = 6 to 8 hrs; depending on the type of food ingested (e.g., fat content)

Anesthesiology 2016; 124:270-300

Case #3: Oooo….the strip!

- 32y/o G2P1 at 38wks underwent IOL and labor augmentation with oxytocin.
- ARM – 1 hr ago
- Pain now 10/10; cervix: 7cm
- Now requesting an epidural

LATE DECELERATION: NICHD Workshop on Electronic Fetal Monitoring
- Symmetrical gradual decrease and return of FHR associ with uterine contraction
- A gradual FHR decrease: onset - the FHR nadir ≥30 secs
- Nadir of the deceleration after the peak of the contraction
- In most cases, the onset, nadir, and recovery of the deceleration occur after the beginning, peak, and ending of the contraction, respectively.

JOGNN, 37, 510-515; 2008
Case #4: I could do with a laugh

26y/o G1P0; 40 wks gestation
- Presents with spontaneous labor
- BMI 25; healthy with a reassuring airway exam
- She is requesting pain relief

Case #4: I could do with a laugh
- The patient requests nitrous oxide labor analgesia.
- The patient's nurse is reviewing the protocol for administration.

Case #4: I could do with a laugh
- Nitrous oxide: less effective than epidural labor analgesia
- Side-effects: nausea, vomiting, dizziness, drowsiness
- Satisfaction

<table>
<thead>
<tr>
<th>Hospital</th>
<th>Nitrous use among laboring women</th>
<th>Conversion rate to neuraxial analgesia</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sutton (Stanford)</td>
<td>3%</td>
<td>63%</td>
</tr>
<tr>
<td>Richardson (Vanderbilt)</td>
<td>19%</td>
<td>40%</td>
</tr>
</tbody>
</table>


Case #4: I could do with a laugh
- She is done with the nitrous and she and her Doula are now requesting a remifentanil PCA.

Case #4: I could do with a laugh
- Do you offer this patient a remifentanil PCA?

Audience Vote:
- Yes, I would offer her a remifentanil PCA.
- No, I would not offer her a remifentanil PCA.
Remifentanil Labor Analgesia

Melber AA. Remifentanil patient-controlled analgesia (PCA) in labour - in the eye of the storm. Anaesthesia 2019, 74, 277-279 (Editorial)


Weibel S. Patient-controlled analgesia with remifentanil versus alternative analgesic methods for pain relief in labour. Cochrane Database of Systematic Reviews 2017, issue 4. CD011989


Case #4: I could do with a laugh

She is done with the nitrous and the remifentanil and now requests real analgesia.

You have heard from a colleague that Dural Puncture Epidurals (DPE) are now considered better than epidurals or CSEs.

Do you perform a DPE for this patient?

Case #4: I could do with a laugh

Audience Vote:
- Yes, I would perform a DPE.
- No, I would perform an epidural.
- No, I would perform a CSE.

Case #4: I could do with a laugh

She is now postpartum and is requesting a postpartum tubal ligation. It is 10pm and the plan is to schedule the procedure at 8am the next morning.

Do you pull the epidural, or utilize it the next morning for the tubal ligation?

Case #4: I could do with a laugh

Audience Vote:
- I would leave the catheter in tonight and utilize it the following morning for the PPTL.
- I would pull the catheter out tonight and perform a single shot spinal tomorrow morning.
- I would pull the catheter out tonight and do a GA tomorrow morning.

Anesthesia for Tubal Ligations

- Survey: 26 US Fellowship Directors
  - 58% keep epidural catheter for tubal
  - If no epidural, 94% - single-shot spinal
- Failed Epidural top-up rates: 12-24% 1-2
- RFs for failure: poor patient satisfaction; increased delivery-reactivation time; top-ups during labor

Case #5: A quickie

- G1P0: SVD 2 hr ago with an epidural.
- RN took the epidural catheter out after delivery.
- Now has a retained placenta
- OB calls – patient uncomfortable; placenta ‘not coming out’
- Asks if you can give ‘some sedation’ in the labor room to ‘try again’….it won’t take long 😃

What do you do?
1. Say yes – give sedation
2. Say no – offer an alternative

Case #5: A quickie

- You say no.
- OB not happy as another patient in labor (9cm)
- You want to do the case in the OR

What do you do?
1. Spinal
2. Epidural
3. CSE
4. MAC
5. GA

Case #5: A ‘not-so’ quickie

- You do a spinal
- OB is ‘tugging hard’ on the placenta but ‘thinks it’s coming…….’
- BP dropping; HR increasing
- Blood loss is ‘estimated’ ~ 1 L / 5 min
- What next?

Email: ajbut@stanford.edu
Session IX: Management Updates Safety Session
(ABA Part 2 MOCA Patient Safety Credit)
Moderator: Mark D. Rollins, M.D., Ph.D.

Anesthesia for Non-Obstetric Surgery During Pregnancy
Gillian Abir, M.B., Ch.B., FRCA

Eating During Labor and the “Full Stomach” Pre and Post-Delivery
Atisa B Britton, M.D.

Post-Partum Tubal Ligation: Optimal Anesthetic Technique and Timing
Andrea J. Traynor, M.D.
Non-obstetric Surgery during Pregnancy

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Disclosures
I have no disclosures

Learning Objectives
- Describe when, where and how to perform a safe anesthetic for non-obstetric surgery
- List maternal and fetal risks
- Summarize drug administration during pregnancy
- Evaluate the importance of a multidisciplinary team

Incidence
- Approximately 4M births/year (US)
- Up to 88,000 (2.2%) non-obstetric surgery during pregnancy cases/year (US)

Outline
- Types of surgery
- When and where to perform surgery?
- Maternal and fetal risks
- Operative considerations

Types of Surgery

<table>
<thead>
<tr>
<th>Procedure</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Appendectomy</td>
<td>44</td>
</tr>
<tr>
<td>Open</td>
<td>37</td>
</tr>
<tr>
<td>Laparoscopic</td>
<td>63</td>
</tr>
<tr>
<td>Cholecystectomy</td>
<td>22</td>
</tr>
<tr>
<td>Open</td>
<td>10</td>
</tr>
<tr>
<td>Laparoscopic</td>
<td>90</td>
</tr>
<tr>
<td>Intraperitoneal procedures</td>
<td>11</td>
</tr>
<tr>
<td>Open</td>
<td>81</td>
</tr>
<tr>
<td>Laparoscopic</td>
<td>19</td>
</tr>
<tr>
<td>Breast procedures</td>
<td>8</td>
</tr>
<tr>
<td>Other (vascular, cardiac, neck)</td>
<td>6</td>
</tr>
<tr>
<td>Musculoskeletal procedures</td>
<td>6</td>
</tr>
<tr>
<td>Skin, incision + drainage</td>
<td>3</td>
</tr>
</tbody>
</table>
Trauma....

- 3rd leading cause of death for all ages/sex/race
- Leading cause of death in all women <40 yr
- Leading non-obstetric cause of maternal mortality
- Complicates 6-7% of all pregnancies

Mechanism of Trauma

Compared to Non-pregnant Women, Pregnant Women:

- Sustain violent trauma: 15.9% vs. 9.8% (p<0.001)
- Lower Injury Severity Score: 8.9 vs. 10.9 (p=0.001)
- Dead on arrival: aRR 2.33 (P<0.001)
- Undergo surgery: aRR 0.70 (p=0.001)
- Transfer to another facility: aRR 1.72 (P=0.001)
- Die during hospital course: aRR 1.79 (p=0.004)

Why?

- Physiological changes in pregnancy
- Challenging physical examination
- Imaging modalities not fully utilized
- Systems-level factors:
  - Limited ER physician experience
  - Lack of on-call obstetric services
  - Limited management protocols (if any)

  - 70% more likely to be transferred to another facility
  - 30% less likely to go to the OR

Women and girls of reproductive age

*Statistically significant difference between pregnant and non-pregnant women (p<0.001)
Outline

- Types of surgery
- When and where to perform surgery?
- Maternal and fetal risks
- Operative considerations

Non-obstetric Surgery during Pregnancy

- A pregnant woman should never be denied indicated surgery, regardless of trimester
- Elective surgery should be postponed until after delivery
- If possible, non-urgent surgery should be performed in the 2nd trimester, when preterm contractions and spontaneous abortion are least likely

Decision-making Algorithm

Which Trimester?

- 1st trimester: Risk of teratogenicity
- 2nd trimester:
- 3rd trimester: Risk of preterm delivery

Logistics

- **Personnel**
  - OB team/L+D nurse for monitoring
  - OB team for surgery
  - NICU team
  - Intensivist

- **OR equipment**
  - Uterotonic/lytic medications
  - Wedge (LUD)
  - Fetal monitor
  - Cesarean delivery instruments
  - Neonatal resuscitation equipment (multiples?)

"Think about every possible eventuality … and then think some more!"
Logistics...

PACU
- Fetal monitoring
- Maternal monitoring
- Post-op orders

Patient disposition
- L+D
- Surgical ward
- ICU

Outline
- Types of surgery
- When and where to perform surgery?
- Maternal and fetal risks
- Operative considerations

What is the patient thinking....?
- Will the drugs affect my baby?
- Will I lose my baby?
- Will it affect my ability to breastfeed?
- What if I don’t go ahead with the surgery?

...and what will your answers be?

Maternal Risk Increased?

2539 pregnant women matched 1:1 with non-pregnant women undergoing general surgery

- Overall morbidity: No significant difference
  - 6.6% in pregnant women vs. 7.4% in non-pregnant women (p=0.30)

- 30-day mortality: No significant difference
  - 0.4% in pregnant women vs. 0.3% in non-pregnant women (p=0.82)
30-day Major Postoperative Complications after Non-obstetric Surgery

<table>
<thead>
<tr>
<th>Predictor</th>
<th>aOR (95% CI)</th>
<th>P value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age (per 5 yr increase)</td>
<td>1.32 (1.13, 1.53)</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Preoperative systemic infection</td>
<td>2.30 (1.48, 3.66)</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>New York Heart Class III or IV</td>
<td>3.77 (1.42, 9.81)</td>
<td>0.002</td>
</tr>
<tr>
<td>Ventilator dependency</td>
<td>6.72 (1.84, 24.6)</td>
<td>0.004</td>
</tr>
<tr>
<td>Functional status (dependent/partially dependent for ADLs)</td>
<td>3.34 (1.46, 7.62)</td>
<td>0.004</td>
</tr>
<tr>
<td>Previous procedure (within 30 days)</td>
<td>2.01 (0.84, 4.41)</td>
<td>0.12</td>
</tr>
<tr>
<td>Operative time:</td>
<td></td>
<td></td>
</tr>
<tr>
<td>&lt;1 h</td>
<td>1 (reference)</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>1-2 h</td>
<td>3.33 (1.95, 5.50)</td>
<td>0.011</td>
</tr>
<tr>
<td>2-3 h</td>
<td>2.66 (1.31, 5.46)</td>
<td>0.008</td>
</tr>
<tr>
<td>3-4 h</td>
<td>3.95 (1.64, 9.46)</td>
<td>0.010</td>
</tr>
<tr>
<td>&gt;4 h</td>
<td>5.80 (1.33, 23.6)</td>
<td></td>
</tr>
</tbody>
</table>

Maternal Consequences: Physiological

Respiratory:
- ↑ incidence of difficult + failed intubation
- FRC ↓ 20% (↓ 30% if supine)
- Oxygen consumption ↑ 20%

Blood constituents:
- Hypercoaguable
- ↓ platelets
- ↑ fibrinogen

Cardiovascular:
- CO ↑ 50%
- Supine position: CO ↓ 10-20%
- Blood volume ↑ 45%

Maternal Consequences: Pharmacodynamics

Physiological effects
- Induction agents (propofol): Dose ↓ 35%
- Volatiles (sevo/isoflurane): MAC ↓ 40%
- DMR (succinylcholine): ↓ Sensitivity
- NDMR (aminosteroids): ↑ Sensitivity
- Vasopressors (phenylephrine): ↓ Sensitivity

Maternal Consequences: Airway

Physiological effects
- ETT vs. LMA?
- ↑ risk of aspiration after 18-20 gestation?
- May have dyspepsia/GERD <18 weeks – Ask!
- “Probably safe in healthy, selected patients when managed by experienced LMA users”

Consent for intraoperative CS (if viable)?
Fetal Consequences

- Risk of fetal loss
  - 2% simple appendicitis vs. 6% complicated appendicitis (p<0.05)
  - Laparoscopic vs. open appendectomy = OR 2.31

- Risk of pre-term labor
  - 'Considerable risk' within first week post-appendectomy

- Risk of pre-term delivery
  - 4% simple appendicitis vs. 11% complicated appendicitis (p<0.05)

Teratogenicity Studies

Prospective studies are impractical

Current data taken from:

1) Studies of the reproductive effects of anesthetic agents in small animals
2) Epidemiologic surveys of operating room personnel constantly exposed to sub-anesthetic concentrations of inhalation agents
3) Studies of pregnancy-outcome in women who have undergone surgery while pregnant

Teratogenicity = Any significant postnatal change in function or form in an offspring after prenatal treatment

Drug Categories

- Benzodiazepines?
- Nitrous oxide?

Drug factors
- Dose
- Duration
- Timing of exposure
- Genetic predisposition

Non-drug factors
- Hypoxia
- Hypercarbia
- Stress/anxiety
- Temperature abnormalities
- Carbohydrate metabolism

Fetal Monitoring

When?
- Pre-op/intra-op/postoperatively

Type?
- Intermittent/continuous

Interpretation?
- OB/L+D nurse?

Consequences?
- Ready to act?
- OB team immediately available
- Equipment readily available

Perioperative Fetal Monitoring

- If preivable, ascertain FHR by Doppler before and after the procedure
- If visible*, as a minimum obtain electronic FHR and contraction monitoring before and after the procedure

*Intraoperative electronic FHR monitoring may be appropriate when all of the following apply:
(i) The fetus is visible
(ii) It is physically possible to perform intraoperative electronic fetal monitoring
(iii) A health care provider with obstetric surgery privileges is available and willing to intervene during the surgical procedure for fetal indications
(iv) When possible, the woman has given informed consent to emergency cesarean delivery
(v) The nature of the planned surgery will allow the safe interruption or alteration of the procedure to provide access to perform emergency delivery

* A viable fetus is defined as ≥24 + 0 weeks gestation

Chapter 17, Chestnut’s Obstetric Anesthesia: Principles and Practice. 5th Ed, 2014.
Outline

- Types of surgery
- When and where to perform surgery?
- Maternal and fetal risks
- Operative considerations

Operative Considerations

Maintain maternal and fetal homeostasis:

- Oxygenation
- Carbon dioxide + acid-base balance
- Temperature
- Uteroplacental perfusion (fetal monitoring)

- Cautious positioning
- Cautious surgical techniques
  (insufflation pressures 10-15 mm Hg)
- Treat pre-term labor
  (no need for prophylactic treatment)

In Summary

- Described when, where and how to perform a safe anesthetic for non-obstetric surgery
- Listed maternal and fetal risks
- Summarized drug administration during pregnancy
- Evaluated the importance of multidisciplinary team planning

Pearl et al. www.sages.org

gabir@stanford.edu
Eating During Labor and the “Full Stomach” Pre and Post Delivery

Atisa Britton, MD
Assistant Clinical Professor
UCSF Department of Anesthesia and Perioperative Care
SOAP 2019 Sol Shnider Meeting

Disclosures
I have no conflicts of interest in relation to this presentation.

Overview
- Gastroesophageal anatomic and physiologic changes in pregnancy
- Data on pulmonary aspiration rates during labor and delivery
- Recommendations from professional organizations on oral intake during labor
- Data on anesthesia for surgical abortions
  - Pregnancy aspiration risk
- Data on anesthesia for PPTL and postpartum physiologic changes
  - Postpartum aspiration risk

Objective
Provide data on peripartum aspiration risk to aide in the development of an informed anesthetic plan for pregnant and postpartum patients

Physiological changes of pregnancy and postpartum period

Concern for increased risk of perioperative pulmonary aspiration

Potential for serious morbidity and mortality

Box 30-1
Anatomic and Physiologic Risk Factors for Airway Complications during Pregnancy:
- Airway edema
- Decreased functional residual capacity
- Increased oxygen consumption
- Weight gain
- Breast enlargement
- Full dentition
- Decreased lower esophageal sphincter tone
- Delayed gastric emptying in labor
Box 30-1: Anatomic and Physiologic Risk Factors for Airway Complications during Pregnancy

- Airway edema
- Decreased functional residual capacity
- Increased oxygen consumption
- Weight gain
- Breast enlargement
- Full dentition
- Decreased lower esophageal sphincter tone
- Delayed gastric emptying in labor

Box 30-2: Anatomic and Physiologic Risk Factors for Airway Complications during Pregnancy

- Airway edema
- Decreased functional residual capacity
- Increased oxygen consumption
- Weight gain
- Breast enlargement
- Full dentition
- Decreased lower esophageal sphincter tone
- Delayed gastric emptying in labor
Peripartum LES: Anatomy & Physiology

- Decreased tone of lower esophageal high pressure zone (LEHPZ)
  - Intraabdominal segment of the esophagus displaced into the thorax
  - Progestin

- LEHPZ returns to prepregnancy levels at 1 – 4 weeks postpartum

Gastroesophageal Reflux Disease (GERD)

- 30-50% incidence of GERD during pregnancy
  - 80% regurgitation with no heartburn

- Prevalence of GERD
  - First trimester: 10%
  - Second trimester: 40%
  - Third trimester: 55%

Risk Factors for GERD during Pregnancy

- Gestational age
- GERD prepregnancy
- Multiparity

Risk Factors for GERD

- Gestational age
- GERD prepregnancy
- Multiparity
  - Weight gain
Eating During Labor

THE ASPIRATION OF STOMACH CONTENTS INTO THE LUNGS DURING CONVENTIONAL ANESTHESIA

Curtis L. Mendelson, M.D., New York, N.Y.
(From the Department of Obstetrics and Gynecology, Cornell University Medical College and New York Hospital)

Summary

Experiments were performed on dogs where a 1,000 cc stomach was introduced into the lungs during conventional anesthesia with ether. Results showed no significant difference between the two methods.

Method

Aspiration was recorded in the delivery room and analyzed for pH and oxygen content.

Results

The pH of the aspirate was similar in both groups, indicating no significant difference.

Differential diagnosis between the two groups described, and practical methods for analysis were discussed.

Table 1: Comparison of Results of Aspiration
L&D Pulmonary Aspiration Rates

- OB Anesthesia Closed Claims: 4.2% (prior to 1990) to 0.46% (1990-2003)
- McDonnell 2008 Study: 0.4%
- SOAP Serious Complications Registry 2014 (>300,000 deliveries, >250,000 neuraxial anesthetics, >5,000 GAs): No aspiration events

- Decreased use of GA (increased use of neuraxial anesthesia)
- Aspiration prevention measures
- Improvements in airway management

Gastric Ultrasound

Table: Gastric Volume Distribution

<table>
<thead>
<tr>
<th>Method</th>
<th>Volume (ml)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ultrasound</td>
<td>250 ± 30</td>
</tr>
<tr>
<td>Endoscopy</td>
<td>100 ± 20</td>
</tr>
<tr>
<td>Gastric emptying</td>
<td>50 ± 10</td>
</tr>
</tbody>
</table>

Neuraxial Opioids and Gastric Emptying

- Although some controversy exists, there is evidence that gastric emptying is delayed in the presence of epidural or intrathecal opioids.

- *2426 nulliparous, non-diabetic women at term, with a singleton cephalic presenting fetus & in labor with a cervical dilation of < 6 cm*
- Consumption of a light diet or water during labor
- Primary outcome: NSVD rate

- Other outcomes:
  - Duration of labor
  - Need for augmentation of labor
  - Instrumental and cesarean delivery rates
  - Incidence of vomiting
  - Neonatal outcomes (1 and 5 minute Apgars, NICU or special care baby unit admissions)
Results: No differences in any of the outcome measures

Conclusion: Consumption of a light diet during labor did not influence obstetric or neonatal outcomes in participants
ACOG COMMITTEE OPINION

Oral Intake During Labor

Abstract: There is insufficient evidence to address the validity of any particular fluid or food intake in labor patients. Hypoglycemic responses and insulin uptake are reduced in laboring patients. Oral intake is therefore recommended in labor patients.

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PRACTICE PARAMETER

Practice Guidelines for Obstetric Anesthesia
An Updated Report by the American Society of Anesthesiologists Task Force on Obstetric Anesthesia and the Society for Obstetric Anesthesia and Perinatology

Clear Liquids.
- The oral intake of moderate amounts of clear liquids may be allowed for uncomplicated laboring patients.
- The uncomplicated patient undergoing elective surgery may have clear liquids up to 4 to 6 hours prior to induction of anesthesia.

Recommendations for Aspiration Prevention

Clear Liquids.
- Examples of clear liquids include, but are not limited to, water, fruit juices without pulp, carbonated beverages, clear teas, black coffee, and sports drinks.
- The volume of liquid ingested is less important than the presence of particulate matter in the liquid ingested.

Clear Liquids.
- Labored patients with additional risk factors for aspiration (e.g., morbid obesity, diabetes mellitus, and difficult airway) or patients at increased risk for operative delivery (e.g., cardiac or respiratory problems) may have further restrictions of oral intake, determined on a case-by-case basis.

Solid Foods.
- Solid foods should be avoided in laboring patients.
Key Points: Eating During Labor

- Divergent recommendations amongst professional organizations worldwide
- Controversy based on low incidence of aspiration + high morbidity
- Evidence shows that eating during labor does not affect obstetric and neonatal outcomes

The “Full Stomach” Pre and Post Delivery

Anesthesia and Aspiration Risk During and After Pregnancy

- No consensus
- No guidelines

“Full Stomach” Pre Delivery

**Recommendations for Aspiration Prevention**

- The patient undergoing elective surgery (e.g., scheduled cesarean delivery or bypass tubal ligation) should undergo a fasting period for solids of 6 to 8h depending on the type of food ingested (e.g., fat content).
Study | Sample Size | Mean trimester patients | Incidence of aspiration |
--- | --- | --- | --- |
Dean et al. J Clin Anesth. 2011 | 62,105 | 31,839 (51.9%) | None |
Gokhale et al. Anesth Analg. 2016 | 5,579 | 1,707 (30.6%) | None |
Mancuso et al. Contraception. 2017 | 313 | 103 (32.8%) | None |

Potential Benefits:
- Decreased aspiration risk
- Easy/quick administration
- Decreased recovery time

Potential Risks:
- Neurologic complications / TNS

However, compared with anesthesia and local anesthesia, general anesthesia involving tracheal intubation also has been associated with increased risk of complications, especially of hemorrhage, and therefore is not recommended for first-trimester uterine aspiration or second-trimester dilation and evacuation (D&E) by the World Health Organization.7-10
Summary: “Full Stomach” Pre Delivery

• Decreased LES tone as early as the first trimester
• Prevalence of GERD increases dramatically in the second trimester
• Current data shows low incidence of aspiration events in second late trimester abortions performed under deep sedation without intubation
• Major limitation: No prospective data!

“Full Stomach” Post Delivery

Risk Factors for Postpartum Aspiration

• Gastric emptying
• Gastric volume and pH
• Gastroesophageal reflux

Postpartum Gastric Emptying

Paracetamol Absorption Test
Gin et al:
• Day 1 and day 3, 6 weeks – No delay
Whitehead et al:
• 2 hours - Delay
• 18-24 hours, 24-48 hours - No delay
Nimmo et al:
• 2-5 days - No delay

Postpartum Gastric Emptying

Applied Potential Tomography
Sandhar et al:
• 37-40 weeks gestation
• 2-3 days postpartum
• 6 weeks postpartum
• No delay

Epigastric impedance
O’Sullivan et al:
• 60 minutes – No delay
Postpartum Gastric pH and Volume

- No difference in intragastric pH and volume of postpartum women compared to nonpregnant women
  - Blouw et al: Mean time to delivery 19.5 hours
  - Lam et al: 9 to 120 hours postpartum

Postpartum Gastroesophageal Reflux

- Vanner and Goodman: Significant decrease in gastroesophageal reflux by the second day after delivery

Summary: “Full Stomach” Post Delivery

- Most studies show no delay in gastric emptying starting at 24 hours
- Reflux is decreased starting at 48 hours
- LEHPZ returns to prepregnancy levels within 1-4 weeks postpartum
- No difference in gastric acid secretion (remains highly acidic)

Aspiration Prophylaxis

- Metoclopramide:
  - Increases lower esophageal sphincter tone
  - Enhances gastric emptying
- Antacids and H2-receptor antagonists
  - Increases gastric pH

Take Away Points

- Peripartum pulmonary aspiration is rare
  - ...likely too rare to be used as a primary outcome for RCTs
- Peripartum aspiration results in significant maternal morbidity
- LES tone and difficult intubation are major risk factors for aspiration during pregnancy and the immediate postpartum period (+ delayed gastric emptying during labor)

Take Away Points

- ACOG and ASA recommend avoiding solid foods during labor
- Pregnancy induced physiologic and anatomic changes can help guide the anesthetic plan
- Utilizing neuraxial anesthesia (avoiding GA) is the most effective way to reduce the risk of aspiration
- Need more reliable data informing an evidence-based approach to anesthesia care for pregnant and postpartum women!
Thank You
Postpartum Tubal Ligation

Andrea J. Traynor, M.D.
Clinical Associate Professor
Obstetric Anesthesiology Fellowship Director
Stanford University School of Medicine

Disclosures
Nothing to disclose
Except.....

I'm passionate about this topic!

Why this is important
Decision Making Process
Barriers to Care
Anesthetic Technique

Tubal Ligation
One of the most effective methods of birth control
Failure rate = 6/1000

2nd most commonly used method of birth control

Postpartum Tubal Ligation
Request Completion Rate = 31-56%

Why?
Unfulfilled Requests

709 Patients
324 (46%) did not receive procedure

121 (37%) - No consent
21 (6.5%) - OR availability

Predominantly African American, Latino, unemployed, unmarried, insured by Medicaid


What’s the issue with consent?

Why??

Consent for Tubal Ligation

Almost half of pregnancy care = Medicaid

Medicaid Title XIX Consent Form – signed, in chart

Over age 18-21, mentally competent

>30 days, not more than 180 days

No Consent = No Tubal

Complications of Tubal Ligation

Large Swiss study >5000 patients = zero deaths

Complications <0.5%
• Intraabdominal injury, fever, hemorrhage (0.27%), thromboembolic events


What about patients with co-existing disease?
Complications of Repeat Pregnancy in Sick Patients

Maternal Mortality (CDC) = 23.8 per 100,000
Severe Maternal Morbidity = 144/10,000 delivery hospitalizations (2014)

Racial and ethnic disparities – African Americans most at risk

Interpregnancy interval <18 months increases the risk of:
- Small for Gestational Age
- Preterm Birth
- Low Birth Weight

(CDC.gov, accessed 3/16/2019
Richardson MG. Anesth Analg 2018;126:1225–31

Consequences of Unintended Pregnancies

- Poor Quality Maternal Child Relationships
- Higher rates of Developmental Delay
- Adverse effects on maternal mental health

Staff and OR Availability

Hospitals Offering PPTL
- Stratum I: 85%
- Stratum II: 90%
- Stratum III: 87%


How often does inadequate staffing interfere with tubal ligation?


1460 Women Delivered
- 429 Requested PPTL
- 269 (69%) Received the Procedure
- 133 (31%) Did not

Those who did not were given similar methods of birth control

Pregnancies within a year?

(Thurman AR, Janecek T. Obstet Gynecol. 2010 Nov;116(5):1071-7)

47% pregnant within one year

(Thurman AR, Janecek T. Obstet Gynecol. 2010 Nov;116(5):1071-7)
### Complications of Repeat Pregnancy in Sick Patients

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- Small for Gestational Age
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- Low Birth Weight

(CDC.gov, accessed 3/16/2019)

Richardson MG. Anesth Analg 2018;126:1225 –31

### Consequences of Unintended Pregnancy

2010 – 138,853 Medicaid Funded Sterilizations  
53% of requests unfulfilled  
29,013 unintended pregnancies in the US  
Cost of a Medicaid Birth 2010 = $12,744

$371,000,000


---

### ACOG Committee Opinion #530: Access to Postpartum Sterilization

Committee for Healthcare for Underserved Women

“Given the consequences of a missed procedure and the limited time frame in which it may be performed, **postpartum sterilization should be considered an urgent surgical procedure.**”


---

### How Post Partum Tubal Ligation is Done

---

### Anesthetic Technique

**Should I use the epidural?**

Success rates 67-90%
**Anesthetic Technique**

- Single center, 2 years, retrospective
- 202 patients requesting PPTL
  - 131 - Labor Epidural/CSE (65%)
  - 62 - No reactivation attempted

Reactivation Attempt – 53%, n=69
Successful - 74%, n=51
Time since insertion of catheter more correlated with success

Reactivation - attempted within the 24 hours post-placement, ideally within 8 hours of placement or delivery

**Survey: 26 Fellowship Directors from SOAP**

- 44% - Immediately after delivery
- 44% - > 2h after delivery

**Epidural Anesthesia**

- 50% left epidurals in place for PPTL after delivery
- 70% dosed epidurals if <24 hours
- 23% “rarely or never used epidurals”

**Spinal Anesthesia**

- Preferred technique no epidural in situ
- Bupivacaine 10-12.5mg (48%)
- Fentanyl (88%)
- T4-T6 level

**General Anesthesia**

How long after uncomplicated delivery are you willing to provide GA for PPTL?
General Anesthesia

Respondents saying that GA was “rarely or never used” = 24%

What about aspiration risk?

• Zero Cases of Aspiration
• All Patients Satisfied with Anesthesia

Fig. 1. The relationship between gastric volume and time post-partum. P = 0.009 vs. 0-24 h; P = 0.04 vs. 24-48 h.

ProSeal LMA

• 90 Patients undergoing PPTL
• Overall success rate = 100%
• 83% on first attempt
• 3 patients required intubation

Evans NR. IJOA 2005 (14) 90-95

What I do
I love Tubal Ligations!
I will do them anytime... during the day, during the night, on the weekend...
I will do them with an epidural or a spinal, or a CSE, or even a GA if its preferred by the... 

What I do

Reactivate Epidural
- Patient worried about repeat procedure
- If interval is short and it worked well for labor

General Anesthesia
- Normal body habitus = LMA
- Obese = ETT

Spinal Anesthesia
1.5ml bupivacaine with fentanyl 15mcg
Aim for T6 level

Thank You

SOAP

Brendan Carvalho

Fellows
Sunday, March 17, 2019

Session X: Complications and Uncommon Occurrences
Moderator: Brendan Carvalho, M.B., B.Ch., FRCA

Ethical Dilemmas in Obstetric Anesthesia
Caitlin D. Sutton, B.S., M.D.

Management of Postpartum Headaches
Jessica Ansari, M.D.

The Diagnosis and Management of Peripartum Neurologic Complications
Mark D. Rollins, M.D., Ph.D.
Today we will focus on...

• Ethics fundamentals: What’s the most important principle?
• No consent: What now?
• Ethical policy-making: Who gets what?
• Standards of disclosure: What do we need to tell?

Principlism: An Ethical Framework

Principlism in Practice

Steps for Ethics Work-Up
1. Define dilemma and alternative courses of action
2. Identify relevant principles
3. Evaluate from the perspective of each principle
4. Prioritize the principles*
Dilemma 1: Lost in Translation

- Patient arrives to L&D alone
- Speaks no English
- Repeated late decels seen on monitor
- Stat CD called
- IV in place, labs and maternal VS WNL

How do you proceed?

Is Autonomy Always #1?

Prima facie principle:
- When competing principles have a stronger argument
- When infringing on the principle of autonomy is the least restrictive
- When infringing on the principle of autonomy protects the competing principles

OB Anesthesia: It’s Complicated!

1. Multiple stakeholders: mom, fetus → baby, other parent
2. Impact of pain on decision-making
3. Significant baseline misinformation
4. Strong societal & cultural influence

Dilemma 2: Wait… These new spinal kits don’t come with bupivacaine?

- Monday morning after vacation
- Email from pharmacy: bupivacaine supply running low
- Supplier reports bupivacaine is on backorder, and unclear on when more will be available

How do you implement an ethical policy?
Dilemma 3: Should I tell the patient I’m using isobaric bupivacaine?

- New policy has been implemented
- Scheduled and urgent cesareans get isobaric bupivacaine
- Hyperbaric bupivacaine reserved for stat cesarean deliveries

What do you need to tell the patient?

Ethics & Drug Shortages: Patient Care

Steps for Ethics Work-up
1. Define dilemma and alternative courses of action
2. Identify relevant principles
3. Evaluate from the perspective of each principle
4. Prioritize the principles

Autonomy, Paternalism & Shared Decision-Making

What risks do we need to tell?

Reasonable Person Standard:
What a reasonable person would want to know

Professional Practice Standard:
What a reasonable physician would say

What risks do we need to tell?

Subjective Patient Standard:
What does this patient want to know?
Dilemma 3: Should I tell the patient I’m using isobaric bupivacaine?

- New policy has been implemented
- Scheduled and urgent cesareans get isobaric bupivacaine
- Hyperbaric bupivacaine reserved for stat cesarean deliveries

What do you need to tell the patient?

Summary

- Using principlism to resolve ethical dilemmas in OB anesthesia
- Autonomy: Often (but not always) the top priority
- Shared Decision-Making: Different situations call for different models
- Standards of Disclosure: Aim for subjective patient standard
Management of Postpartum Headache

JESSICA ANSARI, MD
CLINICAL INSTRUCTOR OF ANESTHESIOLOGY, PERIOPERATIVE AND PAIN MEDICINE

Overview
- Incidence and DDx for postpartum headaches
- Discuss post dural puncture headache
- Review the evidence for epidural blood patch
- Review the evidence for other treatments for post dural puncture headache
- Review the evidence for preventive measures in case of wet tap

Disclosures
- None

Acute Postpartum headache
- Very common!
- 30-40% incidence in the first days to weeks after delivery in prospective studies

Postpartum Headache*
- 80-90% are primary, non-dangerous headaches
  - Tension type headaches
  - Migraines
- Only about 10% are secondary
  - Post dural puncture headache
  - Analgesic or caffeine rebound
  - Preeclampsia related
  - Intracranial HTN
  - Cerebral venous sinus thrombosis
  - Brain tumor
  - Other ischemic or hemorrhagic

A quick note on the previous slide
- In patients seeking care for postpartum headache, the majority (75% in a recent study) are actually secondary headaches
  - Post dural puncture headache
  - Preeclampsia spectrum headaches
  - Bad stuff (bleeds, tumors, etc)
  - Recurrence of migraines
Red flags that warrant careful evaluation

- Hypertension
- Neurological deficits (other than tinnitus and/or muffled hearing)
- Unusually severe or "thunderclap" headaches
- Headaches that worsen when lying down or awaken the patient from sleep
- Loss of previously positional nature of a post dural puncture headache

Post Dural Puncture Headache (PDPH)

- Headache that occurs within 5 days of a neuraxial procedure
- Usually orthostatic (worse upon sitting or standing)
- More than 50% will also have
  - Neck pain or stiffness
  - Photophobia
  - Tinnitus or hypoacusis
  - Nausea

Why the headache? CSF hypotension

Brain sags in the upright position and stretches the pain sensitive dura, cranial nerves, veins, and sinuses

Why the headache? Compensatory Vasodilation

- Increased cerebral blood flow shown by doppler of middle cerebral artery
- Some cerebral vasoconstrictors offer temporary symptomatic relief (Caffeine, triptans)

Post Dural Puncture Headache (PDPH)

- When do we see it?
  - Unintended puncture with large bore epidural needle


Van de Velde. Ten years of experience with accidental dural puncture and post dural puncture headache in a tertiary obstetric anaesthesia department. IJOA, 17, 4098.
Post Dural Puncture Headache (PDPH)

- When do we see it?
  - Intentional dural puncture with a 25-27g pencil point needle (spinal for Cesarean, eg)
    - = 1%

- Spinal tap (lumbar puncture) with a 20-22g cutting needle
  - = 10-30%
  - Larger bore, cutting needle

Not benign, and not necessarily self-limited

- Limits interaction between mother and infant
- May impact breastfeeding success
- Increased hospital length of stay
- Emergency department visits
- Decreased patient satisfaction
- Lawsuits
- Rare severe sequelae: subdural hematoma and venous sinus thrombosis
- Can be associated with chronic headache and back pain

Long Term Consequences of “Wet Tap”, Chronic Headache

- Treatment: Gold standard, the epidural blood patch
  - Sterile injection of 10-30mL of the patient’s blood into the epidural space
  - Mechanism:
    - Clot over defect in meninges
    - “Pressure patch” pushes CSF cephalad for immediate relief
When Should I do It?

- There is benefit to delay about 24h.
- It depends upon the degree of pain.
- Practical considerations regarding patient discharge.

Which level?

- An MRI study using 20 mL blood.
- Spreads 3.5 levels above.
- Spreads 1 level below the site of injection.
- Attempt to perform below or at level of previous dural puncture.

How Much Blood Should I Use?

- 121 patients randomized to:
  - 15 mL blood: 61% partial relief, 10% complete relief.
  - All patients got intended amount.
  - 20 mL blood: 73% partial relief, 32% complete.
  - 81% got intended amount.
  - 30 mL blood: 67% partial relief, 26% complete.
  - Only 54% got intended amount.
- Rationale for 20mL as the “sweet spot”.

Blood Patch Efficacy – it works

- Patients with PDPH after spinal with a 20g cutting needle.
- Over 80% of the “conservative treatment” group still have headache at 7 days.

Risks and Side Effects

- Pain at injection site.
- 25% experience aching in back, buttocks, or legs.
- Neck pain, vagal symptoms (transient bradycardia).
- Repeat unintentional dural puncture.
- Worsening headache if recognized.
- Arachnoiditis if blood injected intrathecally.

Treatment: “Conservative management”

- No evidence for bed rest, abdominal binders, or hydration other than symptom palliation.
- Not practical for new mothers.
**Treatment: Caffeine or theophylline**

- **Mechanism:** cerebral vasoconstriction
- **In studies, temporary but no prolonged benefit**
- **No statistically significant difference in need for blood patch**
- **Contraindicated in preeclampsia**
- **Case reports of precipitating seizures**

**Ona. Drug therapy for treating post-dural puncture headache. 2015 Cochrane review**

**Treatment: Other systemic therapies**

- **Corticosteroids**
  - No benefit to single dose cosyntropin in one small RCT
  - Possible benefit for repeated dosing of hydrocortisone
  - **Downside:** side effects
- **Gabapentin or pregabalin**
  - Small studies suggest benefit
- **Triptan medications**
  - No prolonged benefit in one small RCT
- **Neostigmine and atropine**

**Ona. Drug therapy for treating post-dural puncture headache. 2015 Cochrane review**

**Treatment: Sphenopalatine Ganglion Block**

- **Sphenopalatine Ganglion (SPG) block**
  - Retrospective study of patients who received SPG block (42) compared to epidural blood patch (39)
  - Better early relief and no difference long term with SPG block


**The Wet Tap scenario: Can I prevent the headache?**

While you may or may not develop a headache, I certainly have one!
Prevention: Not worth forcing bed rest

- No evidence to support the common practice of recommending bed rest and aggressive hydration in the prevention of PDPH.

Prevention: Low hanging fruit

- Replace some CSF volume with sterile LOR saline
  - One small study (n = 43), immediate injection of 10 mL saline through the epidural needle substantially reduced the incidence of PDPH (32%, compared with 62% in a matched control group) and decreased need for EBP (p = 0.004).
  - Consider replacing stylet prior to removing needle
  - May prevent a “wicking strand” of arachnoid from coming out

Prevention: Intrathecal catheters

- Meta analysis of 9 studies:
  - May not decrease incidence of PDPH (RR 0.82, CI 0.67-1.1)
  - Do decrease need for blood patch (RR 0.94, CI 0.49-0.84)
  - Need to be left >24 hours

Risk / benefit depends on institution and patient factors
- Difficulty of placing block
- Comfort with intrathecal dosing
- Anticipated time to delivery

Kneen. Insertion of an intrathecal catheter following accidental dural puncture: A meta-analysis. IJOA. 2013

Prevention: Prophylactic blood patch

- Mixed depending on study design
- Best study by Scavone et al (prospective, randomized, double blind)
  - 64 parturients
  - 56% of prophylactic EBP group get PDPH
  - 56% of sham EBP group get PDPH
  - Trend toward less need for blood patches in the prophylactic group (5 -> 2 days)
  - Most have moved away from prophylactic blood patch
  - Evidence isn’t great
  - Unnecessary treatment of some women who wouldn’t get a headache

Scavone. Efficacy of a prophylactic epidural blood patch in preventing post dural puncture headache in parturients after inadvertent dural puncture. Anesthesiology 2004

Prevention: Cosyntropin

- ACTH analog
- Mechanism unknown: possibly
  - Increases CSF production
  - Decreases inflammation
  - Acts on opioid receptors
- RCT data: 1mg cosyntropin compared to placebo for prophylaxis
  - 69% PDPH in control group
  - 30% needed EBP
  - 33% PDPH in cosyntropin group
  - 11% needed EBP

Hakim. Cosyntropin for prophylaxis against postdural puncture headache after accidental dural puncture. Anesthesiology. 2007

Summary

- Postpartum headaches are common and generally benign
- Women seeking help for headaches generally require treatment for:
  - Post dural puncture headache (most common)
  - Preeclampsia-related headache
  - Migraine disorder recurrence
  - Other bad stuff that requires imaging
- Watch for:
  - HTN
  - Focal neurological deficits
  - “Thunderclap” symptoms
  - Nonpostural headaches
Summary

- Postdural puncture headaches
  - Are not necessarily benign
  - Are linked to long term headache and back pain

Summary

- Treatment should be offered to women with post dural puncture headache
  - Blood patch is the gold standard
  - Sphenopalatine ganglion block promising for:
    - Milder headache / spinal associated headache
    - Helping patient wait 24h for blood patch
    - Patients who refuse blood patch
  - Bed rest, caffeine, and hydration are not evidence based or recommended substitutes

Summary

- If you have a wet tap with an epidural needle:
  - Counsel the patient and follow carefully postpartum
  - 50-80% will develop headache, usually in 24-48 hours
  - Introduce the concept of blood patch so it sounds less crazy
  - Consider flushing 10mL sterile saline intrathecally
  - Possible small benefit to intrathecal catheter
  - Use your judgement given the patient and your institution
  - No great evidence for prophylactic blood patch
  - Consider one dose of cosyntropin after delivery, especially if blood patch may prove very difficult
1.37 million women receiving labor epidurals:

- Deep epidural infections 1 in 145,000
- Epidural Hematoma 1 in 168,000
- Persistent Neurologic Injury 1 in 240,000
- Transient Neurologic Injury 1 in 6,700
Serious Complications Related to Obstetric Anesthesia
The Serious Complication Repository Project of the Society for Obstetric Anesthesia and Perinatology

Robert C'Angelo, M.D., Richard M. Smiley, M.D., Ph.D., Edward T. Riley, M.D.,
Scott Seger, M.D., M.A.C.O.M.

Anesthesiology June 2014

257,000 obstetric anesthetics:
- Epidural Abscess/Meningitis 1 in 63,000
- Epidural Hematoma 1 in 251,000
- Serious Neurologic Injury 1 in 11,000
- Anesthesia Neurologic Injury 1 in 36,000

Injuries in Obstetric Anesthesia
Closed Claims

![Graph showing injuries in obstetric anesthesia closed claims.]

Transient Neurologic Symptoms

- **Signs & Symptoms**
  - Pain of buttocks & thighs with possible radiation to the lower extremities.
  - May start a few hours after a spinal anesthetic and may last as long as 10 days.
  - Exclusively a pain syndrome: no associated weakness or loss of bowel or bladder function.
  - Typically will resolve within 10 days

Epidural Abscess

**Rate**: (0.6-2.6/100,000)^

- **Signs & Symptoms**
  - Presents 4 to 10 days postpartum
  - Backache & localized tenderness
  - Most common organism Staph aureus
  - Fever, headache, neck stiffness
- **Susicion**
  - MRI w/ gadolinium
  - Antibiotics & surgical decompression

Epidural Hematoma

**Rate**: (1.3-1.8/100,000)^

- **Signs & Symptoms**
  - Acute back and radicular pain
  - Lower limb numbness & weakness
  - Urinary and bowel dysfunction
- **Suscicion**
  - Immediate MRI & Neuro consult
  - Minimize time to decompression

![Graph showing comparison of injuries in obstetric anesthesia claims.]

Huang H et al. Journal of Clinical Anesthesia 57 (2019) 60-71

![Graph showing transient neurologic symptoms.]

Chang, J.O.B. 2006; 12:4-5

![Graph showing epidemic abscess.]

Chang, J.O.B. 2005; 13:3-4

![Graph showing epidural hematoma.]

Chang & Annap. 2003; vol A-37
MRI after Neuraxial Analgesia

Table 1.

<table>
<thead>
<tr>
<th>MRI Findings</th>
<th>% ± SE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Thecal Compression</td>
<td>6</td>
</tr>
<tr>
<td>Epidural Air</td>
<td>77 ± 7.7</td>
</tr>
<tr>
<td>Epidural Fluid</td>
<td>3.3 ± 3.3</td>
</tr>
<tr>
<td>Paravertebral Edema</td>
<td>43 ± 9.0</td>
</tr>
<tr>
<td>Needle Track</td>
<td>50 ± 9.10</td>
</tr>
</tbody>
</table>

Obstetric Anesthesia Neurologic Injuries

Direct Trauma and Injury

- Single root neuropathy (0.75-3.7 / 10,000) 1,2
- Radicular injuries often w/ pain or paresthesias 3
- Damage to conus medullaris from spinal/CSE 4
- Neurotoxicity from wrong drug or high concentration

References:
1) Scott DB, et al. BJA 1990; 64:527-41
2) Scott DB, et al. BJA 1990; 64:527-41

Obstetric Anesthesia Neurologic Injuries

Prevention
- Thorough Pre-procedure H&P
- Stop needle advancement if pain
- Inject or place catheter only if pain resolved
- If pain persists or reoccurs with injection then resite
- Use of low lumbar puncture site
- Double check drug and dosage
- Aseptic technique wash hands, wear hat & mask

Wong CA. Best Practice & Research Clinical OB & Gyn 2010; 24:367-81

Neurologic Injuries Intrinsic to Childbirth

- Reported incidence ranges between 1 to 92 in 10,000 (approaching 1%)
- Symptoms improve or resolve in vast majority
- Median duration 6 – 8 weeks

Wong CA. Best Practice & Research Clinical OB & Gyn 2010; 24:367-81
Neurologic Injuries Intrinsic to Childbirth

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Intrinsic Nerve Injury

<table>
<thead>
<tr>
<th>Nerve</th>
<th>Roots</th>
<th>Sensory Deficit</th>
<th>Motor Deficit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lateral Fem Cutaneous</td>
<td>L2,3</td>
<td>Anterolateral Thigh</td>
<td>None</td>
</tr>
<tr>
<td>Femoral</td>
<td>L2,3,4 (perineal)</td>
<td>Anteromedial Thigh / Medial Calf &amp; Medial Foot</td>
<td>Hip Flexion &amp; Knee Extension / Patellar Reflex</td>
</tr>
<tr>
<td>Obturator</td>
<td>L2,3,4 (perineal)</td>
<td>Medial Thigh / Medial Knee</td>
<td>Hip Adduction</td>
</tr>
<tr>
<td>Lumbosacral Plexus*</td>
<td>L1-5L4</td>
<td>Lateral Leg / Donum Foot</td>
<td>Foot Dorsiflexion &amp; Eversion / Hip Extension &amp; Abduction</td>
</tr>
<tr>
<td>Sciatic</td>
<td>L4-5L5</td>
<td>Medial &amp; Posterior Thigh</td>
<td>Knee Flexion</td>
</tr>
<tr>
<td>Peroneal</td>
<td>L4-5L5</td>
<td>Anterolateral Leg / Donum Foot &amp; Toes</td>
<td>Foot Dorsiflexion &amp; Eversion</td>
</tr>
<tr>
<td>Posterior Tibial</td>
<td>L4-5L5</td>
<td>Sole of Foot</td>
<td>Foot Plantar Flexion &amp; Inversion</td>
</tr>
</tbody>
</table>

Postpartum rate of 4 / 1000

Compression under the inguinal ligament
- Sensory deficit along anterolateral aspect of thigh
- Risk with prolonged hip flexion or pressure at waist
- Purely sensory nerve

Lateral Femoral Cutaneous

Compression under the inguinal ligament
- Sensory deficit along anterolateral aspect of thigh
- Risk with prolonged hip flexion or pressure at waist
- Purely sensory nerve

Femoral Nerve

Postpartum rate of 3 / 1,000

Compression under inguinal ligament
- Partial hip flexion and weakness of knee extension
- Diminished patellar reflex
- Hyperesthesia over anteromedial thigh & medial calf
- Risk with flexion, abduction, external rotation thigh
- Retractor can compress against pelvic wall (C/S)

Obturator Nerve

Postpartum rate of 3 / 1,000

- Fetal / retractor compression on pelvic wall
- Lithotomy position affects obturator canal

- Weakness of hip adduction and internal rotation
- Sensory loss at groin and medial leg
- Abnormal wide gait with leg circumduction
**Lumbosacral Plexus Injury**

Compression on pelvic wall by fetal head, forceps, or retractors during C/S
- 75% unilateral & 25% bilateral
- Can affect quadriceps, hip adduction, hip flexion
- Foot drop and inversion
- Can resemble pure root or peripheral nerve lesion
- Often multiple root levels
- Risk with large fetus, malpresentation, small pelvis

**Sciatic Nerve**
- (L4/S2) Peroneal
- (L4/S3) Tibial

Stretch injury with lithotomy and improper leg extension & external hip rotation
- Also misplaced gluteal injections
- Sensory loss lower 2/3 lateral leg
- Sensory loss dorsum of foot
- Weak knee flexion and possible foot drop

**Peroneal Nerve**

External compression at fibular head
- Weak foot dorsiflexion and eversion
- Sensory loss lower 2/3 lateral leg
- Sensory loss dorsum of foot and toes
- Stirrups, poles, side rails, hand over lateral knee

**Foot Drop Differential**

<table>
<thead>
<tr>
<th>Differential</th>
<th>L3 Root</th>
<th>Lumbar Plexus</th>
<th>Sciatic</th>
<th>Peroneal</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ankle Inversion</td>
<td>Weak</td>
<td>Weak</td>
<td>Normal/Weak</td>
<td>Normal</td>
</tr>
<tr>
<td>Ankle Jerk</td>
<td>Normal (except S1)</td>
<td>Normal (except S1)</td>
<td>Normal/Weak</td>
<td>Normal</td>
</tr>
<tr>
<td>Plantar Flexion</td>
<td>Normal</td>
<td>Normal</td>
<td>Normal/Weak</td>
<td>Normal</td>
</tr>
<tr>
<td>Toe Flexion</td>
<td>Normal</td>
<td>Weak</td>
<td>Normal/Weak</td>
<td>Normal</td>
</tr>
<tr>
<td>Sensory Loss</td>
<td>Common</td>
<td>Post Demarked</td>
<td>L5 Dermatome</td>
<td>Dorsum Foot Lateral 2/3 Leg</td>
</tr>
<tr>
<td></td>
<td>Common</td>
<td>Common</td>
<td>Can be severe</td>
<td>Can be severe</td>
</tr>
<tr>
<td>Pain</td>
<td>Radicular</td>
<td>Radicular</td>
<td>Range</td>
<td>Range</td>
</tr>
</tbody>
</table>


**Assessment following Neurologic Injury**

- H & P including details of labor & delivery
- Assessment neurologic deficits and pain / back pain
- Onset, progression and dermatomal vs. peripheral
- Sensory and motor tone of paraspinal muscles
- Deep palpation of spinous process
- Consider neurologist consultation (EMG and NCS?)
- Consider physical therapist referral

**Medicolegal Implications**

- Nerve injury was leading cause of claims
- Effective communication between providers, patients & families helps prevent lawsuits
- Most pregnant women want to know possible complications of neuraxial anesthesia (even rare)
- Consider separate consent for neuraxial labor analgesia
Summary

- Serious & permanent neurologic complications are rare
- Intrinsic childbirth injuries may be near 1%
- Prompt recognition, diagnosis & treatment are needed to prevent serious injury
- Effective communication with patients and other providers is essential