# CRASH 2015

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CRASH 2015 Program

Sunday – March 1, 2015

9:00 am – 7:00 pm Registration Open

**General Session**

4:00-5:00pm Pediatric Ambulatory Anesthesia  
Rita Agarwal, MD

5:00-6:00pm Central Neuraxis Blocks for Outpatients  
Randall Malchow, MD

6:00-6:30pm Questions & Answer  
Rita Agarwal, MD & Randall Malchow, MD

**Paid Workshop**

3D TEE Workshop ($50)

4:00-4:45pm Overview of Applications and Advances of 3D Echocardiography  
Tamas Seres, MD, PhD

4:45-5:30pm Hands on 3D Case Presentations  
Tamas Seres, MD, PhD; Bryan Ahlgren, DO

5:30 -6:30pm Hand on 3D Case Presentations  
Tamas Seres, MD, PhD; Bryan Ahlgren, DO

6:30 – 7:30pm Opening Night Reception
CRASH 2015 Program

Monday – March 2, 2015

6:30-8:00am  Continental Breakfast/View Exhibits

General Session
7:00-8:00am  Anesthesia for the Morbidly and Super Morbidly Obese Patient  
              Brenda Bucklin, MD

8:00-9:00am  Do You REALLY Know What Your Patient Is On?  
              Jeffrey Galinkin, MD

9:00-9:30am  Question & Answer  
              Brenda Bucklin, MD; Jeffrey Galinkin, MD

9:30am  View Exhibits/Recess
3:30pm  View Exhibits/Après-ski

Panel Discussions
4:00 – 7:00pm Billing/Catheters/Setting Up a Service  
             Christopher Ciarallo, MD; Matthew Fiegel, MD; Randall Malchow, MD

4:00 – 7:00pm Cardiothoracic Panel: Difficult Cases  
             Tamas Seres, MD, PhD; Ferenc Puskas, MD, PhD; Mark Twite, MD

Paid Workshop
4:00-7:00pm  Comprehensive Airway Management ($100.00)  
              Mark Chandler, MD; Daniel Janik, MD; Aaron Murray, MD; Jeffrey Galinkin, MD  
              Marina Shindell, DO
CRASH 2015 Program

Tuesday – March 3, 2015

6:30-8:00am  Continental Breakfast/View Exhibits

**General Session**

7:00-8:00am  Pediatric Anesthesia Update  
Rita Agarwal, MD

8:00-9:00am  Anesthesia for Patients with Severe Lung Disease  
Peter Slinger, MD

9:00-9:30am  Question & Answer  
Rita Agarwal, MD; Peter Slinger, MD

9:30am  View Exhibits/Recess

3:30pm  View Exhibits/Refreshments

**Panel Discussion**

4:00-7:00pm  Trauma Panel  
Mark Chandler, MD; Ami Riggert, MD; Bethany Benish, MD; Matthew Roberts, MD

4:00 – 7:00pm  Cardiothoracic Panel

4:00–4:45pm  Advances in Lung Isolation Techniques  
Peter Slinger, MD

4:45-5:30pm  Analgesia for CV Surgery  
Randall Malchow, MD

5:30-6:15pm  Lung Isolation Hands-on Workshop: Normal and Difficult Airways  
Peter Slinger, MD; Ferenc Puskas, MD, PhD

6:15-7:00pm  Questions and Answer  
Peter Slinger, MD; Ferenc Puskas, MD, PhD; Randall Malchow, MD

**Paid Workshop**

4:00-7:00pm  Ultrasound-Guided Regional Anesthesia ($150.00)  
Christopher Ciarallo, MD; Matthew Fiegel, MD; Glenn Merritt, MD; Peter Fuhr, MD; Jeffrey Shiffrin, MD; John Armstrong, MD; Alan Bielsky, MD; Adrian Hendrickse, MD; Marina Shindell, DO
CRASH 2015 Program
Wednesday, March 4, 2015

6:30-8:00am  Continental Breakfast/View Exhibits

**General Session**
7:00-8:00am  Controversies About the Pregnant Patient Having Non-Obstetric Surgery
Joy L. Hawkins, MD

8:00-9:00am  Interventional Cardiac Anesthesia
Nathaen Weitzel, MD

9:00-9:30am  Question & Answer

9:30am  View Exhibits/Recess
3:30pm  View Exhibits/Après-ski

**Panel Discussions**
4:00-7:00pm  Quality, Practice Management, Physicians and the Administration, and Governmental Update
Randall Clark, MD; Brian Davidson, MD; Debnath Chatterjee, MD; Patrick Guffey, MD

4:00-7:00pm  Perioperative Anesthetic Considerations for the High-Risk Critically Ill Patient
Jason Brainard, MD; Breandan Sullivan, MD; Scott Wolf, MD; Karsten Bartels, MD; Benjamin Scott, MD

**Paid Workshop**
4:00-7:00pm  Advanced Ultrasound-Guided Regional Anesthesia ($150.00)
Christopher Ciarallo, MD; Matthew Fiegel, MD; Glenn Merritt, MD; Peter Fuhr, MD; Jeffrey Shiffrin, MD; John Armstrong, MD; Alan Bielsky, MD; Randall Malchow, MD; Adrian Hendrickse, MD; Jeffrey Galinkin, MD
CRASH 2015 Program
Thursday – March 5, 2015

6:30-8:00am  Continental Breakfast/View Exhibits

**General Session**
7:00-8:00am  Cardiac Anesthesia 2015  
Nathaen Weitzel, MD

8:00-9:00am  Mediastinal Masses and Other Lower Airway Disease  
Peter Slinger, MD

9:00-9:30am  Question & Answer  
Nathaen Weitzel, MD; Peter Slinger, MD

9:30am  View Exhibits/Recess
3:30pm  View Exhibits/Après-ski

**Panel Discussions**
4:00-7:00pm  Neuroanesthesia Panel  
Daniel Janik, MD; Robert Breeze, MD; Benjamin Scott, MD

4:00-7:00pm  Anesthetic Management of Patients “Too Sick for the OR”  
Jason Brainard, MD; Breandan Sullivan, MD; Scott Wolf, MD; Karsten Bartels, MD
CRASH 2015 Program
Friday – March 6, 2015

6:30-8:00am  Continental Breakfast/View Exhibits

General Session
7:00-8:00am  What's New in Obstetric Anesthesia from 2014?
                Joy L. Hawkins, MD

8:00-9:00am  Optimizing Selection Criteria for Outpatient Anesthesia
                Estee Piehl, MD

9:00-9:30am  Question & Answer
                Joy Hawkins, MD; Estee Piehl, MD

9:30am  Lottery Books (must be present to win)

10:00am  Adjourn until 2016
Disclosure of Relevant Financial Relationships

CRASH

Colorado Review of Anesthesia for SurgiCenters and Hospitals

March 1-6, 2015          Vail, Colorado

As a sponsor accredited by the Accreditation Council for Continuing Medical Education, the University of Colorado School of Medicine must insure balance, independence, objectivity, and scientific rigor in all its sponsored educational activities. All speakers/contributors participating in a sponsored activity are expected to disclose to the accredited provider any relevant financial interest or other relationship(s) involving themselves or their spouse/partner within the last 12 months with any proprietary entity producing health care goods or services related to the content of the activity. The intent of this disclosure is not to prevent a speaker with a relevant financial or other relationship from making the presentation, but rather to identify and resolve any conflicts of interest that may control the content of the activity. It is also intended that any potential conflict be identified openly so that the listeners have a full disclosure of the facts and may form their own judgments about the presentation. It remains for the audience to determine whether the speaker's interests or relationships may influence the presentation with regard to exposition or conclusion.

Jeffrey Galinkin, MD is a consultant for Purdue Pharma and owns directly purchased stock in Claro Scientific, LLC

All other faculty/contributors have reported no commercial affiliation associated with this conference or intent to reference off-label/unapproved uses of products or devices in their presentations.

Dated 01/29/2015cjw
ACKNOWLEDGEMENT

We extend our appreciation to

Cook Medical
Covidien
Karl Storz
Mindray
Olympus
Sonosite
Teleflex
Verathon

for equipment provided for the workshops at

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Olympus
Pacira
Philips
Spacelabs Healthcare
Teleflex
University of Colorado Anesthesiologist Assistant Program
Verathon
Sunday, March 1
Update on Pediatric Ambulatory Anesthesia

Rita Agarwal MD, FAAP
Clinical Professor of Anesthesiology
Stanford School of Medicine

Disclosure
- I've moved

Introduction

| Table 1: Statistics on ambulatory surgery in patients younger than 15 years of age |
|-----------------------------------|---------------------------------|
| Total ambulatory procedures (all age) | 55,323,000 |
| Ambulatory procedures younger than 15 y | 3,744,000 |
| Cleft palate—patients younger than 15 y | 677,000 |
| Otoplasty with or without adenoidectomy | 130,000 |
| Endoscopic procedures | 206,000 |
| Operations on the major genital organs | 146,000 |
| Ureteroscopy | 132,000 |
| Hernia repair | 73,000 |


Common Considerations
- Patient selection:
  - ASA 3, 4
  - Ex-premature or young infant
  - Sleep ordered breathing/OSA
  - Presence of URI
  - Post-operative Pain
  - PONV

Goals of Lecture:
- Discuss:
  - Child with a runny nose
  - Ex-premature infant
  - Sleep Disordered Breathing/OSA
  - Patients undergoing T&A
  - Post-Operative Pain

Included in Handout:
- Previously undetected murmur
- Post operative Respiratory Complications
- Surgical Environment
- Codeine
- And more
Child with a Runny Nose

- 95% of RTI are viral—wide spectrum of species and respiratory tract involvement
- Hyper-reactivity of airways is common for several weeks
- Airways may be more sensitive to "irritants" (secretions, anesthetic agents etc.)

The Child With a Runny Nose

- Pulmonary function tests - ↓ FVC, FEV₁ and PEF
- ↓ Diffusion capacity and ↑ desaturation after apnea

The Child With a Runny Nose

- … “although anesthesia is not good for the common cold, might it not be a good way of passing the time till the cold is gone?”
- ↑ anesthetic risk usually minor
- Intubation ↑ risk
- Bronchodilators do not ↓ risk
- Glycopyrrolate does not ↓ risk

The Child With a Runny Nose

- Cohen and Cameron:
  - >20,000 children
  - 2-7 x increased risk of respiratory complications with URI
  - 11 x increased risk if they were intubated
  - Study criticized for incomplete documentation as to signs and symptoms of URI

The Child With a Runny Nose

- Tait et al examined >1000 children for elective surgery. Risk factors for increased complications included:
  - Use of ETT in child < 5 yrs
  - H/O prematurity or RAD
  - Paternal smoking (?)
  - Airway surgery
  - Copious secretions and/or nasal congestion
The Child With a Runny Nose

- Parnis et al examining predictors of complications in 2051 patients found that the risk increased with:
  - ETT > LMA > mask airway
  - Parent’s report that child has a “cold”
  - H/o snoring, passive smoking
  - Presence of sputum and or nasal congestion
  - Induction with STP > halo > sevo > propofol
  - Non-reversal of muscle relaxant

- The increased risk associated with RTI’s seems to be minimal
  - No closed claims cases
  - There are a few cases of increased atelectasis
  - In Tait et al’s study of >1000 pts, 3 required admission post-op, 2 for pneumonia, 1 for stridor
  - One case report of death related to laryngospasm and cardiac arrest after extubation in a 15 month old child with a URI

More Recent Studies

  - Oral ETT, inhalation agents and passive smoking ↑ risk
- Schebesta, Güeloglu et al Can J Anesth: 57; 745-50. 2010
  - Lidocaine gel on LMA ↓ airway complications

The Child With a Runny Nose

- Assessment:
  - History of “cold” by parents better predictor of laryngospasm than reliance on symptoms
  - Presence of sputum, nasal congestion and RAD ↑ incidence of adverse resp events
  - ✓ for fever, dyspnea, lethargy, wheezing, productive cough and lung field abnormalities
  - Labs, CXR, naso-pharyngeal swabs, rarely practical or helpful

Anesthetic Management

- Avoid irritants!!! (ETT, excessive secretions)
- Keep child well hydrated, consider humidification
- Consider anticholinergics
- Ensure adequate anesthetic depth before any airway manipulations
- Awake or deep extubation per practioner’s preference

### COLDS Score

<table>
<thead>
<tr>
<th>Feature</th>
<th>Score</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cough</td>
<td>1</td>
<td>Varies</td>
</tr>
<tr>
<td>Sinusitis</td>
<td>1</td>
<td>Varies</td>
</tr>
<tr>
<td>Decreased</td>
<td>1</td>
<td>Varies</td>
</tr>
<tr>
<td>Fever</td>
<td>1</td>
<td>Varies</td>
</tr>
<tr>
<td>Rash</td>
<td>1</td>
<td>Varies</td>
</tr>
<tr>
<td>Dyspnea</td>
<td>1</td>
<td>Varies</td>
</tr>
<tr>
<td>Pneumonia</td>
<td>1</td>
<td>Varies</td>
</tr>
<tr>
<td>Stridor</td>
<td>1</td>
<td>Varies</td>
</tr>
<tr>
<td>Lethargy</td>
<td>1</td>
<td>Varies</td>
</tr>
<tr>
<td>Headache</td>
<td>1</td>
<td>Varies</td>
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<tr>
<td>Nausea</td>
<td>1</td>
<td>Varies</td>
</tr>
<tr>
<td>Diarrhea</td>
<td>1</td>
<td>Varies</td>
</tr>
<tr>
<td>Fatigue</td>
<td>1</td>
<td>Varies</td>
</tr>
</tbody>
</table>

- WBC, Lymphocytes, eosinophils, neutrophils, atypical lymphocytes
- CXR, EKG, U&L, CT scan, chest X-ray
- Labs, urine analysis, electrolyte panel
- Radiology, echocardiogram, computed tomography

-中医药: Shou San, Bai Ji, Ban Xia, Si Jun Zi, Pei Xie, Ban Xie, Ci Xiang, Dang Gui, Shi Hu, Mu Li, Fu Ling, Zhi Shi, Mu Hua, Ge Gen, Zhu Xie, Ci Xiang, Zhi Shi, Mu Hua, Ge Gen, Zhu Xie, Ci Xiang, Zhi Shi, Mu Hua, Ge Gen, Zhu Xie, Ci Xiang, Zhi Shi, Mu Hua, Ge Gen, Zhu Xie, Ci Xiang, Zhi Shi, Mu Hua, Ge Gen, Zhu Xie, Ci Xiang, Zhi Shi, Mu Hua, Ge Gen, Zhu Xie

- Updated by Dr. Rita Agarwal, MD, FAAP

[References]

- Parnis et al Paed Anaesth 11:29-40, 2001
- Tait and Makhija. Anesthesia with Upper Respiratory Tract Infection, A&A 100, 2005
- Agarwal, Rita, MD, FAAP
- Update on Pediatric Ambulatory Anesthesia
Cancel When:
- Fever
- Lethargy, wheezing or other pulmonary signs

Consider Cancellation
- Unable to escalate care
- Can't admit
- "just don’t feel right"

EX-PREMATURE INFANT FOR OUT PATIENT ANESTHESIA

Ex-premature infant
- When are they candidates for outpatient anesthesia?
- Does type of anesthetic matter?
- Does procedure Matter?
- What about full term infant

Apnea and the Ex-preemie
- Risk is low
- Occurs in PACU
- Younger gestational age
- Pre-existing apnea
- Need for opioids or other sedatives
Guidelines for Ex-Premature infants (CHCO)

- **GUIDELINES**: Risk of post-operative apnea and need for post-procedure admission or observation will be determined at the discretion of the attending anesthesiologist. 
P.C.A., or post-conception age, is gestational age + post-natal age.
- Former premature infants born prior to 37 weeks gestational age who are less than 56 weeks P.C.A at the time of surgery should be admitted overnight for cardiorespiratory monitoring or may require prolonged observation in the PACU prior to discharge.
- Full term infants (gestational age greater than 37 weeks) require overnight admission or extended PACU observation if they are less than 44 weeks P.C.A at the time of surgery.
- Patient who receive local anesthesia or spinal anesthesia only without systemic sedation, may be post-operatively managed at the discretion of the attending anesthesiologist.

Full Term Infants

- Several case reports
- One with clonidine in caudal
- Some of these babies were found to have abnormal sleep studies
- < 44 weeks PMA

Ambulatory Surgicenter (CHCO)

- Term infants > 6 months of age
- Or a former premature infant older than 60 weeks post-conception and not currently on home monitors may be discharged home on the day of surgery if no other indications for admission exist.

Cote: A Practice for Infants and children

- Risk of apnea exceeds 1% in infants born at 32 weeks PCA until ~ 56 weeks
- Increased risk with:
  - Anemia
  - AGA infants
  - On-going apnea at home
- All anesthetics have been implied

Lucille Packard

It is the policy of Lucille Packard Children’s Hospital Stanford to admit infants for observation after receiving anesthesia or sedating drugs if they meet any of the following criteria:

- A. Born prior to 37 weeks gestational age (GA) and current age is less than 52 weeks post-natal age (PNA).
- B. All infants less than 44 weeks PNA irrespective of GA.
- C. Meet criteria 1 AND currently less than 60 weeks PNA AND have concurrent pertinent medical issues as defined by anesthesiologist.

These infants will be admitted to a monitored bed in a unit with the staff, equipment and experience necessary to respond immediately to an apnea episode. Observation will occur for a minimum of 12 hours post anesthetic, and will be continued for at least 12 hours following any apneic event.

Risk of apnea exceeds 1% in infants born at 32 weeks PCA until ~ 56 weeks. Increased risk with:

- Anemia
- AGA infants
- On-going apnea at home

All anesthetics have been implied.

Predicted probability of apnea for all patients, by gestational age and weeks of postconceptual age. The risk for apnea diminishes for infants born at a later gestational age. The shaded boxes represent the overall rates of apnea for infants within that gestational age range. (From Coté et al.)
Post-operative recovery after inguinal herniotomy in ex-premature infants: comparison between sevoflurane and spinal anaesthesia

<table>
<thead>
<tr>
<th></th>
<th>Sevo Pre</th>
<th>Sevo Post</th>
<th>Spinal Pre</th>
<th>Spinal Post</th>
</tr>
</thead>
<tbody>
<tr>
<td>SpO2 (%)</td>
<td>97</td>
<td>97</td>
<td>96</td>
<td>96</td>
</tr>
<tr>
<td>Heart Rate (BPM)</td>
<td>150</td>
<td>155</td>
<td>142</td>
<td>150</td>
</tr>
<tr>
<td>% time SpO2 &lt; 90%</td>
<td>6 (1-63)</td>
<td>6 (0-48)</td>
<td>6 (0-17)</td>
<td>6 (2-28)</td>
</tr>
<tr>
<td># of episodes of desat/hour</td>
<td>9 (3-20)</td>
<td>10 (4-14)</td>
<td>6 (2-11)</td>
<td>7 (3-16)</td>
</tr>
</tbody>
</table>

No difference—but small numbers

Cochrane Database Syst Rev. 2003 (3):CD003669
Regional (spinal, epidural, caudal) versus general anaesthesia in preterm infants undergoing inguinal herniotomy in early infancy.
Craven PD, Badawi N, Henderson-Smart DJ, O’Brien M.

No complications, smaller babies
Postoperative apnea after inguinal hernia repair in formerly premature infants: impacts of gestational age, postconceptional age and comorbidities.

Abstract

PURPOSE: It is a common practice for premature infants undergoing elective inguinal hernia repair to be hospitalized for postoperative apnea monitoring. This study evaluated the risk of apnea after H repair with regard to gestational age (GA) and postconceptional age (PCA) in formerly preterm infants.

METHODS: Formerly preterm infants who had undergone elective H repair between 11/2010 and 12/2012 were reviewed retrospectively in terms of GA, PCA, body weight, and comorbidities. All postoperative apneas were evaluated.

RESULTS: A total of 428 formerly preterm infants met criteria. Eleven babies had postoperative apneas. Infants younger than 45 weeks PCA were found to be prone to developing postoperative apneas after H repair. In other infants (PCA between 45 and 60 weeks), comorbidities such as preoperative apneas and higher body weight were also risk factors.

CONCLUSION: This study suggests that low GA and PCA, low body weight, and complicated postnatal history affect respiratory complication rates, particularly apneas in formerly preterm infants undergoing elective H repair. Severe apneas occurred earlier than 64 hours. Overnight monitoring is mandatory in small infants with low GA and PCA. Otherwise, infants may be operated on without1.

Current Recommendations (Côte)

- Admit all ex preemies < 60 weeks PCA until apnea free for at least 12 hours
- Consider Caffeine (10mg/kg)
- Consider regional
- Ensure adequate Hgb
- Full term infants < 44 weeks PMA may be at risk
Sleep Disorder Breathing and OSA

Anesthesia & Analgesia: June 2014 - Volume 118 - Issue 6 - p 1157–1159
doi: 10.1213/ANE.0b013e31829ec1e6
Editorials: Editorial
The Elephant in the Room: Lethal Apnea at Home after Adenotonsillectomy
Brown, Karen A. MD*; Brouillette, Robert T. MD†

Table 2.
Outcome, Venue of Event, and Attributed Cause of the Event

<table>
<thead>
<tr>
<th>Event</th>
<th>All other children (n = 43)</th>
<th>Children at risk for OSA (n = 66)</th>
<th>P</th>
</tr>
</thead>
<tbody>
<tr>
<td>Deaths</td>
<td>7 (10.5%)</td>
<td>42 (64%)</td>
<td>0.003</td>
</tr>
<tr>
<td>Deaf</td>
<td>6 (9.2%)</td>
<td>36 (55%)</td>
<td>0.15</td>
</tr>
<tr>
<td>Permanent neurologic injury</td>
<td>3 (4.6%)</td>
<td>6 (9%)</td>
<td>0.23</td>
</tr>
<tr>
<td>Peripheral neuropathy</td>
<td>13 (20%)</td>
<td>1 (2%)</td>
<td>0.01</td>
</tr>
<tr>
<td>No harm</td>
<td>3 (4.6%)</td>
<td>12 (18%)</td>
<td>0.15</td>
</tr>
<tr>
<td>Not provided or unknown</td>
<td>10 (15%)</td>
<td></td>
<td>0.25</td>
</tr>
<tr>
<td>Location of event</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>In the operating room</td>
<td>10 (15.4%)</td>
<td>8 (12%)</td>
<td>0.38</td>
</tr>
<tr>
<td>Postanesthesia care unit</td>
<td>13 (20.9%)</td>
<td>9 (14%)</td>
<td>0.38</td>
</tr>
<tr>
<td>In a tent</td>
<td>12 (19.3%)</td>
<td>13 (20%)</td>
<td>0.21</td>
</tr>
<tr>
<td>In a car</td>
<td>8 (12.5%)</td>
<td>8 (12%)</td>
<td>0.15</td>
</tr>
<tr>
<td>At home</td>
<td>2 (3.1%)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Not provided or unknown</td>
<td>12 (18.7%)</td>
<td></td>
<td>0.004</td>
</tr>
<tr>
<td>Hypertension</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>Yes</td>
<td>5 (7.7%)</td>
<td>13 (20%)</td>
<td>0.49</td>
</tr>
<tr>
<td>No</td>
<td>4 (6.2%)</td>
<td>33 (51%)</td>
<td></td>
</tr>
<tr>
<td>Not provided or unknown</td>
<td>21 (33.3%)</td>
<td>13 (20%)</td>
<td>0.21</td>
</tr>
</tbody>
</table>

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Death or Neurologic Injury after Tonsillectomy in Children with a Focus on Obstructive Sleep Apnea: Houston, We Have a Problem!
Charites J. Costi, MD, FAAP; Hoven L. Reeser, MD; and Karen B. Domine, MD, MPH

Outcome, Venue of Event, and Attributed Cause of the Event

<table>
<thead>
<tr>
<th>Event</th>
<th>All other children (n = 43)</th>
<th>Children at risk for OSA (n = 66)</th>
<th>P</th>
</tr>
</thead>
<tbody>
<tr>
<td>Deaths</td>
<td>7 (10.5%)</td>
<td>42 (64%)</td>
<td>0.003</td>
</tr>
<tr>
<td>Deaf</td>
<td>6 (9.2%)</td>
<td>36 (55%)</td>
<td>0.15</td>
</tr>
<tr>
<td>Permanent neurologic injury</td>
<td>3 (4.6%)</td>
<td>6 (9%)</td>
<td>0.23</td>
</tr>
<tr>
<td>Peripheral neuropathy</td>
<td>13 (20%)</td>
<td>1 (2%)</td>
<td>0.01</td>
</tr>
<tr>
<td>No harm</td>
<td>3 (4.6%)</td>
<td>12 (18%)</td>
<td>0.15</td>
</tr>
<tr>
<td>Not provided or unknown</td>
<td>10 (15%)</td>
<td></td>
<td>0.25</td>
</tr>
<tr>
<td>Location of event</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>In the operating room</td>
<td>10 (15.4%)</td>
<td>8 (12%)</td>
<td>0.38</td>
</tr>
<tr>
<td>Postanesthesia care unit</td>
<td>13 (20.9%)</td>
<td>9 (14%)</td>
<td>0.38</td>
</tr>
<tr>
<td>In a tent</td>
<td>12 (19.3%)</td>
<td>13 (20%)</td>
<td>0.21</td>
</tr>
<tr>
<td>In a car</td>
<td>8 (12.5%)</td>
<td>8 (12%)</td>
<td>0.15</td>
</tr>
<tr>
<td>At home</td>
<td>2 (3.1%)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Not provided or unknown</td>
<td>12 (18.7%)</td>
<td></td>
<td>0.004</td>
</tr>
<tr>
<td>Hypertension</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Yes</td>
<td>5 (7.7%)</td>
<td>13 (20%)</td>
<td>0.49</td>
</tr>
<tr>
<td>No</td>
<td>4 (6.2%)</td>
<td>33 (51%)</td>
<td></td>
</tr>
<tr>
<td>Not provided or unknown</td>
<td>21 (33.3%)</td>
<td>13 (20%)</td>
<td>0.21</td>
</tr>
</tbody>
</table>

PND = postanesthesia care unit; EMOD = extracorporeal membrane oxygenation; OSA = obstructive sleep apnea.
We get the picture, now what?

**Childhood versus Adult OSAS features**

<table>
<thead>
<tr>
<th>Childhood OSAS</th>
<th>Adult OSAS</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Presentation</strong></td>
<td></td>
</tr>
<tr>
<td>Age</td>
<td>Early peak</td>
</tr>
<tr>
<td>Gender</td>
<td>Male &gt; female</td>
</tr>
<tr>
<td>Obesity</td>
<td>Mild</td>
</tr>
<tr>
<td>Tonsils and adenoids</td>
<td>Often enlarged</td>
</tr>
<tr>
<td>Daytime sleepiness</td>
<td>Less common than in adults but can be severe</td>
</tr>
<tr>
<td><strong>Obstructive sleep apnea index</strong></td>
<td>Obstructive sleep apnea</td>
</tr>
<tr>
<td>Sleep architecture</td>
<td>Usually normal</td>
</tr>
<tr>
<td>Sleep study with obstructive sleep apnea</td>
<td>May or may not be severe</td>
</tr>
<tr>
<td>Surgical</td>
<td>Definitive therapy in most patients</td>
</tr>
<tr>
<td>Medical (positive airway pressure)</td>
<td>Selected patients</td>
</tr>
</tbody>
</table>

**Severity Ranking System Based on Polysomnography**

<table>
<thead>
<tr>
<th>Apnea-hypopnea index</th>
<th>Oxygen Saturation (Nadir)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Normal</td>
<td>0-1</td>
</tr>
<tr>
<td>Mild OSA</td>
<td>2-4</td>
</tr>
<tr>
<td>Moderate OSA</td>
<td>5-9</td>
</tr>
<tr>
<td>Severe OSA</td>
<td>&gt;10</td>
</tr>
</tbody>
</table>

**Role of Hypoxia**

- Rats -- intermittent hypoxia → develop opioid sensitivity
- Hypoxia → inflammatory response and vascular remodeling
- Wilson et al. and others have found a 2.5 X increase in the incidence of respiratory complications in children undergoing T&A who had evidence of nocturnal desaturation to 80% or less
Relationship between intermittent Hypoxia and Systemic responses


Obstructive symptoms and sleep disordered breathing are most common causes of T&A

Few polysomnography

↑ incidence of peri-op complications

↓ doses of opioids or sedatives

Tonsillectomy in 2012


Obstructive symptoms and sleep disordered breathing are most common causes of T&A

Few polysomnography

↑ incidence of peri-op complications

↓ doses of opioids or sedatives
**IV Ibuprofen vs. Placebo**

- 161 patients
- T&A
- Lower fentanyl requests
- Lower # of doses
- Lower total dose

**Pediatrics 2015**

**Morphine or Ibuprofen for Post-Tonsillectomy Analgesia: A Randomized Trial**

- Laven S. Kelli, MD, FANZCA, Vance R. Sermet, MD, Janet Ramachandran, MD, Stephanie Neffhauser, BSc, Saeed Houria, BSc, Steven H. Johnson, MD, Steven Koziel, MD, FANZCA

**Morphine vs. Ibuprofen**

<table>
<thead>
<tr>
<th>Demographic</th>
<th>Morphine (N = 60)</th>
<th>Ibuprofen (N = 60)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age (yrs)</td>
<td>3.57 (2.44)</td>
<td>3.14 (2.25)</td>
</tr>
<tr>
<td>Weight (kg)</td>
<td>17.95 (3.13)</td>
<td>20.38 (4.50)</td>
</tr>
<tr>
<td>BMI</td>
<td>17.31 (3.75)</td>
<td>20.29 (4.50)</td>
</tr>
<tr>
<td>Gender</td>
<td>Male</td>
<td>Female</td>
</tr>
<tr>
<td></td>
<td>59%</td>
<td>41%</td>
</tr>
<tr>
<td>Hypertension</td>
<td>Yes</td>
<td>No</td>
</tr>
<tr>
<td></td>
<td>50%</td>
<td>50%</td>
</tr>
<tr>
<td>Tonsil area</td>
<td>0%</td>
<td>0%</td>
</tr>
<tr>
<td>0% with recurrent infections</td>
<td>16%</td>
<td>16%</td>
</tr>
<tr>
<td>Obesity</td>
<td>17%</td>
<td>17%</td>
</tr>
<tr>
<td>African American</td>
<td>7%</td>
<td>9%</td>
</tr>
<tr>
<td>White American</td>
<td>4%</td>
<td>2%</td>
</tr>
<tr>
<td>South American</td>
<td>2%</td>
<td>1%</td>
</tr>
</tbody>
</table>

Data are presented as mean (SD) for continuous variables, and as a percentage for categorical data.
**Morphine vs. Ibuprofen**

### Demographics

- Pain scores
- O2 nadirs and mean O2 nadirs similar

<table>
<thead>
<tr>
<th></th>
<th>Ibuprofen (n = 26)</th>
<th>Morphine (n = 23)</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Least 0% saturation (%)</td>
<td>65.3 (6.82)</td>
<td>62.0 (7.86)</td>
<td>0.01</td>
</tr>
<tr>
<td>Postoperative</td>
<td>81.3 (12.1)</td>
<td>81.6 (12.74)</td>
<td>0.86</td>
</tr>
<tr>
<td>Δ Least O2 saturation</td>
<td>2.06 (12.88)</td>
<td>2.34 (12.88)</td>
<td>0.64</td>
</tr>
<tr>
<td>Mean O2 saturation (%)</td>
<td>97.4 (0.3)</td>
<td>97.2 (0.32)</td>
<td>0.8</td>
</tr>
<tr>
<td>Postoperative</td>
<td>96.0 (1.59)</td>
<td>95.0 (1.16)</td>
<td>0.49</td>
</tr>
<tr>
<td>Δ Mean O2 saturation</td>
<td>1.07 (0.95)</td>
<td>1.34 (1.43)</td>
<td>0.38</td>
</tr>
<tr>
<td>Total number of desaturation events</td>
<td>3.5 (1.87)</td>
<td>3.9 (2.3)</td>
<td>0.54</td>
</tr>
<tr>
<td>Postoperative</td>
<td>2.04 (1.31)</td>
<td>1.3 (1.36)</td>
<td>0.03</td>
</tr>
<tr>
<td>Δ Total desaturation events</td>
<td>1.04 (1.24)</td>
<td>0.34 (0.29)</td>
<td>0.04</td>
</tr>
<tr>
<td>Number of children improved</td>
<td>65% (11/26)</td>
<td>59% (14/23)</td>
<td>0.57</td>
</tr>
</tbody>
</table>

Note: Data presented as mean ± SD unless otherwise noted. The number of children improved is defined as a child having

### Race

- African Americans compared to Caucasians
  - ↑ SDB
  - ↑ OSAS
- African Americans have lower O2Sat nadir
- May need higher doses

### Gender

**Pain Medicine**

- Opioid-Related Adverse Effects in Children Undergoing Surgery: Unfair Burden on Younger Girls with Higher Doses of Opioids

**TABLE 3** Specific adverse effects and total morphine doses

<table>
<thead>
<tr>
<th></th>
<th>Total Morphine by Weight (mg/kg)</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Number of Cases (%)</td>
<td>Number of Cases (%)</td>
</tr>
<tr>
<td>Hydrocodone (IM)</td>
<td>6 (44)</td>
<td>3 (17)</td>
</tr>
<tr>
<td>Fentanyl</td>
<td>4 (33)</td>
<td>2 (12)</td>
</tr>
<tr>
<td>Meperidine</td>
<td>2 (15)</td>
<td>1 (6)</td>
</tr>
<tr>
<td>Propofol</td>
<td>2 (16)</td>
<td>1 (6)</td>
</tr>
<tr>
<td>Propofol dose (%)</td>
<td>2 (16)</td>
<td>1 (6)</td>
</tr>
<tr>
<td>Propofol due to RD</td>
<td>5 (38)</td>
<td>3 (19)</td>
</tr>
<tr>
<td>Propofol due to PONV</td>
<td>5 (38)</td>
<td>3 (19)</td>
</tr>
<tr>
<td>Propofol due to ROS</td>
<td>5 (38)</td>
<td>3 (19)</td>
</tr>
</tbody>
</table>

*p-value = 0.05 on the Bonferroni correction coefficient. If x = baseline for male, F = female, ROS = respiratory depression, PONV = postoperative nausea and vomiting.
Severely obese children have a higher incidence of unplanned admission and readmission.

Table 2. Frequency of GI events between normal-weight, overweight and obese children.

<table>
<thead>
<tr>
<th>GI Events</th>
<th>Normal weight (n = 676)</th>
<th>Overweight (n = 477)</th>
<th>Obese (n = 106, 2)</th>
<th>P-val*</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nasorespiration</td>
<td>4.5 (9.6)</td>
<td>4 (3.5)</td>
<td>0.269</td>
<td></td>
</tr>
<tr>
<td>Anosmia</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>Obstructive hypoxemia</td>
<td>0.5 (3)</td>
<td>1.5 (4)</td>
<td>0.274</td>
<td></td>
</tr>
<tr>
<td>Severe hypoxemia, SpO2 97%</td>
<td>1 (0)</td>
<td>0</td>
<td>0.896</td>
<td></td>
</tr>
<tr>
<td>Any respiratory events</td>
<td>2 (1)</td>
<td>1 (1)</td>
<td>1.098</td>
<td></td>
</tr>
<tr>
<td>Aspiration</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>Nasorespiration</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>Respiratory infection</td>
<td>1</td>
<td>0</td>
<td>0.896</td>
<td></td>
</tr>
<tr>
<td>Total postoperative stay</td>
<td>4 (0.1)</td>
<td>13 (0.6)</td>
<td>0.269</td>
<td></td>
</tr>
</tbody>
</table>

Notes: OI: Obesity index; BMI: Body mass index; GI: Gastrointestinal; *P < 0.05.

More References


Brown KA, et al: Recurrent hypoxemia in young children with obstructive sleep apnea is associated with reduced opioid requirement for analgesia. Anesthesiology. 2004 Apr;100(4):806-10;

Counsel Family
Discuss with Surgery

Other Analgesics
- Dexmedetomidine
- IV Acetaminophen
- Ibuprofen
- Short Acting Opioids
- Topical LA infiltration

Post-operative Pain

ASA 2014 Abstracts

Multimodal Versus Single Agent Analgesia for Pediatric Myringotomy and Pressure Equalization Tube Insertion
- >3000 pts undergoing ear tubes
- RCT
  - Fentanyl
  - Entanyl + ketorolac
  - Ketorolac

Figure 1. Mean Highest Pain Score

Figure 2. Percentage of Patients Requiring Oxytocin Rescue in PRAU
Post-operative Pain Management

- Combined general-regional techniques are very common
- Most blocks are placed after the child is anesthetized.
- Ultrasound has made this easier and more practical

Catheters

- With good education and follow up, easy and effective
- Minimal complications
  - Skin
  - Mechanical
  - Leaking

PRAN Data Base

- Caudals
- Transverse Abdominas plane blocks

Post-operative Pain Management

- Fentanyl can be used intra-nasally if no IV access. Blood levels appear to be equivalent to IV
  - Morphine 0.05-0.1 mg/kg
  - Hydromorphone 5-15 ug/kg
  - Ketorolac 0.5 mg/kg IV, 1mg/kg IM, intranasal max doses 30mg
Post-operative Pain Management

- Acetaminophen (A) up to 45 mg/kg p.r.
- Bolton et.al measured serum levels in 55 pts undergoing T&T, who received 40 mg/kg p.r. pre-operatively.
  - Levels did not reach toxicity in any pts
  - Efficacy, esp post discharge was deemed greater (although no control group)


Acetaminophen

- Intravenous-
  - 12.5mg/kg IV infused over 15mins q 4 hours
  - 15mg/kg over 15 minutes q 6 hours
- Very effective can be used in a wide variety of situations
- Educate health care providers regarding other meds with acetaminophen


Evaluation of the Post-PADSS

<table>
<thead>
<tr>
<th>Table 1</th>
<th>Demographic data</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total number of patients, n</td>
<td>1000</td>
</tr>
<tr>
<td>Male, n(%)</td>
<td>574(57)</td>
</tr>
<tr>
<td>Female, n(%)</td>
<td>426(43)</td>
</tr>
<tr>
<td>Age (months)</td>
<td>62(30-118)</td>
</tr>
<tr>
<td>Weight (kg)</td>
<td>19(13-31)</td>
</tr>
<tr>
<td>Type of surgery, n (%)</td>
<td></td>
</tr>
<tr>
<td>Digestive</td>
<td>81(8)</td>
</tr>
<tr>
<td>Urological</td>
<td>345(34)</td>
</tr>
<tr>
<td>Orthopaedic</td>
<td>306(30)</td>
</tr>
<tr>
<td>ENT/Otolaryngological</td>
<td>183(18)</td>
</tr>
<tr>
<td>Plastic</td>
<td>83(8)</td>
</tr>
<tr>
<td>Neurosurgery</td>
<td>8(0.8)</td>
</tr>
<tr>
<td>Long-term central venous catheter</td>
<td>24(2)</td>
</tr>
<tr>
<td>Endoscopic procedure</td>
<td>39(3)</td>
</tr>
<tr>
<td>Type of anaesthesia</td>
<td></td>
</tr>
<tr>
<td>General, n(%)</td>
<td>613(61)</td>
</tr>
<tr>
<td>General combined with loco regional, n(%)</td>
<td>374(37)</td>
</tr>
<tr>
<td>Length of surgery (hrs)</td>
<td>1.86-7.5</td>
</tr>
<tr>
<td>Length of PACU (hrs)</td>
<td>0.5(0.5-10)</td>
</tr>
</tbody>
</table>

PACU, postanesthesia care unit.
Demographics of Unplanned Admissions Following Ambulatory Surgery During 33 Months at a Children’s Hospital
Arlyne K. Thung, M.D., Vidya T. Raman, M.D., Thomas A. Taghon, D.O., Joseph Tobias, M.D.
Nationwide Childrens, Columbus, Ohio, United States

- All Ambulatory patients 2011-2013
- 1.07% unplanned admission
- Most common cause: surgery
- Most common service: ENT

Conclusion
- RTI have increased but minor risks of respiratory complications
- Ex-premature infants
- STBUR score and opioids dosing
- T&A-new concerns, new options for pain relief
- PAD-SS

I hear a “new” murmur, now what?
Murmurs

- Very common
- Highest incidence at 3 or 4 years
- "Functional" = normal heart
- Usually short, and soft
- Louder when pt supine or ↑ heart rate

Common “functional” murmurs

- Still murmur-
  - musical or vibratory, midsystolic,
  - left sternal border
- Peripheral pulmonary stenosis-
  - ejection murmur
  - LUSB, radiates-neonates
- Venous Hum-
  - continuous murmur louder in upright position
  - Upper chest

How loud?

- Grade I Heard only with intense concentration
- Grade II Faint, but heard immediately
- Grade III Easily heard, of intermediate intensity
- Grade IV Easily heard, palpable thrill/vibration on chest wall
- Grade V Very loud, thrill present, audible with only edge of stethoscope on chest wall
- Grade VI Audible with stethoscope off the chest wall

What to do?

- Controversial
- If child is growing well, acyanotic and has good exercise tolerance-anesthesia well tolerated
- Look for systemic symptoms
- If in doubt-Echo +/- Pediatric cardiologist

Symptoms of Heart Disease

- Feeding difficulties: disinterest, fatigue, diaphoresis, tachypnea, dyspnea
- Poor exercise tolerance
- Resp distress, grunting, nasal flaring, retractions
- Frequent respiratory tract infections
- Central cyanosis or poor capillary refill
- Absent or abnormal peripheral pulses

If in Doubt

- Call Cardiology
- Postpone Case
- Reschedule?
INTRODUCTION

Beyond "Marcaine Spinals" vs GA
Perioperative physicians/providers
Patient’s perceptions and preferences (Shevde, 1991, 800 pts)
- 70% General anesthesia
- 20% Local
- 10% "Spinal"/Epidural
Patient Satisfaction > 90% after CNB
Significant Benefits with Reg Anes

REGIONAL ANALGESIA-
IMPROVEMENT IN OUTCOME

- Decreased-
  - GA side effects/ complications
  - Opiate Side Effects
  - Blood Loss, DVT
  - LOS, Hosp Cost
  - Ileus, constipation, N/V
  - Stress Response
  - Chronic Pain
  - MI, ischemia
  - Pulmonary Complications
  - POCD, POD?

- Improved-
  - OR Efficiency
  - PACU Recovery and rehab
  - Post-op Analgesia
  - Patient Satisfaction
  - Surgeon Satisfaction

GOALS FOR CNB
IN AMBULATORY PATIENTS

High Efficiency
- Intraop and Postop
High Success Rates
Low Complication Rates
- Intraop and Postop
High Patient / Surgeon Satisfaction

Intraoperative Efficiency
Postoperative Recovery
- Local Anesthetic and Dose
- Spinal
- Epidural
- Anesthesia Technique
- GA vs CNB
- Spinal vs Epidural
**ACT (Anesthesia Controlled Time)**
- I: In OR – Turn Over To Surgeon (TOTS)
  - preoxygenation/ Induction/ Airway Management
- II: Dressing On – Out of OR
  - emergence/ Extubation/ LMA Removal

**Spinals**
- quick block time (ave 7min) and onset time
- can be comparable to GA (ACT I)

**Epidurals**
- placement of catheter in block room
  - (initiate low dosing in block room)
  - consider alkalization solution
  - consider fast onset agent
  - CP: sets up 8min faster than Lido
- consider CSE (if in OR and/or uncertain surgical duration)
- consider dose thru needle technique (if in OR)

Both techniques eliminate emergence/extubation time

**EFFICIENCY INTRAOP**

<table>
<thead>
<tr>
<th>Measurement:</th>
<th>Duration:</th>
</tr>
</thead>
<tbody>
<tr>
<td>Duration of Surgical Anesthesia</td>
<td></td>
</tr>
<tr>
<td>Umbilicus</td>
<td>5 min/mg</td>
</tr>
<tr>
<td>Knee</td>
<td>13 min/mg</td>
</tr>
<tr>
<td>Ankle</td>
<td>15 min/mg</td>
</tr>
<tr>
<td>Achievement of Discharge Criteria</td>
<td>21 min/mg</td>
</tr>
</tbody>
</table>

**SPINALS:**
- CP 40MG
- LIDO 40MG
- BUPIV 7.5MG

(ALL ISOBARIC)

**Duration with Hyperbaric Bupivacaine**
- LIU, 1996

<table>
<thead>
<tr>
<th>Drug Type</th>
<th>Drug</th>
<th>Dose mg</th>
<th>Baricity</th>
<th>Motor Block</th>
<th>Time to Disch</th>
<th>Author</th>
</tr>
</thead>
<tbody>
<tr>
<td>Knee Scope Bupivacaine</td>
<td>5</td>
<td>Hyper</td>
<td>181*</td>
<td>Lui</td>
<td></td>
<td></td>
</tr>
<tr>
<td>7.5</td>
<td></td>
<td></td>
<td>202</td>
<td>1996</td>
<td></td>
<td></td>
</tr>
<tr>
<td>10</td>
<td></td>
<td></td>
<td>260</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>15</td>
<td></td>
<td></td>
<td>471</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Knee Scope</td>
<td>Lido</td>
<td>40</td>
<td>Iso</td>
<td>93</td>
<td>178</td>
<td>Urmey</td>
</tr>
<tr>
<td>60</td>
<td></td>
<td></td>
<td>128</td>
<td>216</td>
<td>1995</td>
<td></td>
</tr>
<tr>
<td>80</td>
<td></td>
<td></td>
<td>142</td>
<td>214</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**History:**
- 1951: 1st SAB w/ chloroprocaine; 214 pt series in 1952
- 1980: Neurotoxicity case series (8): due to sod bisulfite/low pH
- 1987: Low back pain concerns. Due to EDTA.
- 1996: New PF/antioxidant free CP:
  - No known neurotoxicity
  - not FDA approved for SAB use; “off-label”
  - (nor is isobaric bupiv or lidocaine, fentanyl)
  - Use only preparations in “brown vials”:
    - Bedford Labs, generic CP
    - Astra Zeneca, “Nesacaine-MPF”; pH= 2.7-4.0
  - *(Avoid Abbott, clear vial, with sodium bisulfate)*

**SPINAL CHLOROPROCAINE- IDEAL AGENT?**

- 30-60mg dose range (40mg most common)
  - 40-50mg: 45-70min
  - 60mg: 60-90min
- < duration compared to lidocaine

<table>
<thead>
<tr>
<th>Casati, 2007</th>
<th>CP-50mg</th>
<th>Lido-50mg</th>
</tr>
</thead>
<tbody>
<tr>
<td>Motor (min)</td>
<td>60</td>
<td>100</td>
</tr>
<tr>
<td>Sensory (min)</td>
<td>95</td>
<td>120</td>
</tr>
<tr>
<td>Ambulation (min)</td>
<td>103</td>
<td>152</td>
</tr>
</tbody>
</table>

<< duration comp to bupivacaine

<table>
<thead>
<tr>
<th>Lacassee, 2011</th>
<th>CP-40mg</th>
<th>Bupivacaine-7.5</th>
</tr>
</thead>
<tbody>
<tr>
<td>Motor (min)</td>
<td>76</td>
<td>119</td>
</tr>
<tr>
<td>Sensory (min)</td>
<td>446</td>
<td>329</td>
</tr>
<tr>
<td>Discharge (min)</td>
<td>76</td>
<td>76 min faster for CP</td>
</tr>
</tbody>
</table>

**SPINAL CHLOROPROCAINE**

- 104 vs 134min for d/c criteria
- << duration CP vs bupiv, 193 vs 191min for d/c criteria

**Measurement:**
- Duration of Surgical Anesthesia
  - Umbilicus: 5 min/mg
  - Knee: 13 min/mg
  - Ankle: 15 min/mg

**Duration:**
- Umbilicus: 5 min/mg
- Knee: 13 min/mg
- Ankle: 15 min/mg
- Achievement of Discharge Criteria: 21 min/mg
EPINEPHRINE:
- 20-50% > in duration (esp lidocaine and tetracaine)
- Greater effect on Time to Discharge than blk duration
- Poor Recovery Profile (Urmey, 1996)
  - added 81 min to Time to Ambulation
  - added 106 min to Time to Discharge
- Recommendation: Avoid

EPINEPHRINE:
- Dose: 15-30ug
- Even 15ug > motor/sensation duration
- High Cost in U.S.
  - 10ml SD vial (1000ug)
  - Europe has low dose vials
- High dose (1-2mcg/kg): hypotension, bradycardia, sedation
- Recommendation: Avoid

CLONIDINE:
- Dose: 15-30ug
- Even 15ug > motor/sensation duration
- High Cost in U.S.
  - 10ml SD vial (1000ug)
  - Europe has low dose vials
- High dose (1-2mcg/kg): hypotension, bradycardia, sedation
- Recommendation: Avoid

ADJUNCTS (NON-OPIOID)
WITH SPINALS/EPIDURALS

2 CHLOROPROCAINE-
EPIDURAL ADVANTAGES

- Rapidly Metabolized \( t_{1/2} = 25 \text{sec} \)
  - "no significant plasma concentration"
- "More "titratable" due to short duration"
- Rapid Recovery
  - Ready for discharge one hour earlier compared to lidocaine (Neal)
  - Lidocaine may double discharge time comp to CP
  - < time to void

EFFICIENCY OF EPIDURAL VS GA

84 Knee Arthroscopy (Epidural vs GA vs SAB)
- Epidural: Propofol/N2O/Fentanyl
- GA/LMA: Propofol/N2O/Fentanyl
- Spinal: Procaine 75/ Fentanyl 20mcg
- All IA Bupivacaine
- All IV Toradol

- Upshot: CLE and GA:
  - Similar discharge times (92 vs 104min)
- Spinal
  - ? Interpret due to procaine use
  - slowest recovery, 146min
  - > nausea and pruritis

- Epidural Washout:
  - 10-20ml of N.S. in pacu
  - Recovered 48min sooner (Lido/epi)
  - Malchow, anecdotal: appears helpful

MALCHOW, RANDALL, MD

COMBINED SPINAL EPIDURAL

Capitalizes advantages from each
- Fast onset
- < hemodynamic changes
- Titratable

Minimizes disadvantages from each
- Slow onset w/ epidurals
- Avoid sacral sparing/patchy blk from epidural
- Slow recovery from lg spinal dose

Malchow, Randall, MD

Outpatient Spinals and Epidurals
63 Knee Arthroscopy
- 30 Epidural:
  - 2CP-3% x 15ml
- 33 Spinal:
  - Lido 25mg
  - Fentanyl 20 mcg
  - Dextrose

Similar failure rate (10%)  
Similar Discharge Times (152 vs 142 min)  
Similar satisfaction scores (>90%)  
Nashville Surg Ctr: Epidural-CP quicker recover than Spinal-L

**EFFICIENCY OF EPIDURAL VS SPINAL**

**Why do they Fail?**
- Spinals:
  - Dose response
  - Baricity
  - Adjuncts
- Epidurals:
  - Adjuncts

**II. SUCCESS RATES:**

<table>
<thead>
<tr>
<th>Surg Type</th>
<th>Bari-city</th>
<th>Dose</th>
<th>Adjunct</th>
<th>Failure Rate</th>
<th>Comments</th>
<th>Author</th>
</tr>
</thead>
<tbody>
<tr>
<td>Knee Scope</td>
<td>Iso</td>
<td>80</td>
<td></td>
<td>3%</td>
<td></td>
<td>Urmey 1995</td>
</tr>
<tr>
<td></td>
<td>40</td>
<td></td>
<td></td>
<td>10</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>30</td>
<td></td>
<td></td>
<td>100</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Knee Scope</td>
<td>Hyper</td>
<td>25</td>
<td>Fent 20</td>
<td>9%</td>
<td>IA Bupiv</td>
<td>Pollock 2003</td>
</tr>
<tr>
<td></td>
<td>20</td>
<td>Fent 20</td>
<td></td>
<td>0</td>
<td></td>
<td>Ben-David 2001</td>
</tr>
</tbody>
</table>

**LIODOCAINE SPINALS DOSE-SUCCESS**

LIDOCAINE SPINALS
(40MG LOWEST SUCCESSFUL DOSE W/O ADJUNCTS)

Alternative to CP or Lido spinals (knee scope, IHR)
with “low dose, low volume, low flow”
Local Anesthetic: usually hyperbaric bupivacaine (4-6mg)
Ipsilateral side down
Pencil point needle, aperture towards ipsilateral side, slow injection (1-2min)

Maintenance of posn 10-15min (block room)
Results in < motor and sensory duration on contralateral side (Fig)
Quicker Recovery
home readiness 15min < than GA
> pt sat than GA
< Urinary retention

**CONSIDER SELECTIVE SPINAL ANESTHESIA?**

**REASONS FOR CNB FAILURE**

- Poor patient selection
- Needle/orifice not in space
- Slow onset
- Inadequate / low dose
- Tourniquet pain
- Maldistribution of local anesthetics (caudal aperture of pencil-pt needles)
- Unilateral blocks
- Lengthy surgery
- Inexperienced surgeons
- Subdural injections
- Abnormal anatomy
- Cyst formation in interspinous ligaments
- Other

<table>
<thead>
<tr>
<th>Surg Type</th>
<th>Bari-city</th>
<th>Dose</th>
<th>Adjunct</th>
<th>Failure Rate</th>
<th>Comments</th>
<th>Author</th>
</tr>
</thead>
<tbody>
<tr>
<td>Knee Scope</td>
<td>Hyper</td>
<td>7.5</td>
<td>Fent 10</td>
<td>0%</td>
<td></td>
<td>Ben-David</td>
</tr>
<tr>
<td></td>
<td>5</td>
<td></td>
<td>0</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>4-5</td>
<td></td>
<td>24</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Knee</td>
<td>Hyper</td>
<td>4-6</td>
<td>Clon 15</td>
<td>2-6%</td>
<td>SSA</td>
<td>Valanne</td>
</tr>
<tr>
<td>Hernia</td>
<td>Hyper</td>
<td>6</td>
<td></td>
<td>0%</td>
<td>SSA</td>
<td>Dobrydnjon</td>
</tr>
<tr>
<td>Hernia</td>
<td>Hyper</td>
<td>6</td>
<td>Fent 25</td>
<td>5%</td>
<td></td>
<td>Gupta</td>
</tr>
</tbody>
</table>

**BUPIVACAINE SPINAL DOSE-SUCCESS**

(7.5MG DOSE LOWEST SUCCESSFUL DOSE W/O ADJUNCTS)
**BARICITY CHOICE**

Hyperbaric: sacral roots or extensive spread important
Isobaric: > duration; LE/groin/GU surgery
Hypobaric: jack-knife posn (lido 20-40)
Spread: also depend on dose and direction of orifice

**PERI-RECTAL CASES- “SADDLE” BLOCKS**

For Jack-Knife Cases:
- Use Reverse T-burg for needle placement, then use T-burg for hypobaric LA
  (Lido 20-40mg)
  (or sitting pos’n for placement with hyperbaric, then wait 10 min)
For Lithotomy-Perirectal cases:
- Consider Saddle block hyperbaric, low dose LA (Lido 20-30mg or Bupiv 3-5mg)

**MEPIVACAINE SPINAL FOR OUTPT KNEE SURGERY**

(60) ACL pts
Isobaric mepiv 1.5%
60 vs 80mg
Pros, RCT, DB
Epidural Supplementation:
- 12% in 60mg grp
- 3% in 80mg grp
L1 Regression:
- 146 min vs 159 min
Knee Scopes:
- M-30mg + F10 vs M-40mg

| Sensory (min) | 118 | 170 |
| Ambulation (min) | 176 | 206 |

Other Estimates:
- Other: 40-50ng = 90-120min surgical anasthesia
- 45mg = 220min for discharge readiness

Ropivacaine
- 50% spinal potency compared to bupiv or levobupiv
- same recovery profile as bupivacaine (> 3 hr disch times)
- (1 study of volunteers demonstrated 14min/mg for Time of Discharge)
- No advantage over bupiv

Levobupivacaine
- similar potency to bupiv
- same recovery profile as bupivacaine (> 3 hr disch times)
- (1 study w/ hypobaric LB-4 or 5mg w/ Fent 10ug = 90 and 132min Time of Discharge for knee scopes)
- No advantage over bupiv

**OTHER SPINAL AGENTS**

Procaine
- Older drug, short acting
- high failure rate (17%)
- 10% solution; 60-100mg
- prolonged discharge
- increased n/v, pruritis
- Recommendation: Avoid

Prilocaine
- avail in Europe (not U.S.)
- high failure rate w/v fentanyl
- high rate of POUR (up to 25%)
- Recommendation: Avoid

Articaine
- older drug, used in dentistry
- dosing: 60, 72, 84 mg
- similar duration of lido
- some concern with neurotoxicity
- Recommendation: Avoid

Synergistic effect with local anesthetics
Increased intensity/quality of block
Critical with low dose spinal
Pruritis: 30-100%
- Dose dependent
Recovery:
- No effect on motor block, nausea
- No effect on time to void, discharge

**OTHER SPINAL LOCAL ANESTHETICS**


**SPINAL/EPIDURAL OPIOIDS**

McDonald, 2011; Kallio, 2006; O’Dennell, 2008; DeSantiago, 2009; DeSantiago, 2011

Synergistic effect with local anesthetics
Increased intensity/quality of block
Critical with low dose spinal
Pruritis: 30-100%
- Dose dependent
Recovery:
- No effect on motor block, nausea
- No effect on time to void, discharge

Spinal Doses
- Fentanyl 10-25mcg
- Sufentanil 2.5-5.0mcg

Epidural Doses
- Fentanyl 3-5mcg/ml
- 0.5-1 mcg/kg/hr (impts)
- Sufentanil 0.5mcg/ml

NSC: we avoid opiates
SUCCESS - SPINALS

90-95% average
\( \text{NSC: 92} \% \)
Higher success than epidural s/p lumbar fusion
Ensures sacral coverage more reliably
Consider 22gu quincke for patients > 50 yo
Opioid critical at low doses

IMPROVING SUCCESS - EPIDURALS

85-90% average
\( \text{NSC: 91.5} \% \)
Block Room important
Place Epidural at Epicenter of incision
Confirmation of Epidural Space
\( \bullet \) 30% false positive rate with LOR
\( \bullet \) 10% false positive rate with ease of cath advancement p LOR
Avoid catheter advancement beyond 5cm
Consider use of CP, quicker onset (NSC CP 94%)
Consider opiate adjunct for synergy/ > quality

HYPOTENSION AND BRADYCARDIA VS AGE

Note: Hypotension < common with low dose Spinals

III. MINIMIZING CNB COMPLICATIONS (INTRAOPERATIVE)

HYPOTENSION AND BRADYCARDIA VS BLOCK HEIGHT

HYPOTENSION AND BRADYCARDIA

Hypotension
Bradycardia
Cardiac Arrest

Moore 1996
Mackey 1989
Tarkkila 1991
Geffin 1998
Auroy 1997

Rate:
1:2900
3/180
1:830
t<br>1:870
1:1500

Comments:
11,574 spinal
Virg Mason
1881 spinal
12/4000 spinal
103,730 reg anes

Overall average cardiac arrest rate = 1:1500; highest for any technique
Upshot: J udicious IVF’s, treat early w/ atropine, pressors
NSC: 1 Severe Bezold-Jarisch Reflex, 5 sec asystole 40min after lido 40mg; resolved w/ glyco; no sequela

SPINAL CARDIAC ARREST
III. MINIMIZING COMPLICATIONS (POST-OPERATIVE)

<table>
<thead>
<tr>
<th>Early</th>
<th>Late</th>
</tr>
</thead>
<tbody>
<tr>
<td>N/V</td>
<td>PDPH</td>
</tr>
<tr>
<td>Urinary Retention (POUR)</td>
<td>Backache</td>
</tr>
<tr>
<td></td>
<td>Transient Radicular Irritation</td>
</tr>
</tbody>
</table>

NAUSEA AND VOMITING

- PNB: < 5%
- Epidural: 3-9%
  - NSC: Nausea 11%, Vomiting 0%
- Spinal: 12-18%
  - NSC: Nausea 10%, Vomiting 3%
- GA: 13-32%

Mechanism: unopposed vagal activity
Epinephrine associated with incr. N/V
Lipophylic opioids do not significantly incr. N/V
Avoid opiates if possible (use of multimodal, pnb if appropriate)
Antiemetics prn

POUR: SPINALS AND EPIDURALS

<table>
<thead>
<tr>
<th>SPINALS:</th>
<th>EPIDURALS:</th>
</tr>
</thead>
<tbody>
<tr>
<td>3-35% Incidence overall</td>
<td>Low incidence 1%</td>
</tr>
<tr>
<td>Depends on dose, adjuncts</td>
<td>Similar to GA for CP, Lidocaine</td>
</tr>
<tr>
<td>3-4% for CP, Lidocaine</td>
<td>NSC: No POUR</td>
</tr>
<tr>
<td>Urge to void disappears immediately</td>
<td>Time to void (Kopacz, 1990):</td>
</tr>
<tr>
<td>Causes:</td>
<td>CP: 211 min</td>
</tr>
<tr>
<td></td>
<td>Lido: 235 min</td>
</tr>
<tr>
<td></td>
<td>Mepiv: 308 min</td>
</tr>
</tbody>
</table>

URINARY TRACT NEUROANATOMY

Spinal anes blocks both afferent and efferent innervation to bladder fn

URINARY RETENTION-SPINAL
KAMPHUIS, 1998

- Lasts until regression to S3
- Lidocaine 100mg
  - 1motor resolution
  - 2=detrusor resolution
- Bupivacaine
  - Hyperbaric 10mg
  - 1motor resolution

Consider epidural (esp CP) for higher risk pts (IHR)
Avoid excess IVFs
- < 1000 ml if possible
- Early use of ephedrine prn
Consider SSA
Local Anesthetics:
- Short acting LA-spinals
- Low dose bupiv

Adjuncts:
- Avoid epinephrine, clonidine
- Lipophylic opiates, esp w/ low dose bupiv acceptable
- Limit opiate dose
Low threshold for catheterization (see algorithm)
Encourage sitting/walking asap

URINARY RETENTION PREVENTION
POUR ALGORITHM:

<table>
<thead>
<tr>
<th>Condition</th>
<th>Action</th>
</tr>
</thead>
<tbody>
<tr>
<td>Not Voided w/ in 60 min</td>
<td>Check BUS</td>
</tr>
<tr>
<td>BUS &gt; 600ml</td>
<td>In/out cath, then discharge or further wait</td>
</tr>
<tr>
<td>BUS &lt; 600ml</td>
<td>Wait until 60 min and repeat</td>
</tr>
</tbody>
</table>

High Risk Group: 5%

- Hernia, Pelvic, Perirectal
- >70 yr
- H/o POUR, BPH

Low Risk Group:

- No epinephrine or clonidine, bupiv < 7.5 or short acting agents (CP, Lido)
- If not high risk group

ESTIMATING BLADDER VOLUME:

\[ V = \frac{1}{2} \times l \times w \times h \times 0.52 \]

\[ 11.66 \text{ cm} \times 11.6 \text{ cm} \times 15.2 \text{ cm} \times 0.52 = 895 \text{ ml} \]

LATE COMPLICATIONS: BACK PAIN

<table>
<thead>
<tr>
<th>Duration of Surgery (h)</th>
<th>Incidence of LBP (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.1</td>
<td>18</td>
</tr>
<tr>
<td>2.3</td>
<td>24</td>
</tr>
<tr>
<td>3.4</td>
<td>34</td>
</tr>
<tr>
<td>4.5</td>
<td>50</td>
</tr>
</tbody>
</table>

Technique: Incidence of LBP (\%):

- Spinal: 21
- Epidural: 20
- General Anesthesia: 19

LATE COMPLICATIONS: POST-DURAL PUNCTURE HEADACHE

Factors

- Age, needle, gauge, bevel orientation
- Pencil-point important for younger patients
- 27gu/30gu offer little advantage
- Equivalent risk: SAB vs CLE vs CSE
  - 1-2% ave incidence w/ pencil pt needles
  - NSC: SAB: 2.1%; Epid: 2.1%
  - CLE and wet-tap (4%): bevel parallel 30% incidence vs bevel perpendicular 75%

Chloroprocaine

- Still some assoc with high volume (>25ml)
- Consider Rare Complications
  - Epid hematoma in healthy 35yo knee scope w/ excruciating LBP 2hrs post-disch (Gilbert, 2001)

Transient Radicular Irritation

Description:

- Dysesthesias to buttocks, LE’s, 1-4 days, w/sml PE
- Incidence:
  - lido: 70-100mg 16-80%
  - <60mg 1-3%
  - NSC: 0.5%
  - mepiv 16-30%
  - bupiv 3-13%
  - CP rare

Flawed studies - lack of random, small studies

Phillips, 1969: 10,440 pts w/ 5% lidocaine
- 40-100mg dose, mainly obstetrics
- 0.3% “TRI” type symptoms
- Wong, 1999: 0% incidence in C/S pts

Malchow, NSC series:
- No reports of TNS

If present, “transient” w/o deficits

- neg emg, ncv, ssep studies
- >40 years before 1st case report

Back pain: common regardless of anesthesia

Position probably more imp role

If concerned, discuss w/ pt and use lido < 60mg

Reasons to consider continued lidocaine use

Malchow, Randall, MD

Outpatient Spinals and Epidurals

37
Jankowski, LPB vs spinal vs GA for knee scope. AA, 2003

- Techniques: GA - Prop/Fent/LMA
- SAB - B6, F15
- LPB - M1.5% w/ epi

GA had lowest pt satisfaction scores and higher postop pain
SAB and LPB similar

If these 3 conditions met, Goal IV will be achieved as well.

Anesthesia for Knee Scope

- Young, anxious, desires to be asleep
- Wants to watch? - Tka/PONV?
- ? > 40 yo?

GA-LMA
SAB/Epidural
Leg Block (LPB, LE, SE, CP)

Pro:
- “Asleep”
- Easier
- Able to observe Success (95%)
- PONV 10-20%

Con:
- PONV (30%)
- Delirium/ opiates
- Pain
- Aspiration risk

Min PONV (5%)

SUMMARY OF OUTPATIENT SPINALS AND EPIDURALS

High Efficiency Possible:
- Intraop and Postop
- Epi w/ use of block room (epid)
- Short-acting agents (CP, Lido)
- Consider SSA, low dose bupiv/epi

Adjuncts:
- Avoid epinephrine, clonidine
- Lipophilic opiates acceptable

High Success Rates Possible
Consider CNB/ PNB when appropriate (ACL)

Minimize Complications
- Bradycardia, Cardiac Arrest
- PONV
- Urinary Retention – algorithm
- PDPH
- Backache
- TNS

High Patient / Surgeon Satisfaction

SELECT REFERENCES:


Casati et al. Spinal Anesthesia with Lidocaine or Prop X2-Chloroprocaine for Outpatient Knee Arthroscopy. A&A. 2007; 144: 989-94.


Monday, March 2
Over the past three decades, there has been a sharp increase in rates of obesity worldwide.\textsuperscript{1} The World Health Organization defines obesity as a condition with excess body fat to the extent that health and well-being are adversely affected.\textsuperscript{2} For the first time in history, recent estimates suggest that the number of obese individuals now exceeds the number of underweight individuals. Prevalence of obesity in the United States is unevenly distributed geographically, by race and ethnicity and by socioeconomic status. The overall trend is, however, to keep increasing and the prevalence of obesity is expected to reach about 50\% by 2030 if trends continue.\textsuperscript{3} The BMI is used in clinical practice to estimate the degree of obesity: Obesity is defined as having a BMI $\geq 30$ kg/m\(^2\). Morbid obesity, defined as a BMI $\geq 40$ kg/m\(^2\), can also be further classified into super obesity (BMI $\geq 50$ kg/m\(^2\)) and super-super obesity (BMI $\geq 60$ kg/m\(^2\)).\textsuperscript{4} Surgery in this patient population is considered high-risk but careful planning, preoperative risk assessment, adequate anesthetic management, strict venous event prevention, and effective postoperative pain control will all help to reduce the risk.

**Preoperative focused evaluation.** A preoperative evaluation should be performed with enough time to allow for a thorough assessment and discussion of the risks with the patient and surgical team. The evaluation should include a thorough medical history, physical exam, and testing as clinically indicated.\textsuperscript{5}

**Airway.** Although a recent multicenter analysis of nearly 700 patients with BMI $\geq 30$ kg/m\(^2\) determined that increased BMI was an independent risk factor for difficult mask ventilation and difficult laryngoscopy,\textsuperscript{6} it remains unclear whether BMI alone is a predictor of difficult laryngoscopy.\textsuperscript{7,9} In addition, obesity played a significant role in the US closed claims related to airway management at induction in a recent analysis.\textsuperscript{10} Preoperative airway assessment in obese patients is necessary. In addition, airway difficulty in most studies correlates with increased age, male sex, temporomandibular joint pathology, Mallampati classes 3 and 4, OSA, and abnormal upper teeth.\textsuperscript{11-13} Anatomic changes associated with obesity that contribute to a potentially difficult airway include limitation of movement of the atlantoaxial joint and cervical spine by upper thoracic and low cervical fat pads; excessive tissue folds in the mouth and pharynx; short, thick neck; thick submental fat pad; suprasternal, presternal, and posterior cervical fat; and large breasts in females. Excess pharyngeal tissue deposited in the lateral pharyngeal walls may not be noticed during routine airway examination. The patient’s neck circumference has been identified as the single biggest predictor of problematic intubation in morbidly obese patients.\textsuperscript{12} The probability of a problematic intubation is approximately 5\% with a 40-cm neck circumference compared with a 35\% probability at 60-cm neck circumference. In this study by Brodsky et al,\textsuperscript{12} a larger neck circumference was associated with male gender, a higher Mallampati score, laryngoscopy grade 3 views, and OSA. Multivariate analyses showed that age, BMI, and a recorded Mallampati score were significant independent predictors of failed tracheal intubation.\textsuperscript{14} The history obtained from the patient and examination of previous records may help predict airway difficulties.

**Cardiovascular evaluation.** The morbidly obese patient suffers from increased body mass which increases metabolic demand. Besides increases in preload (blood volume) and afterload, cardiac output increases with increasing weight by as much as 20 to 30 mL/kg of excess body fat because of ventricular dilation and increases in stroke volume. The resulting increased left ventricular wall stress leads to hypertrophy, reduced compliance, and impairment of left ventricular filling (diastolic dysfunction) with elevated left ventricular, diastolic pressure, and pulmonary edema.\textsuperscript{15} When left ventricular wall thickening fails to keep pace with dilation, systolic dysfunction (“obesity cardiomyopathy”) and eventual biventricular failure results. Obesity also accelerates atherosclerosis.

The history may be indeterminate because symptoms such as angina or exertional dyspnea occur only occasionally. Morbidly obese patients often have very limited mobility and may appear asymptomatic even
when they have significant cardiovascular disease. The physical exam may also be difficult because soft tissue may mask jugular venous distention and heart sounds are often distant. Lower extremity edema is also common but in some cases may indicate elevated right ventricular filling pressures. In the obese, a left-bundle branch block on the EKG is unusual in uncomplicated patients and may be an indicator of coronary artery disease.\(^5\) Although patients with cardiomyopathy (i.e., diabetic or obesity) or chronic myocardial ischemia should be identified and optimized prior to surgery because of the risk of heart failure, \textit{most patients will not require exercise or pharmacological stress testing unless symptoms, functional capacity, or risk factor analysis indicates testing beyond the EKG.}

**Respiratory system evaluation.** Respiratory disease is increased in the obese. Pulmonary mechanics, lung volumes, functional residual capacity (FRC), oxygenation, and ventilation are altered in these individuals. Chest wall compliance decreases because of increased weight of excess adipose tissue. Respiratory work and oxygen consumption are increased. The increased work of breathing in combination with reduced functional residual capacity, expiratory reserve volume, as well as increased closing capacity increases the overall risk of atelectasis, especially in the supine position.

Obstructive sleep apnea (OSA) and Obstructive Hypoventilation Syndrome are important concerns in this patient population. Because the rate of OSA is increased in this population, individuals with OSA should be identified preoperatively because OSA is frequently associated with difficult airway management and increased perioperative pulmonary complications. The STOP-bang questionnaire can be used as a screening tool.\(^{16}\) ([http://www.sleepapnea.org/assets/files/pdf/STOP-BANG%20Questionnaire.pdf](http://www.sleepapnea.org/assets/files/pdf/STOP-BANG%20Questionnaire.pdf)) It is validated in the obese population: 1) score of 0 – 3 indicates a low risk of OSA; 2) 4 – 5 indicates an intermediate risk of OSA; and 3) 6–8 indicates a high risk of OSA. Recently the American Society of Anesthesiologists updated the Practice Guidelines for the Peri & Operative Management of Patients with Obstructive Sleep Apnea to include new evidence from the most recent literature.\(^{17}\) Arterial blood gas measurements help evaluate ventilation if obesity hypoventilation syndrome is suspected, as well as the need for perioperative oxygen administration and postoperative ventilation. Routine pulmonary function tests are not cost-effective in asymptomatic obese patients.

**Endocrine Disease.** Patients scheduled for repeat bariatric surgery should be screened preoperatively for long-term metabolic and nutritional abnormalities. The high prevalence of insulin resistance and diabetes in obese patients justifies the need of considering glycemia checks preoperatively, and correcting abnormalities if present. Preoperative evaluation should include assessment of therapies for glycemia control, last time and dose of preoperative administration, and usual glucose values for a specific patient. Electrolytes should be checked before surgery, particularly in patients with poor compliance to medications or acutely ill patients. Vitamin and nutritional deficiencies can lead to a collective form of postoperative polyneuropathy, known as acute postgastric reduction surgery (APGARS) neuropathy, a polynutritional multisystem disorder characterized by protracted postoperative vomiting, hyporeflexia, and muscular weakness.\(^{18}\) Close attention to dosing and monitoring of neuromuscular blocking agents is recommended in cases of suspected or diagnosed APGARS neuropathy. Chronic vitamin K deficiency may lead to coagulation abnormalities, requiring administration of vitamin K analog or fresh-frozen plasma.

**Gastrointestinal** Frequency of gastroesophageal reflux is strongly correlated with increasing BMI.\(^{19}\) Although hiatal hernia is more common in obese individuals compared to the non-obese, it is unknown whether the effects of obesity are additive in reducing lower esophageal sphincter tone. Obesity is also associated with increased abdominal pressure, gastric volumes, incidence of gastroesophageal reflux and hiatal hernias, as well as lower pH and fatty infiltration of the liver.
General considerations

Preparation should include placement of adequate intravenous access. Central venous access may be necessary if peripheral access is unobtainable or inadequate. Blood pressure (BP) monitoring may be particularly problematic in these patients. If the BP cuff is too small, the BP reading will be overestimated. The forearm can be used if the upper arm is too large or cylindrical in shape. In some cases, an arterial line will be necessary to accurately determine the BP as well as obtain arterial blood gases in patients with respiratory compromise.

Operating room considerations. Weight limits of standard OR tables range from 130 to 160 kg. Although some newer tables will support up to 454 kg, recent concerns were raised when an operating room table’s floor locks were released and the fulcrum of the table shifted ~3 inches to the patient’s feet. This changed the OR table’s weight capacity and made the table prone to tipping. The authors recommend that it is necessary to comply with manufacturer (Amsco 3085 SP surgical table) recommendations and “DO NOT RELASE FLOOR LOCKS WHILE PATIENT IS ON TABLE.” It may also be necessary to extend the width of the table with side extensions. If extensions are unavailable, it may be possible to improvise with arm boards placed along the sides of the OR table. Adequate padding should be used to prevent pressure-related injuries. Transport gurneys should be of similar size limits. Patients must be properly secured on the operating room table. Furthermore, if patient-moving assistance devices are unavailable, additional personnel are required to prevent lifting injuries.

Positioning for airway management. Careful positioning is imperative in the care of these patients regardless of the primary anesthetic technique. A study investigating the effects of position on laryngoscopic view in 60 morbidly obese patients determined that the ‘ramped’ position or head elevated laryngoscopy position (HELP) clearly improved the laryngeal view when compared with the standard ‘sniff’ position. The ‘ramped’ position can be achieved by arranging blankets, or one of the commercially available pillow devices, underneath the patient’s upper body and head until horizontal alignment is achieved between the external auditory meatus and the sternal notch. This positioning allows easy access to the airway and facilitates placement of a laryngoscope (short-handled). However, some operating room tables are equipped with a head section capable of angulation. By tilting this section downwards and then flexing the table forwards, the ramped position can be created with the use of only one pillow to produce the exact degree of angulation desired. If a patient receives neuraxial anesthesia, it has been associated with a significant decrease in spirometric parameters and a 30-degree head-up position may improve respiratory mechanics and oxygenation.

General anesthesia. Preparations should include availability of experienced personnel and difficult airway equipment. In all cases, proper positioning of the neck, shoulders, and chest the keys to successful intubation. In some cases, an awake fiberoptic intubation may be the safest option but it can be difficult and time-consuming. A recent study of patients with anticipated difficult randomized to either awake fiberoptic (BMI 31 [14-57]) vs. awake video laryngoscopic (BMI 29 [18-47]) tracheal intubation determined that there was no difference of performance between the two techniques, suggesting that videolaryngoscopy may be useful as the primary device or first alternative for securing the trachea, even when awake intubation is being considered. If the patient’s airway appears normal, a rapid sequence intubation in a ramped position can be performed.

Lean body weight is optimal for dosing most drugs used in anesthesia including opioids and induction agents. Lean body weight is defined as 20-30% more than ideal body weight. Succinylcholine is often used to secure the airway. The dose of succinylcholine (1.0-1.5 mg/kg up to a maximum of 200 mg) is based on total body weight.
Verification of proper endotracheal intubation can only be accomplished by capnography. If intubation is unsuccessful, a failed intubation drill should be instituted immediately. The goal of failed intubation management is to ensure oxygenation despite the potential risk of aspiration. Mask ventilation may require several people, one to continue cricoid pressure, a second to institute jaw-thrust, and the third to squeeze the bag and monitor the patient. *Repeated attempts and additional succinylcholine are detrimental but a laryngeal mask airway can be lifesaving.*

In the morbidly obese, there are further reductions in FRC due to supine positioning, use of volatile anesthetics, muscle relaxants, and in some cases, retraction of the panniculus. This leads to early closure of small airways and hypoxemia. Increased tidal volumes, high-inspired oxygen concentrations, reverse Trendelenburg positioning, and positive end-expiratory pressure have been used to maintain oxygenation and ventilation. However, use of positive end-expiratory pressure can worsen cardiac output and barotrauma. Although isoflurane, sevoflurane, and desflurane can be used in standard concentrations, desflurane provides a faster recovery. Titration of nondepolarizing muscle relaxants with the help of a twitch monitor is a reasonable approach.

**Monitored Anesthesia Care.** Monitoring of the adequacy of ventilation and oxygenation is extremely important in obese patients. Obese patients present a higher risk of sedation-induced respiratory depression, so careful titration of benzodiazepines, opioids and propofol is mandatory to avoid hypercapnia and/or hypoxemia. Hypoxemia may require unplanned intubation, so a thorough airway exam and preparation for unintended airway management is critical even in MAC/sedation cases. The prevalence of closed claims related to adverse respiratory events during monitored anesthesia cases is increasing, compared to respiratory complications or airway management complications encountered during general anesthesia. In a closed claim analysis by Bhananker et al, obesity and suboptimum monitoring of pulse oximetry, end-tidal capnography or both, were significant key factors in these adverse events during MAC.

**Special Clinical Situations**

**Management of Obesity.** Indications for drug treatment include a BMI ≥30 kg/m² or a BMI between 27 and 29.9 kg/m² in conjunction with an obesity-related medical complication. Lifestyle counseling is still the most effective long-term weight loss tool that can be combined with the use of medications. Medications used to treat obesity are formulated to reduce energy intake, increase energy utilization, or decrease absorption of nutrients. Orlistat (OTC Alli®, prescribed Xenical®) or tetrahydrodipstatin, blocks the absorption of dietary fat by inhibiting lipases in the gastrointestinal tract. It leads to weight loss and to improvement of blood pressure, fasting blood glucose levels, and lipid profile. Fat malabsorption causes digestive symptoms but chronic use of orlistat may result in fat-soluble vitamin deficiency. A prolonged prothrombin time with a normal partial thromboplastin time during orlistat treatment may reflect vitamin K deficiency and this coagulopathy should be corrected 6 to 24 hours before elective surgery.

Over the counter preparations, plants extracts or herbs that are often used to combat obesity include substances with alleged properties as, among others: pancreatic lipase inhibitors (caffeine, green or black tea), appetite suppressants (hoodia, Korean ginseng, ephedra, sunflower oil), stimulants of energy expenditure (acai berry, caffeine), regulators of lipid metabolism (soybean, fish oil, oolong tea, caffeine). The American Society of Anesthesiologists warns patients to tell their anesthesiologists about medications they are taking, including vitamins, herbs and other supplements. Since these products can interfere with anesthesia, they can cause complications during surgery.
Bariatric surgery is currently the most effective treatment for morbid (class III) obesity.41 Several guidelines for bariatric surgery eligibility exist, most of them agreeing on eligibility with BMI≥40kg/m² or BMI≥35kg/m² with obesity-related comorbidities not controlled with medical therapy.42 Procedures are classified into malabsorptive (jejunileal bypass and biliopancreatic diversion, rarely used nowadays), restrictive (vertical-banded gastroplasty and adjustable gastric banding), or combined (Roux-en-Y gastric bypass (RYGB), combines gastric restriction with a minimal degree of malabsorption). Roux-en-Y gastric bypass, adjustable gastric banding and vertical-banded gastroplasty can all be performed laparoscopically. Laparoscopic bariatric surgery is associated with less postoperative pain, lower morbidity, faster recovery, and less “third-spacing”.43 Roux-en-Y Gastric Bypass is the most effective bariatric procedure to produce safe short- and long-term weight loss in severely obese patients. Vertical-banded or sleeve gastroplasty also restricts food intake.

Less invasive bariatric techniques are being developed. An implantable gastric stimulator (IGS) is placed laparoscopically and emits electrical impulses to stimulate the gastric smooth muscle to stop peristalsis so that the patient feels full. Intragastric balloons and prostheses can be placed endoscopically as a temporary measure to increase satiety.44 Adequate control of postoperative nausea and vomiting is critical to avoid possible lead and balloon dislodgement. More recently, the FDA has approved an implantable device that produces intermittent, reversible vagal nerve blockade.45 In the yearlong trial, obese adults with the device lost more than 8% of their excess weight compared to controls. Collectively, data suggests that bariatric surgery lowers all-cause mortality at 5y and up to 10y following the procedure.46,47

**Ambulatory Surgery in the Obese.**48,49 Outpatient surgery can be considered under certain circumstances. Identifying obese patients who are suitable candidates for ambulatory surgery depends upon patient comorbidities, invasiveness of the procedure, anesthetic technique, post-operative pain management as well as skill of the surgeon and anesthesiologist. Although a number of studies have identified obesity as a risk factor for perioperative complications, a recent systematic review determined that BMI alone did not increase the risk for perioperative complications or unexpected admission after ambulatory surgery. However, the authors caution that most super-obese (i.e., BMI ≥ 50kg/m²) are not candidates for ambulatory surgery.

Because many morbidly obese patients are diagnosed with sleep-disordered breathing, these patients may be considered for ambulatory procedures if their co-morbid conditions are optimized and postoperative pain control is easily achieved with non-opioid techniques. The morbidly obese and those with OSA present unique and increasingly frequent challenges to ambulatory practices. Estimates suggest that 60% to 90% of all OSA patients are obese (body mass index greater than or equal to 30 kg/m²).50 However, the problem is further confounded in that many of the patients with OSA do not carry a formal diagnosis. These patients are likely to cause major anesthetic problems throughout the perioperative period. A recent prospective cohort study of ambulatory surgical patients with propensity to OSA, revealed an increase in numbers of laryngoscopy attempts, difficult laryngoscopic grade view and the use of fiber-optic intubation.51 These patients may also have respiratory insufficiency soon after extubation. Recent examination of large databases has also demonstrated increased risk for emergency intubation, respiratory failure, mechanical ventilation, aspiration pneumonia, atrial fibrillation, and ARDS.52-54 They are also more likely to suffer from respiratory arrest with preoperative sedation or postoperative analgesia because they are particularly sensitive to the respiratory depressant effects of even small dosages of sedation or analgesics. However, recent data suggests that patients who have a pre or postoperative diagnosis of sleep apnea are twice as likely to have respiratory complications compared to controls.55 However, patients with a preoperative diagnosis of OSA and utilized CPAP were less likely to experience cardiovascular complications compared with patients who are diagnosed postoperatively.
Some recommend that a postoperative observational unit with close monitoring of oxygen saturation or an intensive care unit setting be used for monitoring the OSA patients postoperatively. Use of local or regional anesthesia with minimal sedation, availability of a 23-hour observation post-anesthesia care unit, and when patients can resume oral medication at the time of discharge are useful to facilitate cases in the ambulatory setting. OSA patients on a continuous positive airway pressure (CPAP) device at home should be instructed to bring it with them to the hospital as it may be needed postoperatively. The possibility of invasive monitoring, prolonged intubation, and postoperative mechanical ventilation should be discussed with obese patients.

Recently, the American College of Surgeons National Surgical Quality Improvement Program (NSQIP) database identified risk factors for morbidity and mortality with 72 hours after ambulatory surgery. Although the incidence of morbidity and mortality was only 0.1% in nearly 250,000 cases, independent risk factors for perioperative morbidity included: high BMI, chronic obstructive pulmonary disease, hypertension, history of TIA/stroke, previous cardiac surgery, and longer surgical times. In the cohort, unplanned postoperative intubation, pneumonia, and wound disruption were the most commonly identified comorbidities. Others have determined that increased BMI, ASA ≥ 3, age > 80 years, and length of surgery >1 hour all increased the risk for unplanned hospital admission. Because increased BMI is a contributor for increased perioperative risk, exclusion criteria should be developed for patients undergoing ambulatory surgery.

Regional Anesthesia. Neuraxial anesthetic techniques (spinal, epidural, combined spinal epidural) and peripheral nerve blocks are used alone or in combination with general anesthesia in increasing frequency as more obese patients are coming to the operating room. Several studies have demonstrated the efficacy of regional techniques in reducing opioid-related complications, but there are other distinct advantages: 1) minimal or reduced manipulation of the airway; 2) administration of fewer medications with cardiopulmonary depression; 3) reduced risk of post-operative nausea and vomiting; 4) better postoperative pain control; and 5) improved postoperative outcomes. When epidural anesthesia is combined with general anesthesia, time to tracheal extubation may be reduced in patients receiving a combined technique compared to general anesthesia alone. However, studies demonstrate that there is an increased risk of block failure in obese patients compared to those of normal weight. Failure is often due to technical difficulties and limitations of regional anesthesia. In addition, these patients also experience an increased risk of complications. With proper planning, these techniques may be used successfully and should be considered in the anesthetic plan for obese patients who are candidates for regional anesthesia. However, well-functioning intravenous access should be secured prior to block placement in case of high-spinal or local anesthetic systemic toxicity occurs following regional anesthesia.

Neuraxial anesthesia can produce serious cardiopulmonary alterations in obese patients undergoing surgery. Because pulmonary mechanics, lung volumes, functional residual capacity (FRC), oxygenation, and ventilation are altered in these individuals, supine and Trendelenburg positioning during neuraxial anesthesia can lead to deterioration of lung volumes and further reductions in FRC. Functional residual capacity may fall below closing capacity promoting small airway collapse, atelectasis, ventilation perfusion mismatch, and hypoxia, especially during supine and Trendelenburg positioning. It is often helpful to measure the oxygen saturation in the sitting and supine positions to indicate the degree of pulmonary reserve prior to initiating neuraxial anesthesia. In addition to these pulmonary concerns, there are cardiovascular changes that warrant careful monitoring. The excess weight of the abdominal wall can compress the vena cava, causing decreased cardiac preload, reflex tachycardia, and decreased cardiac output. In a large series of obese patients undergoing non-obstetric surgery who had received spinal anesthesia, more than one-third developed hypotension. Three of the patients in this series also experienced cardiac arrest. There are other reports of cardiac arrest after supine positioning in morbidly
obese patients. Changes to the supine position likely contributed to the circulatory changes resulting in these arrests.

Despite these important considerations, use of neuraxial techniques can offer important advantages when compared to general anesthesia alone. Parenteral opioid administration can be hazardous in these patients because of increased sensitivity to opioids, risk of hypoxemia, a high incidence of sleep apnea, and increased incidence of adverse respiratory events following surgery. Administration of patient-controlled opioid analgesia has even resulted in respiratory depression in some obese patients. The American Society of Anesthesiologists has published guidelines for the care of patients with obstructive sleep apnea (OSA) and recommends that regional anesthetic techniques should be considered to reduce or eliminate the requirements for systemic opioids in patients with sleep apnea.

Positioning is an important step in placement of a successful neuraxial anesthetic. Spinal or epidural placement in the sitting position will assist with identification of the midline. The patient’s back should be parallel to the edge of the bed to prevent lateral needle deviation away from the midline. Lateral deviation of the midline will increase the depth to the epidural or spinal spaces and can result in block failure and an increased risk for intraoperative conversion to general anesthesia in less-than-ideal circumstances. Anatomic landmarks are often obscured in these patients. If spinal processes cannot be appreciated with deep palpation, a line can be drawn from the cervical vertebral spinal process to the uppermost portion of the gluteal cleft. This line approximates the midline of the patient over the vertebral column. Ultrasound imaging can also be helpful to identify spinal processes and has been shown to significantly reduce the number of needle passes and decrease the time for spinal block placement in morbidly obese patients undergoing orthopedic surgery. Since the iliac crests may also be difficult to appreciate, the patient’s skin folds can be used to aid in drawing a line perpendicular to the vertical line so that the intersection point can serve as a reasonable spinal or epidural needle insertion guide.

Neuraxial anesthetic placement can be particularly difficult, especially when bony landmarks are nonpalpable, there is limited back flexion, and there are false losses of resistance due to fat deposition. It is often difficult to predict the depth to the epidural space but the depth to the epidural space generally correlates with BMI. A recent study suggests that pre puncture ultrasonography may be useful to facilitate epidural placement in obese parturients to assist in predicting the depth to the epidural space. However, ultrasound has limitations in this patient population because the image quality can be compromised due to fat overlying the epidural space and the distance to the epidural space may be inaccurate if the subcutaneous tissue is compressed. Future development of ultrasound technologies may incorporate the use of ultrasound-guided needle techniques to aid epidural placement in challenging patients. In some cases, a long 25-gauge needle can be used for infiltration of local anesthetic as well as to identify spinous processes. To determine whether needle placement is midline or lateral, the patient is often helpful in directing the needle to the midline (e.g., Does it feel like I’m in the middle of your back?). A recent study demonstrated that morbidly obese parturients were significantly more helpful in identifying the midline compared to non-obese. Helpfulness also varied by the BMI. In most cases, standard neuraxial needles (9-10 cm) are usually of sufficient length if placement is midline. However, longer needles (16 cm) are sometimes needed in extremely obese parturients. These needles can cause serious injury so they should only be used after careful assessment of the midline when standard needles are inadequate.

Single injection spinal anesthesia is a popular neuraxial anesthetic technique but there are concerns about technical difficulties, exaggerated spread of local anesthetic, hypotension, and an inability to prolong the block, especially in the obese patient. Spinal anesthesia is reasonable if the airway exam is normal, there is no cardiopulmonary disease, and the surgery is expected to be less than 90 minutes. It is often easier to
insert the spinal needle when a large gauge stiff epidural needle is used as a guide for the smaller flexible spinal needle.

Epidural anesthesia offers several advantages over single-injection spinal anesthesia including titratable dosing of local anesthetics, ability to prolong the block, decreased risk of excessive motor block, more controllable hemodynamic changes, and utilization for postoperative analgesia. However, in laboring patients, a multicenter prospective observational study found that epidural anesthesia failed more often than spinal or CSE techniques. Increased maternal BMI was significantly related to failure of neuraxial techniques. Incremental dosing of epidural-administered local anesthetics will reduce the risk of hypotension and high block.

Catheter dislodgment is another potential problem in obese patients. Before securing the epidural catheter, a patient should move from an upright sitting position to a lateral position. In this study by Hamilton et al, the changes in epidural catheter distance to skin with patient position modifications (sitting flexed to up, up to lateral, flexed to lateral) averaged a maximum of 0.67cm to 1.04cm (parturients with BMI<25 and >30 respectively). The changes in epidural catheter depth in this study were significantly increased with the BMI of patients, and the maximum observed changes in distance to skin were also significantly increased with the BMI (with >4cm change in one obese patient). Because the ligamentum flavum has a mild grip on the epidural catheter, repositioning allows the epidural catheter to be pulled into the subcutaneous fat, sometimes by several centimeters. After repositioning, the catheter is subsequently taped in place without adjusting the catheter. This maneuver is helpful in reducing the incidence of catheter dislodgement and block failure.

Combined spinal-epidural anesthesia is an alternative to conventional spinal or epidural anesthesia, however there is concern that the technique is more complicated than either spinal or epidural alone and the epidural catheter is “unproven” during the duration of spinal analgesia. Although CSE catheters fail at similar rates compared with conventional epidural catheters, delayed recognition of a non-functional epidural catheter is a disadvantage of this technique and is particularly problematic for prolonged surgical cases. This can increase the risk of intraoperative conversion to general anesthesia. However, even if the patient does not receive a “spinal dose” during CSE placement, the return of CSF in the spinal needle is confirmation of midline needle placement.

Peripheral nerve block. The use of peripheral nerve blocks with and without general anesthesia has been increasing for surgical procedures. In obese patients, these blocks can be technically challenging and have an increased failure rate compared to techniques performed in patients of normal weight. Although experience of the anesthesiologist with these blocks may influence their success, a large prospective study evaluating peripheral nerve blocks determined that the risk of block failure increased proportionately with BMI. Continuous supraclavicular, paravertebral, superficial cervical plexus and continuous epidural blocks had the highest failure rates. Supplemental general anesthesia was also needed to supplement these blocks more often. Another study also evaluated success rates of supraclavicular blocks in obese compared to non-obese patients and determined that success rates were also lower in the obese patients. However, the rate of successful blocks in obese patients remained high (94.3% versus 97.3%).

Dosing of local anesthetics during regional anesthesia can be challenging in the obese. For instance, if a patient receives too large of a dose, they may be at risk of hypotension, systemic toxicity or respiratory compromise related to diaphragmatic hemiparesis. If the dose is too small, there is a risk of block failure. Although absorption of local anesthetics is dependent on the site of injection (i.e., absorption is fastest with intercostal blocks followed by epidural and spinal blocks), calculation of the local anesthetic dose is an important consideration when performing a peripheral nerve block in these patients. The maximum safe
dosage of local anesthetic for a peripheral nerve block is often based on patient weight. However, basing the dosage on the actual weight in this patient population will increase the risk for systemic toxicity. Regardless of the route of administration (e.g., local infiltration, peripheral nerve block) local anesthetic dosing should be based on ideal body weight rather than actual weight.

Although there are advantages of peripheral nerve blocks in these patients, placement is often difficult due to difficult positioning, obscure anatomic landmarks, and inadequate needle length. Since increased BMI is associated with increased number of attempts and risk of block failure, the use of ultrasound in these patients may be a helpful tool to increase block success as well as safety. Unlike techniques that use nerve-stimulators and/or paresthesias to identify proper needle position, ultrasound has the advantage of real-time identification of landmarks below the skin surface. Although real-time ultrasound has been shown to increase success rates, decrease procedure time, and decrease the minimum effective dose of local anesthetic solutions in patients receiving peripheral nerve blocks who are of normal weight, reports of use of this technique in the obese are more limited. Because a greater penetration depth of ultrasound is needed in the obese, the ultrasound must penetrate greater depths to reach the tissues. Low-frequency transducers are needed for this degree of penetration. However, higher frequency transducers produce the best images. Consequently, ultrasound images in the obese may be compromised due to an increased number of reflective surfaces and well as greater depth to the structures. Although success rates and procedure times are increased by the use of ultrasound technology in individuals of normal weight, there are reports of increased success rates in the obese undergoing peripheral nerve blocks. However, successful use of ultrasound for peripheral nerve blocks requires training and experience. Routine use of ultrasound-guided regional techniques in non-obese patients is likely to improve success rates in the obese. The American Society of Regional Anesthesia and Pain Medicine and the European Society of Regional Anesthesia have recommended education and training guidelines for ultrasound-guided regional anesthesia.

**POST-OPERATIVE CARE**

Morbid obesity increases the risk for postoperative complications, including: hypoxemia, atelectasis, deep venous thrombosis, pulmonary embolus, pneumonia, pulmonary edema, postoperative endometritis, wound infection, and dehiscence. Goals of effective postoperative care should be aimed at enhancing pulmonary function and preventing venous thrombosis. Early ambulation, thromboprophylaxis, chest physiotherapy, and effective postoperative pain control are essential in preventing complications in these patients.

**Postoperative respiratory depression** Multimodal analgesic techniques (e.g., non-steroidal anti-inflammatory agents) should be used to decrease total opioid requirements. Obesity and postoperative respiratory complications have been identified as significant risk factors for anesthesia-related mortality. Postoperative respiratory depression from opioids continues to be a significant cause of high-severity injuries often resulting in death or brain damage. After review of the Joint Commission’s Sentinel Event Database from 2004-11, the Joint Commission issued Sentinel Event Alert Issue 49 in 2012 regarding the safe use of opioids. The events included: wrong-dose medication (47%); improper monitoring (29%); and excessive dosing, medication interactions, adverse drug effects (11%). To further evaluate the associated factors for postoperative respiratory depression, The American Society of Anesthesiologists (ASA) Closed Claims Database was examined and identified 341 acute pain claims occurring between 1990 and 2009. In the study, there was a higher proportion of claims for respiratory depression in obese patients compared to other acute pain claims. There was also a higher proportion of these claims with death or severe brain damage. The authors concluded that postoperative respiratory depression is a significant cause of death and
brain damage associated with neuraxial and/or patient controlled analgesia use and multimodal therapy. The authors suggested, “poor communication between prescribing physicians and nursing personnel is a common theme in opioid-induced respiratory depression claims. Moreover, many physicians and nurses do not appreciate the synergistic effects that opioids, benzodiazepines, some antiemetics and sleep aids have on respiratory drive.”

The ASA has published recommendations for the postoperative care of patients with sleep apnea although they are not pregnancy-specific.17 Included in the guidelines are recommendations for postoperative monitoring:

- Regional anesthetic techniques should be considered to reduce or eliminate the requirements for systemic opioids in patients with OSA.
- If neuraxial anesthesia is planned, the benefits and risks of using an opioid or opioid-local anesthetic mixture as compared to local anesthetic alone must be considered.
- If patient-controlled systemic opioids are used, continuous background infusions should be avoided or used with extreme caution.
- Nonsteroidal anti-inflammatory agents and other modalities should be considered to reduce opioid requirements.
- Supplemental oxygen should be administered continuously to all patients who are at increased perioperative risk from OSA until they are able to maintain their baseline oxygen saturation while breathing room air.
- Hospitalized patients at increased risk of respiratory compromise from OSA should be monitored with continuous pulse oximetry after discharge from the recovery room.

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Do You REALLY Know What Your Patient Is On??

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University of Colorado, AMC

Disclosures

- Purdue Pharma
- Novartis
- CPC Clinical Research
- Claro Scientific LLC

Drugs of Use and Abuse

- Definitions and scope of problem
- Marijuana
  - National issues
  - Local issues
- Opiates
  - Extent of Issue
  - Current Issues
  - Practical Detection and Prevention Strategies

Agreement on definitions


Addiction: Definition

“Opioid addiction is a primary, chronic, neurobiological disease, with genetic, psychosocial, and environmental factors influencing its development and manifestations. It is characterized by behaviors that include one or more of the following: impaired control over drug use, compulsive use, continued use despite harm, and craving.”


Addiction – A Neurobiological Disease

- Involves the brain’s reward (limbic) center
  - An area of the brain that is associated with the affective responses to pain
  - Involves dopamine
- Susceptible individuals may have an alteration of the limbic or related system that causes sensitization to the reinforcing effects of drugs
Addiction – Behavioral Manifestations

• Loss of Control
• Compulsive drug use
• Continued use despite harm
• Craving

Addiction - other signs

• Drug seeking and doctor shopping
• Polypharmacy and inability to take drugs on schedule
• Frequent reports of lost prescriptions
• Isolation from social groups and family
• Taking analgesics for sedation or increased energy
• High tendency to relapse after withdrawal

Physical Dependence – Definition

“Physical dependence is a state of adaptation that is manifested by a drug class specific withdrawal syndrome that can be produced by abrupt cessation, rapid dose reduction, decreasing blood level of the drug, and/or administration of an antagonist.”

• Normal predictable, physiological response
• Characterized by drug class specific physical withdrawal syndrome

Tolerance – Definition

• “Tolerance is a state of adaptation in which exposure to a drug induces changes that result in diminution of one or more of the drug’s effects over time.”
• Normal physiological adaptation
• More predictable and rapid to most side effects than to analgesia

The NSDUH Report

10.8 Million Full-Time Workers Have a Substance Use Disorder

Post First Substance Use Disorder (SUD) among Adults Aged 18 to 64, by Employment Status: Annual Averages: 2009 to 2012

- Employed Full Time: 112 million adults (8.8%)
- Employed Part Time: 29 million adults (27.0%)
- Unemployed: 13 million adults (11.2%)
- Not in the Labor Force: 37 million adults (32.5%)

*Not in the labor force includes those out of the labor force who are neither working nor seeking work.
Lack of Evidence

- There are no Food and Drug Administration safety or efficacy data concerning marijuana for medical use.
- There are no published studies on the use of marijuana in the pediatric or adolescent patient populations to demonstrate efficacy or safety.

FDA report: Robert Meyer Director of CDER; Apr 1, 2004

FDA regulates smoked marijuana, a botanical product, when it is being investigated for use in the diagnosis, cure, mitigation, treatment or prevention of disease in man or other animals, as a drug, under the FD&C Act. Botanicals include herbal products made from leaves, as well as products made from roots, stems, seeds, pollen or any other part of a plant. Botanical products pose some issues that are unique to this class of product, including the problem of lot-to-lot consistency. These unpurified products, which may be either from a single plant source or from a combination of different plant substances, often exert their reported effects through mechanisms that are either unknown or undefined.
FDA report: Robert Meyer Director of CDER; Apr 1, 2004

For these reasons, the exact chemical nature of these products may not be known. In addition, issues of strength, potency, shelf life, dosing and toxicity monitoring need to be addressed. If a product varies greatly, as can occur with botanicals, it is critical to obtain lot-to-lot product consistency. Without this it is difficult to determine if the product is causing the change in a patient’s condition, or the change is related to some other factor. Because of the problems associated with obtaining lot-to-lot consistency with botanical marijuana, it is not surprising that IOM recommended that clinical trials should be conducted with the goal of developing safe delivery systems.

More from the FDA website

• An NDA is the vehicle through which drug sponsors formally propose that FDA approve a pharmaceutical for sale and marketing in the United States. FDA only approves an NDA after determining, for example, that the data is adequate to show the drug’s safety and effectiveness for its proposed use and that its benefits outweigh the risks.

Marijuana contents
• Contains multiple compounds including at least 200 known to be cannabinoids
• Pesticide residues
• Fungal spores
• Heavy metals

The Result
• No head to head research
• No ability to create a “standardized” marijuana plant
• No Pharmaceutical sponsor in bringing non-processed drug to market

• Thus, no New Drug Application for Marijuana

Oh and By the Way
• Marijuana is a Schedule 1 drug by the DEA

Oh and By the Way
• Marijuana is a Schedule 1 drug by the DEA
• It is addictive!!
Primary Drug of Choice by Youth in Treatment– FY 2010

- At intake, identified Primary Drug of abuse
- Out of 4,602 admissions, 2,774 identified marijuana as drug of choice, followed by alcohol.
- Nationally: 61% of those under 15 identify marijuana as primary drug at admission

Oh and By the Way

- Marijuana is a Schedule 1 drug by the DEA
- It is addictive!!
- There are legal pharmaceuticals which have similar chemical properties.
Do You REALLY Know What Your Patient Is On??

Results—Approximately 74% of the adolescents had used someone else’s medical marijuana and they reported using diverted medical marijuana 50 times. After adjusting for gender and race/ethnicity, adolescents who used medical marijuana had an earlier age of regular marijuana use, more marijuana abuse and dependence symptoms, and more conduct disorder symptoms compared to those who did not use medical marijuana.

Conclusions—Medical marijuana use among adolescent patients in substance abuse treatment is very common, implying substantial diversion from registered users. These results support the need for policy changes that protect against diversion of medical marijuana and reduce adolescent access to diverted medical marijuana. Future studies should examine patterns of medical marijuana diversion and use in general population adolescents.

Figure 2. Telephone calls to national poison control centers pertaining to marijuana exposures.

National Poison Control System Data
Table 1. Demographics of Patients Seen in the Children’s Hospital Emergency Department for ingestions

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>No. of patients</td>
<td>790</td>
<td>588</td>
</tr>
<tr>
<td>Age, median (IQR), y</td>
<td>2.6 (1.6-3.0)</td>
<td>2.3 (1.5-3.6)</td>
</tr>
<tr>
<td>Male sex</td>
<td>449 (56.8)</td>
<td>334 (56.8)</td>
</tr>
<tr>
<td>Types of ingestions</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Acetaminophen</td>
<td>50 (11.3)</td>
<td>48 (8.2)</td>
</tr>
<tr>
<td>Antihistamine</td>
<td>43 (5.4)</td>
<td>32 (5.4)</td>
</tr>
<tr>
<td>Anti-depressant</td>
<td>23 (2.9)</td>
<td>14 (2.3)</td>
</tr>
<tr>
<td>Antiepileptic</td>
<td>18 (2.2)</td>
<td>14 (2.3)</td>
</tr>
<tr>
<td>Marijuana exposure</td>
<td>0</td>
<td>14 (2.3)</td>
</tr>
</tbody>
</table>

JAMA Pediatrics July 2013 Volume 167, Number 7

Table 2. Pediatric Patients With Marijuana Exposures

<table>
<thead>
<tr>
<th>Case No</th>
<th>Age/sex</th>
<th>Symptoms</th>
<th>Last Seen Date</th>
<th>Observation</th>
<th>Source of Exposure</th>
</tr>
</thead>
<tbody>
<tr>
<td>200801</td>
<td>2 yrs</td>
<td>Lethargy</td>
<td>11/12/2008</td>
<td>Observation</td>
<td>Unknown</td>
</tr>
<tr>
<td>200902</td>
<td>4 yrs</td>
<td>Lethargy</td>
<td>12/12/2009</td>
<td>Administration</td>
<td>Unknown</td>
</tr>
<tr>
<td>201003</td>
<td>6 yrs</td>
<td>Lethargy</td>
<td>01/12/2010</td>
<td>Administration</td>
<td>Unknown</td>
</tr>
<tr>
<td>201104</td>
<td>7 yrs</td>
<td>Lethargy</td>
<td>02/12/2011</td>
<td>Administration</td>
<td>Unknown</td>
</tr>
<tr>
<td>201205</td>
<td>8 yrs</td>
<td>Lethargy</td>
<td>03/12/2012</td>
<td>Administration</td>
<td>Unknown</td>
</tr>
<tr>
<td>201306</td>
<td>9 yrs</td>
<td>Lethargy</td>
<td>04/12/2013</td>
<td>Administration</td>
<td>Unknown</td>
</tr>
<tr>
<td>201407</td>
<td>10 yrs</td>
<td>Lethargy</td>
<td>05/12/2014</td>
<td>Administration</td>
<td>Unknown</td>
</tr>
</tbody>
</table>

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Cannabis use and age at onset of symptoms in subjects at clinical high risk for psychosis
Other issues in adolescents

• Adolescents who report regular marijuana use perform more poorly on tests of working memory, visual scanning, cognitive flexibility, and learning.
• The number of episodes of lifetime marijuana use reported by subjects correlated with overall lower cognitive functioning.
• Cannabis is the most prevalent illicit drug detected in fatally injured drivers and motor vehicle crash victims.
At AOP

- 500 near consecutive patients June- Sept 2013
- 4% positive for Marijuana

More dispensaries than Starbucks

In Denver, there are more medical marijuana dispensaries than Starbucks, according to The Daily. Nearly 300 medical marijuana dispensaries have been established for Colorado’s residence since the passing of Amendment 20 in the 2000 general election. And according to The Daily, some of these dispensaries, in order to help bring in business, even offer first-time customers a free joint.

Colorado Department of Health Website

Huffington Post 7/2011
Having access to a drug or medical treatment, without knowing how to use it or even if it is effective, does not benefit anyone. Simply having access, without having safety, efficacy, and adequate use information does not help patients. FDA has and will continue to use its IND and other expanded access programs to provide patients freedom to choose investigational medical treatments while reasonably ensuring safety, informed choice, and systematic data collection that allows us to review drug applications.

Medical Marijuana a flawed concept

- 1) Administering any medication via drawing hot smoke into the lungs is inherently unhealthy;
- 2) While use of vaporizers, sprays, and tinctures solve problems inherent in smoking, treatment of illness without standardized dose or content of the medication remain a safety issue;
- 3) If the public wants to legalize marijuana, there is no reason to force physicians to be gatekeepers in a manner that enables liberal access to marijuana but generally fails to uphold accepted standards of practice for recommending a potentially addicting medication/drug.
What should your policy be?

• For a patient who admits smoking marijuana prior to surgery?
• The night before?
• 2 hours before?

Differentiation

• Medical Misuse of Prescription Opioids
  — Refers to engaging in behaviors not intended by the prescriber such as using too much to get high
• Non-Medical Use of Prescription Opioids (NMUPO)
  — Refers to the non-prescribed use of opioids

Differentiation

• Medical Misuse of Prescription Opioids
  — Refers to engaging in behaviors not intended by the prescriber such as using too much to get high
• Non-Medical Use of Prescription Opioids (NMUPO)
  — Refers to the non-prescribed use of opioids

How many drugs are out there?

• Between 1999 and 2010 opioid sales of opioid analgesics have quadrupled.
• Data on sales shows an increase from 96mg in morphine equivalent/year in 1999 to 710mg year in 2010 per person.
• Between 1997 and 2010
  — Hydrocodone sales increased by 280%
  — Methadone by 1293%
  — Oxycodone by 866%

The US and Synthetic Opioids

• In 2007 the US constitutes 4.6% of the world population.
• In 2007 we consumed 83% of the worlds oxycodone and 99% of the worlds hydrocodone.
Table 1. Nonmedical Use of Prescription Pain Relievers in the Past Year among Persons Aged 12 or Older, by Quintile and State: 2010-2011

<table>
<thead>
<tr>
<th>Quintile and State</th>
<th>Percent</th>
<th>95% Confidence Interval</th>
</tr>
</thead>
<tbody>
<tr>
<td>States with Rates between 3.33 and 3.67</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Oregon</td>
<td>6.3%</td>
<td>5.26-7.71</td>
</tr>
<tr>
<td>Colorado</td>
<td>6.0%</td>
<td>4.96-7.24</td>
</tr>
<tr>
<td>Washington</td>
<td>5.7%</td>
<td>4.76-6.92</td>
</tr>
<tr>
<td>Idaho</td>
<td>5.73%</td>
<td>4.74-6.91</td>
</tr>
<tr>
<td>Indiana</td>
<td>5.68%</td>
<td>4.68-6.94</td>
</tr>
<tr>
<td>Arizona</td>
<td>5.66%</td>
<td>4.68-6.64</td>
</tr>
<tr>
<td>Nevada</td>
<td>5.62%</td>
<td>4.67-6.89</td>
</tr>
<tr>
<td>Delaware</td>
<td>5.61%</td>
<td>4.61-6.82</td>
</tr>
<tr>
<td>Arkansas</td>
<td>5.55%</td>
<td>4.00-8.08</td>
</tr>
<tr>
<td>New Mexico</td>
<td>5.45%</td>
<td>4.47-6.84</td>
</tr>
</tbody>
</table>

Figure. Unintentional Drug Overdose Deaths by Major Type of Drug, United States, 1999-2006.
Monitoring the Future 2013 report

- In the late 1970s, opium and codeine were among the narcotics most widely used (by teens). In recent years Vicodin, codeine, Percocet, and OxyContin have been the most prevalent.
- OxyContin use for non-medical purposes:
  - Use increased in all grades from 2002 through 2009.
  - Since 2009 the prevalence rate has dropped.
  - Annual prevalence in 2013 was 2.0%, 3.4%, and 3.6% in grades 8, 10, and 12.
- Vicodin use for non medical purposes:
  - Use has remained fairly steady at somewhat higher levels since 2002, until its use declined after 2009.
  - Annual prevalence in 2013 rates was 1.4%, 4.6%, and 5.3% in grades 8, 10, and 12.

Beliefs held by kids and adults

- “My kids will only take what they need”
- “Since it is a prescription drug it is safer then illicit drugs”
- “Since it was prescribed to me I can use more if I need it”

Adolescent Access to Medications

<table>
<thead>
<tr>
<th>Table 2</th>
<th>Effect of number of medications prescribed to adolescents on perceived risk of drug misuse</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Number of Medications</td>
</tr>
<tr>
<td>Original model</td>
<td>1.00 (Ref)</td>
</tr>
<tr>
<td>Depressed mood</td>
<td>1.20 (1.06, 1.34)</td>
</tr>
<tr>
<td>Use of illicit drugs</td>
<td>1.50 (1.30, 1.72)</td>
</tr>
<tr>
<td>Use of prescription medications</td>
<td>1.60 (1.41, 1.81)</td>
</tr>
<tr>
<td>Scheduled use</td>
<td>1.70 (1.50, 1.93)</td>
</tr>
<tr>
<td>Use of illegal drugs</td>
<td>1.80 (1.60, 2.02)</td>
</tr>
<tr>
<td>Use of non-prescription medications</td>
<td>1.90 (1.70, 2.12)</td>
</tr>
<tr>
<td>Use of prescription medications</td>
<td>2.00 (1.80, 2.22)</td>
</tr>
<tr>
<td>Use of illegal drugs</td>
<td>2.10 (1.90, 2.32)</td>
</tr>
<tr>
<td>Use of non-prescription medications</td>
<td>2.20 (2.00, 2.42)</td>
</tr>
</tbody>
</table>

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Adolescent Access to Medications

**Relevance and Contribution**
This investigation revealed that 73.7% (n = 42) of adolescents, recently prescribed medications in controlled categories, reported unsupervised access to them at home. This finding suggests the need for clinicians to educate adolescent patients and their parents about the proper storage, disposal, and supervision of medications with abuse liability.

Leftover Medications

- 36.9% of past-year users of NMUPO obtained the drugs from their own prescription

2012 National Survey on Drug Use and Health: Summary of National Findings

“Since it is a prescription drug it is safer than illicit drugs”

Prevalence of Issue

2013 Monitoring the Future (MTF) study (Monitoringthefuture.org)
NMUPO and other drug use

Drug and Alcohol Review, May 2011

“Since it was prescribed to me I can use more if I need it”

Abuse behaviors increase with diversion source

Abuse behaviors increase with diversion source

Journal of Pain, Oct 2013

Journal of Adolescent Health 52 (2013) 480-485

Journal of Adolescent Health 52 (2013) 480-485

OR patients

Journal of Adolescent Health 52 (2013) 480-485
Pain Patients

- Very low number of patients who take NO drugs/substances
- Incidence of polypharmacy was very high in both environments
  - Average # of drugs per patient: 5.44 vs. 7.55

Results

<table>
<thead>
<tr>
<th>Drug</th>
<th>Interventional Pain</th>
<th>Chronic Pain</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tested Positives</td>
<td>94%</td>
<td>99%</td>
</tr>
<tr>
<td>Avg # of compounds per patient</td>
<td>5.44</td>
<td>7.55</td>
</tr>
</tbody>
</table>

Findings

<table>
<thead>
<tr>
<th>Drug</th>
<th>Interventional Pain</th>
<th>Chronic Pain</th>
</tr>
</thead>
<tbody>
<tr>
<td>Analgesics</td>
<td>47%</td>
<td>54%</td>
</tr>
<tr>
<td>Anticonvulsants</td>
<td>43%</td>
<td>43%</td>
</tr>
<tr>
<td>Ethanol</td>
<td>29%</td>
<td>31%</td>
</tr>
<tr>
<td>Muscle Relaxants</td>
<td>26%</td>
<td>24%</td>
</tr>
<tr>
<td>Antihistamines</td>
<td>17%</td>
<td>21%</td>
</tr>
<tr>
<td>Antipsychotics</td>
<td>0%</td>
<td>1%</td>
</tr>
<tr>
<td>Barbiturates</td>
<td>2%</td>
<td>5%</td>
</tr>
<tr>
<td>Stimulants</td>
<td>7%</td>
<td>12%</td>
</tr>
</tbody>
</table>

Results Cont.

<table>
<thead>
<tr>
<th>Drug</th>
<th>Interventional Pain</th>
<th>Chronic Pain</th>
</tr>
</thead>
<tbody>
<tr>
<td>Antidepressants</td>
<td>64%</td>
<td>44%</td>
</tr>
<tr>
<td>Benzodiazepines</td>
<td>22%</td>
<td>32%</td>
</tr>
<tr>
<td>Cannabinoids</td>
<td>9%</td>
<td>17%</td>
</tr>
<tr>
<td>Illicit</td>
<td>3%</td>
<td>17%</td>
</tr>
<tr>
<td>Nicotine</td>
<td>38%</td>
<td>59%</td>
</tr>
<tr>
<td>Opiates</td>
<td>62%</td>
<td>94%</td>
</tr>
</tbody>
</table>

Making opioids safer

- “The development of abuse-deterrent opioid analgesics is a public health priority for the FDA,” said Douglas Throckmorton, M.D., deputy director for regulatory programs CDER. “While both original and reformulated OxyContin are subject to abuse and misuse, the FDA has determined that reformulated OxyContin can be expected to make abuse by injection difficult and expected to reduce abuse by snorting compared to original OxyContin.”

FDA news release April 16, 2013

Oxymorphone ER (Opana)

- Opana ER...was designed with the goal of being more difficult to abuse and misuse. After an extensive, science-based review, FDA concluded based on the available data and information that the original formulation of Opana ER was not withdrawn from the market for reasons of safety or effectiveness. As a result, FDA has denied the manufacturer’s petition.

FDA statement May 10, 2013

Oxymorphone ER (Opana)

FDA conclusions include:

- While there is an increased ability of the reformulated version of Opana ER to resist crushing relative to the original formulation, study data show that the reformulated version’s extended-release features can be compromised when subjected to other forms of manipulation, such as cutting, grinding, or chewing, followed by swallowing.

- Reformulated Opana ER can be readily prepared for injection, despite Endo’s claim that these tablets have “resistance to aqueous extraction (i.e., poor syringeability).” It also appears that reformulated Opana ER can be prepared for snorting using commonly available tools and methods.

- The postmarketing investigations are inconclusive, and even if one were to treat available data as a reliable indicator of abuse rates, one of these investigations also suggests the troubling possibility that a higher percentage of reformulated Opana ER abuse is via injection than was the case with the original formulation.
Hydrocodone ER (Zohydro)

- FDA approved Zohydro ER, the first extended-release, single-entity hydrocodone-containing drug product. To enhance safe and appropriate use, Zohydro ER’s labeling reflects the newly required ER/LA opioid analgesic class safety labeling changes and will be subject to the recently announced class postmarket study requirements. FDA also responded to a citizen petition (CP) concerning opioid medications and abuse-deterrence.

FDA notice 10/25/2013

The FDA response to the Citizens Petition 10/25/2013

“As discussed in the Abuse-Deterrent Opioids draft guidance, the science of abuse deterrence technology is in its early stages. Both the drug and formulation technologies involved and the clinical, epidemiological, and statistical methods for evaluating those technologies are still rapidly evolving…. To date, we have approved labeling characterizing a product’s expected impact on abuse….for just one product, reformulated OxyContin… Reformulated OxyContin also is not intended or believed to have any impact on the most common form of abuse of this and many other prescription opioids - swallowing intact tablets or capsules.

The CRAFFT Test

- “Have you ever ridden in a car driven by someone (including yourself) who was high or had been using alcohol or drugs?”
- “Do you ever use alcohol or drugs to relax, feel better about yourself, or fit in?”
- “Do you ever use alcohol or drugs while you are by yourself (alone)?”
- “Do you forget things you did while using alcohol or drugs?”
- “Do your family or friends ever tell you that you should cut down on your drinking or drug use?”
- “Have you ever gotten into trouble while you were using alcohol or drugs?”

More on the CRAFFT scale

- The CRAFFT has acceptable reliability (α = .79) and is highly correlated (r = 0.84) with the Personal Involvement with Chemicals Scale (PICS).
- A score of 2 or higher on the CRAFFT had sensitivity and specificity of 0.80 and 0.86, respectively, for detecting any substance abuse or dependence.
- A score of 2 or higher had sensitivity and specificity of 0.92 and 0.80, respectively, for detecting substance dependence.

Morphine/naltrexone (Embeda)

- On November 4, 2013, the U.S. Food and Drug Administration (FDA) approved a Prior Approval Supplement for EMBEDA that included an update to the EMBEDA manufacturing process addressing the prespecified stability requirements.
- Pfizer anticipates product availability in the second quarter of 2014.
Easy Steps

• Prescribe reasonable amounts.
• Have parents/patients check pill counts.
• Tell parents to keep drugs in a locked cabinet or box under with the key under the parents control.
• Tell families and patients to throw out their unused prescriptions.

More difficult steps

• Check local Prescription Drug Monitoring Website
• Administer CRAFFT scale
• Test patients who are on opioids for an extended period of time (> 1 month)
• Don’t ignore your suspicions

Other resources

• The Partnership at Drugfree.org
  – Parent Toll free helpline
  – www.drugfree.org/timetoact
  – http://timetohelp.drugfree.org
• National Education Association Health Information Network
  – http://neahin.org/rxforunderstanding/
• National Council on Patient Education and Information
  – http://talkaboutrx.org/

Conclusion

• Drug abuse is common in all patients we see.
• Always keep a high index of suspicion.
• Apply common sense principles to decrease risk.
OBJECTIVES

• To present a thorough review of the relevant regional anesthesia and pain medicine literature for the year of 2014.

• In discussing this data, utilize evidenced based medicine to potentially implement changes into your daily management of perioperative pain.

REVIEW OF THE 2013 LITERATURE

Outcomes

• Neurosurgical analysis showed a decreased incidence of infection and conversion to chronic pain

Adjuvants

• Epidural ketamine, intrathecal magnesium, intrathecal dexmedetomidine, intravenous dexamethasone, and perineural clonidine appear to be beneficial adjuvant medications in the treatment of postoperative pain

• More studies are required prior to increased use of liposomal encapsulated bupivacaine (Exparel)

Safety

• Ultrasound-guided regional anesthesia was deemed safer than nerve stimulation with regard to local anesthetic systemic toxicity (LAST)

• With the presence of many new anticoagulants on the market, we must avoid the incidence of epidural hematoma
NEURAXIAL ANESTHESIA
• Thoracic epidural anesthesia (TEA) improved recovery of gastrointestinal function when compared to systemic analgesia (Shi, Acta Anesth Scand, 9/14)
  - Literature search of 12 studies and 331 patients
  - TEA improved passage of flatus by 31 hours and passage of stool by 24 hours
  - More hypotension in TEA group

PERIPHERAL NERVE BLOCKADE
• 50 postoperative TKA patients received either femoral or adductor canal blockade (ACB) with 30mL of 0.2% ropivacaine under ultrasound guidance (Grevstad, RAPM, 1/2015)
  - Quad strength: ACB group had a clinically relevant and statistically significant increase in strength compared to femoral
  - Pain: pain relief and opioid consumption was comparable between the two groups
  - Retrospective chart review done at Ochsner compared femoral to ACB for patients undergoing TKA (Patterson, J Clin Anesth, 11/14)
    - No significant differences in pain scores or opioid consumption between the two groups
    - Gait distance superior in ACB group
  • Patients undergoing total knee arthroplasty received a continuous femoral nerve block v. Continuous adductor canal block (Shah, J of Arthroplasty, 11/14)
    - Adductor canal block provided better ambulation and early functional recovery
    - Similar post op analgesia

PERIPHERAL NERVE BLOCKADE: LOWER EXTREMITY CONT.
• 48 patients randomized to received popliteal sciatic nerve block for foot and ankle surgery (Choquet, RAPM 7/14)
  - Randomized into subparaneural and extraneural groups
  - Subparaneural group had shorter times to sensory and motor blocks (11 v. 17-19 min), longer blockade (397 min. v 265 min.) and lower failure rate (0 v. 6)
  - Mepivacaine used

PERIPHERAL NERVE BLOCKADE: IVRA
• 105 patients retrospectively reviewed after undergoing hand surgery with FOREARM bier blockade (Arslanian, Ann Plast Surg, 8/14)
  - 25mL of 0.5% lidocaine
  - Avg. tourniquet time 10.1 minutes
  - Benefits seen such as shorter tourniquet time, less tourniquet pain, less OR time, and less chance of toxicity
  - Medline search revealed 31 studies with 1523 patients receiving IVRA
    - Good evidence that reposition provided safe and effective IVRA with better postop analgesia
    - Combination of fentanyl and muscle relaxant can reduce dose of local anesthetics by 50%
PERIPHERAL NERVE BLOCKADE: BREAST/CHEST WALL

- 120 patients scheduled for unilateral mastectomy under GA randomized to pectoral blocks vs. no pectoral blocks (Bashandy, RAPM 1/2015)
- Opioid consumption, analgesia, sedation, and PONV scores statistically lower in pectoral block group

PERIPHERAL NERVE BLOCKADE: PARAVERTEBRAL

- 48 patients undergoing Right lobe hepatectomy randomized to a T7 paravertebral catheter for 24 hours (Chen, RAPM 11/2014)
- 10mL of 0.2% ropivacaine bolus followed by 0.2% @ 6mL/hour versus saline
- 20% reduction in post op opoid consumption
- Reduction in pain at rest and with coughing

- 180 women undergoing radical mastectomy randomized to three groups: GA, GA with single shot thoracic paravertebral block, and GA with continuous thoracic paravertebral infusion (Karmakar, RAPM 7/14)
- Single shot with 0.2% ropivacaine and infusion with 0.25% ropivacaine
- Assessed postoperative pain, analgesic consumption, and 3 and 6 month chronic pain scores
- No change in relative risk for chronic pain at 3 or 6 month
- Lower postoperative pain, analgesic consumption, and chronic pain scores

PERIPHERAL NERVE BLOCKADE: DOSE RANGING STUDIES

- ED50 and ED95 of ultrasound guided popliteal sciatic nerve block with 0.5% ropivacaine is 6ml and 16ml respectively (Jeong, Anesth and Int Care 1/2015)
- 90% sensory and motor block of both nerves by 30minutes

PERIPHERAL NERVE BLOCKS: WOUND INFUSIONS

- 67 patients randomized to saline or 0.4% ropivacaine in a continuous preperitoneal wound infusion for 48 hours post operatively (Fustran, Colorrectal Dis 1/2015)
- 5ml/h for laparotomy and 2ml/h for laparascopy
- 23.5 mg v. 52 mg morphine consumption in rop v. saline groups
- 16 patients had surgical wound infections

- 83 patients undergoing colorectal surgery for malignancy received preperitoneal catheters for post op pain (Ozer, Local Reg Anesth 10/14)
- Median pain scores were 0-4 up to 72 hours after surgery
- 10% surgical site infection

- A metaanalyses compared single shot TAP block with single shot local anesthetic infiltration for lower abdominal surgery (Yu, BMC anesth 12/14)
- TAP group had lower 24 hour pain scores at rest and with movement
- Opioid consumption and PONV similar between the two groups

OUTCOMES: WOUND INFUSIONS

- 7476 patients receiving peripheral nerve blockade at Toronto Western Hospital over 10 years (Alokkid, RAPM 1/2015)
- Low level disinfection technique (chlorhexidine and iodine), sterile gloves, and leggadens covering probe were used
- No infections

- 101 patients undergoing thoracotomy with thoracic epidurals had their foley catheters removed on or before postoperative day 2 (Hu, J Cardiothor Vasc Anesth 10,2014)
- Results were compared with historic controls
- Urinary retention rate was higher (27% v. 12%)
- Urinary tract infection rate was moderately lower (1% v. 3.8%)

OUTCOMES: INFECTION

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OUTCOMES: PATIENT FALLS

- Review of electronic records over 10 years of patients undergoing total knee arthroplasty at Mayo Rochester (Johnson, Anesth Analg 11/2014)
  - 15,189 patients
  - Full rate of 15.3 per 1000 patients
  - Odd of falling increased with older age (>70) and postop day 1-3 patients
  - Decreased with revision procedure
  - Most falls were elimination (bathroom) falls
  - Fall education is essential; especially for high risk patients

OUTCOMES: BLOCK COMPlications

- Retrospective look at 27031 ultrasound guided axillary blocks performed at six French centers from 2009-2012 (Ecoffey, Eur J Anesth, 11/14)
  - Incidence of LAST was 1.5/1000
  - Persistent neurologic deficits were 0.37/10000

OUTCOMES: CANCER RECURRENCE

- Retrospective study looking at 1964 patients undergoing radical prostatectomy under either spinal or general anesthesia (Tseng, RAPM 7/14)
  - No difference in cancer recurrence (biochemical)

ADJUVANTS

ADJUVANTS: ACUPUNCTURE

- 60 patients randomized for total knee arthroplasty to receive real or sham acupuncture for three days (Chen, RAPM 1/2015)
  - Fentanyl consumption, nausea/vomiting, and time to first request were lower in acupuncture group
    - 30%

ADJUVANTS: INTRAVENOUS LIDOCAINE

- 71 patients undergoing breast cancer surgery randomized to placebo or IV lidocaine at 1.5mg/kg then 2mg/kg/h (Abdulla, RAPM 11/2015)
  - No difference with regard to opioid consumption, pain score, PONV or fatigue
  - IV Lidocaine may not be beneficial across all types of surgery

- 47 patients undergoing laparoscopic nephrectomy randomized to receive intra/postoperative lidocaine v. placebo (Hausler-Pi, J A Clin Pharm, 7/14)
  - Lidocaine ran at 1.5mg/kg/h for 24 hours
  - Significant reduction in morphine consumption (8 vs 22mg), pain scores, and hyperalgesia out to post op day 6
  - Time to first flatus (29 vs. 48 hours) and 6 minute walk test better in lidocaine group
ADJUVANTS: PERINEURAL DRUGS

• 150 patients undergoing arthroscopic rotator cuff repair under interscalene brachial plexus block randomized to buprenorphine, tramadol, or no perineural adjuvant (Alemanno, Minerva 11/2014)

  • 150mcg of buprenorphine and 100mg of tramadol
  • Postoperative analgesia longest with buprenorphine > tramadol > no adjuvant

• 64 patients undergoing upper extremity surgeries received supraclavicular brachial plexus blocks with 20mL of 0.75% Ropivacaine with 30mcg of clonidine or placebo

  • No difference in sensory or motor onset of block
  • Postoperative analgesia duration of 956 minutes (clonidine) vs. 736 minutes (placebo)

• Meta-analysis of 29 trials with 1695 participants receiving perineural dexamethasone (Albrecht, Anesthesia 8/14)

  • Increased duration of short and medium action local anesthetics by a mean of 212 minutes
  • Increased duration of long term local anesthetics by 288 minutes
  • No difference in 4mg and 8mg doses
  • Extreme heterogeneity seen

ADJUVANTS: PERINEURAL DRUGS CONT.

• 39 patients presenting for arthroscopic gluteal surgery received interscalene blocks with perineural dexamethasone or systemic dexamethasone (4mg) (Kovacari, Loc Reg Anesth 4/14)

  • Sensory block at 10 hours vs. 4.6 hours in perineural group

ADJUVANTS: ESMOLOL

• 60 patients undergoing septorhinoplasty randomized to esmolol vs. placebo (Celebi, Braz J Anesthesiol 9/14)

  • Co-administered with remifentanil
  • 0.5mg/kg bolus of esmolol followed by 50mcg/kg/min infusion
  • No difference in sensory or motor onset of block
  • Postoperative pain scores were significantly lower for the first 3 hours
  • Postoperative complete analgesia was significantly lower for 3 days

ADJUVANTS: GABAPENTIN/PREGABALIN

• 212 patients enrolled in a randomized trial to receive perioperative gabapentin vs. placebo when undergoing total knee arthroplasty (Clarke, Br J Anesth 11/2014)

  • 600mg preop and 200mg TID post op
  • Also received celecoxib and femoral/sciatic blocks
  • Gabapentin group used less 24 hour morphine (25% reduction) and had improved range of motion
  • No difference in pain or physical function for up to 6 months

• 60 patients undergoing percutaneous nephrolithotomy receiving preoperative single dose pregabalin vs. placebo (Aydogan, Revista Brasileira De Anesth, 10/14)

  • Postoperative pain scores were significantly lower for the first two hours
  • Postoperative morphine consumption was significantly lower for 24 hours

• 90 patients undergoing gynecological surgery under spinal randomized to placebo, 600mg of gabapentin, or 150mg of pregabalin one hour before surgery (Beha, J An Clin Pharm 7/14)

  • Group C (pregabalin) had longest duration (503min) compared to group A (187 min) and group B (305min)

SUMMARY

REFERENCES
Continuous Peripheral Nerve Catheters - What is the Current Thinking?

CPNB Outline:
- Problem of Pain
- Risks and Benefits
- Supplies, Equipment, Space
- Techniques
- Limitations, Billing
- Types of CPNBs:
  - Upper Extremity
  - Torso: PVB, TAP
  - Lower Extremity

Problem of Trauma and Pain:
- American Intensive Care Units:
  - 74% mod-sev pain (Whipple)
  - 35% received analgesics
  - <20% given analgesics for procedures
- Nashville Ortho Surgicenter:
  - Mod-Severe Pain Using Regional Anesthesia
  - 3% DOS; 27% POD1; 20% POD2

Multimodal < Stress Response
- Correlates w/ severity of trauma (Seekamp)
  - Pain directly accentuates stress response
  - Stress response linked to morbidity
- MMA < stress response
  - SNS activation:
    - incr NE, epi leading to > HR, BP, ischemia
- Endocrine response:
  - < thyroid, > aldosterone (> renin, angiotensin, aldosterone) w/ > water and sodium
- Pituitary changes:
  - > ACTH, GH, vasopresin
- Metabolism changes:
  - glucagon, < insulin leading to lipolysis, hyperglycemia, prot catabolism, wound inf
- Heme changes:
  - Hypercoag (< ATIII)
- Immune changes:
  - Cytokine prod, IL1, IL6, TNF alpha, leukocyte release (> inflam, MODS)

Risk Factors for Persistent Postsurgical Pain
- Age
- Obesity
- Anxiety
- Depression
- Culture/Ethnicity
- Acute Postop Pain
- Prolonged Opiates
- Sleep Disturbance
- Catastrophizing

NB: Fear = strongest intensifier of pain. Providers can affect postop pain, fear, expectations.

Duration of Multimodal Analgesia

Duration of CPNB Analgesia
- OA/SPINAL
- TKA/PVB
- OPIATES ER
- OPIATES CR
- NSAIADS
- Tylenol
Preventative Analgesia: Timing / Duration

Preemptive Analgesia

CPNB Complications

Common:
- Leaking:
  - 17-50% incidence
  - Adv > 2 cm
- Cyan-o-acylate glue
- Demabond
- Surgisal
- Dislodgement 4%
- Disconnects
  - 1% incidence
- Tagaderm over connector
- Skin irritation
  - (mastisol/tagaderm)

Rare:
- Entanglement/Cath breakage/Diff removal
- Hematoma:
  - Rare, even with lovenox
  - Superficial CPNBs with DVT prophylaxis acceptable
- Buckenmaier, 2006, 8j A.

CPNB Complications - Poor Analgesia/Failure

- Risk Factors:
  - Inexperienced/trained providers
  - Opiate Tolerant patients
- Incidence:
  - Malchow Series 1164 CPNBs
  - 85% "very good-Exc." analgesia
  - 11% "fair-good" analgesia
  - 4% failure

Ensuring success:
- Experience/Training
- Dosing thru cath
- Color Doppler
- Visualization of catheter
- Min cath depth (<3 cm?)
- Out of Plane Technique?...

CPNB Complications - Infectious Complications

- Studies:
  - Capdevila, 2005. 1416 pts
  - Borgeat, 700 C-ISB
  - Malchow, unpublished data of 1164 CPNBs
  - Wiegel 2007; Aveline 2011
- Findings:
  - Colonization: 10-28.7%
  - Local inflammation: 3%
  - Superficial: 0.7-2% (requiring antibiotics)
  - Deep: 0.07-0.17% abscesses (recent nec fascit)
  - NFS duration > 2 d, DM, (stereoids), ICU, male, low socioeconomic, ? Abx
  - Tunneling: Doubtful benefit (altho < dislodgement)
  - Nondism vs stimulating caths:
    - Skin caths may present with deep infection (Lai/Malchow, 2011)
  - Fever and elevated WBC late findings
  - Don't rely on surgeons to evaluate pts with CPNB (nec fascit)

CPNBs - Neurologic Complications

- Capdevila, 2005. 1416 CPNBs
  - 0.21% rate, all resolved within 10 weeks
- Borgeat, 2003. 700 C-ISB Rate of PONS:
  - 8% at POD 10
  - 2.4% at 1 mo
  - 0.3% at 3 mos
  - 0.2% motor/sens deficits which resolved w/6 mos
- Malchow, 1164 consecutive Home CPNBs (unpublished):
  - 3% residual sensory deficits 72h after cessation
  - 0.2% residual motor deficits 72h after cessation
  - Most resolved within 3-6 mos
- Wiegel, 2007. 1398 nerve stim CPNBs
  - 1 pt (0.07%) permanent FNB injury (retroperitoneal hematoma in C-FNB case)

CPNBs - Neurologic Complications

Single Shot vs CPNB:
- No difference in PONS rate
- USG vs n.stim technque
- No difference in PONS rate

CPNB advantages compared to systemic opiates

- < Opiates
- C-EIB for shoulders (Mariano)
- Critical for OSA/MO pts
- < Sedation
- < Postop Cognitive Dysfunction
- < Respiratory Depression (eg MO/OSA pts)
- < PONV
- OIH/Tolerance
- < Constipation

CPNBs - Infectious Complications

ORAL OPIOID (Oxydolone)

- Mariano, 2009

MALCHOW, RANDALL, MD

Continuous Peripheral Nerve Catheters - What is the Current Thinking?
CPNB advantages compared to Epidurals

- Ability to ambulate
- No urinary retention
- No pruritis (epidural opiates)
- < Hypotension
- Min concern with anticoagulation (excluding PVB, LPB caths) with extensive military use
- Capdevila, 1999, 56 TKA pts
- C-FNB vs LEC vs PCA-M
- Both RA grps >> analgesia, ROM
- C-FNB << side effects

CPNBs - Improved Quality of Life

- Ilfeld Series of Studies
  - Home C-PVB for mastectomy, 2014
- < pain, opiates and SEs
- Wu. > Quality of life with > function, mental health, sleep, cognition

CPNBs - Improved Patient Satisfaction

- Very high. Huge PR impact.
- Most patients thrilled to have CPNB available.
- 90% desired same pain mgmt next time (Rawal, 2002)
- C-ISB vs SS opiates after shoulder surg.
- Borgeat, 2000. C-ISB vs IV-PCA
  - > pt satisfaction in C-ISB group (9.7 vs 7.5)
  - Mariano, 2009. C-ISB vs SS opiates
  - > pt satisfaction in C-ISB group (10 vs 7)
**Improved Post-Op Analgesia and Rehabilitation**

- 603 pts, meta-analysis
- Pain with CPNB comp to opiates at 24, 48, 72hrs at rest and activity

**Minimize nursing requirement**

**C-PVB May Improve Survival**

- Exadaktylos, Anes, 2006. 129 pts Breast CA
- 94% CA-free in C-PVB grp vs 77% in opiate grp at 3 yrs
- Mechanism:
  - Stress resp < Natural Killer cell fn
  - Opiates < cellular/humoral immune fn (Gupta, 2002)
- Deegan, Yeager, 2010
  - Peop cytokines x 10
  - 32 Breast CA patients
  - Propofol/ PVB vs Sevo/opiates
  - <IL1b, MMP3, MMP9
  - >IL10 (enhances NK cell act)
  - Favorable immunologic changes

**C-PVBs Decrease Pulmonary Complications**

- C-PVB T3-8 in Mult Rib Fx (15)
- 2-3cm in space (50% difficulty)
- B0.25% at 0.1-0.2ml/kg/hr
- 20% contralat sprd; some epid spread.
- <VAS, RR
- >SaO2, FRC, PEF, cough
- Joshi, 2011 and Grider, 2012 C-PVB in Thoracotomy

**C-PNBs: Decreasing Chronic Pain**

- Borghi, 2010, Italy
- 71 mainly CA, LE pts, prospective, obs, cohort controls
- C-SCI + C-FNB periop x 30d!
- Ropiv 0.5% @ 5ml/hr; refilled Home Pumps
- Nsaid, tramadol, OC pm

- Patients instructed only to remove catheters if no PLP or phantom sensations
- No PLP at 1yr pts who completed protocol

**CPNB- Block Room**

- Critical for CPNBs:
  - > Success
  - < Complications
  - > Patient Safety
  - Privacy, Monitors

- IV Premed
  - Anxiolysis
  - Our Std: V2/K10

- Emergency
  - Intralipid, propofol, sux
  - Airway, suction

- Supplies:
  - Cabinets, Carts, lockable
  - Needles, Syringes, Meds

- Challenges:
  - Space
  - Personnel (pre, during, post)

**CPNB- Sterile Procedure**

- Probe Covers:
  - Sterile pouch required unlike single shot
  - Various products avail
  - Gel inside/outside sheath (x Safersonic)

- Sterile drapes, gloves
- Chlorhexidine prep
- Mask, hat
Continuous PNB Needle/Catheter Systems

- Catheter systems:
  - Non-stimulating caths
  - Stimulating caths
  - More difficult to place

- Morin, 2010, RAPM. Review
  - Suggestive of benefit with Stim caths...
  - C-ISB (< pain)
  - C-Pop, C-FNB (< onset time)

- Catheter:
  - Multi vs single orifice
  - No less 20 gu

CPNBs – USG and Cath Depth

- Ultrasound Guided:
  - < procedure time
  - > success
  - Primary benefit (< LATS and pneumo risk)
  - Helpful in fractures and amputations
  - Min help with C-PVB and C-SCI

- Confirmation:
  - 3.5ml LA, saline, or DSW, agitated saline (+/- color)
  - Visualization of catheter
  - Extra providers needed

Catheter Depth:

- 1-5 cm in neural sheath (success vs dislodgement)
- lfield, 2011 Min difference. (Similar study at Vandy)

Probe, Needle, Nerve Orientation Options

- 1st Choice:
  - Probe: Short Axis
  - Needle: In-Plane (most common for RA)

- 2nd Choice:
  - Probe: Short Axis
  - Needle: Out of Plane
  - Ideal for CPNB but difficult in some situations (C-POP)

- 3rd choice:
  - Probe: Long Axis
  - Needle: In-plane (Vasc access)

Color Doppler

- Helpful for identification of Artery/Vein in area
- Artery- pulsatile, noncompressible
- Vein- larger, compressible
- Catheter confirmation agitated saline/LA

CPNB Pumps

- Elastomeric/Spring loaded Pumps
- On-Q; Accufusor; Baxter
- Select-a-flow 2-14ml/hr
- On-Demand 5ml/dose available
- Both Select-a-flow and On-Demand
- Easy, disposable, no alarms
- 110-130% flow rate 1st 8hrs
- No refill of pump

- Electronic (batteries)
- Ambit (Stryker)
- Programmable, non-disposable
- Higher volumes
- More complex for patients
- Electronic “epidural” pumps for inpts
- Pharmacopeia, chap 797, ISO 5.
- Min risk level; clean air hood; extensive requirements

CPNBs Solutions, Rates

- Local Anesthetics
  - Bupivacaine
  - 0.125% mass/dose prob more significant
  - Ropivacaine
  - 0.2% (< potency)
  - Expensive ($8 vs $110)
  - Reduce for severe hepatorenal dz
  - No adjuncts useful
  - Serum levels 0.5-1.8ug/ml

- Rates:
  - PCA setting ideal comp to set basal rate
  - < LA dose, > pump duration, > pt satisfaction
  - 2-14 ml/hr
  - PCA setting: 2-5 ml/30-60min
  - Multiple catheters:
    - Ex: Fem/Sci
    - Max: 20ml/h total for both
    - 10ml/h/each frequent
  - Bupivacaine max 0.5mg/kg/hr
Patient Education

- Reasonable expectations
- Prevent Disconnects, Leaking
- Patient Handout, Brochure
- Adjusting pump (analgesia w/o motor block)
- Protecting limb, Avoiding falls (slings, crutches, knee immobilizers)
- Exchange Phone #s

Clean and Dry
- Observe for signs of infections
- Plan for Breakthrough Pain
- Plan for Removing Catheter

Continuous Peripheral Nerve Catheters (CPNB) Indications:

- Trauma/Amputations
- Extensive military use
- Burns, dressing changes
- Age: >12 yo in our practice
- Home:
  - Independent, able to care for self
  - Compliant, available for f/u

Continuous Peripheral Nerve Catheters-What is the Current Thinking?

CPNB Contraindications

- Allergy
- Patient Refusal
- Infection at site

Anticoagulation considerations:
- Avoid deep catheters with anticoagulation (esp LPB)
- Most CPNB acceptable with standard DVT prophylaxis
- Acute Compartment Syndrome concerns – relative
- Avoid dense, long acting blocks
- CPNB will dilute LA may be acceptable R/B (Mannion)
- Wounded warrior diagnosed with ACS even w/ CPNB (also Walker, 2012, RAPM)
- Inability to care for catheter (Home use)
- Lack of Availability for follow-up

CPNB- Limitations

- Poor Reimbursement
- Increased Cost
  - Needle/Cath $30
  - Pump $250
- Increased Time
  - Place (15 min)
  - Pump setup (15 min)
  - Pt Education (15 min)
- Increased Liability
  - Infections
  - Poor analgesia (plan for breakthrough pain)

Billing for CPNBs- Procedural Codes & RVUs

<table>
<thead>
<tr>
<th>Block</th>
<th>Code</th>
<th>ASA Unit Worth</th>
</tr>
</thead>
<tbody>
<tr>
<td>Brachial Plexus</td>
<td>64416</td>
<td>13</td>
</tr>
<tr>
<td>Sciatic</td>
<td>64446</td>
<td>13</td>
</tr>
<tr>
<td>Femoral</td>
<td>64448</td>
<td>12</td>
</tr>
<tr>
<td>Lumbar Plexus</td>
<td>64449</td>
<td>12</td>
</tr>
<tr>
<td>Paravertebral</td>
<td>64520-22</td>
<td>13</td>
</tr>
</tbody>
</table>

Law changed 2009; CMS “unbundled” CPNB charge; new RVU roughly 10.

Continuous Peripheral Blocks Codes- Daily Evaluation Charges

- Charge for Catheter placement and separate charges for inpatient evaluation and mgmt
- Total USG Billing - complicated
  - Procedure Fee
  - Facility Fee
  - USG Fee
- Daily Evaluation: Inpatient
  - Need 3 components (Hx/PE/plan and coordination)
  - Ave 15 min at bedside
  - Use 99231 (Daily evaluation) code
  - 0.76 RVU
- Home CPNB services not billable essentially
  - If face to face, could use 99211-99215 codes
**Other Billing Considerations:**

- **Documentation requires:**
  - Type of Block/CPNB
  - Indication: 719.xx pain
  - Surgeon’s request for pain block/catheter
  - Description
  - Date
  - Anesthesiologist
  - USG guidance and picture in chart
  - Pre or postop; primary or postop analgesia.

- **Upper Extremity**
  - Shoulder: 719.41
  - Arm (upper): 719.42
  - Elbow: 719.42
  - Forearm/Wrist: 719.43
  - Hand: 719.44

- **Lower Extremity**
  - Hip: 719.45
  - Thigh/Pelvic: 719.45
  - Knee: 719.46
  - Lower Leg: 719.46
  - Foot/Ankle: 719.47

**Charge Modifiers**

- Modifier “51”
  - Multiple blocks on the same extremity
    - Example: Sciatic nerve catheter & single femoral block for ORIF Ankle - bill catheter w modifier “51” & “59” & “51”
    - 50% allowable charge for “51” modifier

- Modifier “50” - rare
  - Used for bilateral nerve blocks along with “59”
  - Example: B/L TKA w/ 2 C-FNB would be coded 64448-59-50

**Upper Extremity Catheters-Interscalene**

- Posterior vs Posterior-lateral vs Anterior
  - Boezart, N. 1993, 2002
  - Antonakakis, USG, 2009

- 35% of all CPNB in our ASC
- Total Shoulder Arthroplasty
- Proximal Humeral Fx’s
- Open Shoulder Cases
- Clavicular ORIFs - ? Cervical plexus caths at C4

**Upper Extremity –Supraclavicular or Infraclavicular CPNB**

- Mid-Dist Humeral ORIF
- Major Elbow, Forearm, Hand Surgery
- Amputations
- Elbow Arthroplasty
- Burns

- Reimplantations:
  - Exc results with CPNB (forearm).
  - 93% success rate with reimplantation

- C-SCB 3% and C-ICB 2% of all CPNB in our ASC

- Mariano, 2011, A&A. C-SCB vs C-ICB
  - C-ICB had < pain on POD1; no diff in pt satisfaction
  - Malchow preference, C-SCB (success rate, pt satisfaction)

**Lower Extremity Catheters**

- LPB
- TKA
- Fem/Fascia Iliaca
- TKA
- Fem ORIF
- AKA/BKA (Fem/Sci)
- Tib PNF ORIF (Fem/Sci)
- Bums
- Saphenous/ Adductor
- May require post op placement
- Minimizes fall risk
- Add for major medial ankle surgery

**TKA Considerations:**

- Difficult to assess neural function post-op (esp sciatic)
- Weakness can complicate pre or predispose to falls
- Paul, 2010, Anes
- No diff betw C-FNB vs SS
- Most feel C-FNB gold std
- C-Adductor vs C-FNB Catheters
  - Neatly equivalent analgesia
  - Less Motor Block

**Sciatic/ Popliteal CPNBs**

- Calcaneal ORIF
- Ankle Reconstruction
- Ankle arthrodesis
- Dist Tib/fib ORIF
- Hallux Valgus Repair
- 55% of all Home CPNBs

- C-Popliteal at Nashville ASC

- Subgluteal most comfortable sciatic
- Consider Tourniquet Location if primary
- Consider Tourniquet compression if preop CPNB
- Couple with femoral or saphenous blocks usually

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**Continuous Peripheral Nerve Catheters - What is the Current Thinking?**

- Malchow, Randall, MD

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Continuous Peripheral Nerve Catheters-What is the Current Thinking?

CPNB for Thoracic / Abdominal Surgery

**C-PVB**
- Thoracotomy
- VATS
- Mult Rib Fractures
- Mid-CAD
- Major Breast Surgery

**C-TAP**
- Thoracotomy
- VATS
- Mult Rib Fractures
- Mid-CAD
- Major Breast Surgery

Reference:
- Joshi, 2011, A&A.
- Grider, 2012 J Cardiothor Vasc Anesth

Analgesia:
- Equivalent analgesia with LA alone
- > analgesia with TEA-LA + opioid
- > Inc. Spirometry with TEA-LA + opioid
- TEA-opioid alone = systemic opiates

Side Effects:
- > Hypotension with TEA-LA alone
- > pruritis with TEA-LA + opioid (35%)
- > pulm complications with systemic opioids vs C-PVB or TEA

Post-Thoracotomy Pain Syndrome:
- 20% with TEA or C-PVB
- Up to 50% without Adv RA

Conclusion

Continuous Peripheral Nerve Blocks
- Introduction
- Risks and Benefits
- Supplies, Techniques
- Indications, Limitations
- Specific Types

Questions and Answers?
Liposomal Bupivacaine

Christopher Ciarallo, MD FAAP
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Disclosures

I have no commercial conflicts of interest

Objectives

- Describe the vehicle, prescribing instructions, and pharmacokinetics of liposomal bupivacaine
- Identify the potential local and systemic toxicities associated with liposomal bupivacaine administration
- Review the available literature describing liposomal bupivacaine local infiltration for postoperative analgesia
- Review the (limited) literature describing perineural and neuraxial administration of liposomal bupivacaine

Perineural Catheters

1. Technically more difficult
2. Expensive
3. Inflammation (3-4%)
4. Infection (<1%)
5. Catheter dislodgement
6. Catheter knotting / breaking
7. Intravascular migration
8. Myonecrosis
9. Hematoma

Liposomal Bupivacaine (Exparel®)

- DepoFoam®
  - Multivesicular spherical lipid particles in a honeycomb formation
  - Aqueous center containing encapsulated drug
  - Same delivery system as DepoDur®
- Approved only for surgical site infiltration
  - Contraindicated for paracervical blocks
  - Phase 2 and 3 trials for peripheral nerve blocks
Table 1. Comparisons of Liposomes and Liposomes

<table>
<thead>
<tr>
<th>Component</th>
<th>Unilamellar Liposome</th>
<th>Multilamellar Liposome</th>
<th>Liposome bupivacaine</th>
</tr>
</thead>
<tbody>
<tr>
<td>Compound</td>
<td>Unilamellar Liposome</td>
<td>Multilamellar Liposome</td>
<td>Liposome bupivacaine</td>
</tr>
<tr>
<td>Lipid</td>
<td>Phosphatidylcholine</td>
<td>Lipid</td>
<td>Lipid</td>
</tr>
<tr>
<td>Albumin</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Dose</td>
<td>10 mg</td>
<td>20 mg</td>
<td>0.89 mg/ml</td>
</tr>
<tr>
<td>Concentration</td>
<td>10 mg/liter</td>
<td>20 mg/liter</td>
<td>0.89 mg/ml/liter</td>
</tr>
<tr>
<td>pH</td>
<td>7.4</td>
<td>7.4</td>
<td>7.4</td>
</tr>
<tr>
<td>Temperature</td>
<td>Room temperature</td>
<td>Room temperature</td>
<td>Room temperature</td>
</tr>
</tbody>
</table>

Pharmacokinetics

Table 2. Pharmacokinetic parameters for liposomal bupivacaine and bupivacaine HCl

<table>
<thead>
<tr>
<th>Timepoint</th>
<th>Liposomal bupivacaine</th>
<th>Bupivacaine HCl</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.1 mg</td>
<td>0.05 mg</td>
<td>0.05 mg</td>
</tr>
<tr>
<td>0.05 mg</td>
<td>0.05 mg</td>
<td>0.05 mg</td>
</tr>
<tr>
<td>0.025 mg</td>
<td>0.05 mg</td>
<td>0.05 mg</td>
</tr>
<tr>
<td>0.0125 mg</td>
<td>0.05 mg</td>
<td>0.05 mg</td>
</tr>
</tbody>
</table>

Liposome bupivacaine compatibility with other local anesthetics, including lidocaine, ropivacaine, mepivacaine, or bupivacaine HCl (at liposome bupivacaine to bupivacaine HCl ratios < 2:1), which resulted in substantial displacement and release of free bupivacaine from liposomes . . .

Prescribing Information

(Pacira Pharmaceuticals, Inc.)

- 20 ml, single use vial, 1.33% (13.3 mg/ml)
- Refrigerated
  - May be stored unopened at room temperature for up to 30 days
- May be maximally diluted to 0.89 mg/ml
- Must be used within 4 hours of opening
- Minimum 25 gauge needle
- $285 per 20 ml vial (AWS)

- Similar physical appearance to propofol.

Liposomal Bupivacaine Compatibility

A review of the compatibility of liposome bupivacaine with other drug products and commonly used implant materials.

Liposome bupivacaine had clinically meaningful interactions with other local anesthetics, including lidocaine, ropivacaine, mepivacaine, or bupivacaine HCl (at liposome bupivacaine to bupivacaine HCl ratios < 2:1), which resulted in substantial displacement and release of free bupivacaine from liposomes . . .

Liposome bupivacaine may be locally administered after ≥ 20 minutes following local administration of lidocaine, ropivacaine, or mepivacaine.

The administration of EXPAREL may follow the administration of lidocaine after a delay of 20 minutes or more. Other formulations of bupivacaine should not be administered within 96 hours following administration of EXPAREL.
Liposomal Bupivacaine Systemic Toxicity

Toxicity of Bupivacaine Encapsulated into Liposomes and Injected Intravenously: Comparison with Plain Solutions

Jean Boggs, MD, Anne Decking, MSc, Nicole Lassalle, MD, Hassan Benabid, MD, El Manoua Abid, MD, Jean Claude Dupont, MD, and Franck J. Legros, MD

Laboratory of Neurophysiology, University of Brussels, Campus Erasme, Brussels, Belgium, and Yonsei University College of Medicine, Seoul, Korea.

The presence of intravascular and intrathecally injected liposomal bupivacaine did not significantly affect serum bupivacaine levels or the incidence of toxic effects when compared with plain bupivacaine. The authors concluded that liposomal bupivacaine is a safe and effective treatment for systemic toxicity, particularly in high-risk patients.

- Slow infusion of liposomal bupivacaine titrated to toxicity required larger doses
- No bolus, no temporal evaluation, no attempts at resuscitation
- Not using proprietary DepoFoam®

Liposomal Bupivacaine Local Toxicity

Research Article

The Safety of EXPAREL® (Bupivacaine Liposome Injectable Suspension) Administered by Peripheral Nerve Block in Rabbits and Dogs

In conclusion, a single administration of EXPAREL was demonstrated to be safe by peripheral nerve block in rabbits and dogs when tested in comparison with bupivacaine HC3 and saline. EXPAREL did not cause overt irritation or local tissue damage even when injected at high dose or concentration around the brachial plexus nerve bundle.

Bupivacaine did not impact directly on neural tissue, and the findings of granulomatous inflammation were more consistent with a nonspecific foreign—body type reaction most likely mediated by the DepoFoam particles.

Neurologic / Cardiovascular Toxicity

Table 1. Incidence of Cardiovascular Tachyarrythmias by Systemic Organ Class and Performed Time (All Phase II Wounded Infiltration Study) Denotes

- Slow infusion of liposomal bupivacaine titrated to toxicity required larger doses
- No bolus, no temporal evaluation, no attempts at resuscitation
- Not using proprietary DepoFoam®

Myotoxicity

Chondrotoxicity appears to be a much more salient problem in intra-articular usage of EXPAREL.

Table V. Total bupivacaine concentration in wound drainage fluid over 12 hours with bupivacaine HCl or liposome bupivacaine. Values are means.

<table>
<thead>
<tr>
<th>Treatment Group</th>
<th>Bupivacaine HCl 150 mg</th>
<th>Liposome bupivacaine</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>2.3</td>
<td>0.6</td>
</tr>
<tr>
<td></td>
<td>266 mg</td>
<td>4.9</td>
</tr>
<tr>
<td></td>
<td>399 mg</td>
<td>5.8</td>
</tr>
<tr>
<td></td>
<td>532 mg</td>
<td>5.5</td>
</tr>
</tbody>
</table>

Caution...

The Food and Drug Administration (FDA) has approved liposomal bupivacaine for local infiltration, but has not granted approval for the use of liposomal bupivacaine in peripheral and neuraxial nerve blocks. Until FDA approval is granted, liposomal bupivacaine in regional anesthesia should be considered investigational. The risks and benefits of liposomal bupivacaine in peripheral and neuraxial nerve blocks need further investigation.

- Not approved for:
  - age < 18 years old
  - pregnant patients (Category C)
  - breastfeeding mothers


Ankle Block
The effect of liposomal bupivacaine injection during total hip arthroplasty: a controlled cohort study  
*BMC Musculoskeletal Disorders* 2014, 15:310

- Reduced morphine use in first 24 hours
  - (53 vs. 24 mg)
- Reduced LOS
  - (2.47 vs. 1.93 days, p=0.05)
- Controls via retrospective chart review
- Significant bias toward hip resurfacing in control group (33% vs 11%)

Liposomal bupivacaine infiltration into the transversus abdominis plane for postsurgical analgesia in open abdominal umbilical hernia repair: results from a cohort of 13 patients  
*Journal of Pain Research* 2014:7 477–482

- No control group
- 77% required supplemental analgesia
- No adverse events
- 10 day follow-up by surgeons

A randomized, double-blind, dose-ranging study comparing wound infiltration of DepoFoam bupivacaine, an extended-release liposomal bupivacaine, to bupivacaine HCl for postsurgical analgesia in total knee arthroplasty

2012) 530–536

![Graph](image1.png)

**Fig. 3.** Mean area under the curve (AUC) for the numeric rating scale at rest (NRS-R) from 0 through 5 in the bupivacaine HCl and DepoFoam bupivacaine treatment groups. *P*<0.001, *P*<0.005.

Extended pain relief trial utilizing infiltration of Exparel®, a long-acting multivesicular liposome formulation of bupivacaine: a Phase IV health economic trial in adult patients undergoing open colectomy  
*Journal of Pain Research* 2012:5 567–572

![Graph](image2.png)

**Fig. 4.** Mean plasma bupivacaine concentrations after administration of DepoFoam bupivacaine or bupivacaine HCl by infiltration in patients undergoing total knee arthroplasty.  
*The Knee* (2012) 530–536
Liposomal Bupivacaine Versus Traditional Periarticular Injection for Pain Control After Total Knee Arthroplasty

Deren T. Bagby, MD, Phillip H. Ireland, MD, R. Michael Meneghini, MD

Department of Orthopaedic Surgery, Indiana University Health Physicians, Indiana University School of Medicine, Indianapolis, Indiana

The Journal of Arthroplasty 29 (2014) 1687-1690

Table 2

<table>
<thead>
<tr>
<th>Drug Outcome Measures</th>
<th>Liposomal Bupivacaine</th>
<th>Bupivacaine Injection</th>
<th>P Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Time until 1st opioid (min)</td>
<td>14.2 ± 4.17</td>
<td>48.8 ± 14.7</td>
<td>0.79</td>
</tr>
<tr>
<td>Self-Rated Pain</td>
<td>First 24 h</td>
<td>1.74 ± 2.10</td>
<td>1.74 ± 1.24</td>
</tr>
<tr>
<td></td>
<td>Remaining Stay</td>
<td>4.89 ± 1.35</td>
<td>4.38 ± 1.80</td>
</tr>
<tr>
<td></td>
<td>Total</td>
<td>4.11 ± 1.86</td>
<td>3.03 ± 2.90</td>
</tr>
<tr>
<td>Opiate Usage (Mg)</td>
<td>First 24 h</td>
<td>6.21 ± 3.30</td>
<td>13.75 ± 12.3</td>
</tr>
<tr>
<td></td>
<td>Remaining Stay</td>
<td>7.40 ± 5.07</td>
<td>65.50 ± 16.00</td>
</tr>
<tr>
<td>Anti-Emetic Doses</td>
<td>First 24 h</td>
<td>0.72 ± 1.45</td>
<td>0.47 ± 0.65</td>
</tr>
<tr>
<td></td>
<td>Remaining Stay</td>
<td>1.03 ± 1.85</td>
<td>0.81 ± 1.55</td>
</tr>
<tr>
<td>Nabixone Doses</td>
<td>First 24 h</td>
<td>0.03 ± 0.25</td>
<td>0.00 ± 0.00</td>
</tr>
<tr>
<td></td>
<td>Remaining Stay</td>
<td>0.00 ± 0.00</td>
<td>0.02 ± 0.15</td>
</tr>
</tbody>
</table>

Mg = Intravenous Morphine Equivalents.

The Journal of Arthroplasty 29 (2014) 1687-1690

The Use of Exparel (Liposomal Bupivacaine) to Manage Postoperative Pain in Unilateral Total Knee Arthroplasty Patients

Jonathan W. Sudano, MD, David J. Lisini, MD, Nathan T. Barnes, PA-C, Brinaya R. Aroc, BSN, RN, CRN

Department of Orthopaedic Surgery, Indiana University Health Physicians, Indianapolis, Indiana

The Journal of Arthroplasty xxx (2014) xxx-xxx

Fig. 2. Comparison of average pain scores for patients treated with FNB and Exparel. * indicates significant difference.

Fig. 6. Comparison of average opioid use for patients treated with FNB and Exparel. * indicates significant difference.

The Journal of Arthroplasty xxx (2014) xxx-xxx

Femoral Block

Fig. 3. Comparison of average pain scores for patients treated with FNB and Exparel. * indicates significant difference.

Fig. 4. Comparison of average pain scores for patients treated with FNB and Exparel. * indicates significant difference.

The Journal of Arthroplasty xxx (2014) xxx-xxx
Epidural Liposomal Bupivacaine: Sensory Blockade

Based on this case, we speculate that other types of rib pathology—for example, traumatic rib fractures—may also be amenable to palliation with intercostal nerve block with liposomal bupivacaine.

SABER-Bupivacaine

(Investigational Product; Not FDA approved)
Objectives
After 30 minutes, understand:

1. Pathophysiology of pulmonary hypertension (PH)
2. Anesthetic management of PH
3. Strategies to prevent and treat a PH crisis

Case Scenario
• 18yr old, 70kg female with PH
• Requires Broviac® catheter placement and lung biopsy
• Last Echocardiogram report
  – Tricuspid regurgitant (TR) jet 5m/sec (BP 110/70)
  – No PFO
• Patient’s medications
  – Epoprostenol sodium (Flolan®)
  – Sildenafil (Revatio®)
  – Bosentan (Tracleer®)
  – Aspirin
  – Nifedipine

Definition: Pulmonary Hypertension
• mPAP ≥ 25 mmHg at rest
  • Normal mean pulmonary artery pressure (mPAP)≈15mmHg
    – independent of age, gender, ethnicity
  • During exercise mPAP increases slightly
    – dependent on age and level of exertion

• PVRI ≥ 3 Wood units m²
  • In association with variable degrees of:
    • Pulmonary vascular remodeling
    • Vasoconstriction
    • In-situ thrombosis

Disclosures
• No financial disclosures
• Some drugs discussed are an off-label application
Case Scenario

- 18yr old, 70kg female with PH
- Requires Broviac® catheter placement and lung biopsy
- Last Echocardiogram report
  - TR jet 5m/sec (BP 110/45)
  - No PFO
- Patient’s medications
  - Epoprostenol sodium (Flolan®)
  - Sildenafil (Revatio®)
  - Bosentan (Tracleer®)
  - Aspirin
  - Nifedipine

ECHO: Systolic TR Velocity

Bernoulli Equation

\[ sPAP = 4v^2 + RAP \]

\[ = 4(5^2) + 10 \]

\[ = 110 \text{ mmHg} \]

Limitations:
- Need TR
- Assumes perfect alignment between Doppler and TR jet

Definition: Pulmonary Hypertension

- \( mPAP \geq 25 \text{ mmHg} \) at rest
- Normal mean pulmonary artery pressure (\( mPAP \)) = 15 mmHg

\( \bullet PVRI \geq 3 \text{ Wood units m}^2 \)

Pulmonary Vascular Resistance

\[ \text{PVR} = \Delta P/\text{flow} \]

\[ \Delta P \text{ (TPG)} = mPAP - LAP \]

\[ \text{PVR} = mPAP - LAP/\text{CO} \]

Cardiac Cath: Gold standard

1. Hemodynamics
   \[ \text{PVR} = mPAP - LAP/\text{CO} \]
   Normal PVR 1-1.4 Wood units m² (90 – 120 dynes/s/cm²)
   PH PVR > 3 Wood units m² (240 dynes/s/cm²)
   Wood units x 80 = dyynes/s/cm²

2. Vasoreactivity testing
   Short acting pulmonary vasodilator
   - iNO, IV adenosine
   Drop in mPAP > 10 mmHg
   Responders (<10%) may benefit from calcium channel blockers

3. Rule out associated disease states
   - Pulmonary vein disease
Non-invasively monitor patients with PH?

- Right ventricle (RV) function
  - Ability of the RV to cope with progressive increase in PA pressure
  - Determines patient’s functional capacity and survival
- Other ECHO parameters (observer angle dependent):
  - TAPSE (Tricuspid Annular Plane Systolic Excursion)
  - Tei index

Increase of 0.1 in S:D ratio associated with 13% increase in yearly risk for lung transplant or death.

S:D ratio > 1.4 associated with worse:
- RV function
- Hemodynamics
- Exercise capability
- Clinical status

PH Classification: What increases mPAP?

\[ PVR = mPAP - \frac{LAP}{CO} \]
\[ mPAP = LAP + (CO \times PVR) \]

1. ↑LAP
   - LV systolic / diastolic dysfunction
   - Mitral valve stenosis / regurgitation

2. ↑CO
   - Congenital heart disease with L to R shunt

3. ↑PVR
   - Pulmonary parenchymal disease
   - Thromboembolic disease

WHO Classification Conferences

- 1973 Geneva
- 1988 Evian
- 2003 Venice
- 2008 Dana Point
- 2011 Panama
  - Pulmonary Vascular Research Institute
  - Classification specific to children
- 2013 Nice, France

WHO Classification

- Group I  PAH
- Group II  Left sided heart disease
- Group III  Lung disease and/or hypoxia
- Group IV  Chronic embolic/thrombotic
- Group V  Miscellaneous
WHO Classification

- **Group I** PAH
  - Idiopathic
  - Heritable: TGF-β Family (BMPR2, ALK-1, Endoglin)
  - Drugs: Fenfluramine, methamphetamine
  - Herbal supplements: St. John’s Wort
  - Associated with:
    - Congenital heart disease
    - Connective tissue disease (SLE)
    - HIV
    - Chronic hemolytic anemias (Sickle cell disease)
    - Schistosomiasis
    - Pulmonary veno-occlusive disease (PVOD)

- **Group II** Left heart disease
  - Mitral valve disease

- **Group III** Lung disease and/or hypoxia
  - COPD
  - BPD
  - Interstitial lung disease
  - Sleep-disordered breathing
  - High altitude

- **Group IV** Chronic embolic/thrombotic
- **Group V** Miscellaneous
  - Myeloproliferative disorders
  - Metabolic disorders

---

Pediatric Pulmonary Hypertension

**PH: Congenital Heart Disease**

- **Biventricular Circulation**
  - \( mPAP > 25\text{mmHg} \) & \( PVRI > 3\text{ Wood units m}^2 \)
  - Positive vasodilator response is a fall in \( mPAP \) and \( PVRI \) by 20% with no change in \( CO \)

- **Univentricular Circulation**
  - following cavopulmonary anastomosis
  - \( PVRI > 3\text{ Wood units m}^2 \) or \( TPG > 6\text{ mmHg} \)
  - EVEN IF \( mPAP < 25\text{mmHg} \)

---

**Adult: Epidemiology & Survival**

- Rare disease 5-15 cases / million
- REVEAL
  - Age of presentation increased from 35yrs in 1980s to 53yrs
  - Male:Female 1:4
  - 1yr survival 80-90%
  - 3yr survival 60%

---

**Pediatric: Epidemiology & Survival**

**TOPP\(^1\)**
- Global registry
- At diagnosis:
  - Median age 7yrs
  - Dyspnea & fatigue
  - 43% other disorders
    - 85% CHD, 12% BPD
    - Chromosome anomalies 13% (Trisomy 21)

**REVEAL\(^2\)**
- USA registry
- At diagnosis:
  - Median age 7yrs
  - Dyspnea
  - \( mPAP 56\text{mmHg} \)
  - PVRI 17 Wood units m\(^2\)
  - 5yr survival 75%

\(^1\)Berg R, Lurie D. 2012; 379:537-46
\(^2\)Hunt Circulation 2012;125:113-122
Case Scenario

• 18yr old, 70kg female with PH
• Requires Broviac® catheter placement and lung biopsy

• Last Echocardiogram report
  – TR jet 5m/sec (BP 110/45)
  – No PFO

• Patient’s medications
  – Epoprostenol sodium (Flolan®)
  – Sildenafil (Revatio®)
  – Bosentan (Tracleer®)
  – Aspirin
  – Nifedipine

Question

With no PFO on ECHO, what may happen during an acute increase in PVR?

<table>
<thead>
<tr>
<th>Option</th>
<th>BP</th>
<th>SpO₂</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>↓</td>
<td>↓</td>
</tr>
<tr>
<td>2</td>
<td>↑</td>
<td>↑</td>
</tr>
<tr>
<td>3</td>
<td>↓</td>
<td>↔</td>
</tr>
<tr>
<td>4</td>
<td>↓</td>
<td>↓</td>
</tr>
</tbody>
</table>

PH: Pathology

A. Vasculopathy of the pulmonary arteriole cells
   1. Endothelial
      Intimal hyperplasia
   2. Smooth muscle cell (SMC)
      Medial hypertrophy
   3. Adventitial
      Proliferation

B. Vasoconstriction

C. Thrombosis

Pathophysiology of Pulmonary Circulation

Poiseuille’s Law: \( R = \frac{\pi r^4 p}{8nl} \)

8mm \( \approx 1 \times R \)
4mm \( \approx 16 \times R \)
2mm \( \approx 256 \times R \)

FIXED Structural changes decrease X-sectional area
REACTIVE Vascular smooth muscle contraction

Cool Chest 2005;128:656-571
Twite, Mark, MA, MB, BChir, FRCP

CRASH 2015: Pulmonary Hypertensive Crisis
PH: Ventilation

Ventilation strategy for PH:
- Oxygen
- Tidal volume 6ml/kg
- Rate – mild hypocapnia
- Optimum PEEP
- Recruitment maneuvers
- Drain pleural effusions/pneumothorax

Adapted from West’s Essential Physiology 10th Ed.

PVR changes with pH and PaO₂

Rudolph J Clin Invest 1966;45:399-411

Discussion

What will be your airway and ventilation strategy to facilitate the lung biopsy?

Concerns?

Does anyone want a type & screen or cross match?

Case Scenario

• 18yr old, 70kg female with PH
• Requires Broviac® catheter placement and lung biopsy
• Last Echocardiogram report
  – TR jet 5m/sec (BP 100/45)
  – No PFO
• Patient’s medications
  – Epoprostenol sodium (Flolan®)
  – Sildenafil (Revatio®)
  – Bosentan (Tracleer®)
  – Aspirin
  – Nifedipine

Case Scenario

• 18yr old, 70kg female with PH
• Requires Broviac® catheter placement and lung biopsy
• Flolan® running via PIV
• NPO status good
Question
What is this patient’s risk of cardiac arrest under general anesthesia?
1. 10 times LESS
2. SAME
3. 10 times GREATER
4. 40 times GREATER

PH: Peri-operative risk

<table>
<thead>
<tr>
<th>Population</th>
<th>Procedures (n)</th>
<th>Cardiac arrest (%)</th>
<th>Death (%)</th>
<th>Reference</th>
</tr>
</thead>
<tbody>
<tr>
<td>All children</td>
<td>All (1,089,200)</td>
<td>0.027</td>
<td>0.004</td>
<td>Morray et al. Anesthesiology 2000;93:6-14</td>
</tr>
<tr>
<td>All children</td>
<td>All except cardiac surgery (88,639)</td>
<td>0.029</td>
<td>0.016</td>
<td>Flick et al. Anesthesiology 2007;106:226-237</td>
</tr>
<tr>
<td>Children with heart disease</td>
<td>Cardiac cath (4,445)</td>
<td>0.49</td>
<td>0.08</td>
<td>Battuti et al. Pediatr Anesth 2007;17:1083-88</td>
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<td>Children with PAH</td>
<td>All except cardiac surgery (256)</td>
<td>1.17</td>
<td>0.78</td>
<td>Carmosino et al. Anesth Analg 2007;104:521-527</td>
</tr>
<tr>
<td>Children with PAH</td>
<td>Cardiac cath (141)</td>
<td>2.13</td>
<td>1.42</td>
<td>Carmosino et al. Anesth Analg 2007;104:521-527</td>
</tr>
<tr>
<td>Children with PAH</td>
<td>Cardiac cath (70)</td>
<td>5.71</td>
<td>1.43</td>
<td>Taylor et al. Br J Anaesth 2007;99:637-641</td>
</tr>
<tr>
<td>Children with PAH</td>
<td>Cardiac cath (128)</td>
<td>0.8</td>
<td>0</td>
<td>Williams et al. Pediatr Anesth 2010;20:28-37</td>
</tr>
</tbody>
</table>

Adapted from Friesen Pediatr Anesthesia 2008;18:208-216

Discussion

What is your plan for induction of anesthesia?
Use the existing PIV?
Drugs?

PH: Goals of anesthetic management

1. Avoid increases in pulmonary vascular resistance (PVR)
   - Hypoxia, Hypercarbia, Metabolic acidosis
   - Sympathetic stimulation secondary to noxious stimuli (endotracheal intubation, surgery, tracheal suctioning)
2. Avoid systemic hypotension
   - Decreases coronary artery blood flow leading to myocardial ischemia and ventricular dysfunction
   - A rapid increase in PVR to a point where PAP > SBP leads to RV failure especially if there is no PFO (or atrial septostomy)

Hemodynamic effects of anesthetic drugs

<table>
<thead>
<tr>
<th>Anesthetic</th>
<th>Contractility</th>
<th>MAP</th>
<th>HR</th>
<th>PAP</th>
<th>PVR</th>
<th>RR</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nitrous oxide</td>
<td>↓</td>
<td>↓</td>
<td>↓</td>
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<td>↓</td>
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<tr>
<td>Isoflurane</td>
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<td>↑</td>
<td>↑</td>
<td>↑</td>
<td>↑</td>
</tr>
<tr>
<td>Opioids</td>
<td>↓</td>
<td>↓</td>
<td>↓</td>
<td>↓</td>
<td>↓</td>
<td>↓</td>
</tr>
<tr>
<td>Benzodiazepines</td>
<td>↓</td>
<td>↓</td>
<td>↓</td>
<td>↓</td>
<td>↓</td>
<td>↓</td>
</tr>
</tbody>
</table>

MAP: mean arterial pressure; HR: heart rate; ↓: decrease; ↑: increase; ↓↓: no significant change; *Ketamine can decrease contractility in vitro and in catecholamine-depleted patients. Dexmedetomidine can increase HR during leading dose administration.
Preparation

- iNO in the room
  - Set-up and working, weaning plan to avoid rebound PH
- Anesthesia drugs
  - 4% topical lidocaine spray for vocal cords
  - Balanced technique
  - Resuscitation drugs ready
- Communicate with surgeon
  - High risk patient
  - Local anesthetic
- Post-op plan
- Communicate with PH team

Pulmonary Hypertensive Crisis

- Pulse-oximetry desaturation  Sats 70%
- Hypotensive  BP 60/30
- Tachycardia → Bradycardia  HR 30
- ECG ST segment changes

PH: Pathophysiology of RV Failure

- \( P_{O_2} \) and \( P_{O_2} \) will ↓ iPVR
- Hyperventilate
- PVR is directly related to \( PaCO_2 \)
- Exclude pneumothorax
- Optimize ventilation
- ↓ Mean Airway Pressure
- Avoid \( P_{aw} > P_{aw} \)
- Correct metabolic acidosis
- PVR is directly related to \( H^+ \) level
- Administer pulmonary vasodilators
- iNO
- Decrease sympathetic mediated ↑ PVR
- Analgesia
- Support cardiac output
- Adequate preload, epinephrine, vasopressin
- ECMO
- Support cardiac output and oxygenation

Disposition and Follow-up

- Extubated and returned to the ICU
- Returned emergently to the OR 3 hours later
  - Bleeding via Chest Tube
  - Hypoxic and hypotensive

Summary

- Knowledge & therapy of PH is an evolving field
- Patients with systemic PH are HIGH risk
- Goals for anesthesia in PH
  - Preparation
  - Good airway management
  - Balanced anesthetic drug technique
Thankyou!

Mark.Twite@UCDenver.edu

Bibliography


Ferenc Puskas, M.D., Ph.D.
Difficult Case
Monday, March 2, 2015
Panel Discussion

*Considerations for Tracheal Resection*

**Objectives**

At the conclusion of this session, the participant will be able to:

1. Describe the surgical anatomy and methods of upper (tracheal) and lower (carinal) airway resection and reconstruction

2. Discuss anesthetic challenges, including preoperative assessment, airway management, endotracheal and endobronchial tube choice and intubation, modes of ventilation, emergence and post-anesthesia care management

**Difficult Case**

A 32-year-old female with poorly controlled IDDM presents with several months of progressive stridor and dyspnea. She had been first treated for adult onset asthma without effect. A chest CT showed severe tracheal narrowing. The patient underwent a flexible and rigid bronchoscopy with general anesthesia. Bronchoscopy showed normal subglottic opening, normal vocal cords and a discrete tight tracheal stenosis with an appearance of a mature scar at approximately 4 cm below the carina. Past medical history is significant for morbid obesity (156 cm and 118 kg) and an episode of sepsis, respiratory failure from a perforated diverticulitis, which required ICU admission and intubation. Current medications are prednisone, insulin, Combivent and Advair. Tracheal resection and reconstruction was scheduled.

Tracheal resection is most often performed for postintubation stenosis or tumor resection. Risk factors for postintubation stenosis include duration of intubation, ETT cuff overinflation, ETT repetitive movement, hypotension, infection and comorbid conditions (diabetes). Other indications for stenosis include congenital lesions, infectious/inflammatory pathology. Postintubation Tracheal Stenosis is an iatrogenic lesion caused by cicatricial healing of an area of transmural injury to the airway. Etiologically intubation of the airway resulting in local ischemia or necrosis and subsequent stenosis during the phase of healing by secondary intention and has an incidence up to 20%. It is caused by the cuff of the endotracheal tube or pressure from the rigid endotracheal or tracheostomy tube. As the blood supply of the trachea is segmental, blood vessels perforate the tracheal wall at each interannual space and arborize the submucosa compression of the submucosa can thus cause regional ischemia of the cartilaginous ring. Ventilated patients have frequently decreased systemic
perfusion pressure, which can be a contributing factor. With the removal of the tube healing by secondary intention leads to cicatization and local stricture, typically in 3-6 weeks. New more compliant, D-shaped, high-volume, low-pressure cuffs have been shown to greatly reduce the incidence of airway injury. In addition it has become the standard of care to routinely monitor intracuff pressure and maintain it below 30 mmHg, or as low as needed to create an adequate seal for ventilation.

**Anesthetic setup and considerations**

Typical monitoring includes standard ASA monitors but reliable pulse oximetry is particularly important. An intra-arterial catheter is useful for continuous blood pressure monitoring and for additional periodic monitoring of oxygenation and CO₂ retention. Since the innominate artery lies anterior to the trachea, a left arm or femoral cannulation is desired to avoid conflicting readings from compression or ligation of the artery.

**Required Anesthesia equipment**

- Anesthesia machine capable of delivering 20 L/min O₂
- ETT: size 4mm uncuffed to 8 cuffed, flexible armored tubes (sterile and unsterile various sizes), extra-long ETTs (customized or standardized)
- High frequent positive pressure ventilator – optional
- Automated jet ventilator or type of manual jet ventilation capabilities (high frequency and low frequency) with catheters
- Extra anesthesia circuits - sterile
- Second anesthesia machine
- Fluid warmer
- Warming blanket
- NG tube

Central line access is typically not indicated unless mandated by the patient’s history. Neck and chest access may not be ideal sites for central line access. Reliable IV access is necessary with typically two peripheral IVs, one in each arm. A decision-making algorithm is helpful in determining anesthetic management with open communication between the surgeon and anesthesiologist.

**Anesthesia Induction**

Premedication and induction needs to take into consideration the extent of tracheal stenosis. Preoperative sedation should be managed carefully to avoid total airway obstruction. This might be best avoided until the patient is in the operating room with preparation made for induction. Non-particulate antacids and metoclopramide and histamine-2 blockers should be administered in patients with reflux. However not administering anti-sialagogues can be considered as they may create thickening of secretions and form mucus plugs causing further obstruction. Proper positioning of the
head and neck extension with shoulder elevation are critical for manipulation of the airway with rigid bronchoscopy. The eyes should be properly protected. If an awake examination or intubation is required, topical anesthesia minimizes the response to instrumentation. Structures anesthetized include the tongue, posterior pharynx, epiglottis, glottis, and infraglottic airway. The major nerves of the airway are branches of the trigeminal nerve and glosso-pharyngeal nerve, superior laryngeal nerve, and recurrent laryngeal nerve. Nebulized 4% lidocaine usually provides topical anesthesia for most of these structures. More intense block to the tongue, pharynx, and superior epiglottis occurs with intraoral glosso-pharyngeal nerve block and superior laryngeal nerve block. Topical anesthesia to the lower airway can be accomplished with transtracheal block, spray injection via fiberoptic bronchoscope or inhalation of nebulized local anesthetic. Medications for IV sedation include judicious use of benzodiazepines, dexmedetomidine, propofol and opioids such as remifentanil. If an awake intubation is needed, induction of anesthesia is avoided until an airway (ETT) has passed the obstruction or if the obstruction is unlikely based on direct visualization. Less severe obstructions allow for an inhalational induction typically with sevoflurane with the patient spontaneously breathing. This is performed after aggressive denitrogenation with 100% oxygen for 5 minutes or more. If ventilation is compromised the patient is awakened. Placement of an LMA for flexible bronchoscopy can be performed or the anesthetic may be deepened to allow rigid bronchoscopy without paralysis. Blood pressure support may be with a vasopressor. An LMA can be placed to facilitate oxygenation and ventilation during bronchoscopic evaluation and treatment of proximal lesions (balloon dilatation). Regardless of the mode of induction, a physician or surgeon adept at rigid bronchoscopy must be available to control the airway. Once the obstruction is examined by rigid bronchoscopy and selective dilation is performed a more secure airway is established. If the obstruction is proximal to the carina, an ETT is placed with the tip above the lesion. In high lesions a small ETT is placed through the narrowing. In minimal airway compromise, IV induction after pre-oxygenation may be appropriate. Once the airway is controlled beyond the obstruction and positive pressure ventilation is adequate, neuromuscular blockers may be given. Cardiopulmonary bypass or extracorporeal membrane oxygenation have been used prophylactically or during airway catastrophes. Proper planning must be performed for potential cannulation strategies.

**Emergence and Extubation**

Rapid extubation is always the primary goal to avoid anastomotic failure from mechanical positive pressure ventilation. Complete reversal of neuromuscular blockade is critical. During extubation it is important to minimize coughing, gagging, and neck extension. Cervical flexion is desired as it allows for maximum amount of approximation of the trachea. The surgeon will place a guardian stich to prevent head and neck extension. Additionally pillows placed behind the head support neck flexion. Anxiolysis upon emergence may be combated with dexmedetomidine, or low doses of propofol or remifentanil, and allows for a smooth transition and cooperative patient. Criteria for extubation must be met with the patient following commands. If controlled ventilation
must be continued, repositioning of the ETT cuff distal to the anastomotic site is desirable. If extubation is delayed, spontaneous ventilation is the desired ventilator mode. Pain management can be performed with minimizing the use of opioid narcotics. Analgesics that do not depress respiration such as acetaminophen, ketamine, and ketorolac are considered good alternatives. Oxygen via mask should be provided immediately after extubation. Phonation is elicited to determine potential laryngeal nerve damage. If reintubation is required, minimizing head extension is important to prevent tension on the anastomosis. The most ideal method of reintubation is with oral or nasal fiberoptic bronchoscopy. Typically an uncuffed ETT is reasonable to minimize contact with the anastomosis. Cuffed ETTs should be positioned with the cuff distal to the anastomosis. During reintubation, examination of the anastomotic site is performed and vocal cord dysfunction can be identified.
Tuesday, March 3
NOTHING TO DISCLOSE

- Moved to California
- Working at Stanford and Lucille Packard Children’s Hospital
- This is my last year as CRASH Program Director
- Can’t ski cause I broke my wrist
- Please encourage next year’s organizer’s to invite me back 😊

OBJECTIVES:

- Surgical Environment
- Codeine
- Anesthesia and neurodevelopment
- PRAN Update
- Lidocaine and laryngospasm
- Clotting-differences in children
- Machine washout

AMERICAN PEDIATRIC SURGICAL ASSOCIATION

- American College of Surgeons
- Society for Pediatric Anesthesia
- American Academy of Pediatrics
- Children’s Hospital Association
- Created task force in 2012
- Met in 2012, 13, 14
- Develop “consensus recommendations”
Currently a "mismatch"

Suboptimal care

35% of neonates in 2009 complex surgery at non-specialty institutions/units

"Appropriate pediatric anesthesia expertise, including both relevant training and an adequate level of ongoing clinical pediatric practice, was judged to be critical"

**OPTIMAL RESOURCES FOR CHILDREN’S SURGICAL CARE**

- Pediatric Anesthesiologist for children < 1 year of age
- Dedicated area for pre and post
- Special needs for emotional well being
- Anesthesia and resuscitation equipment readily available
- One + PALS certified person available
- Admission and monitoring for neonates and Ex-premature infants
- Formal transfer agreements

**AMBULATORY SURGERY RECOMMENDATIONS**

1. Pediatric Anesthesiologist for children < 1 year of age
2. Dedicated area for pre and post
3. Special needs for emotional well being
4. Anesthesia and resuscitation equipment readily available
5. One + PALS certified person available
6. Admission and monitoring for neonates and Ex-premature infants
7. Formal transfer agreements
DEFINITIONS

Anesthesiologist with pediatric expertise: An anesthesiologist with pediatric expertise is defined as an anesthesiologist either eligible to certify or with a current certificate of the American Board of Anesthesiology, or equivalent, in addition, the individual will demonstrate ongoing pediatric clinical engagement in patients younger than 18 years of age, as well as 10 relevant category 1 CME credit hours annually.

Pediatric anesthesiologist: Pediatric anesthesiologist is defined as an individual certified in anesthesia by the American Board of Anesthesiology or equivalent, in addition to being certified or eligible for certification in pediatric anesthesia by the American Board of Anesthesiology or equivalent organization. Such an individual must demonstrate adequate ongoing engagement in the practice of pediatric anesthesia in patients younger than 18 years of age.

DRAFT-11/20/14

Optimal Resources for Children’s Surgical Care Verification/Consultation Program for Hospitals

Hospital Prereview Questionnaire (PRQ)

1. Overview

1. Name of Hospital/Health System

2. Address

3. City, State, Zip

OPTIMAL RESOURCES

- Information being widely disseminate
- Plan to start voluntary reviews
- Administered by American College of Surgeons

HOPEFULLY YOU ARE NOT STEAMING HOT OR FEELING LIKE YOU’RE ABOUT
ANESTHESIA AND NEURO DEVELOPMENT

Anesthesia Before Age 2 May Link Learning Disability Later On

ANESTHESIA AND NEUROTOXICITY

New FDA statement coming soon

- Much Stronger Warning

- Over-inhibition
- All volatile anesthetics, midazolam, propofol, and ketamine have been implicated
- Many species including primates
- So far opioids seem to be OK

VOLATILE AND OTHER ANESTHETICS

OF MICE AND MEN

- Mice
  - Brain Growth Spurt: first 1-2 weeks of life
  - Anesthetized for 5-6 hours
  - Many unmonitored
  - Pain and surgical stress are harmful

- Humans
  - Brain Growth Spurt: prenatal-24 months
  - Equivalent to several days-months
  - Monitored
  - Pain and surgical stress are harmful

Table 1. Characteristics of eligible studies for meta-analysis.

<table>
<thead>
<tr>
<th>Study Title</th>
<th>Authors</th>
<th>Year</th>
<th>Country</th>
<th>Study Design</th>
<th>Sample Size</th>
<th>Study Population</th>
<th>Outcome Measure</th>
<th>Additional Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>Study 1</td>
<td>Wang, X.</td>
<td>2014</td>
<td>China</td>
<td>Retrospective</td>
<td>1000</td>
<td>Children</td>
<td>Neurodevelopment</td>
<td>High risk of bias</td>
</tr>
<tr>
<td>Study 2</td>
<td>Xu, Z.</td>
<td>2014</td>
<td>India</td>
<td>Case-control</td>
<td>500</td>
<td>Adults</td>
<td>Neurodevelopment</td>
<td>Low risk of bias</td>
</tr>
<tr>
<td>Study 3</td>
<td>Miao, C-H</td>
<td>2014</td>
<td>Japan</td>
<td>Prospective</td>
<td>750</td>
<td>Pregnant Women</td>
<td>Neurodevelopment</td>
<td>Randomized control</td>
</tr>
</tbody>
</table>

All children undergoing pyloric stenosis b/w 1986-1990 in Denmark
- Compared with 5% age matched sample
- 9th grade standardized educational test
- Small % of Danish children do NOT take these tests
- Variables: sex, birth weight, parental education and age.
- Exclusions: congenital malformation, hyperbilirubinemia, neonatal jaundice

**RESULTS**

<table>
<thead>
<tr>
<th></th>
<th>Pyloric Stenosis</th>
<th>No Pyloric Stenosis</th>
</tr>
</thead>
<tbody>
<tr>
<td>% male</td>
<td>80</td>
<td>51.6</td>
</tr>
<tr>
<td>Parental Age</td>
<td>similar</td>
<td>similar</td>
</tr>
<tr>
<td>Parental Education</td>
<td>slightly lower</td>
<td></td>
</tr>
<tr>
<td>Mean Birth Weight (g)</td>
<td>3345</td>
<td>3434</td>
</tr>
<tr>
<td>Age at time of surgery</td>
<td>40 days</td>
<td></td>
</tr>
<tr>
<td>Congenital malformations</td>
<td>6.8%</td>
<td>4.4%</td>
</tr>
<tr>
<td>Non-attainment-boys</td>
<td>22%</td>
<td>16%</td>
</tr>
<tr>
<td>Non-attainment-girls</td>
<td>13%</td>
<td>10%</td>
</tr>
</tbody>
</table>

\[ OR = 1.37 \]

- Mean test scores similar once low birth weight and congenital malformation are excluded
- Higher incidence of test Non-Attainment in exposed patients boys > girls

**CONCLUSION**

- 100 children who had surgery < 1 yr of age
- Performance on “high stakes” test at age 12
- Diagnosis of “learning disability”
- Phone surveys
- Slightly higher incidence of “learning disabilities”
PROBLEMS WITH THE STUDY

- Small
- Retrospective
- GA group was 90% male
- Maternal education slightly lower
- Learning disabilities not defined

ING ET AL. ANESTHESIOLOGY 2014

- Data sets derived from children born between 1989-1992
- Extensive and repeated individual neurodevelopmental tests
  - ICD 9 diagnoses of “ADHD”
  - Neuropsychological test
  - Group Academic tests
- No difference in group tests
- Neuropsych testing and ICD diagnosis alterations

FLICK EDITORIAL

Most studies with negative results used were large and reviewed group tests of achievements
Most positive studies were small and looked at individual cognitive evaluation
Use of ICD-9 codes for ADHD are controversial and inaccurate
**SELECTED REFERENCES**


**SHOULD WE WAIT?**

- What should we tell families?
- Informed consent?
- Are some medication better?
- Can anything help?

**UPDATE FROM PEDIATRIC REGIONAL ANESTHESIA NETWORK**

- Anesthesia & Analgesia: January 2015 - Volume 120 - Issue 1 - p 151-196
  - Pediatric Anesthesiology: Research Report
  - Are Caudal Blocks for Pain Control Safe in Children? An Analysis of 18,650 Caudal Blocks from the Pediatric Regional Anesthesia Network (PRAN) Database

<table>
<thead>
<tr>
<th>Incidence (95% confidence interval)</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Block failure</td>
<td>1% (0.8 to 1.1)</td>
</tr>
<tr>
<td>Blood aspiration</td>
<td>0.6% (0.5 to 0.8)</td>
</tr>
<tr>
<td>Positive test dose</td>
<td>0.1% (0.1 to 0.2)</td>
</tr>
<tr>
<td>Dural puncture</td>
<td>0.08% (0.005 to 0.01)</td>
</tr>
<tr>
<td>Cardiac arrest</td>
<td>0.005% (~ to 0.002)</td>
</tr>
<tr>
<td>Seizure</td>
<td>0.005% (~ to 0.002)</td>
</tr>
<tr>
<td>Sacral pain</td>
<td>0.005% (~ to 0.002)</td>
</tr>
<tr>
<td>Muscle spasm</td>
<td>0.005% (~ to 0.002)</td>
</tr>
</tbody>
</table>
Mean dose 1.4 mg/kg bupivacaine + epi
>4000 received more than 2mg/kg
Almost 1000 received more than 2.5mg
Dosing variability
Decreasing use of ultrasound

Almost 19,000 patients and no temporary or permanent sequelae
A great deal of dosing variability with the only 2 cases of possible systemic toxicity occurring at doses well below currently recommended doses

7.7% with Anatomic landmarks
88% with U/S
13% with nerve stimulation
No postoperative neurologic symptoms (PONS)
No local anesthetic systemic toxicity (LAST)
One post-op infection
One intravascular puncture
ASLEEP VS. AWAKE

<table>
<thead>
<tr>
<th>Age Group</th>
<th>&lt;5 yr</th>
<th>5 to 10 yr</th>
<th>10 to 12 yr</th>
<th>13 to 16 yr</th>
<th>17 to 18 yr</th>
</tr>
</thead>
<tbody>
<tr>
<td>Single shot blocks</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Nerve block</td>
<td>764</td>
<td>334</td>
<td>164</td>
<td>78</td>
<td>10</td>
</tr>
<tr>
<td>Low back</td>
<td>37</td>
<td>93</td>
<td>120</td>
<td>323</td>
<td>945</td>
</tr>
<tr>
<td>Lower extremity</td>
<td>12</td>
<td>48</td>
<td>185</td>
<td>496</td>
<td>1967</td>
</tr>
<tr>
<td>Total</td>
<td>853</td>
<td>424</td>
<td>249</td>
<td>727</td>
<td>368</td>
</tr>
<tr>
<td>Catheter blocks</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Nerve block</td>
<td>314</td>
<td>187</td>
<td>314</td>
<td>1284</td>
<td>2876</td>
</tr>
<tr>
<td>Total</td>
<td>1329</td>
<td>5285</td>
<td>7626</td>
<td>7767</td>
<td>10448</td>
</tr>
</tbody>
</table>

TAP BLOCKS

- 1994 patients
- Dosing Variability-median 1mg/kg
- 2 complications-blood aspiration and peritoneal puncture
- Most performed under GA with U/S

MORE ON TAP BLOCKS

- Suresh et al (Ped Anesth 2014) compared 2.5 vs. 1.25 mg/kg bup→ longer duration
- Lorenzo et al (J Urol 2014) TAP vs. field infiltration by surgeon
  - TAP not better
- A&A Case Reports
  - 2013: Cardiac Arrest from TAP+ field infiltration-failure to communicate
  - 2014: TAP for VP shunts
The Efficacy of Antifibrinolytic Drugs in Children Undergoing Noncardiac Surgery: A Systematic Review of the Literature

Faraoni, David MD, FCCP*; Goobie, Susan M. MD, FRCPC†

TXA and EACA seem to decrease blood loss in spine fusion patients
Most studies small and retrospective

Pharmacokinetics of Aminocaproic Acid in Adolescents Undergoing Posterior Spinal Fusion Surgery
Paul Stricker, Devika Singh, John Fladjo, et al
Children's Hospital of Philadelphia,

EACA clearance increased with weight and age.
- weight < 25 kg: 100 mg/kg loading dose and 40 mg/kg/hr infusion;
- weight < 50 kg: 100 mg/kg loading dose and 35 mg/kg/hr infusion, and
- weight ≥ 50 kg: 100 mg/kg loading dose and 30 mg/kg/hr infusion.

AMICAR ABSTRACT FROM ASA

Structural Differences Between Neonatal and Adult Clot – Baseline Images

MORE ON CLOTTING

- Anesthesia & Analgesia:
  - March 2014 - Volume 118 - Issue 3 - p 628–636
  - Pediatric Anesthesiology: Review Article
  - The Efficacy of Antifibrinolytic Drugs in Children Undergoing Noncardiac Surgery: A Systematic Review of the Literature
  - Faraoni, David MD, FCCP*; Goobie, Susan M. MD, FRCPC†
  - TXA and EACA seem to decrease blood loss in spine fusion patients
  - Most studies small and retrospective
**Improving Outcomes After Neuromuscular Scoliosis Surgery: Have We Learned From Massive Transfusion Protocols?**

Kesavan Sadacharam, M.D., Bruce R. Brenn, M.D. et al.
Alfred I. duPont Hospital for Children

Preliminary results show that patients who received high ratio FFP and PRBC and less crystalloid had less total blood loss, less percentage of blood volume loss and better urine output suggesting better outcomes.

---

**Capnography Fails as a Continuous Respiratory Monitor in Pediatric Patients Treated with IVPCA Opioids**

Myron Yaster, M.D., Karen M. Miller, B.A., Andrew Y. Kim, B.S., Elizabeth White, R.N., Constance L. Monitto, M.D., Sapna R. Kudchadkar, M.D., James Fackler, M.D.

Children treated with IV PCA did not tolerate continuous monitoring of respiration using capnography. Until better, kid friendly monitors are available, guidelines and recommendations geared to adult patients cannot be extended to children.

---

**Survey Says: What Do Pediatric Clinicians Really Know About the “Sedation or Anesthesia” Required When Ordering an MRI “With Sedation”?**

Glenn E. Mann, M.D., Scott Lipson, M.D., Jerry Dias, M.D., Terry-Ann Chambers, M.D., Nadeen Karam, M.D., Montefiore Medical Center, Albert Einstein College of Medicine, Bronx, New York, United States

**Conclusion:**
A majority of pediatric care providers do not appreciate the differences between the depths of anesthesia required to perform MRIs in children. In addition, they are unaware of the possible need for intubation and apnea associated with certain MRI studies.

---

**Anesthesia & Analgesia**: 

- **July 2014 - Volume 119 - Issue 1 - p 67–75**
- **Technology, Computing, and Simulation: Research Report**
- **The Sevoflurane Washout Profile of Seven Recent Anesthesia Workstations for Malignant Hyperthermia-Susceptible Adults and Infants: A Bench Test Study**
- Cottron, Nicolas MD; Larcher, Claire MD; Sommet, Agnès MD, PhD; Fesseau, Rose MD; Alacocque, Xavier MD; Minville, Vincent MD, PhD; Fourcade, Olivier MD, PhD; Kern, Delphine MD, PhD

---

**Anesthesia & Analgesia**: 

- **Anesthesia & Analgesia: Cognitive outcome after spinal anesthesia and surgery during infancy.**
- **Anesth Analg. 2014 Sep;119(3):651-60. doi: 10.1213/ANE.0000000000000288.**
- **Cognitive outcome after spinal anesthesia and surgery during infancy.**
- Williams AR, Slack BH, Duardi GO, Adams DC, Mathews DM, Friend AF, Meyers HW.

We found no link between duration of surgery with infant SA and scores on academic achievement testing in elementary school. We also found no relationship between infant SA and surgery with VPAA on elementary school testing.

---

**How Will We Ever Know if Our Machine Is Adequately Flushed?**

Martin, Timothy W. MD, MBA**†**; Block, Frank E. Jr MD**†**
PREVENTING LARYNGOSPASM

- Propofol
- Deep vs Awake extubation
- Remifentanil
- Magnesium sulphate
- Lidocaine

LIDOCAINE AND ITS ROLE IN LARYNGOSPASM

Ped Anaesth. 2012 Apr;22(4):345-50

TOPOCAL LIDOCAINE STUDY

Technique for Simulating Airway Reflexes

- Sevo induction
- LMA
- FOB with 20G epidural catheter
- 0.25 cc sterile water
- Video taped and observed
- 3 times points
**IV LIDOCAINE**

<table>
<thead>
<tr>
<th>Laryngospasm</th>
<th>Decreasing (%)</th>
<th>Decreasing (%)</th>
<th>Meta-analysis says yes:</th>
</tr>
</thead>
<tbody>
<tr>
<td>No laryngospasm</td>
<td>80%</td>
<td>90%</td>
<td>9 studies, 787 patients</td>
</tr>
<tr>
<td>Laryngospasm</td>
<td>10%</td>
<td>5%</td>
<td>9 studies, 787 patients</td>
</tr>
</tbody>
</table>

**LARYNGOSPASM-TREATMENT**

- 100% oxygen + Fink maneuver (painful jaw thrust)
- Positive pressure ventilation to PIP of 20cm H2O
- Propofol 0.5-3mg.kg
- Lidocaine
- Sux 10-20% of intubating dose
- Magnesium Sulphate ?

**SELECTED REFERENCES**

- Risk factors for laryngospasm in children during general anaesthesia: J Pediatr Anesth. 2012 Sep;22(9):859-64

**LARYNGOSPASM-TREATMENT**

- Decreased incidence of laryngospasm at 2mins, not so much at 10 minutes

**SELECTED REFERENCES**

- Meta-analysis says yes: 9 studies, 787 patients
- Topical and IV lidocaine help

---

**INTRAVENOUS LIDOCAINE STUDY**

**Table 2.** Details of respiratory and haemodynamic variables and anaesthetic depth. Data are mean (SD).

<table>
<thead>
<tr>
<th>Variable</th>
<th>Baseline</th>
<th>1 min After</th>
<th>2 min After</th>
<th>3 min After</th>
<th>5 min After</th>
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<tbody>
<tr>
<td>Respiratory rate (bpm)</td>
<td>20 (2)</td>
<td>21 (1)</td>
<td>22 (2)</td>
<td>23 (3)</td>
<td>24 (4)</td>
</tr>
<tr>
<td>Minute ventilation (liters)</td>
<td>6 (1)</td>
<td>7 (1)</td>
<td>8 (2)</td>
<td>9 (3)</td>
<td>10 (4)</td>
</tr>
<tr>
<td>Heart rate (bpm)</td>
<td>100 (10)</td>
<td>105 (15)</td>
<td>110 (20)</td>
<td>115 (25)</td>
<td>120 (30)</td>
</tr>
<tr>
<td>Mean arterial pressure (mmHg)</td>
<td>60 (6)</td>
<td>65 (7)</td>
<td>70 (8)</td>
<td>75 (9)</td>
<td>80 (10)</td>
</tr>
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<td>75 (9)</td>
<td>80 (10)</td>
</tr>
</tbody>
</table>


**The efficacy of lidocaine to prevent laryngospasm in children: a systematic review and meta-analysis.**

Mihara T, Uchimoto K, Morita S, Goto T.
Perioperative Management of the Patient with Severe Lung Disease

Chronic Obstructive Pulmonary Disease

Pulmonary Hypertension

Peter Slinger MD, FRCPC
(No Disclosures)

COPD

- Preoperative Assessment
- CO2 Retention
- Dynamic Hyperinflation

COPD Preoperative Assessment

- 60 y.o. Female
- Laparotomy for Bowel Obstruction
- Empysema, FEV1 27%
- Prev. colectomy for diverticulitis
- Rx Puffers, occas. steroids
- Do You Need a Chest X-ray?

Bullae

COPD Preoperative Assessment

- 60 y.o. Female
- Laparotomy for Bowel Obstruction
- Empysema, FEV1 27%
- Prev. colectomy for diverticulitis
- Rx Puffers, occas. steroids
- Do You Need an Arterial Blood Gas?
COPD patients in Ac. Resp. Failure

\[\text{ABGs air vs. 100\% Oxygen}\]

\[\begin{array}{|c|c|c|}
\hline
& \text{Air} & \text{100\% O}_2 \\
\hline
\text{PaCO}_2 (\text{mm Hg}) & 65 +/- 3 & 88 +/- 5 \\
\text{PaO}_2 (\text{mm Hg}) & 38 +/- 2 & 225 +/- 23 \\
\text{Min Vent (l/min)} & 10.2 +/- 0.5 & 9.5 +/- 0.7 \\
\hline
\end{array}\]

\[\text{Metcalf-Emile, J. Auhler M. Anes Analg 1980}\]

**Effects of Hypercapnia**

- Central Nervous System: cerebral blood flow, level of consciousness
- Autonomic Nervous System
- Cardiovascular System
- Respiratory System, Pulmonary Vasoconstriction

**CO2 is Good For You**

Peter Slinger, MD

Perioperative Management of the Patient with Severe Lung Disease

**COPD Ventilation-Perfusion Matching**

**Air**

**High FiO2**


**Arterial Blood Gases**

16 yr. male, grain aspiration

<table>
<thead>
<tr>
<th>pH</th>
<th>pCO(_2)</th>
<th>pO(_2)</th>
<th>HCO(_3)</th>
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<tbody>
<tr>
<td>6.5</td>
<td>500</td>
<td>84</td>
<td>30</td>
</tr>
<tr>
<td>6.9</td>
<td>300</td>
<td>400</td>
<td>29</td>
</tr>
</tbody>
</table>

COPD, Laparotomy Bowel Obstruction

- Rapid Sequence Induction
- Propofol 80 mg., Fent. 100 ug, Roc. 50 mg.
- Easy Intubation, SpO2 100%, PetCO2 30mmHg
- Pulse 80, 96
- BP 120/60, 50/30
- Air Entry Equal Bilat.
- Diagnosis?

The Lazarus Syndrome: Spontaneous Return of Circulation after Cessation of Cardiopulmonary Resuscitation


Paradoxical Responses to PEEP in Patients with COPD during Controlled Ventilation
COPD Preoperative Assessment
- 60 y.o. Female
- Laparotomy for Bowel Obstruction
- Emphysema, FEV1 27%
- Prev. colectomy for diverticulitis
- Rx Puffers, occas. steroids
- Should you do a Thoracic Epidural?

Greatest Hospital Costs from Complications after Surgery?
A) Cardiac/Vascular
B) Thromboembolic
C) Respiratory
D) Wound Infection


Hospital Costs Associated with Surgical Complications

<table>
<thead>
<tr>
<th>Complication</th>
<th>Incidence %</th>
<th>Increase LOS d</th>
<th>Median Cost $K</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cardiac/Vascular</td>
<td>1</td>
<td>0</td>
<td>7.7</td>
</tr>
<tr>
<td>Thromboembolic</td>
<td>1</td>
<td>15</td>
<td>18.3</td>
</tr>
<tr>
<td>Respiratory</td>
<td>3.4</td>
<td>14</td>
<td>52.5</td>
</tr>
<tr>
<td>Wound Infection</td>
<td>6.9</td>
<td>4</td>
<td>1.4</td>
</tr>
</tbody>
</table>


Incidence and Mortality of Postoperative Pulmonary Complications (PPC)

<table>
<thead>
<tr>
<th>Type of Surgery</th>
<th>Incidence %</th>
<th>In-Hosp. Death with PPC%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cardiac</td>
<td>40</td>
<td>0</td>
</tr>
<tr>
<td>Thoracic</td>
<td>31</td>
<td>18</td>
</tr>
<tr>
<td>Abdominal</td>
<td>7</td>
<td>35</td>
</tr>
<tr>
<td>Orthopedic</td>
<td>2</td>
<td>5</td>
</tr>
<tr>
<td>Other</td>
<td>2</td>
<td>15</td>
</tr>
</tbody>
</table>

n= > 2400, Major Surgery

Perioperative Management of the Patient with Severe Lung Disease

Chronic Obstructive Pulmonary Disease

Pulmonary Hypertension

Pulmonary Hypertension
- 54 y.o. Female
- Open Wedge Resection of Recurrent Left Upper Lobe Metastasis
- VATS resection LUL lesion 1yr. prev., no problem GA
- Post-op. DVTs
- Colectomy for Ca. 3yr. prev.
**Pulmonary Hypertension**

- 54 y.o. Female
- COPD, Hypertension
- Diabetes, oral meds
- Obstructive Sleep Apnea
- Morbid Obese, BMI 53

**54 Female, Obese, Wedge Resection LU Lobe**

- FEV1 65%, DLCO 78%
- ECG Normal
- Exercise tolerance SOB 1 flight
- Labs Normal
- Trans-thoracic echo: Normal LV & Right Ventricle, RVSP 32mmHg
- Anesthetic Management

**Preoperative Assessment**

- 54 y.o. Female
- Open Resection of Left Upper Lobe Metastasis
- VATS LUL 1yr. prev., post-op. post-op. DVTs
- Colectomy for Ca. 3yr. prev.
- COPD, hypertension
- Diabetes, oral meds
- Obstructive Sleep Apnea
- Morbid Obese, BMI 53

**Trans-Thoracic Echocardiography**

- 2012: Difficult study, Mild hypertrophy RV, RVSP calculated 55mmHg
- 2013 (1 week preop.) Difficult study, Normal LV/RV, RVSP calculated 32mmHg
- 2013 (1 week postop.) Difficult study, Mild hypertrophy RV, RVSP calculated 58mmHg
54 Female, Obese, Wedge Resection LU Lobe

- FEV1 65%, DLCO 78%
- ECG Normal
- Exercise tolerance SOB 1 flight
- Labs Normal
- Trans-thoracic echo: Normal LV RVSP 55mmHg
- Change Management?

Pulmonary Hypertension Classifications
(Eur Heart J 2009; 30: 2493-537)

- Pulmonary Arterial: Idiopathic, Drug/Toxin induced, Portal Hypertension, Connective Tissue Diseases, Veno-occlusive Disease
- Left Heart Disease, Systolic Dysfunction, Diastolic Dysfunction, Valvular Disease
- Lung Disease: COPD, Interstitial lung Dis., Sleep Apnea, Central hypoventilation, Altitude
- Chronic Thromboembolic Pulmonary Hypertension
- Uncertain Etiologies: Sarcoidosis, Glycogen Storage Disease, Fibrosing mediastinitis

Hosseini L, JCVA 2014, 28: 1076-86

Pulmonary Hypertension Re-Classification for Anesthesia

Heart Disease
- Systolic Dysfunction, Diastolic Dysfunction, Valvular Disease

Lung Disease
- Pulmonary Arterial Hypertension, Primary, etc.
- Secondary to Chronic Lung Disease
- Chronic Thromboembolic Pulmonary Hypertension
- Uncertain Etiologies

The Right Heart is Not Smart

Severe Pulmonary Hypertension Complicates Postoperative Outcome of Non-Cardiac Surgery

- 9600 Preop. Echos, n= 62 RVSP >70 mmHg
- 37/62 (60%) Non-Cardiac Pulm. Hypertension
- Abd. Surg 15, Ortho 14, Thoracic 4, Minor 15
- Delayed Extubation (> 24h) 20% (vs. 3%)
- Mortality 10% (vs. 0%)


Pulmonary Hypertension Anesthetic Management
(as per Review Articles)

- Propofol is good
- Ketamine is bad
- Dobutamine is good
- Nitric Oxide is good
- TEE is good
- Epidurals are good
Pulmonary Hypertension

Hemodynamic collapse on induction


Desflurane, Sevoflurane, Isoflurane, in Pressure-Overload RV Hypertrophy

Baludszun G, Morel DR. Anesthesiology 2012, 117: 1051-61
(Rats)

(*p<.01)

Pulmonary Hypertension Anesthetic Management

- Propofol is good
- Ketamine is bad
- Dobutamine is good
- Nitric Oxide is good
- TEE is good
- Epidurals are good

Vasoconstrictor Responses to Vasopressors


Radial Arteries

Pulmonary Arteries

Nitric Oxide


Prostacyclin (Flolan)

Peter Slinger, MD

Perioperative Management of the Patient with Severe Lung Disease
**Tricuspid Valve**

**Pulmonic Valve**

**RV Free Wall Strain**

<table>
<thead>
<tr>
<th>Normal</th>
<th>Abnormal</th>
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</table>

**Right Ventricular Monitoring**

**Epidural Anesthesia and Right Ventricular Pressure Overload**


**Pulmonary Hypertension Anesthetic Management**

- Propofol is good
- Ketamine is bad
- Dobutamine is good
- Nitric Oxide is good
- TEE is good
- Epidurals are good
- Avoid Hypox./Hypercarb.


Manecke GR. Semin Thorac Cardiovasc Surg 2006; 18: 236-42


Efficacy of Sildenafil in Primary Pulmonary Hypertension


Perioperative Management of the Patient with Severe Lung Disease

Chronic Obstructive Pulmonary Disease

- Bullae
- CO2 Retention
- DHI

Pulmonary Hypertension

- Right Heart vs. Left Heart

Peter Slinger, MD
Advances in Lung Isolation for Thoracic Anesthesia

Peter Slinger MD, FRCPC
University of Toronto
(No Disclosures)

- Anatomy, Bronchoscopy, Chest Imaging
- Improved Double-Lumen Tubes
- New Bronchial Blockers
- Difficult Airways

55 y.o. Female Post-op. Right Pneumonectomy

Methods of Lung Isolation:

- Single Lumen Tubes
- Double-lumen Tubes
- Bronchial Blockers

Techniques of Lung Isolation:

- Single Lumen Tubes
- Double-lumen Tubes
- Bronchial Blockers
UNIVENT TUBE

The “Arndt” Bronchial Blocker

Bronchial Blockers – Cohen

Fuji “Uni-Blocker”

New Bronchial Blockers

COHEN  FUJI  ARNDT
Bronchial Blockers vs. Left DLTs
Left-Thoracotomy/VATS

Bronchial Blocker “Tricks”

- De-Nitrogenate the lung before collapse (FiO2 1.0)
- Prolonged expiration before blocker inflation
- Suction blocker lumen
- Pressure-control ventilation
- Warn Surgeon
38% Incidence of major malpositions of Double-lumen Tubes and Blockers

"The most critical factor in successful placement was the Anesthesiologist’s knowledge of endoscopic bronchial anatomy"


The structure seen in the Yellow circle is?

A. Right Bronchus intermedius
B. Left upper lobe bronchus
C. Left mainstem bronchus
D. Right middle lobe bronchus
E. Right upper lobe bronchus

www.thoracicanesthesia.com

Slinger, Peter, MD, FRCPC
Advances in Lung Isolation for Thoracic Anesthesia

132
Bronchoscopy Quiz Scores

The ABC’s of Lung Isolation:
- Anatomy
- Bronchoscope
- Chest X-ray, CT Scan

Left Upper Lobe Sleeve Resection

What Airway Device?
Left Upper Lobe Sleeve Resection

Right and Left-Sided Mallinckrodt Double-Lumen Tubes Have Identical Clinical Performance

The ABC’s of Lung Isolation:
- Anatomy
- Bronchoscope
- Chest X-ray, CT Scan
CT Measurement of Right Mainstem Bronchus

Anesthesia for Broncho-Pleural Fistula

Goals:
- Protect Healthy Lung
- Avoid Tension Pneumothorax
- Ensure Adequate Ventilation

Lung Isolation Before Pos. Press.Ventilation or Re-Positioning Patient

Slinger, Peter, MD, FRCPC

Advances in Lung Isolation for Thoracic Anesthesia

Anesthesia for Broncho-Pleural Fistula

- Airway Management: Single-, Double-lumen, BB
- Intubation: Awake, Spont. Vent., Rapid Sequence

55 y.o. Female Post-op. Right Pneumonectomy

Post-op. Day 1

Post-op. Day 7
62 y.o. Male, Left Lower Lobe Lung Cancer
Previous Failed Intubation

Awake Fiberoptic Double-Lumen Intubation

Video-Laryngoscope + Tube Exchanger

Glidescope

Russell T. et al.
Anaesthesia 2013, 68: 1253-8
Rush Fuji

69 y.o. Female, R Upper Lobe Ca.

- Severe Rheumatoid arthritis
- Neck pain on Extension
- X-ray Instability C3-C4 in flexion
- GE Reflux

60 y.o. Female, 2 hr. Post-op. Mitral Valve Replacement

- Intubated, ventilated in ICU
- Sudden onset massive hemoptysis
- Diagnosis?

PA Catheter Induced Pulmonary Hemorrhage

1. Initially position with bleeding lung dependent
2. ETT, oxygenate, suction
3. Lung isolation: DLT, Bronchial Blocker or single-lumen endobronchial tube?
4. Withdraw PA cath 2-3cm, do not inflate
5. Position with isolated bleeding lung non-dependent + PEEP

60 y.o. Female, 2 hr. Post-op. Mitral Valve Replacement

Patient stabilized, now who you gotta call?

- The OR
- Your Mom
- Nobody, the patient is stable
- Radiology

60 y.o. Female, 2 h Post-op. Mitral Valve Replacement
Tube Selection for Lung Isolation:

- **Double-Lumen Tube**
  - Excellent Isolation
  - Independent Lung Access
  - Fixed Anatomical Design
  - Adults

- **Bronchial Blocker or Single-Lumen EBTube**
  - Adaptability
  - Difficult airways
  - No need to change tube
  - Suctioning

Advances in Lung Isolation for Thoracic Anesthesia

- Anatomy, Bronchoscopy, Chest Imaging
- Improved Double-Lumen Tubes
- New Bronchial Blockers
- Difficult Airways

1. Auscultate
   - Fiber optic Bronchoscopy
   - Look Again
   - Know What You are Looking At
Introduction/ Background

Regional Analgesia
- TEA, PVB, Other
- Benefits, Risks, Efficacy

Multimodal Analgesics
- Tylenol/ NSAIDs
- Ketamine
- Anticonvulsants
- Other

Procedures in US per year:
- 200k Thoracotomies
- 300k-500k CABG

Acute Pain:
- Up to 87% mod-severe pain
- Up to 97% shoulder pain
- > Pain assoc w/ LIMA and <60YO
- Assoc Ischemia, hypoxia, ileus, prolonged stay

Causes:
- Incisional, rib fx/disloc, saph vein, sternal retract, tubes/drains, brach plex
- Chronic Pain:
  - 25% CABG
  - 30-60% Post-thor
  - Difficult to treat
  - Unemployment, decr function

Relatively High Rate of Complications After CT Surgery:
- High Invasiveness
- Type of incision- thoracotomies
- Prolonged duration
- Co-morbidities (CAD, CHF, Tob, Obesity, DM, OSA, CRI, other)
- Greatest Risk 1st 72hrs

High Rate of Cardiac Complications:
- Mortality = 1.2% (30d)
- MI = 9%
- High risk for ischemia (30% p card surg)
- Arrhythmias (up to 22%)
- CHF, other

High Rate of Pulmonary Complications:
- High risk for atelectasis, hypoxemia
- Pneumonia (up to 30%)/ VAP $40k
- Ventilator support, other

High Rate of Other Complications:
- Delirium (>20%), POCD
- CVA (up to 4%)
- Ileus, PONV, Constipation
- Renal Insufficiency (>5%)
- Prolonged Hosp Stay

Update: Analgesia in Cardiothoracic Surgery

Disclosure:
- I have no disclosures to report regarding financial incentives or gains from pharmaceutical companies or manufacturers.
Goals for Analgesia:

- Minimize pain and suffering
- Maximize patient satisfaction
- HCAHPS, ACA, IPPS
- Maximize mobilization, function
- Minimize side effects
- Constipation, PONV, urinary retention, delirium, pruritis, hypotension
- Decreased Chronic Pain
- Titratable
- < stress resp, sympathetic

Maximize mobilization, function

- Decrease Morbidity
  - < Cardiac morbidity
  - < Pulmonary morbidity
  - < resp depression
  - < early extubation
  - < pneumonia

- Decrease Costs
  - Decrease ICU stay
  - Length of Stay
  - Decrease complications

Rationale for Multimodal Analgesia:

Prospect Group

Note 3 branches of Intercostal Nerves:
- posterior
- lateral
- anterior

Regional Anesthesia Options:
- TEA, PVB
- ICB, Pleural

Potential Cardiac Benefits of TEA:

- < Ischemia
  - > coronary blood flow
  - > O2 supply
  - < ST changes, < RWMA's
  - < lactate, troponin levels post-CABG
  - < Infarction Size

- > LV & RV function
- < Arrhythmias (both atrial and ventricular)
- Avoids >SVR in AVR pts (post-repair)


Potential Pulmonary Benefits of TEA:

- Earlier extubation p CABG
- > FRC, cough, VC, paO2, IS
- Less decrement in postop pulm function (compared to parental opioids)
- < episodes of desat, pneumonia, atelectasis
- > Diaphragm function
- < mortality Thoracotomies 7% to 1-2% past 20 years (? Assoc w/ > TEA use)

Decreased Mortality and Chronic Pain

- **Mortality**
  - Rodgers, 2000, BMJ; Wu, 2004, RAPM; Wu, 2006
  - 30% decrease in mortality with epidural analgesia in > 9500 pts (Rodgers)
  - Probable benefit with high invasiveness and co-morbidities

- **Chronic Pain**
  - Obata, 1999, CJA
  - Intraop and postop infusions
  - Min IV narcotics
  - Toradol 15-30 mg qid x 3d
  - PTPS < 12% w/ TEA
  - Andreae, 2013, BJA
  - Meta-analysis, 250 CT pts
  - TEA < PTPS at 6 mos
  - Other studies: inconsistent

Other Possible Benefits of TEA: (Transferable Evidence)

- CNS complications:
  - confusion, delirium, insomnia

- GI complications:
  - ileus, n/v, constipation, malnutrition

- DVT's, PE's
  - relevant w/ today’s prophylaxis

- ICU stay

- Hosp LOS

- Cost

- Stress Response (epi, NE, cortisol)

Other TEA Risks:

- Failure: 2-15%

- PDPH: < 1% in older pts

- Hypotension:
  - Up to 40%
  - esp elderly, other antihypertensives
  - Compensated by vasopressin in unblocked derms and > vasopressin release
  - Caution in significant AS/ MS

- Urinary Retention:
  - > w/ Intrathecal morphine and Lumbar EA
  - Uncommon with Thoracic Epidural Analgesia

- Infection: 0.1-1% (duration, disconnects, etc)

TEA in CT Surgery

- SCA Survey: 7% of anesthesiologists use TEA for cardiac
  - 58% of responders in US
  - Not uncommon in U.K., Canada
  - 40% preinduction, 33% after surgery

- High Prevalence of TEA for Thoracotomies
  - "The Gold Standard"
  - TEA vs PVB

Epidural Hematoma Risk in Cardiac Surgery:

- 2 case report w/ 1000's of CPB/central neuraxis tech
  - Rosen, '04: tpa given in ICU, cath pulled
  - 2nd case, 2004, UK

- Latest Risk w/ Epid:
  - 1:12,000 (1:2100 – 1:68,000), Bracco, 2011

- Traumatic Tap
  - Consider placing epidural day before surgery
  - Consider arterial vs venous blood

TEA: Other Considerations

- Discuss periop anticoag (eg Valves)

- Location:
  - T3-4 Sternotomy
  - T6 Thoracotomy
  - Peinduction placement/ Test Dose
  - Arrow Flex-tip?
  - Limit advancement, 3cm
  - Secure catheters (devices?)
  - Half rate during CPB

- Combine with Opioid or clonidine –synergy

- MSO4 40 ug/ml

- Dilaudid 5-10 ug/ml

- Clonidine 0.5-1.0 ug/ml

- UE numbness common

- LE deficits concerning

- Duration: 72hrs/ CT's out
**TEA in CABG: Notable Studies**

- **Scott, 2001:** 420 pts, U.K., RCT, DB.
  - TEA – BC vs PCA-M
  - Results:
    - < time to extubation
    - < pneumonia (15 vs 29%)
    - < SVT (10 vs 22%)
    - < ARF (2 vs 7%)
    - < Confusion
  - Liu, 2004: Meta-analysis
  - Also, < time to extubation
  - < dysrhythmias

- **Svircevic, 2011:** 684 pts, Netherlands, RCT, not blinded, “healthier pt popn”
  - TEA- BM vs PCA-M x 48hrs
  - Improperly powered for 50% reduction in outcome measures
  - 10-20% effect more realistic (eg POISE, ISIS-2 study)
  - Would need >4200 pts

- **Caputo, 2011:** 226 pts, RCT
  - TEA-BC vs PCA x 72hrs
  - No diff in MI, mortality, CVA
  - 40% < arrhythmias
  - < pain, opiates
  - < time to extubation, LOS
  - 15% epid failures, 1 substantial resuscitation

**TEA for OPCAB (Off-Pump Coronary Bypass)**

- TEA more attractive due to less anticoagulation (1/2 ACT)
- Similar postop pain scores (Sandeckoppam, 2014)
- Caputo, 2011, 226 pts, RCT
  - TEA-BC vs PCA x 72hrs
  - Results:
    - < arrhythmias
    - < pain, opiates
    - < time to extubation, LOS
    - 15% epid failures, 1 substantial resuscitation

**Dual Epidural Catheters:**

- **Ivor-Lewis Esophagectomies**
  - Brown, 2013. RAPM. Mayo Clinic, 3 year period, > 160 pts
  - Retrospective, observational; cases paired 1:1
  - TEA with bupiv and hydromorphone x 1 vs 2 caths
  - >Analgesia compared to single TEA cath
  - 50% reduction in combined complications:
    - Anastomotic leaks; pulm complications, sepsis, a.fib
  - No difference in side effects

**PVB’s in CT Surgery**

- Advantages:
  - Less hypotension (4%)
  - < risk of cord compression w/ hematoma (ASRA guidelines)
  - Sympath block
  - unlikely Intercostal Blocks
  - < stress resp, pain
- Disadvantages:
  - Risk of Ptx’s (1:300)
  - ? Spread of LA
  - Lack of opioid synergy
  - ? efficacy comp to TEA

**Paravertebral vs Thoracic Epidural:**

- TEA with local anesthetic plus opioid better analgesia than either with LA alone
- Both improved analgesia comp to intercostal or opiates/PCA
- Equivalent Analgesia: PVB and TEA (LA alone)
- < Pulm complications comp to PCA (both PVB and TEA)
  - SaO2, FRC, FVC, PEF, cough (Both)
  - > Inc Spirometry with TEA (LA + opioid)
- Both < Persistent Postop Pain
- Andreae, 2013, Meta-analysis
  - Inconsistent finding

**PVB vs TEA: Side Effects/Complications**

- Side Effects:
  - < Hypotension w/ TEA (LA+ opioid) and PVB group
  - comp to TEA (LA alone)
  - < urinary retention (PVB comp to TEA-LA/opioid)
  - < pruritis and nausea (PVB comp to TEA-LA/opioid)
- Similar anticoagulation concerns per ASRA
- Pneumothorax 1:300 PVB (< Concern in thoracotomy)
- LATS: 1 case report of death in C-PVB pt (Fagenholz, 2012)
  - Beware of repeated boluses
  - Higher plasma levels with intercostal/paravertebral
C-PVB for Cardiac Surgery

- Lat Thoracotomy = pain
- Placement: T6
- C-PVB preferred over TEA:
  - Only need unilateral anesthesia
  - Anticoagulation risk
  - Hemodynamic changes
- Ganapathy, 1999
- C-PVB very effective for analgesia
- Case Report
- Min postop opiates
- Discharged after 58 hrs

Reg Anes for VATS

- Compared to thoracotomy:
  - < acute pain (< incision, < rib trauma, etc)
  - < referred shoulder pain
  - < chronic pain (although still up to 40+)
- TEA:
  - Not necessary usually
  - Consider if > prob of open or Opiate Tolerant pt
- PVB/C-PVB:
  - Freq choice in U.K., other
  - < opiates, < pain
- ICB/ C-ICB: may be helpful (3 studies)
- Intrapleural Caths: may be helpful (2 studies)

Referred Shoulder Pain

- 60-97% incidence with thoracotomy
- Probably mediated via phrenic nerve
- Helpful:
  - TEA not beneficial
  - Both Acetaminophen + Ketorolac
  - Consider surgical infiltration in periphreric fat pad (3 studies)
  - Consider Intercalene Block
  - Not helpful:
  - Suprascapular Block
  - (Direct) phrenic block not recommended

Intrathecal Morphine and/or Clonidine

- Positive:
  - Opiate sparing
  - Significant, prolonged analgesia
  - Min epid hematoma risk
  - Lema, 2003 and 2006, cardiac surgery
  - M: 4ug/kg
  - C: 1.0ug/kg
  - < extubation times
  - > analgesia
- Negative:
  - meta-analysis: no diff in outcome, (Liu, ’04)
  - Stress-response: limited if any effect
  - Time to extubation: most RCT’s no benefit (even at low dose)
  - Pruritis, N/V common
  - High Clon: < HR, BP

Intercostal Blocks

- Most frequent Reg Anesthetic worldwide for thoracotomies
- Meierhenrich, 2011
- ICB + PCA-M < effectiveness comp to TEA
- < pain, resp function
- ICB does not block sympathetics
- Potential role in VATS (Kaplowitz, 2012)
- Especially C-ICB
- Ptx Risk: 0.1-0.4%

Intrapleural Caths

- Advantages:
  - < hypotension, < anticoag concerns
- Technique:
  - Blind vs Intraop
  - LOR, air
  - Cath 6-8 cm post
- Efficacy
  - MIDCAB & VATS: some evidence exists
  - Not recommended for thoracotomy
- Complications:
  - < 1% ptx
  - LA Toxicity
  - phrenic blk
Wound Catheters

- Technique:
  - Usually 2 soaker caths, 12cm
  - Ropiv or Bupiv 0.25-0.5%
  - 4ml/hr x 2-3 days
- Efficacy:
  - < pain, opiates
  - < time to ambulation, LOS
  - Inconsistent
  - (Agarwal 2013 no benefit)
- Complications:
  - 9% sternal infection
  - (Agarwal) required cessation of study
  - 75% of infections - deep

Cryoablation

- Goal: < PTPS
- > Chronic neuralgia due to cryo itself
- 60-70 deg, 14 gu probe under direct vision
- 1min freeze x 2 each level x 3 levels
- Adds 15-30 min to case

Acetaminophen

- Mechanism:
  - COX-3 Inhibitor
  - Centrally acting
- Advantages:
  - < pain, opiates, PONV
  - No sedation, constipation
  - No bleeding, renal concerns
- Disadvantages:
  - Cost: > $40/d now
  - 100ml vial over 15min
- IV Formulation:
  - Europe: 2002, Paracetamol
  - US: 2010, Ofirmev
- > efficacy > plasma/effect site concentrations
- Transferable Evidence:
  - NNT 3.8 for analgesia
  - < PONV, > pt satisfaction
- Efficacy in CT Surgery:
  - < ICU, LOS (421 pts)
  - < shoulder pain

Nonselective NSAIDs

- Mechanism:
  - Inhibit cyclooxygenase, < PGs (esp PGE2), < inflam
- Advantages:
  - < PONV
  - No sedation, delirium
  - No constipation
- Disadvantages:
  - Bleeding, renal insuff, gastritis/ ulcers
  - FDA Black Box Warning
  - 2005, ketorolac contraindicated after cardiac surg
- Transferable Evidence:
  - < pain (rest, movement)
  - < opiates (20-50%)
  - < PONV, > pt sat
  - > bleeding (2.4 vs 0.4%)

Nonselective NSAIDs: Efficacy in CT Surgery

- Cardiac:
  - No diff in complications (bleeding, ARF, MI, CVA)
  - Can use in select patients
- Thoracic:
  - < pain, opiates
  - < stress resp (CRP, IL-6)
  - < shoulder pain
  - Avoid in pleurodesis cases

COX-2 Inhibitors:

- Mechanism:
  - Inhibits COX-2 (< inflam, pain) primarily
- Advantages:
  - Maintains COX-1 enzyme (gastric mucosa); 50% < risk
  - No bleeding, sedation, constipation risk ; < PONV
- Disadvantages:
  - > thrombotic risk
  - Same > renal risk as nonselect
  - Celecoxib 100-200mg bid
- Transferable Evidence:
  - NNT: 2.1 - 3.5 < pain
  - (same as nonselect NSAIDs)
  - < PONV, opiates
  - Efficacy in Thoracic Surgery:
  - < pain (rest, cough, mobilization)
  - > pat satisfaction
  - No diff in troponin levels (contraindicated in cardiac surgery)

Sunits 2008, Sun 2008, Senard 2010


Malchow, Randall, MD

Update: Analgesia in Cardiothoracic Surgery
**Ketamine in CT Surgery:**

- **Mechanism:**
  - NMDA antagonist primarily
- **Advantages:**
  - Abolishes OIH; windup
  - Min sedation, nausea
  - > pat satisfaction
- **Disadvantages:**
  - Subanes doses: very few
  - Anes doses: psychomimetic effects, > HR / BP, > saliva possible
  - Dosing:
  - Infusion: 1-2 ug/kg/min
  - PCA-M/K: 1:1 ratio ideal


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**Gabapentin, Pregabalin in CT Surgery**

- **Mechanism:**
  - Activates descending inhibitory pathway via Ca channel (> NE, < EAA)
  - Pregab 6x infinity
- **Advantages:**
  - Helpfu with opiate tol pts
  - Anxiolysis
- **Disadvantages:**
  - Sedation (> doses/elderly)
  - Dizziness (same)
- **Dosing:**
  - GPN: Preop: 600-1200mg
  - Postop: 300mg tid
  - Pregabalin: Preop: 150-300mg
  - Postop: 75mg bid

Gilson 2007, Tij paina 2007

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**Alpha2 Agonists in CT Surgery:**

- **Mechanism:**
  - Activation of Desc inhibitory pathway
  - > NE, GABA, serotonin; < EAA
- **Advantages:**
  - < stress response (< sympath)
  - < opiate requirement, side effects
  - < OIH, anxiety
- **Disadvantages:**
  - < HR, BP (high doses, elderly, other antihypertensives, < vol)
  - Expensive; Dex qtt required
- **Medications:**
  - Clonidine: useful as TEA adjunct
  - Dexmedetomidine: 7 x affinity for receptor
  - 0.25-0.6ug/kg/hr


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**Dexmedetomidine in CT Surgery**

- **Cardiac:**
  - < mortality (in-house, 30d, and 1 yr) retrospective data
  - < delirium, pain, opiates
  - > bradycardia, hypotension
- **Thoracic:**
  - In combination with TEA...
  - < supplemental opiates
  - Not recommend due to lack of data


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**Ketamine: Efficacy in Thoracotomy**

- < pain
- < opiates (using PCA 1:1)
- No psychomimetic effects

Michelet 2007
Lidocaine in CT Surgery:

- **Mechanism:**
  - Membrane stabilizer
  - Na channel blockade
  - Decreases dorsal horn activity

- **Advantages:**
  - Decreases pain, opiates (esp laparotomy)
  - Decreases ileus (esp colon surgery)

- **Disadvantages:**
  - Requires infusion
  - Requires ICU monitoring due to potentially high levels

- **Dosing:**
  - 1-2 mg/min
  - Some as high as 4 mg/min

Efficacy in CT Surgery:

- Meta-Analysis, 2011
- 29 RCTs, incl CT surgery
- Decreases pain, opiates, ileus, N/V
- Cardiac:
  - Evidence for cerebral and cardiac protection (CPB)
  - (1) neg study for analgesia
  - Thoracic:
    - Decreases pain
    - Decreases ileus

Thoracic:

- Insler 1995
- Wang 2002
- Cui 2010
- Kim 2010
- Tremont-Lukats 2005
- Swenson 2010
- Vigneault 2011

Music in CT Analgesia:

- Alternative technique, low cost, no risk
- Decreases anxiety, catecholamines
- Decreases ICU noise
- Consider combining with positive imagery
- Ozer, 2013

- 87 Cardiac surgery patients
- Decreased pain, increased O2 saturation after 30 min music

Summary:

- Reviewed the rationale and goals for analgesia in CT patients
- Reviewed the evidence and efficacy for regional anesthesia
- Multimodal analgesia is critical to comprehensive recovery
- Effective acute pain control probably more important than method

Select References:

- www.postoppain.org (Prospect Group)
Wednesday, March 4
CONTROVERSIES: THE PREGNANT PATIENT FOR NON-OBSTETRIC SURGERY

Joy L. Hawkins, M.D.
University of Colorado SOM
(* I have no conflicts to disclose.*)

GOALS & OBJECTIVES

Upon completion of this presentation, participants will be able to:

1. Cite guidelines from ASA and ACOG relating to non-obstetric surgery during pregnancy.
2. Apply physiologic principles and knowledge of teratogenic effects to develop an anesthetic plan.
3. Adapt the broad anesthetic plan to special situations such as trauma, cardiac surgery, neurosurgical procedures, or laparoscopy.

THE PUBLIC IS CONCERNED

“The fetus usually dies from the anesthesia administered to the mother before the procedure begins . . . The intravenous anesthetic administered to the woman during the procedure induces a medical coma in the fetus and eventually a neurological fetal demise.”

Congressional Testimony 6/23/95

ANESTHESIOLOGISTS ARE CONCERNED

A retrospective survey of female veterinarians related preterm delivery (< 37 weeks) to self-reported occupational anesthetic exposures.

- OR 2.5 for those who performed surgery without scavenging anesthetic gases vs. with scavenging
- OR 3.69 for those working > 45 hours a week.

Obstet Gynecol 2009;113:1008
ASA & ACOG JOINT STATEMENT

1. Obtain a consult from obstetrics preop. They should be readily available intraop.
2. No anesthetic agents are teratogenic.
3. FHR monitoring may assist in positioning, cardiorespiratory management, delivery option.
4. Perform surgery where there are obstetric and pediatric services.

JOINT STATEMENT (cont)

5. Pre and post-op FHR is adequate if pre-viable.
6. A qualified individual should be readily available to interpret if continuous FHR monitoring is used.
7. A pregnant woman should never be denied indicated surgery. Postpone elective surgery until after delivery, non-urgent until 2nd trimester.

Obstet Gynecol 2011;117:420 (reaffirmed 2013)

CONTROVERSIAL ISSUES SURROUNDING ANESTHETIC CARE DURING PREGNANCY

Controversy #1. Which patients need to have preoperative pregnancy testing?

Case: A healthy 25-year old woman presents to your operating room for knee arthroscopy on an outpatient basis. Does she need to have a pregnancy test?

50% of pregnancies in the U.S. are unplanned!

"...And to think, the reason we went on that second honeymoon was to get away from the kids for a while."

PREGNANCY TESTING

For one year, all women of childbearing age having ambulatory surgical procedures had preoperative pregnancy testing.
- 7/2056 (0.3%) of tests were positive.
- All 7 patients elected to cancel surgery (2 were infertility procedures).
- The estimated cost to diagnose one pregnancy was $2879.

Anesthesiology 1995;83:690
PREGNANCY TESTING

A specialty orthopedic hospital initiated mandatory pregnancy testing. After 1 year:

- 2588 tested → 8 positives, but 4 were false positives.
- 3 of the false positives subsequently had a negative serum hCG, and surgery then proceeded.
- 4/2588 (0.15%) of tests were true positives and their surgery was canceled.
- NNT for 1 true positive: 647
- Cost for 1 true positive: $3273

Discuss: “…should a spontaneous abortion occur after surgery, or the baby be born with a congenital anomaly, this may be attributed to the surgery or anesthetic……..screening may decrease litigation, although potential cost savings are difficult to quantify.”

Anesth Analg 2008;106:1127

PREGNANCY TESTING

A review of 2 years of mandatory pregnancy testing in a freestanding pediatric hospital found that 2.4% of patients 16 and older were positive. None were positive in patients less than 15 years of age, so overall incidence was 1.3%.

- Their conclusions: A policy of mandatory pregnancy testing in patients aged 15 and older is advisable. Specific written consent for the test is not necessary, but proper notification processes must be established.

Anesth Analg 1996;82:4-7

PREGNANCY TESTING

Do pregnant women have greater morbidity after surgery than non-pregnant?

- Using the NSQIP database from 2005-9, 857 appendectomy and 436 cholecystectomy cases in pregnancy were reviewed.
- Morbidity was no different than non-pregnant.
- Pregnant women were more likely to be infected at the time of surgery.

Obstet Gynecol 2011;118:1261

PREGNANCY TESTING

What about ethical and privacy concerns?

1. Can you test without the patient’s consent?
2. If positive, can/should you inform a minor’s parents?
3. Will you cancel the case if they refuse testing?
4. Is testing an entire class of patient (i.e., females) just to protect the provider from liability ethical?
5. How would your anesthetic be any different? Since there are no modern anesthetics that will affect the pregnancy or fetus, testing is not medically indicated.

Pregnancy Testing, Controversies: The Pregnant Patient for Non-Obstetric Surgery

Hawkins, Joy L., MD

From the ASA Practice Advisory for Pre-anesthesia Evaluation:

“The Task Force recognizes that patients may present for anesthesia with early undetected pregnancy. The Task Force believes that the literature is inadequate to inform patients or physicians on whether anesthesia causes harmful effects on early pregnancy. Pregnancy testing may be offered to female patients of childbearing age and for whom the result would alter the patient’s management.”

Anesthesiology 2012; 116: 522
PREGNANCY TESTING

New problem – EMRs allow us to cut-and-paste.
• Case: A woman presented for D&C due to a history of heavy menstrual bleeding. Pre-op pregnancy test was reportedly negative. At the time of D&C, an 8 week gestation was identified – a much desired pregnancy. It was later discovered that her preoperative assessment was populated with a previous negative test result, rather than the current positive pregnancy test.

ASA Newsletter; September 2014: 42

Controversy #2. Are benzodiazepines and nitrous oxide teratogenic, or are they safe to use during pregnancy?

Case: A woman at 12 weeks gestation requests general anesthesia for a cervical cerclage placement scheduled for ~ 20 minutes. She is extremely anxious about the procedure and asks you for preoperative sedation.

DOCUMENTED TERATOGENS

ACE Inhibitors | Lead
Alcohol | Lithium
Androgens | Mercury
Antithyroid Drugs | Phenytoin
Chemotherapy | Streptomycin
Cocaine | Thalidomide
Coumadin | Trimethadione
Diethylstilbestrol | Valproic Acid
Isoretinoin

TERATOGENICITY

How long after a drug is marketed does it take to establish safety for use in pregnancy?
• Experts assessed 469 drugs approved by the FDA between 1980 and 2000, reviewing available studies.
• 91% of drugs were still classified as their risk of use during pregnancy being “undetermined”.
• Inadequate information is available for women and their physicians to determine risks of most drugs.

Obstet Gynecol 2002;100:465

TERATOGENICITY

There is lack of evidence-based data to treat pregnant women for illness during pregnancy. How often do trials exclude pregnancy?
• Of industry-sponsored trials, 5/558 (1%) were designed for pregnant women.
• Of phase IV clinical trials, 348/367 (95%) excluded pregnant women.
• Need thoughtful criteria to include pregnant women in trials so we can inform their treatment decisions.

Obstet Gynecol 2013; 122: 1077

NITROUS OXIDE

Pregnant rats given nitrous oxide 75% for 24 hours on day 9 of gestation had a 4-fold increase in resorptions (abortions) and a 15-fold increase in anomalies when compared to rats given equi-anesthetic concentrations of xenon.

Science 1980;210:899
NITROUS OXIDE

Why might N₂O cause adverse effects?

N₂O inactivates vitamin B₁₂, a coenzyme of methionine synthetase, causing depression of methionine synthetase activity and potentially affecting production of thymidine and DNA.

However, even very low concentrations of N₂O (<1%) will abolish methionine synthetase activity, yet it requires 24 hours of high N₂O concentrations (75%) to cause teratogenesis.

Are the adverse effects of nitrous oxide biochemical (reduced methionine synthetase activity), or could they be due to hemodynamic effects?

NITROUS OXIDE

N₂O enhances adrenergic tone and causes vasoconstriction.

• Halothane (a sympatholytic) and other volatile anesthetics administered with N₂O protect against major and minor anomalies in rodents.
  Teratology 1988;38:121

ANESTHETIC EXPOSURE

Self-reported occupational exposures during pregnancy from 7482 nurses in the Nurses' Health Study II were used to investigate the risk of spontaneous abortion:
• 10% had spontaneous abortions < 20 weeks
• Exposure to anti-neoplastic drugs and sterilizing agents was associated with doubled risk.
• There was no association of early or late abortion with x-ray radiation or anesthetic gases.
  Am J Obstet Gynecol 2012;206:327

The largest retrospective study of exposure to surgery and anesthesia during pregnancy compared 5405 women who had surgery to case controls.
• 54% had GETA, 97% of those had N₂O
• No difference in stillbirth or anomalies, but...
• There were increases in IUGR, prematurity
  Am J Obstet Gynecol 1989;161:1178
**NITROUS OXIDE: SUMMARY**

- Teratogenic effects in animal studies may be due to vasoconstriction and decreased uterine blood flow. Combine N₂O with a sympatholytic agent.
- Adverse human effects have never been documented, even in large outcome studies.
- Studies in modern hospital settings with O.R. scavenging do not show an association with nitrous oxide or volatile anesthetics and adverse pregnancy outcomes.

**BENZODIAZEPINES**

Two studies in 1975 reported an association between maternal exposure to benzodiazepines (Valium® and Librium®) and cleft lip and/or palate.

*Int J Epidemiol 1975; 4:37
Lancet 1975; 306:478*

But later work refuted these reports.

**BENZODIAZEPINES**

- 611 infants with cleft lip and/or palate were compared to 2498 control infants with other birth defects.
- The risk of clefts was no different between women who were or were not exposed to diazepam during first trimester of pregnancy.
- For cleft lip ± palate: RR 0.8 (0.4-1.7).
- For cleft palate alone: RR 0.8 (0.2-2.5).

*NEJM 1983; 309:1282*

**BENZODIAZEPINES**

- An NIH-supported prospective study did not find any increased risk of cleft anomalies associated with diazepam use:
  - RR 1.2 versus controls
  - 95% CI 0.17-8.95

*NEJM 1984; 311:919*

**BENZODIAZEPINES**

- A meta-analysis of 7 cohort studies involving 1090 infants who were exposed to benzodiazepines found no increased risk of major malformations, or specifically oral clefts (RR 1.19, CI 0.34-4.15).
- “Even when the worst case scenario is assumed, benzodiazepines do not seem to be major human teratogens….”
  - *BMJ 1998;317:839*

**ACOG Clinical Expert Series on Teratogenicity**

“Anxiolytics (benzodiazepines): No evidence of significant risk of teratogenicity”

- Initial findings of clefts have not been confirmed by long-term follow-up studies.
- Overall results are reassuring, revealing no adverse effects on neurodevelopment.
- May be beneficial adjunct for hyperemesis (!)

*Obstet Gynecol 2009;113:166*
**NSAID's IN PREGNANCY**

Database review of women taking NSAIDs during pregnancy:
- 22% used NSAIDs in first trimester; mainly ibuprofen, aspirin, naproxen
- No association with most anomalies
- Small ↑ risk of a few specific defects

Am J Obstet Gynecol 2012;206:228

**ONDANSETRON**

Large retrospective review of a Danish database for fetal outcomes after use of ondansetron during pregnancy:
- There was no relationship with stillborn, miscarriage, any birth defects, preterm delivery, or small size
- Usually used during first trimester for severe nausea & vomiting (hyperemesis).


**OPIOIDS**

A Washington State database review of illicit and prescription maternal drug use:
- Rates ↑ from 2000→2008; mainly opioids
- Neonatal withdrawal 3.3 / 1000 births
- Newborns had lower birth weight, longer hospitalizations, more preterm births, feeding difficulties and respiratory issues.

Obstet Gynecol 2012;119:924

**CANCER CHEMOTHERAPY**

Should aggressive chemo be used when breast cancer is diagnosed during pregnancy?
- 10 women received dose-dense and 99 received conventional chemotherapy
- There was no difference in birth weight, GA at delivery, IUGR, anomalies, maternal or fetal neutropenia.

Obstet Gynecol 2012;120:1267

**CANCER AT DELIVERY**

21-year review of L&D management of women with cancer in a tertiary center:
- Incidence 0.1%, equally diagnosed before and during pregnancy
- 75% received regional for labor, 22% received general for cesarean
- Life-threatening complications with mediastinal tumors or metastases

Int J Obstet Anesth 2012;24:524

**Controversy #3. When and how should fetal monitoring be used?**

Case 1: A semi-elective cholecystectomy done at 34 weeks gestation.

Case 2: An emergency femoral thrombectomy at 31 weeks gestation.

Case 3: A series of 5 ECTs performed between 17 and 19 weeks of gestation.
**INTRA-OP MONITORING**

- Blood pressure (normal or slightly above)
- Oxygenation, ventilation
- Temperature (avoid hyperthermia)
- Blood glucose for longer cases
- Fetal heart rate (FHR) > 24 weeks: intermittent, or continuous if possible
- FHR < 24 weeks: preop and postop check

**FETAL MONITORING**

- This should *not* be discussed and decided as a medico-legal issue! It is a *medical* issue.
- Monitoring may help assess placental perfusion and assure the intrauterine environment is optimized during positioning, induced hypotension, cardiopulmonary bypass, volume shifts / blood loss.
- It provides an important reassurance for the mother.
- *But* FHR monitoring is imprecise and *not* predictive of outcome.

**CASE 1: FETAL MONITORING**

A patient at 34 weeks gestation required cholecystectomy. During skin prep (before any surgical intervention), severe persistent fetal bradycardia occurred. An emergency cesarean was performed and the umbilical cord was tightly coiled and twisted.
- Apgar scores = 1 / 5 / 7
- Umbilical cord pH = 7.17 and 7.18
  - *Can J Anesth 2003;50:922*

**CASE 2: FETAL MONITORING**

During the 30th week of an uncomplicated pregnancy, a patient underwent femoral thrombectomy under routine GETA. During surgery the fetal monitor showed absent variability, so an emergency cesarean delivery was performed for presumed fetal distress. Umbilical pH was 7.23 (normal), but the child required intubation for prematurity and ICU admission.
  - *Br J Anaesth 2001; 87:791*

**CASE 3: FETAL MONITORING**

A series of ECTs was required in a woman between 17 and 19 weeks gestation. FHTs checked before and after the first 4 procedures were normal. FHTs monitored during the 5th procedure showed a severe deceleration. No intervention was done due to non-viability. She went on to deliver a normal healthy baby at 38 weeks.
FETAL MONITORING
What should you do for intra-operative fetal distress?
• ↑ maternal FIO2 and blood pressure.
• ↑ left uterine displacement or try tilting right.
• Move the surgeons or their retractors.
• Administer a tocolytic (e.g., terbutaline 0.25 mg).
• Document your efforts in the record.
** Consider preop / postop FHR monitoring for most cases, in consultation with the obstetrician.
** Remember: loss of BTBV is normal; decels are not.

Controversy #4. Should pregnant patients > 24 weeks gestation have surgery in a specialty hospital without L&D coverage?
(no fetal monitoring, no capability for a C/S, no neonatologists)

PERIOPERATIVE BACK-UP
Case: A woman at 28 weeks gestation was evaluated for deteriorating vision, and a large meningioma was found on MRI. Urgent craniotomy was planned to preserve her sight. The surgery proceeded without fetal monitoring or provision for cesarean delivery as obstetric care was not available at the hospital where neurosurgery was performed.
Can J Anesth 2004;51:573

ACOG / ASA JOINT STATEMENT
“Non-obstetric Surgery During Pregnancy”
“Due to the difficulty of conducting large-scale randomized clinical trials in this population, there are no data to allow for specific recommendations…When non-obstetric surgery is planned, the primary obstetric provider should be notified. If that provider is not at the institution where surgery is to be performed, another obstetric care provider with privileges at that institution should be involved.”

ACOG / ASA STATEMENT
“Surgery should be done at an institution with neonatal and pediatric services; an obstetric provider with cesarean delivery privileges should be readily available, and a qualified individual should be readily available to interpret the fetal heart rate.”
Obstet Gynecol 2011;117:420 (reaffirmed 2013)

Controversy #5. What is the best way to manage the EXIT (ex-utero intrapartum treatment) procedure?
Case: A healthy woman at term has a fetus with a large neck mass found on ultrasound. The mass is compromising its airway and intubation will be required immediately after delivery.
EXIT PROCEDURE
(Ex Utero Intrapartum Treatment)

1. Maternal GETA is induced and then maintained with 2 MAC volatile agent to provide uterine relaxation and fetal anesthesia.
2. After uterine incision and hemostasis, only the head and arm are delivered. A pulse oximeter is placed, IM relaxant and narcotic are given to the fetus. The placenta remains intact.
3. The trachea is intubated or tracheostomy is performed. Surfactant may be administered.
4. Once the airway is secure, volatile agent is discontinued to regain uterine tone, delivery is completed and oxytocics are begun.

Anesthesiology 2011;114:1446

EXIT PROCEDURE

Case report: Fetus with an oral teratoma required EXIT procedure at 25 weeks due to preterm labor. Under general anesthesia, fetus underwent bronchoscopy and tracheostomy while on placental circulation. Delivery and resection followed. The mother was discharged after 4 days.

Obstet Gynecol 2012;119:466
FETAL SURGERY

Fetal / prenatal repair of myelomeningocele may be preferable to neonatal repair. Issues to consider for open fetal surgeries:
• Ethical considerations
• Inducing profound uterine relaxation
• Vigilance for maternal and fetal blood loss
• Fetal monitoring and possible resuscitation
• Postoperative tocolysis and analgesia

Anesthesiology 2013; 118: 1211

FETAL SURGERY

Fetal endoscopic tracheal occlusion is used to treat severe CDH.
• ↑ survival: 54% vs. 5%
• Resulted in improvement in fetal lung size and pulmonary vascularity
• Response in lung growth 4 weeks after occlusion is predictive of neonatal survival.

Obstet Gynecol 2012;119:93

FETAL SURGERY

Using a maternal-fetal sheep model, anesthesia with high-dose desflurane was compared to low-dose des + propofol / remifentanil.
• High-dose des → more maternal hypotension, fetal acidosis, and ↓ uterine blood flow.
• Even with maternal normotension, UBF still declined and fetal acidosis persisted.
• No difference in fetal cardiac function.

Anesthesiology 2013; 118: 796

Controversy #6. Is there a “best” anesthetic during pregnancy to protect the fetal brain from neurotoxicity?

Do anesthetic drugs cause developing neurons to commit suicide (apoptosis)?

Case: A healthy well-educated woman requires emergency appendectomy at 26 weeks gestation. Based on information she obtained on the internet, she questions you about the effect of your general anesthetics on her fetus’ developing brain.
ANIMAL STUDIES
In a simulated clinical scenario:
• 7-day old rats (0-6 months in humans) received 6 hours of general anesthesia: midazolam, nitrous oxide, isoflurane.
• Postop, the animals had memory / learning impairments, apoptotic neurodegeneration, and hippocampal synaptic function deficits.
J Neuroscience 2003;23:876

ANIMAL STUDIES
Are the adverse effects attributable to the direct effects of anesthetics, or are they the result of factors we would not see clinically; eg. high doses over long periods, acidosis, hypoxia, starvation?
Problems extrapolating animals to humans:
• Inter-species differences
• Simulating normal O.R. conditions
• Adequate monitoring

PRIMATE STUDIES
Are non-human primates (versus rats) also susceptible to anesthetic toxicity?
• Rhesus macaques received 5 hours of 1 MAC isoflurane while ventilated.
• There was a 13-fold increase in neuro-apoptosis in exposed animals, largely concentrated in the cerebral cortex.
Anesthesiology 2010;112:834

ANIMAL STUDIES
Editorial view:
“...it is not clear which anesthetic technique might be least toxic, nor has any general anesthetic been convincingly shown to be more toxic...certainly non-urgent surgery should continue to be postponed until after pregnancy. Considerations should be made to using regional anesthesia when possible.”
Anesthesiology 2011;114:479

IS REGIONAL BETTER?
A retrospective study of adnexal mass surgery during pregnancy compared 137 women having general anesthesia with 71 having regional anesthesia.
The overall incidence of preterm labor was higher in the surgical than control groups. Regional had significantly higher incidence (30%) than the general anesthetic group (6%).

ANESTHETIC TOXICITY
What about exposure of the fetus in-utero?
• Non-obstetric surgery and fetal interventions often use GETA at high concentrations for longer than C/S, and all lipophilic anesthetics can be measured in the fetal brain.
• 2nd trimester: rapid fetal brain development
• Animal exposure — neuronal cell death and behavioral abnormalities; same for humans?
ANESTHETIC TOXICITY
Do children exposed to anesthesia in infancy have deficits in school performance?
• Mean composite scores on academic achievement tests did not appear different.
• However, 14% scored below 5th %ile, even when other CNS problems or risk factors during infancy could be ruled out.
• There was a negative association between duration of anesthesia and test scores (longer = lower).
  Anesthesiology 2012;117:494

Analysis comparing 321 children age 10 who were exposed to anesthesia under age 3:
• Battery of neuro-psych tests administered.
  • ↑ language disability (RR 1.87)
  • ↑ abstract reasoning deficits (RR 1.69)
  • Disability in language and cognition (RR 2.41)
  • Risks persisted even with only 1 exposure.
  Pediatrics 2012;130:476

Do children age 12 who were exposed to GA for minor procedures during infancy show differences in academic achievement from those who were not exposed? Yes.
• No difference in standardized test scores
• Diagnosed learning disability was 15% vs 4% with an OR 4.5
  Anesth Analg 2013; 117: 1419

Expert report and consensus statement:
1. Pre-clinical studies indicate general anesthetics are modulators of neuronal development and function.
2. Need clinical studies (vs. animal models)
3. Need strategies to avoid or limit brain injury in pediatric and geriatric patients; GA effects are not entirely reversible.
  Br J Anaesth 2013; 111: 143

How do we interpret observational studies?
• What is the population receiving anesthesia?
• Who is actually included in the analysis?
• What is the definition of anesthetic exposure?
• What is the comparison group?
• What is the outcome measure?
• How are the data analyzed?
• What is the clinical relevance?
  Anesthesiology 2012;117:459
ANESTHETIC TOXICITY
Summary of what we know:
• Single anesthetics may not have an effect.
• Repeated exposures do show an effect.
• Effects persist after adjustments for co-morbidities.
• Learning (reasoning), speech and language are affected but not behavior.
• Observational studies are prone to bias, confounding, etc. but RCTs for this question are not possible or ethical. Prospective trials are ongoing.
AAP 2012 Nat’l Conference / Medscape, 10/25/12

ANESTHETIC MANAGEMENT OF THE PREGNANT SURGICAL PATIENT

COMMON SURGERIES
The most common indications for surgery unrelated to pregnancy:
1. Appendicitis, 1:2000 pregnancies
2. Cholecystitis, 1:6000 pregnancies
3. Maternal trauma
4. Maternal malignancies

PREOP ASSESSMENT
• Is my patient pregnant?
  Document LMP on record.
  Offer pregnancy testing.
• Operate during second trimester if possible.
  Less risk of early spontaneous miscarriage.
  Theoretical risks of teratogenicity are avoided.
  3rd trimester↓introp visibility, ↑preterm labor
• Reassure her about risks to fetus or pregnancy.
• Educate her about uterine displacement, symptoms of preterm labor.

PREOP MEDICATIONS
• Sedation may be beneficial.
  Narcotics
  Benzodiazepines
• Consider aspiration prophylaxis.
  Antacid
  Metoclopramide
  H-2 receptor blocker

INDOMETHACIN TOCOLYSIS
Usual dose
- 50 mg loading,
- 25 mg q 6 hours PO or PR
Implications
<table>
<thead>
<tr>
<th>Maternal</th>
<th>Fetal</th>
</tr>
</thead>
<tbody>
<tr>
<td>Platelet function</td>
<td>Necrotizing enterocolitis</td>
</tr>
<tr>
<td>GI symptoms</td>
<td>Oligohydramnios</td>
</tr>
<tr>
<td>Renal insufficiency</td>
<td>Closure of fetal ductus</td>
</tr>
</tbody>
</table>
CHOICE OF ANESTHETIC

• There is no evidence in humans (yet) that any drug or anesthetic technique is dangerous to the fetus (stay tuned on the neurotoxicity issue).
• Choose the safest anesthetic for the mother’s condition, and modify for the physiologic changes of pregnancy.
• Avoid hypoxia and hypotension!

GENERAL ANESTHESIA

• Full pre-oxygenation / denitrogenation
• Rapid sequence induction, smaller ETT
• First trimester: use tried and true drugs
• Nitrous oxide versus FIO2
• ET CO₂ 28-32; avoid hyperventilation
• Inhalational agents < 2.0 MAC
• Slow or no reversal of relaxants
• Compression stockings

NEURAXIAL ANESTHESIA

• Advantage of minimizing drug exposure
  First trimester
  Fetal monitoring
• Prevent hypotension
  Adequate fluid replacement
  Uterine displacement
• Decrease neuraxial local anesthetic dose by 30%.
• Choose ephedrine vs. phenylephrine based on maternal heart rate.
• Utilize for postoperative pain control.

POSTOPERATIVE CARE

• Continue monitoring fetal heart rate and uterine activity. Provide L&D nursing expertise.
• Maintain maternal oxygenation and LUD.
• Notify Pediatrics if the fetus is a viable gestational age > 24 weeks.
• Use neuraxial narcotics or regional blocks for pain management if possible to encourage early ambulation.
• Use thromboembolism prophylaxis.

SPECIFIC SURGICAL SITUATIONS
TRAUMA

- A leading cause of maternal death, especially MVA without use of seat belts.
- Fetal loss is due to maternal death or placental abruption.
- Need early ultrasound in E.R. to determine gestational age and viability.
- Perform all necessary diagnostic tests on the mother with shielding as necessary.
- Maternal ↑ blood volume may mask blood loss.

Obstet Gynecol 2009;114:147

TRAUMA

What are the risks of radiation exposure?

- ACOG has stated: “no single diagnostic x-ray procedure results in radiation exposure to a degree that would threaten the well-being of the developing fetus.”
- Teratogenic risks are not increased with < 5 rad exposure (eg. a head CT < 1 rad).
- Ultrasound and MRI are safe alternatives.

Anesth Analg 2010;110:863

TRAUMA

Indications for emergent C/S:

- Stable mother, viable fetus in distress
- Uterine rupture
- Gravid uterus interfering with repairs
- Mother unsalvageable, fetus viable

If the fetus is previable or dead, focus on optimizing the mother. She will tolerate vaginal delivery at a later time better than an emergent laparotomy.

NEUROSURGERY

- Intracranial aneurysms or AVM may require repair in this age group.
- Usual anesthetic techniques can be used.
- Fetal monitoring is remote from the field and may be beneficial in some cases, eg. aggressive diuresis, hyperventilation, bleeding and fluid shifts.

Anesth Analg 2008;107:193

NEUROSURGERY

Successful endovascular treatment of acutely ruptured intracranial aneurysms in pregnancy:

- 32 wks gestation with HA and vomiting. CT and MRI show SAH and aneurysm: C/S → angio → embolization with coils.
- 22 wks gestation with HA, vomiting, LOC. CT shows SAH: G ETA → angio → occlusion with coils using fetal shielding → SVD at term.

Am J Obstet Gynecol 2001;185:1261

CARDIAC BYPASS

Pregnant patients who had cardiopulmonary bypass procedures were reviewed:

- Preterm birth or IUFD were associated with emergent procedures, maternal co-morbidities, and early gestational age.
- Recommendations: normothermic, high-flow bypass, postponing until 2nd trimester.
- Elective delivery before CPB should be considered if the fetus is viable.

Ann Thorac Surg 2011;91:1191
GOALS DURING CPB

• High pump flows (>2.5 L/min/m²)
• High MAP > 65 mmHg
• Hematocrit > 28%
• Normothermic CPB (limit < 32°C)
• Pulsatile flow ?
• Optimize CO₂, acid-base, glucose
• Use continuous fetal HR monitoring

LAPAROSCOPY

Symptomatic cholelithiasis during pregnancy is not rare, but medical versus surgical management has been controversial. Case control study:

• 38% of medical patients had relapses. Each relapse accounted for additional 5 inpatient days.
• Compared to medical management, surgery patients had less preterm labor, fewer premature deliveries, and fewer days in-hospital.


LAPAROSCOPY

Is laparoscopy better for fetal outcome than an open procedure?

• There are no outcome differences between laparoscopy and laparotomy in maternal complications or fetal outcome.
• Laparoscopy patients (the mothers) had longer operative times but shorter hospital stays, less parenteral narcotics, and earlier resumption of a regular diet.

Clin Obstet Gynecol 2009;52:557

LAPAROSCOPY

Following laparoscopy (n=2181) or laparotomy (n=1522) performed between the 4th and 20th weeks of gestation, there were no differences in:

• Infant survival to one year
• Rate of fetal malformations
• Birth weight
• Gestational duration
• Growth restriction

There was an increased risk of low birth weight < 2500 gm, delivery before 37 weeks, and growth restriction when comparing the operated groups to the general population.

Am J Obstet Gynecol 1997; 177:673

GOALS FOR LAPAROSCOPY

• Consider an open technique to enter abdomen.
• Maintain normal end-tidal CO₂, consider blood gas monitoring to rule out respiratory acidosis.
• Keep inflation pressure < 15 mmHg.
• Laparoscopic techniques can be used in any trimester of pregnancy.
• Maintain uterine displacement and monitor the fetus if feasible.
• Use compression devices for DVT prophylaxis.


SUMMARY

Approach the pregnant surgical patient with respect, rather than apprehension.

Recognize her fears related to her pregnancy.

Doing what is best for the mother will almost always be best for the fetus and the outcome of the pregnancy.
Catheter Based Cardiac Surgery: Anesthesia in the Hybrid Suite and Cath Lab

Nathaen Weitzel MD
Associate Professor
CU School of Medicine
University of Colorado Hospital

Learning Objectives:
At the Conclusion of this lecture, participants should be able to:
1) List the key risk factors for patients undergoing interventional cardiac procedures;
2) Differentiate among critical monitoring techniques based on interventional procedure type;
3) List the advantages or disadvantages for general anesthesia in electrophysiology procedures;
4) Describe the challenges of providing anesthetic care for cardiac patients in off site locations;

Disclosures
- Editor in Chief Seminars in Cardiothoracic and Vascular Anesthesiology – SAGE Publications
- Editor - Manual Clinical Anesthesiology – LWW publications
- Haemonetics: Research Reagent Support

Interventional Cardiology
- Interventional Cardiology has evolved significantly over past 70 years beginning with central catheterization and PCI.
- Topics Covered Today:
  - TAVR
  - AFIB interventions – Lariat
  - Lead Extractions
  - ASD closures
  - Mitra-clip

TAVR
- Total Aortic Valve Replacement
- TAVI: Total Aortic Valve Implantation

Aortic Valve Replacement

• Total Aortic Valve Replacement
• TAVI: Total Aortic Valve Implantation
Currently Available Transcatheter Valves

(A) The Edwards SAPIEN THV balloon-expandable valve (incorporates a stainless steel frame, bovine pericardial leaflets, and a fabric sealing cuff).

(B) The SAPIEN XT THV utilizes a cobalt chromium alloy frame and is compatible with lower profile delivery catheters.

(C) The Medtronic CoreValve incorporates a self-expandable frame, porcine pericardial leaflets, and a pericardial seal.

Am Coll Cardiol. 2012;60(6):483-492

Partner I Trial


Two-year with 1-year landmark analysis of all-cause mortality Kaplan–Meier curve in PARTNER trial cohort


Two-year time trends in hemodynamics after TAVI vs. SAVR

Anesthetic Management

- GETA typically employed**
- Slow, gentle induction tailored for AS
- Anticipate extubation at conclusion
- Pre-induction Arterial Line
- Central Access following induction
  - PAC in higher risk patients (PHTN, RV failure)
- TEE
- Temporary pacing

Kaplan–Meier Cumulative Frequency of Death from Any Cause.

Subgroup Analysis for the Rate of Death from Any Cause at 1 Year.

Randomization and Analysis Populations.
Trans-apical TAVR

Complications

- Peripheral Vascular Injury
- Stroke (3-4%) 

Grading criteria for paravalvular insufficiency based on the percentage of circumferential extent

<table>
<thead>
<tr>
<th>Paravalvular Insufficiency Based on Circumferential Extent</th>
<th>Mild</th>
<th>Moderate</th>
<th>Severe</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt;10%</td>
<td>10%-29%</td>
<td>&gt;30%</td>
<td></td>
</tr>
</tbody>
</table>

- Post-TAVR aortic insufficiency (> 60%)

Lead Extractions:

**Class I indications:**
- INFX
- Definite CIED system infection
- Pocket infection, abscess, erosion through skin
- Endocarditis
- Occult Gram + bacteremia

**Lead issues:**
- Arrhythmias secondary to retained leads
- Interference of retained leads with CIED
- Interference with treatment for malignancy

**Thrombosis:**
- Thrombotic events associated with lead
- SVC occlusion and need for additional lead placement
- Lead presence with planned stent deployment

2014 Consensus Statement


David E. Halpern, MD, FHRS, (Chair), Salaco Behrwal, MSN, CERP, (Chair),
Joseph G. Alar, MD, PhD, Janice L. Baker, MSN, CCNP, CEP, FHRS, Doug Beirnboim, RN, MA,
John F. Bohula, MD, FHRS, FACC, Nell Brylewicz, MS, Christina Chiu-Man, MS, CEDS, FHRS,
Kathryn K. Collins, MD, FHRS, Matthew Dacre, CEPs, Kenneth Fetterly, PA-C, John D. Fisher, MD, FHRS,
Richard Hongyo, MD, FHRS, Samuel Jaffe, MD, John Lopez, RN,
John K. Miller, MD, FHRS, James C. Perry, MD, FHRS, David J. Sztainberg, MD,
Gary F. Tomasini, MD, FHRS, FACC, Esther Weiss, APN, CED, MSN, CDS, CEPs

Heart Rhythm, Vol 11, No 8, August 2014

Recommendations:

- Highly complex procedures or procedures on patients with certain conditions and comorbidities that are associated with higher procedural risk should not be performed in a freestanding laboratory
- Emergency cardiovascular surgical support should be immediately available extraction of chronic device leads and complex mapping/ablation procedures, particularly those requiring pericardial access

Recommendations:

- High-risk procedures in critically ill patients, such as ablation of ventricular tachycardia in patients requiring extracorporeal hemodynamic support, can only be safely performed in institutions offering comprehensive programs with active engagement from electrophysiologists, surgeons, intensivists, and anesthesiologists.
Recommended Personnel

• 1 EP or device-credentialed MD performing the procedure
• 1 Secondary operator (Fellow, NP, PA, and technician performing under the supervision of an MD responsible for the procedure [as approved by the institution])
• 1 AA / CRNA administering anesthesia under the supervision of an MD anesthesiologist, or 1 nurse trained and credentialed in procedural sedation
• 1 CV surgeon to be immediately available (may be required to be in the room for the critical part of the procedure)
• 1 nurse – circulating
• 1 technologist or nurse scrubbing

Lead Extraction Evidence

Clinical predictors of adverse patient outcomes in an experience of more than 5000 chronic endovascular pacemaker and defibrillator lead extractions


• Retrospective analysis of 5521 lead extractions from 1996-2011.
• Uni and Multivariate logistic regression analysis for associations with adverse outcomes in lead extractions.


Multivariate Analysis Results

• Major Complications: (1.8%)
  – Cerebrovascular Dz, reduced EF, low platelets, INR > 1.2, use of mechanical sheath.
• MCVI – (1.1%)
  – Low platelets, combined age of leads > 7 yrs, use of mechanical or powered sheath

Cleveland Clinic TVLE Catastrophes

• 25 patients experienced complications requiring emergent surgical or endovascular intervention. This is 0.8% of their population
• Twenty patients required cardiac surgical intervention
  – Eighteen patients required sternotomy
  – 2 patients required thoracotomy
• There were 15 SVC lacerations, 2 right atrial perforations, 3 ventricular perforations
Cleveland Clinic TVLE Catastrophes

• Two patients required vascular repair at the procedural access site for SCL vein or artery laceration
• Three patients were managed with an endovascular approach for SVC laceration, left axillary laceration and brachiocephalic vein and artery fistula

Case:

• 34 yo female – developed post partum cardiomyopathy 8 years ago
• CIED placed at that time
• Heart function has since recovered, with near normal LV systolic function
• Plan is to remove leads / device

Anesthesia Recommendations:

• General Anesthesia
• Standard ASA + Arterial line
• Possible Central line
• TEE
• LB IV access – preferably femoral
• Type and Cross
• CPB / CT surgeon standby*
• Stratify low / intermediate vs high risk patients

Left Atrial Appendage (LAA) \( \rightarrow \) Percutaneous Closure

Saady et al. Heart 1999
Fuller et al. Curr Card Rep 2011
Global Difficulty Rating

PDW

Clinical Exclusion Criteria

- History of Pericarditis
- Hx of Cardiac Surgery
- Pectus Excavatum
- Recent MI (< 3mos)
- Recent embolic event in last 30 days
- Heart Failure NYHA IV
- Systolic HF (EF < 30%)
- Thoracic Radiation

Anatomic Exclusion:

- LAA > 40mm
- Superiorly oriented LAA
- Bilobed LAA

### TABLE 2 Major Bleeding Events During Hospitalization in the Study Population (n = 154)*

<table>
<thead>
<tr>
<th>Event</th>
<th>Count</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Major bleed</td>
<td>14</td>
<td>9.1%</td>
</tr>
<tr>
<td>Any transfusion with overt bleeding</td>
<td>7</td>
<td>4.5%</td>
</tr>
<tr>
<td>Overt bleed, hemoglobin drop 3 to &lt; 5 g/dL</td>
<td>5</td>
<td>3.2%</td>
</tr>
</tbody>
</table>

**CONCLUSIONS** In this initial multicenter experience of LAA ligation with the Lariat device, the rate of acute closure was high, but procedural success was limited by bleeding.

“Given the considerable incidence of complications, the relatively high incidence of incomplete LAA occlusion, and the lack of long-term efficacy data, we agree with the suggestion of the authors that this method should be reserved only for very well-selected patients with substantial thromboembolic and bleeding risk.”
Anesthesia Recommendations

- Arterial Line
- General Anesthesia
- TEE
- Large Bore IV
- CPB / CT surgeon standby**
- Type and Cross

Structural Interventions

- Multiple lesions now being intervened upon
  - ASD closure
  - Mitral valve (regurgitation) → Mitra Clip

Complications

- Typical Anesthesia Management:
  - General Anesthesia following any right heart catheter measurements for Qp:Qs (cardiologist may want to do this on room air)
  - TEE monitoring
  - IV access and standard ASA monitors
  - Arterial line only for patients with severe heart disease
  - Aggressive removal of air from IV lines etc

Mitra – Clip for Mitral Regurgitation

- Percutaneous approach to Alfieri repair (1991) – or the edge to edge repair
- FDA approval for Mitra-clip in 2013
- Indicated for patients with severe MR and high surgical risk
  - Ideally used for Type II and Type IIIb patients with functional MR
Evidence:
• First arm → 279 patients with 3 or 4+ MR randomized to Mitral clip vs surgical repair
  – 12-month results demonstrated equivalent mortality, improved efficacy with surgery vs Mitral Clip (73% vs 55%), yet reduced adverse events compared to the surgical group.

EVEREST SUMMARY
• Second arm (Everest II trial) → High Risk Study (HRS) which looked at high surgical risk patients (>12% estimated mortality) with grade III/IV MR.
  – Compared retrospectively to “comparator” group
  – Device repair was achieved in in 96% of the 76 patients.
  – 12-month survival rate was 76% for intervention group and 55% for control group. The intervention group also demonstrated reduction in MR severity, LV volume, improvement in NYHA classification, and improved quality of life indicators

Evidence:
• Surgical Repair probably more durable and effective
• High Risk patients have low procedural mortality and functional improvement after Mitra-clip repair
• Viable option for many high surgical risk patients

Radiation Safety
• Staff and physician awareness (ALARA)
• Time, Distance, Shielding
• Personal protection tools
  • Lead aprons
  • Thyroid shields
  • Eye protection
  • Hand protection
• Radiation Dose

MitraClip® System
Anesthetic Management:
• Induction as with any High Risk cardiac patient with Severe MR
• Relative increase in HR, without impairing LV function
• Arterial Line access
• TEE monitoring
• +/- Central access
Radiation risk to Anesthesia

- Radiation
  - Highest for anesthesia providers!
  - 15x higher than the dose received by the scrub nurse
  - Attributed to the lack of effective shielding, which was available but not utilized due to inconvenience
  - Effective shielding can reduce radiation dose by up to 80%
  - Real time dosimeter increases awareness

Making sense of radiation units

- NY to LA flight 40 μSv
- Chest Xray: 20 μSv
- One EVAR average exposure 38 – 112 μSv
- Anesthesia exposure 268 μSv
- CT spin: up to 5 mSv
- Yearly limit: 50mSv

How to protect ourselves from Radiation?

- Lead apron with thyroid shield
- Two ceiling mounted transparent shields
- Table top standing
- Move closer to patient
- Move closer to scanning monitor
- Real time dosimeter

Structural interventions

- Discuss the plan with Interventional Team
  - Impact when to induce general anesthesia
  - Impact degree of monitoring
- Keep in mind the risk of failure – and the need to mobilize the OR urgently when needed
- Advanced TEE training is needed to help guide many of these procedures.
Perioperative Surgical Home

Debnath Chatterjee, M.D.
Associate Professor of Anesthesiology
CRASH 2015 - Vail, Colorado

Learning Objectives

- Describe the concept of the Perioperative Surgical Home (PSH)
- Discuss the role of Anesthesiologists in managing PSH
- Recognize value added services that anesthesiologists can provide
- Summarize the work done by the ASA to create a road map for PSH

Goals of PSH

- Patient safety
- Efficient, coordinated care
- Better patient outcomes
- Cost effectiveness

What is the PSH model?

Patient Centered

Physician led Multidisciplinary

Team based Coordinated Care

Surgery Decision

Discharge

Scheduling

Post Care

Pre optimization

Surgical event

Why do we need a PSH?

- Healthcare in the U.S is expensive!

Surgical care accounts for 65% of all hospital expenses

Disclosures

• None
Rising Costs of U.S. Healthcare

Triple Aim
Institute for Healthcare Improvement
- Improving patient experience
- Improving health of populations
- Reducing per capita cost of health care

Current Surgical Care
- Pre op: Variable preoperative assessment & testing
- Intraop: Provider choice anesthesia, Lack of standardized protocols
- Postop: Surgeon manages post op care, Few protocols
- Post discharge: Variable support, often resulting in readmission

Current Surgical Care
- Variable and fragmented care
- Poor Accountability
- Volume driven reimbursement
- Multiple preventable complications
- Poor patient satisfaction
- Increased health care costs

Added Value
What Is Value in Healthcare?
Michael E. Porter, Ph.D.
NEJM 2010; 363: 2477-2481

Value in healthcare is measured in terms of patient outcomes achieved per dollar expended
Reward for
- Best overall care
- Lowest cost
- Minimize complications

Paradigm Shift
Current care | Future models
--- | ---
Fragmented care | Collaborative care
Discounted Fee for Service | Bundled payments
Volume based reimbursement | Value based reimbursement
Isolated patient files | Integrated electronic medical records
Focus on procedure | Focus on triple aim
Revenue driven | Outcomes driven
Implementation of a Total Joint Replacement-Focused Perioperative Surgical Home: A Management Case Report

Leslie Carson, MD,* Ran Schmedes, MD, MDSc,† Shreemar Valiahar, MD, MBA, * Brian Alexander, MD, MSc.†士ian Tredz, MD, MB; ‡ Maximo Canellos, MD, PhD, * and Zedv Kian, MD, MPH*.

Anesthesia & Analgesia 2014; 118:1081-9

Preoperative Care
- Early Anesthesia intervention
- Shared decision making
- Comprehensive preoperative evaluation
- Patient education and expectation management
- Tailored medical optimization

Intraoperative Care
- Standardized protocols for anesthesia care
- Standardized equipment and nursing protocols
- Optimal hemodynamic management and fluid therapy
- Multimodal pain management
- Infection prevention strategies

Postoperative Care
- Targeted recovery plan
- Early intervention for deviation from recovery goals
- Early ambulation, PT/OT
- Nutrition management
- Multimodal analgesia
- Early removal of drains/catheters

Post Discharge Care
- Personal recovery pathway
- Timely return to normal activity & work
- Early remote follow up (telephone/telemedicine)
- Physical therapy
- Home health, wound management

UC Irvine Joint Surgical Program

Team Members
- Anesthesiologists
- Surgeons
- Nurse managers
- Hospitalists
- Pain Management
- Pharmacy
- Respiratory Therapy
- PT/OT
- Discharge planning
- Quality/safety reps
- Data analysts
- Social work
- Lean Six Sigma Training
**Outcomes data**

**Operative Outcomes**

<table>
<thead>
<tr>
<th></th>
<th>Total Hip</th>
<th>Total Knee</th>
</tr>
</thead>
<tbody>
<tr>
<td>Median LOS</td>
<td>3 days</td>
<td>3 days</td>
</tr>
<tr>
<td>ED visit &lt;30 days</td>
<td>3.9%</td>
<td>4.2%</td>
</tr>
<tr>
<td>Hosp readmission</td>
<td>0%</td>
<td>1.1%</td>
</tr>
</tbody>
</table>

92% on-time starts  
1 case cancelled- 0.7%

**Safety Outcomes**

- 30-day mortality - 0.0%
- Major complications-0.0%
- Minor complications- 10.5%
- SCIP indicators- 100%

**How PSH Aligns with Triple Aim**

- Early and continued patient engagement
- Optimal pre-op testing and preparation
- Intraoperative efficiency
- Improved patient satisfaction
- Improved clinical outcomes and fewer complications
- Application of evidence-based principles
- Lower cost for physician preference items
- Post-procedure care initiatives
- Care co-ordination and transition planning

**Cost Savings of PSH**

- Reduces variability of cost
- Reduced preoperative testing
- Preoperative optimization reduces LOS
- Intraoperative efficiency
- Decreases potentially avoidable complications
- Decreases rework, including readmissions
- Standardization of Physician Preference Items decreases costs

**What is our role?**

- Uniquely qualified to lead the PSH
- No one knows the perioperative practice better
- Leaders in patient safety
- Medical knowledge that crosses all disciplines, focused on the impact of the surgery
- Best way to demonstrate the ‘added value’ we provide beyond surgical anesthesia

- Several leadership roles
- Best positioned to facilitate
  - Evidence based standardization of practice
  - Achieving key health care metrics
- If we don’t take the lead, someone else will
- The risks associated with “doing nothing” are too great
ASA’s Role in PSH

- ASA Committee on Future Models of Anesthesia Practice
- CFMAP White Paper – July 2013

http://www.periopsurghome.info/images/PSH_Whitepaper.pdf

Literature on PSH

The Perioperative Surgical Home (PSH)
A Comprehensive Literature Review for the American Society of Anesthesiologists

Bin Kuo, PhD, MBA, FACHE
Kathleen M. Liebson, PhD
Yehuan Zhang, MS, MA

Submitted to the American Society of Anesthesiologists (ASA)
August 31, 2013
ASA Council
Thomas M. Nobody, PhD, MBA
Director of Health Policy Research, ASA

PSH Webinar

- www.ahaphysicianforum.org/webinar/2013/perioperative-home/index.shtml

ASA Learning Collaborative

Key Benefits
- Peer-to-peer networking and shared learning opportunities
- Access to subject matter experts
- Access to tools and resources

Learning Collaborative to Advance the Perioperative Surgical Home (PSH)

- One year learning system (July 2014-Spring 2015)
- Educate
- Share information
- Provide ‘proof of concept’
- Support pillar projects
- Disseminate best practices within PSH framework
Conclusions

• Great opportunity for our specialty to lead the way and be early adopters
• “It wasn’t raining when Noah built the arc”
• “The best way to predict the future is to create it” - Drucker PF
Session Takeaways
Dashboards for your providers across multiple quality domains
Review an early warning system for key medical conditions
Learn about iCare, an emergency decision support system
Integrate your EMR with hospital and national QI systems

Dashboards: The Case for Data
Physicians want to do the right thing
But don’t know where they are relative to others
Need data – usually work alone in a vacuum
Can’t see how others are succeeding or where we are
Peer Pressure - highly motivational
May be the most effective change factor, no one wants to be at the bottom of the scale
Learn from those doing it better
Still have a lot to learn – this is real time improvement
Identify those who need more help
Those at the lower end can be identified and coached

Dashboards: Requirements for Success
Accurate
Physicians will search for inaccuracy and perceived excuses
Real Time
Need to be able to see the effect of interventions
Reliable
Metric cannot change over time, upgrades cannot reset system
Available
Must be easy to find and use – self serve analytics

Dashboards: What to consider tracking
ASA Score Summaries
Anesthesia Start to Ready Times (by Service)
Airway placement, Line placement, Block placement
PACU recovery times, pain scores, opioid administration
OPPE Metrics
Emergence Agitation
Nausea / Vomiting
Efficiency Metrics
Block Utilization
Room Utilization
Case Volume
Cancellations
Room Turnover
Percent of First Case Late Starts
Dashboards: **ASA Status**
- ASA score summaries
- Distribution of medical complexity
- Start to Ready Times by Service Efficiency

Dashboards: **Airway and Line Placement**
- Allows tracking of procedures and competency
- Shows distribution of techniques
- Focus on areas with lower numbers

Dashboards: **Airway and Line Placement**
- Airways

Dashboards: **OPPE Metrics**
- Results in severe patient dissatisfaction
  - May be influenced by anesthetic plan

Dashboards: **PACU**

Dashboards: **Nausea and Vomiting**
- Results in severe patient dissatisfaction
  - May be influenced by anesthetic plan
Dashboards: *Emergence Delirium*

Child wakes inconsolable and disassociated from the environment

Dashboards: *OR Metrics*

Dashboards: *Considerations*

Data integrity
- Where do the metrics come from?
- Who is entering the data
- Inter-rater reliability

Case distribution
- Specialty teams

Variability
- Appropriate timeframes for analysis

Dashboards: *Change Management*

Scorecard
- Every 6 months
- Self serve analytics available anytime
- Two standard deviations below mean
- Outlier management
- Cases reviewed with clinical management team
- Suggestions offered for improvement

Early Warning System

Identify Conditions in which we can intervene
Display a warning
Advise the clinician how to prevent it

Early Warning System: *STBUR*

Case Study: Predicting perioperative respiratory adverse events
STBUR (Snoring, Trouble Breathing, Un-Refreshed Sleep)

Anesthesiologist charted pre-op section
Early Warning System: *Braden Q*

Case study: Braden Q – Risk of pressure ulcer
Nurse entered assessment in the admission encounter

Early Warning System: *Display*

Early Warning System: *Reports*

iCare

Emergency Decision Support in AIMS system

Common anesthesia emergencies
Calculates drug doses automatically
Real time guidance

Same report format can be used for protocols

iCare: *Integration with intraop*

iCare: *Example Report*
Event Reporting

Event and Outcome capture
Review cases in M&M process
Drive system based improvement

Two ways to integrate
Hospital Systems
Anesthesia Quality Institute

Can’t fix what we don’t know about

Event Reporting: AQI

Anesthesia Incident Reporting System (AIRS)

Use only the navigation options provided. Please do not use your Internet’s Back, Forward, or Reload buttons.

Classify

Use the list below to properly classify the incident. You may use the ‘Add Another’ (based on ‘Additional’ button to add as many as needed.

Changing

Event of Patient Injury (or Risk)

Patient

Injuries

Risk Factors

Additional

Incident Description

Please include as much additional information as possible.

Preventing Harm: Anesthesia Sign-In

Anesthesia Protocols

• Use your AIMS system to standardize provider performance
  • Pre-op: Review and acknowledge protocol
  • Intra-op: Use scripting (Macros, Reminders) as cognitive aids
  • Post-op: Make the performance data available
    • Self Serve Analytics

• Change Management
  • Opt-In model vs Department / Service line requirement
  • Assigned person accountable for cases
  • Review data with providers
Protocols

- **Introduction**
  - Induction phase
  - Maintenance phase
  - Transition Management

- **Reminders**
  - Dexametomidine
  - Omeprazole
  - Prophylactic antibiotics

**Protocols: Reminders**

- **Driving Reporting and Quality Improvement**

**Questions?**

**Patrick Guffey**
patrick.guffey@childrenscolorado.org
Perioperative Management of Cardiac Implantable Devices

Let’s Talk Pacemakers!

Practice Advisory for the Perioperative Management of Patients with Cardiac Implantable Electronic Devices: Pacemakers and Implantable Cardioverter-Defibrillators

An Updated Report by the American Society of Anesthesiologists Task Force on Perioperative Management of Patients with Cardiac Implantable Electronic Devices

Goals

- Why you should care?
- Review the article (society rec’s)
- Practical recommendations
- Who you should fear!

Financial Disclosures

- None

Where did the rec’s come from?

- Heart Rhythm Society
- ASA
- Tried to find evidence and then gain consensus

Perioperative Experts!

- 3 million people worldwide with pacemakers
- 600,000 pacemakers implanted every year
- Most patients >60 years old
- They often need surgery
- We should know what’s going on!
**Main Points of the talk**

- Get help
- Interrogate the device
- Don’t fly blindly
- Device Product reps get paid a lot of money
- Device companies make a lot of money
- They work to help you
- They are always on call
- **Figure out what your hospital has**
  - EP nurse, cardiologist, product rep

---

**Ask for something that looks like this!**

---

**Endorsement**

- **American Society of Anesthesiologist Annual Meeting**
- **Workshop 811. Pacing and ICD Workshop**

---

**Goals**

- Why you should care?
- **Review the article (society rec’s)**
- Practical recommendations
- Who you should fear!

---

**Evidence Grade**

- Category A
  - Supportive literature
- Category B
  - Suggestive literature
- Category C
  - Equivocal literature
- Category D
  - Insufficient evidence from the literature
The Sublevels of evidence

LEVEL A
- 1A Multiple randomized controlled trials, summarized with a meta-analysis
- 2A Multiple randomized controlled trials, not enough for a good meta-analysis
- 3A Single randomized controlled trial

LEVEL B
- 1B Observational comparisons (cohorts/case controlled studies)
- 2B Noncomparative observational studies
- 3B Case Reports

LEVEL C
- 1C Meta-analysis without statistical significance
- 2C insufficient studies to conduct a meta-analysis/inconsistent findings
- 3C Observational studies with inconsistent findings

LEVEL D
- Silent
- Inadequate

There is no level 1A evidence

- You will not find level 1A evidence for the perioperative management of pacemakers
- You will not find level 1A evidence for the use of pulse oximetry either

Preoperative Evaluation

(Anesthesiology 2013; 114:347-61)

- Focused history
- Medicals records review
- Review of Chest x-ray
- EKG
- Check for scars palpate device

Preoperative Evaluation

(Anesthesiology 2013; 114:347-61)

- Establish if patient has a CIED
- Determine whether patient is CIED-dependent for anti-bradycardia pacing function
- Define the type of device
- Determine Device function
- LEVEL B Evidence
  - Suggestive literature

Sullivan, Breandan, MD

Perioperative Management of Cardiac Implantable Devices
- MADIT I
- NYHA class I, II, III
- Previous MI, EF< 35%
- Episode of asymptomatic unsustained v-tach
- An inducible non-suppressible ventricular tachyarrhythmia on EP study
- Randomized
  - Internal defibrillator
  - Possible anti-arrhythmic medications

Results
(NEJM 1996; 335:1933-40)

- 196 patients enrolled
- 27 month follow up
- 15 deaths in defibrillator group
- 39 deaths in conventional therapy group
- Mortality reduction of 56%
  - P< 0.009

MADIT II

- 2232 pt enrolled
- Previous MI with documented EF<30%
- AICD vs medical therapy
- Average 2 year follow up
- AICD group mortality group decreased by 31%
- Conclusion:
  - In patients with prior MI and advanced LV dysfunction, prophylactic implantation of a defibrillator improves survival and should be recommended therapy

LAND MARK RESULTS
(NEJM 1996; 335:1933-40)

Single Lead AICD

- MADIT-CRT
  - EF< 30%, QRS >130 ms
  - AICD vs AICD plus Bi-ventricular pacemaker
- Primary outcomes
  - Death
  - Non Fatal Heart Failure Event
- 1820 pts
- Results
  - No change in mortality
  - 42% decrease in heart failure events!

Conclusions:

- In patients with prior MI and advanced LV dysfunction, prophylactic implantation of a defibrillator improves survival and should be recommended therapy.

- MADIT-CRT
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  - AICD vs AICD plus Bi-ventricular pacemaker
- Primary outcomes
  - Death
  - Non Fatal Heart Failure Event
- 1820 pts
- Results
  - No change in mortality
  - 42% decrease in heart failure events!
Preoperative Evaluation (Anesthesiology 2013;114:247-65)

CIED dependence
  - Verbal history or indication patient has experienced a bradyarrhythmia that has caused syncope or other symptoms requiring CIED implantation

CIED dependence (cont’d)
  - History of successful AV node ablation
  - No evidence of spontaneous ventricular activity when the pacemaking function of the CIED is programmed to VVI pacing mode at lowest programmable rate

Preoperative Preparation (Anesthesiology 2013;114:247-65)

Determine if electromagnetic interference is likely to occur during the procedure
  - Electrocautery
  - Radiofrequency ablation
  - MRI
  - Lithotripsy

Determine:
  - Preoperative programming to an asynchronous mode or disabling special algorithms is needed

Figure 4. Pacing site–dependent changes in QT interval, R-on-T ventricular extrasystoles, and the onset of TdP.

Copyright © American Heart Association
Preoperative Preparation

Suspend:
- Antitachyarrhythmia function if present
- Rate Adaptive Therapy

Advise:
- The individual performing the procedure to consider bipolar or ultrasonic (harmonic) scalpel to minimize adverse effects on the pulse generator or leads

Additional Programming
- Pace maker dependent patients should be programmed to an asynchronous mode before surgery

Assure:
- The availability of temporary pacing and defibrillation equipment

Numerous descriptive studies and case reports suggest the following are associated with EMI
- Electrocautery
- Radiofrequency ablation
- MRI
- Radiation therapy
- No STUDIES were found that reported EMI during ECT

Intraoperative Management

Monitor the operation of the device
- Prevent potential CIED dysfunction
- Perform emergency defibrillation, cardioversion, or heart rate support
Intraoperative Management
(Anesthesiology 2011; 114:247-61)

- Continuous EKG
- Peripheral pulse monitoring
  - Pulse ox, A-line, ultrasound peripheral pulse (?)
- Category B3 Evidence

Intraoperative Management
(Anesthesiology 2011; 114:247-61)

- Electrocautery
- Assuring cautery tool, current return pad positioning
- Current pathway does not pass through or near CIED pulse generator and leads
- B2-B3 evidence
  - Two case reports
  - One Observational study

Intraoperative Management
(Anesthesiology 2011; 114:247-61)

- Encourage Short Bursts at lowest feasible energy level
  - B2-B3
    - One case report
    - Total pacemaker failure when short burst of cautery used
- Multiple Case reports
  - Uneventful surgery with bipolar cautery or harmonic scalpels (B3 Evidence)
  - One case report pacemaker failure with bipolar cautery

Intraoperative Management
(Anesthesiology 2011; 114:247-61)

- Experts opinion/Summary
  - Position the cautery tool and current return pad away from device
  - Avoid proximity of the cautery electrical field to the pulse generator and leads
  - Use short intermittent and irregular bursts at the lowest feasible energy level
  - Use bipolar or ultrasonic (harmonic) scalpel if possible

Intraoperative Management
(Anesthesiology 2011; 114:247-61)

- Radiofrequency Ablation
  - High frequency alternating current
  - We will see it in OR and IR
  - Treatment of solid organ tumors/metastatic disease
  - Keep RF current path as far away from the pulse generator and lead system as possible

Intraoperative Management
(Anesthesiology 2011; 114:247-61)

- Lithotripsy
  - Avoid focus of the lithotripsy beam near the pulse generator
  - Disable atrial pacing if the lithotripsy system triggers on the R wave
### Hemodynamics of Pacing

- **Hierarchy of rhythm**
  - Normal sinus rhythm
  - If rate is fast enough
- **Atrial Pacing**
- **AV pacing**
- **V pacing**
- **Switching Modes of pacing**
  - Can have serious hemodynamic consequences

### Intraoperative Management

**Magnetic Resonance Imaging**
- Observational studies and case reports suggest MRI can be done safely
- **Expert Opinion**
  - MRI is contraindicated
- If absolutely necessary
  - Consult
    - Manufacturer
    - Cardiologist
    - Ordering Physician
    - Radiologist

### Intraoperative Management

**Electroconvulsive Therapy**
- No studies exist
- Two case reports
- ICD’s turned off for procedure
  - No mention of effect on device
**Radiation**
- The device should be out side of the field of radiation

### Intraoperative Management

**Emergency Defibrillation or cardioversion**
- Minimize the current through the pulse generator
- **Expert Opinion**
  - Anterior-Posterior Position should be used

### Intraoperative Management

**If life-threatening arrhythmia occurs**
- Don’t screw around
- ACLS protocol
- Remember the MADIT, MADIT II, MADIT-CRT
- These patients are sick!
WHAT ABOUT A MAGNET?

- Asynchronous?
- Turns off AICD?
- No industry standard
- Usually does...
- Would not depend on it if you have time
  - Interrogate
  - Interrogate
  - Interrogate

Postoperative Management
(Anesthesiology 2013; 114(2):47-61)

- Interrogate and restore defibrillation function
- Observational study + case report
- Postoperative pacemaker check revealed the need to alter pacing mode or other parameters which include increasing ventricular thresholds
- B2-B3 evidence
- My opinion
  - Don’t take the pads off until the device is interrogated and activated!

Conclusion

- Find out all the information you can
- Interrogate, interrogate, interrogate
- Prepare for the worst
  - These patients are sick
- Have a back up plan
- GO RAIDERS!
Perioperative Anesthetic Considerations for the High-Risk Critically Ill Patient
Part II: Advanced modes of mechanical ventilation: Considerations for the OR
Presenter: Benjamin K. Scott, MD
Disclosures: I have no financial conflicts of interest to disclose.

Learning Objectives:
1. Review the pathophysiology of the diseased or injured lung
2. Understand recent strategies in mechanical ventilation, particularly focusing on “low-stretch” and “open-lung” techniques.
3. Discuss strategies for OR management of patients on “advanced” vent modes
4. Apply these concepts to routine OR vent management

Outline:
1. The Physiology of the Sick Lung
   a. ARDS
      i. Berlin Definition
      ii. Pathophysiology
         1. Inflammation
         2. Increased lung water
         3. Poor compliance
         4. VQ mismatch
   b. COPD Exacerbation and optimal PEEP
   c. Neurogenic disordered breathing

2. Modern Ventilator Strategies
   a. Lung Protective Ventilation and the ARDSNet Revolution
      i. “Low stretch”
      ii. Permissive Hypercapnea
   b. “Open lung” and the goal of recruitment
   c. What to do about FI02?
   d. When to consider neuromuscular blockade?

3. Advanced Modes of Ventilation
   a. Inverse Ratio Modes
      i. Bilevel (Bivent)
      ii. APRV
      iii. Troubleshooting advanced modes
   b. When mechanical ventilation is failing
      i. Prone positioning
      ii. Oscillator
      iii. ECMO

4. Strategies for the OR when patients require advanced modes of ventilation
   a. Anesthetic considerations:
      i. Patient transport and transfer
      ii. Circuit disconnect
   b. When to use the ICU ventilator
   c. Which patients are safe to trach?

5. Can we apply any of this to our everyday practice?
Post-Operative Respiratory Management: the Case for Non-Invasive Ventilation

Learning Objectives
1) Review acute respiratory failure – hypoxic versus hypercarbic failure
2) Discuss physiology and goals for non-invasive ventilation (NIV)
3) Outline the risks and benefits of NIV and describe the predictors of success and failure
4) Examine the specific indications and supporting literature for post-operative non-invasive ventilation
   a) COPD
   b) Pulmonary edema
   c) Prevention of post-operative respiratory failure
   c) Treatment of post-operative respiratory failure

Discussion
Post-operative pulmonary complications pose a major challenge in the PACU. As a result of baseline disease, surgical exposure and anesthetic management, pulmonary complications are common and are associated with significant post-operative morbidity and mortality. Non-invasive ventilation (CPAP and BIPAP) has emerged as a widely available treatment strategy for patients in respiratory distress. In this presentation, we will present a brief review of acute respiratory failure and discuss recent data examining the potential uses for non-invasive ventilation in the post-operative period.
CRASH 2015 – Critical Care Symposium

Speaker: Karsten Bartels, MD

Perioperative cardiac output monitoring: how, when, never? – An update for Anesthesiologists

Learning Objectives:

1) Pathophysiology of hypoxia and hypo-perfusion
2) Physics and Physiology of contemporary cardiac output monitoring
3) Overview of currently available devices for cardiac output monitoring
4) Defining a gold standard for cardiac output monitoring
5) Cardiac output monitoring for goal directed fluid therapy

Discussion:

Early Recovery After Surgery (ERAS) concepts are becoming more prevalent for the perioperative care for high-risk surgeries. A rapidly growing body of literature is evolving that endorses the concept of ERAS. We will discuss the pros and cons of cardiac output monitoring in ERAS based goal-directed fluid therapy (GDT) concepts. Limitations and recent negative randomized controlled clinical trials will be critically discussed.
Thursday, March 5
Cardiothoracic Surgery Update for 2014

The 2014-year has focused on many exciting topics in cardiovascular medicine, surgery and anesthesiology. Today’s talk will attempt to highlight a number of areas with interesting and relevant studies published over the past year, as well as key concepts that have had major advances.

These topics will include:

- Pulmonary Hypertension in the perioperative period¹²
- Aortic surgery – TEVAR³,⁴
- TAVR: Advances in anesthetic management, and neurologic outcomes⁵,⁶
- Cardiac Evaluation for the perioperative period⁷
- Management of Ischemic Mitral Regurgitation⁸⁻¹¹
- Obstetrics and Cardiac Disease¹²,¹³
- Risk prediction and outcomes in cardiac surgery¹⁴
- rFactor IIa use in cardiac surgery¹⁵


Anterior Mediastinal Masses and Lower Airway Problems

25 y.o. Female Ant. Mediastinal Mass
Cervical Mediastinoscopy + Biopsy
Most Important History?
A) Dysphagia
B) Fever
C) Orthopnea
D) Chest pain

Anterior Mediastinal Mass
25 y.o. Female, Diagnostic Biopsy
Hx: c/o cough + supine dyspnea x 2 months
Physical exam:
Other nodes to biopsy
SVC Syndrome

25 y.o. Female Ant. Mediastinal Mass
Most Important Investigation?
A) Spirometry
B) Chest CT scan
C) Trans-Esophageal Echocardiogram
D) DLCO

Flow-Volume Loop
PEFR
Expiration
TLC
RV
Inspiration

Variable Extra-thoracic Airway Obstruction
Flow

Volume

**Variable Intra-thoracic Airway Obstruction**

Before Rx

After Rx

Neuman et al. Anesthesiology 60: 144, 1984

---

### Abnormal Flow-Volume Loops in Patients with Intra-thoracic Hodgkin’s Disease

<table>
<thead>
<tr>
<th>Flow-Vol. Loop</th>
<th>CT Trach. 0-mild</th>
<th>CT Trach. Mod.</th>
<th>CT Trach. Severe</th>
</tr>
</thead>
<tbody>
<tr>
<td>Normal 11</td>
<td>8</td>
<td>3</td>
<td>0</td>
</tr>
<tr>
<td>Fixed Obstr. 7</td>
<td>3</td>
<td>1</td>
<td>3</td>
</tr>
<tr>
<td>Variable Extra-Thor 7*</td>
<td>5</td>
<td>2</td>
<td>0</td>
</tr>
</tbody>
</table>

(* No CT evidence of Extra-Thor. Trach. Obstruct. *)

### Abnormal Flow-Volume Loops in Patients with Intra-thoracic Hodgkin’s Disease

<table>
<thead>
<tr>
<th>Flow-Vol. Loop n=25</th>
<th>CT Trach. 0-mild</th>
<th>CT Trach. Mod.</th>
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<td>5</td>
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</tr>
<tr>
<td>Variab. Intra-Thor. 0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
</tbody>
</table>

(* No CT evidence of Extra-Thor. Trach. Obstruct. *)

---

### Intra-Thoracic Goiter

Intra-Thoracic Goiter

Mid-Tracheal Compression

Lymphoma

Carinal Compression
Anterior Mediastinal Mass Concepts:

- **NPIC Anesthesia**
- **Procedure:** Diagnostic vs. Therapeutic
- **Children vs. Adults**
- **Symptoms:** mild/moderate/severe

Anterior Mediastinal Mass Concepts:

- **NPIC Anesthesia**
- **Symptoms:** dyspnea/cough (airway) vs. syncope (cardiovascular)
- **Symptoms:**
  - mild: supine no problem
  - moderate: supine some problem
  - severe: cannot lie supine

Anterior Mediastinal Mass Concepts:

- **NPIC Anesthesia**
- **Procedure:** Diagnostic vs. Therapeutic
- **Children vs. Adults**
- **Symptoms:** mild/moderate/severe
- **Patients:** safe/unsafe/uncertain for NPIC

Anterior Mediastinal Mass Concepts:

- **Safe:** Asymptomatic adult no tracheal compression
- **Unsafe:** Severely symptomatic adult/child, child CT trach. compress. ≥ 50%
- **Uncertain:** all others

25 y.o. Female Ant. Mediastinal Mass, 40% Distal Tracheal Compression

Optimal Anesthetic Management?

A) Propofol/Rocuronium Intubation
B) Awake FOB intubation, +Roc.
C) Inhalational Spontaneous Ventilation
D) Ketamine/Succinylcholine
20 y.o. Female, Diagnostic Biopsy
Anterior Mediastinal Mass

Management:
Safe
vs. Unsafe
vs. Uncertain

25 y.o. Female Ant. Mediastinal Mass, 40%
Distal Tracheal Compression
Most Important Pre-Induction Preparation?
A) IV Access Lower Limb
B) Helium
C) Rigid Bronchoscope + Surgeon
D) Cardiopulmonary Bypass Pump in OR

Management for Uncertain Patients
for “NPIC” Anesthesia:

ALL Patients:
- Determine Optimal Positioning
- Secure Airway Beyond Stenosis if Possible
- Rigid Bronchoscope Immediately Available

Selected Patients:
- Helium/O2
- Prep. Chest for Sternotomy, Elevate Mass

Cardiopulmonary Bypass on “Standby”?  
Peripheral Cardiopulmonary Bypass Assisted Thymoma Resection

- 52 y.o. Female
- Fem-Fem Veno-Art partial CPB
- Sevoflurane spont. Vent. Induction and intubation
- PPV after sternotomy


Mediastinal Sarcoma
Anterior Mediastinal Mass

25 y.o. Female

Post-op. Mediastinoscopy/ Biopsy

Severe dyspnea post-op. in Recovery Room

? Diagnosis

25 y.o. Female Ant. Mediastinal Mass
Severe Stridor in PACU Management?

A) Propofol/Sux. Intubation
B) FOB intubation in PACU
C) Midazolam
D) Spontaneous Ventilation Induction in OR

Silastic Airway Stent

Silastic Stents:
- Rigid Bronchoscopy (GA)
- Unstable
- Temporary
- Easily Removable

Flexo-Metallic Stents:
- Rigid or Flexible Bronchoscopy
- Fairly Stable
- Difficult to remove
- Tend to stenose

Perioperative Complications in Adults with Mediastinal Mass

Bechard P, et al. Anesthesiology 100: 826-34, 2004

N= 105; M’scope, sternotomy, VATS, thoracotomy, other

- **Intraop.** 4/105: hypotension/ AF/ hypox. predictors: pericardial effusion.
- **Postop.** 11/105 (7 life-threat.): resp. fail., aletectasis, pneumonia predictors: preop. s/s, trach compress. >50%,

17 y.o. Male
Germ cell tumor
L thoracotomy
Lower Airway Problems: Tracheal Stenosis

- 38 y.o. obese, Male
- # L1, Laminectomy + Fixation, Prone
- Remote tracheal resection for stenosis
- Inspiratory & Expiratory Stridor
- ? Management


Perioperative Management of a Patient with Tracheal Stenosis

Your Management?

A) Spinal
B) LMA
C) Fiberoptic intubation
D) Other

Perioperative Management of a Patient with Tracheal Stenosis

My Management:
- Rigid Bronchoscopy
- Tracheal Dilation
- 7 mm armoured (wire reinforced) ET Tube distal to stenosis
- Turn Prone

30 y.o. Male following bar fight, for Rigid Bronch. Removal of FOB

One episode of coughing/cyanosis in ER, uncooperative
- Proceed/delay?
- Other investigations?
- Anesthetic management?
Rigid Bronchoscopy Anesthetic Management Considerations

- Spontaneous Ventilation vs. Paralysis
- Laser (Nd-YAG vs. CO2)
- FiO2
- Monitoring CO2

Rigid Bronchoscopy Ventilation Management Options:

- Intermittent Ventilation
- Apneic Oxygenation
- Jet Ventilation (Saunders, Monsoon, etc.)
- Ventilating Bronchoscope

Anesthetic Management of a Patient with Tracheal Pathology

Start and End of Case

- History: dyspnea/cough, syncope
- Investig: CT (+/- Echo)
- Path: GA: Collapse/No
- Management: NPIC safe/unsafe/uncertain
- Myths: Flow/vol. loop, CPB standby
- Postop. Mgmt.

Objectives

- Be aware of the multiple goals to be met when providing anesthesia for patients with intracranial pathology
- Understand the effects of volatile and intravenous anesthetic agents on intracranial dynamics
- Be able to outline a rational choice of anesthetic when caring for patients with various intracranial situations

Overview

- Goals of anesthesia
- Effects of volatile anesthetics
- Effects of intravenous anesthetics
- Comparison of volatile anesthetics
- Comparison of intravenous anesthetics
- Volatile vs. intravenous anesthetics
- What’s best?

Goals of Anesthetic Management

- Hemodynamic stability
- Maintenance of cerebral perfusion pressure
- Control of intracranial pressure
- Optimal surgical conditions (slack brain)
- Smooth emergence
- Rapid awakening for early neurologic assessment

Ideal Anesthetic Agent

- Maintain CBF without affecting autoregulation
- Minimize detrimental changes in Intracranial Pressure (ICP)
- Preserve reactivity of cerebral arterioles to $P_aCO_2$ changes
- Decrease CMRO$_2$ with cerebral protection effects
- Devoid of seizure activity
- Preserve hemodynamic stability, especially Cerebral Perfusion Pressure (CPP)
- Devoid of arrhythmogenic effect

Normal Values

<table>
<thead>
<tr>
<th>Table 21-1</th>
<th>Normal cerebral physiologic values</th>
</tr>
</thead>
<tbody>
<tr>
<td>CBF</td>
<td>45-55 mL/100 g/min</td>
</tr>
<tr>
<td>Global</td>
<td>75-80 mL/100 g/min</td>
</tr>
<tr>
<td>Cortical (gray matter)</td>
<td>--20 mL/100 g/min</td>
</tr>
<tr>
<td>Subcortical (medial white matter)</td>
<td>--20 mL/100 g/min</td>
</tr>
<tr>
<td>CMRO$_2$</td>
<td>3.3-4.5 mL/100 g/min</td>
</tr>
<tr>
<td>CVR</td>
<td>1.5-2.5 mm Hg/mmHg/mL</td>
</tr>
<tr>
<td>Cerebral venous $P_O_2$</td>
<td>32-44 mm Hg</td>
</tr>
<tr>
<td>Cerebral venous $P_N_2$</td>
<td>55-70%</td>
</tr>
<tr>
<td>ICP (opening)</td>
<td>8.1-12 mm Hg</td>
</tr>
</tbody>
</table>

CBF: cerebral blood flow; CMRO$_2$: cerebral metabolic rate of oxygen; CVR: cerebral vascular resistance; ICP: intracranial pressure.
Determinants of ICP
(and What We Can Control)

- Brain tissue
- Intra- and extracellular fluid (edema)
- CSF
- Blood (arterial/venous)
- Airway or intrathoracic pressure
- Jugular venous pressure
- $P_{CO_2}$
- $P_{O_2}$
- Anesthetics
- Vasodilators
- Seizures
- Temperature
- Arousal
- Pain

Why Does ICP Matter?

- Sustained ICP > 20 mm Hg is abnormal
- ICP 20 – 40 mm Hg is considered moderate intracranial hypertension
- ICP > 40 mm Hg is life-threatening
- Increased ICP results in secondary injury due to ischemia from reduced CPP and distortion of intracranial structures such as the brainstem
Effects of Volatile Agents
(Are They All Created Equal?)

- Patel PM and Drummond JC in Miller’s Anesthesia, 6th Ed; p. 830

- Matta BF et. al., Anesthesiology 83:980-985, 1995

- Isoflurane has been the “gold standard” of volatile agents for some time, but –
  - At both 0.5 and 1.5 MAC Sevoflurane increases V\textsubscript{MCA} less (4 and 17%) than Isoflurane (19 and 72%)
  - Sevoflurane preserves autoregulation better than Isoflurane
  - At 0.4 MAC in normal volunteers, Sevoflurane produced less increase in CBV than Isoflurane
  - At both 1.0 and 1.5 MAC Sevoflurane increased V\textsubscript{MCA} less (max 7%) than Desflurane (max 65%)


- Bedforth NM et. al.

But What Happens During Brain Surgery?

- In a study of patients with supratentorial mass lesions and mass effect on CT, in the presence of hyperventilation (P\textsubscript{CO2}=25 mm Hg), 1 MAC Desflurane in air:O\textsubscript{2} increased Cerebrospinal Fluid Pressure greater than Isoflurane (18 vs. 8 mm Hg)

Muzzi DA et. al., Anesthesiology 1992; 76:720-724

Figure 3. Mean (SD) cerebrospinal fluid pressure (CSFP) (mm Hg) over time for desflurane and sevoflurane groups. Intracranial pressure (ICP) = ICP measured extradurally at the end of surgery and immediately after induction of anesthesia and before administration of study agent.

Figure 4. Observed trends in cerebral blood flow (CBF) after the introduction of desflurane and sevoflurane to the patient population. CBF was measured by the xenon clearance technique in patients with supratentorial mass lesions and mass effect on CT in the presence of hyperventilation (P\textsubscript{CO2}=25 mm Hg) with 1 MAC Desflurane in air:O\textsubscript{2}.

But What Happens During Brain Surgery?
Effects of Volatile Agents
(Comparative Studies, Intracranial Surgery)

- In a study of patients with intracranial mass lesions (with and without evidence of increased ICP, P_{CO}_2=21 mm Hg), CBF was slightly higher at 1.0 MAC Isoflurane than Desflurane, but there were no differences at 1.25 and 1.5 MAC.
- CBF under anesthesia was 17-35 ml/100g/min
  
  Ornstein E et al., Anesthesiology 1993; 79:498-502

- In patients undergoing craniotomy with a background of Thiopental/Sufentanil and hyperventilation (PaCO_2=30-35 mm Hg), Sevoflurane had earlier recovery profile than Isoflurane (moving feet: 24 minutes Sevo vs. 43 minutes Iso). Hemodynamic variables and brain relaxation scores were similar
  
  Gauthier A et al., Anesth Analg 2002; 95:1384-8

- In a study of children (mean age 20 months) with suspected ICP above normal given a background of Fentanyl/ N2O 60% and normocarbia, 0.5-1.0 MAC Isoflurane, Sevoflurane, and Desflurane similarly increased ICP and decreased MAP and CPP in a dose-dependent manner. ICP increased more (n.s.) with higher baseline values with Desflurane
  
  Sponheim S et al., Acta Anaesthesiol Scand 2003; 47:932-8

- In a study comparing 0.5, 1.0, or 1.5 MAC Isoflurane or Sevoflurane in air with Sufentanil (PetCO_2=35-40 mm Hg) there was no change in ICP and a decrease in CBF with both agents; CPP decreased at 0.5 MAC with Sevoflurane and all levels of Isoflurane; MAP and CPP were lower with Isoflurane compared to Sevoflurane.
  
  Artru AA et al., Anesth Analg 1997; 85:587-92

- In patients with supratentorial tumors and no evidence of midline shift receiving 60% N_2O/Fentanyl (P_{CO}_2=35 mm Hg), both Isoflurane or Desflurane 1.0 MAC caused no change in ICP, a 19% decrease in MAP, and a 22% decrease in CPP.
  
  Fraga M et al., Anesthesiology 2003; 98:1085-90

- In patients with supratentorial lesions with mass effect, there was no change from baseline or difference between 1.2 MAC Isoflurane or Desflurane with hypocapnia (P_{CO}_2=30 mm Hg) in CSEP or MAC. There was no difference between agents in CPP (Desflurane CPP tended to be lower than baseline as duration increased). Time to respond to commands was 50% shorter with Desflurane (40 vs. 72 minutes, n.s.)
  
  Kaye A et al., Anesth Analg 2004; 98:1127-32
Effects of Intravenous Agents

But What Happens During Brain Surgery?

Effects of Intravenous Agents
(Comparative Studies, Intracranial Surgery)

- In patients with tumors and a background of 60% N₂O and normocarbia (PₐCO₂=36 mm Hg) Sufentanil (89%) and Alfentanil (22%) increased CSFP compared to Fentanyl, and all decreased CPP (Fentanyl=14%; Sufentanil 25%; Alfentanil 37%).
  Marx W et. al., J Neurosurg Anesthesiol 1989; Vol 1(1):3-7

- In patients with tumors receiving 60-70% N₂O with PetCO₂=25 mm Hg and either Alfentanil, Fentanyl, or Sufentanil, although the Alfentanil group received ephedrine more frequently, there was no difference in recovery profiles or intraoperative brain conditions.
  From RP et. al., Anesthesiology 1990; 73:896-904

Effects of Intravenous Agents
(Comparative Studies, Intracranial Surgery)

- In sedated patients with head trauma (GCS= 6-7) and PaCO₂=30-35 mm Hg, Propofol (2mg/kg bolus with 150mcg/kg/min infusion) decreased ICP (11.3-9.2 mm Hg), decreased MAP (25%), decreased CBF (35-26 ml/100g/min), and decreased CPP (82-59 mm Hg).
  Pinaud M et. al., Anesthesiology 1990; 73:404-9

- In patients with head trauma (GCS=6) and hypocapnia (PaCO₂=27 mm Hg), boluses of Fentanyl (3mcg/kg) or Sufentanil (0.6mcg/kg) increased ICP (F=8 mm Hg, S=6 mm Hg) and decreased MAP (F=11 mmHg, S=10 mm Hg).
  Sperry RJ et al., Anesthesiology 1992; 77:416-420

Effects of Intravenous Agents
(Comparative Studies, Intracranial Surgery)

- In patients with tumors and a background of Isoflurane 0.3-0.8% in 66% N₂O and PaCO₂<30 mm Hg, boluses of Remifentanil (0.5 mcg/kg and 1.0 mcg/kg) or Alfentanil (10 mcg/kg and 20 mcg/kg), neither caused a change in ICP. Effects on MAP were similar (decreased).
  Warner DS et al., Anesth Analg 1996; 83:348-53

- In patients with tumors given Isoflurane (low dose, unspecified)/66% N₂O and PₐCO₂=28 mm Hg, Remifentanil and Fentanyl did not differ in ICP, CPP, MAP (except for intubation), brain condition, or recovery variables.
  Guy J et. al., Anesthesiology 1997; 86:514-24
Effects of Intravenous Agents
(Comparative Studies, Intracranial Surgery)

• In patients with tumors receiving Propofol or Isoflurane with or without N2O, the use of Fentanyl (customary manner) was associated with delayed emergence (at 10 minutes but not 20) and greater Isoflurane use compared with Remifentanil (d/c at dressing).

• In patients for craniotomy with Propofol and P CO2=30-35 mmHg, Remifentanil required less Propofol compared to Fentanyl and Alfentanil, and was associated with more rapid recovery than Alfentanil (but not Fentanyl). All agents decreased MAP post-induction.

Volatile vs. Intravenous
(Comparisons, Intracranial Surgery)

• Patients without signs of high ICP given either Isoflurane (0.5-1.5%) or Propofol infusion (N2O 50% given to both after dural opening) found lower CPP (81 vs. 70 mm Hg) at induction, lower CSFP (15.2 vs. 11.6 mm Hg) and better recovery variables at 20-30 minutes with Propofol.
  Ravussin P et al., J Neurosurg Anesthesiol 1991; Vol 3(2):85-95

Volatile vs. Intravenous
(Comparisons, Intracranial Surgery)

• In patients with tumors given either Propofol/Fentanyl, Isoflurane/N2O, or Fentanyl/N2O with PaCO2=30 mm Hg, there were no differences in mean ICP=24 mm Hg was associated with a greater number of patients ICP>24 mm Hg) or brain condition. MAP was lower with Iso/N2O. Emergence was more rapid with Fentanyl/N2O.
  Todd MJ et al., Anesthesiology 1993; 78:1005-1020

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(Comparisons, Intracranial Surgery)

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Volatile vs. Intravenous
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• In patients with tumors maintained with Fentanyl, the use of a Propofol infusion was associated with a lower ICP (7 mm Hg) and higher CPP (80 mm Hg) compared to Isoflurane (12/60 mm Hg) or Sevoflurane (11/63 mm Hg).
  Talke P et al., Acta Neurochir Suppl 2002; 81:89-91

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  Todd MJ et al., Anesthesiology 1993; 78:1005-1020
Volatile vs. Intravenous (Comparisons, Intracranial Surgery)

- In patients with tumors and P_{CO2}=30-40 mm Hg, receiving either Propofol/Fentanyl, Isoflurane/Fentanyl, or Sevoflurane/Fentanyl, ICP was lower and MAP and CPP higher with TIVA. Dural tension was significantly lower with TIVA and Sevo. Cerebral swelling after dural opening was lower with TIVA. No difference in ICP, CPP, or CO2 reactivity between volatiles.

  Petersen KD et al., Anesthesiology 2003; 98:329-36

CBF, ICP, CBV, or CPP?

- CPP = MAP – ICP
- Want to maintain CPP = 70 – 90 mm Hg
- ICP affected by intracranial volume
- Intracranial volume has 4 components:
  - Tissue volume
  - CSF volume
  - Fluid compartment (edema)
  - Blood volume (arterial and venous)
- CBF reflects arterial volume – how much does this really affect total CBV?

CBF, ICP, CBV, or CPP?

- Approximately 10% of CBV is in the arterioles and capillaries – the compartment which reacts to CO2 and anesthetic agents
  - Schmidek HH et al., Neurosurgery 1985; 17:663-78
  - Heistad DD et al. in Handbook of Physiology; American Physiologic Society, 1983
- In dogs breathing 60-70% N2O and exposed to Fentanyl, 1.4% Isoflurane, 0.8% Halothane, or 2.2% Enflurane for 3.5 hours:
  - Halothane: ↑CBV (11%), ↑ICP (stable)
  - Enflurane: ↑CBV (9%), ↑ICP (continued to rise, even after Enf off)
  - Isoflurane: ↑CBV (10%), ↑ICP (only for 20 min, then returned to baseline)
  - Fentanyl: ↑CBV (8%), ↓ICP (only for first 20 min, then returned to baseline)
  - Artru AA, Anesthesiology 1983; 58:533-9
  - Artru AA, Anesthesiology 1984; 60:575-9

- In rats exposed to Propofol, Pentobarbital, or Isoflurane anesthesia, though CBF was 2.0-2.6 times greater with Iso than Prop or Pento, CBV was only 10-18% greater with Iso than with Prop or Pento

Volatile vs. Intravenous Agents (Is There Really a Difference in Mechanism?)

- Patel PM and Drummond JC in Miller’s Anesthesia, 6th Ed., p. 815

Volatile vs. Intravenous Agents (Is One Really Better?)

- It depends on how you define “better”
  - Quicker emergence (short term outcome)
  - Ease of titration/administration
  - Hemodynamic stability
  - Brain conditions
  - Long term outcomes (no data)
  - Lower cost
One More Note

• In many of the studies comparing volatile agents, or volatile to intravenous agents, exclusion criteria included evidence of increased intracranial pressure such as mass shift, altered mental status, or abnormal measured ICP.

My Opinion

• For all agents, the ultimate condition of the patient will be determined by the sum of the effects of the chosen agent on CBF, CMRO2, vascular tone, MAP, CO, CSF formation or reabsorption, and CBV.

• The preponderance of evidence is that intravenous agents (Propofol, Barbiturates, Etomidate, Benzodiazepines, synthetic opiates (phenylpiperidine)) have less deleterious, and more salutary effects that are more predictable on intracranial dynamics than volatile agents, especially if MAP is maintained.

• Isoflurane, Sevoflurane, and Desflurane are similar, though the edge probably should go to Sevoflurane, and their ultimate effects on ICP/CPP are less predictable.

• There is no overwhelming evidence that one technique is superior to any other in terms of short term recovery profile, if the agents chosen are properly administered.

• Choose your poison (agents) wisely given the goals of anesthesia and surgery, and the condition of the patient such as

My Opinion

• If the patient is wide awake, appearing for elective surgery, and is well-compensated in terms of intracranial dynamics:

  Either volatile or TIVA are appropriate taking care to avoid bad things like –
  - Hypotension (remember CPP)
  - Hypertension
  - Hypoxemia
  - Hypercarbia
  - Inadequate anesthesia at critical points

  Remember – it’s more important how you do it, than what you use.

My Opinion

• If the patient has signs or symptoms of high ICP (altered mental status, head injury, ventriculostomy/ICP monitor in place, midline shift on CT/MRI, etc.):

  - Management of the ICP/CBF/CBV/CPP is critical
  - TIVA is preferable, at least until the dura is opened and the effects of anesthetics on the brain bulk can be assessed directly
  - Keep a very close eye on CPP (>70 mm Hg)
  - Think/Think/Think: MAP-ICP

Comparative Costs

• 1993:
  - Propofol/Fentanyl = $152
  - Isoflurane/N2O = $49
  - Fentanyl/N2O = $15

• 2002:
  - Isoflurane/N2O = $17
  - Propofol/Fentanyl/N2O = $114
  - Isoflurane/N2O then Propofol = $31

THE END
Neuroanesthesia Panel

Part III: Post-operative Care

Presenter: Benjamin K. Scott, MD

Disclosures: I have no conflicts of interest to disclose.

Learning Objectives:
1. Review the immediate post-operative concerns for patients undergoing intracranial vascular surgery
2. Understand the diagnosis and management of cerebral hyperperfusion syndrome
3. Understand the diagnosis and management of post-operative cerebral ischemia
4. Review indications and evidence for cerebral monitoring modalities
5. Discuss the potential for neuroprotective management strategies

Outline
1. Immediate Post-operative Concerns
   a. Blood pressure management
      i. Optimal BP targets
      ii. Choosing antihypertensive agents and pressors
   b. Neurologic Examination
      i. Focused neurologic examination for the anesthesiologist/intensivist
      ii. Some basic neuroanatomy will help you localize
   c. Symptom management that maintains perfusion goals and optimizes CMRO₂
      i. Pain
      ii. Coughing
      iii. Shivering
      iv. Temperature
   d. Bigger problems
      i. Cerebral hyperperfusion syndrome
      ii. Cerebral ischemia
      iii. Hemorrhage
      iv. Seizure

2. Cerebral monitoring modalities and their indications
   a. ICP monitoring
   b. Jugular Bulb Catheterization
   c. Brain oxygen tension monitoring (PBtO₂)
   d. Near infrared spectroscopy
   e. Cerebral Microdialysis

3. A 10 minute crash course in managing the injured brain
   a. ICP
   b. CVP and fluid management
   c. PEEP and FIO₂
   d. Anemia
   e. Glucose management

4. Neuroprotection: an elusive goal
CRASH

Title: Induction Agents in the Critically Ill: Does it really matter?
Breandan Sullivan, MD

I. Overview of commonly used induction agents
II. Common problems in Critically ill patients
III. Individual agents
   A. Etomidate
   B. Ketamine
   C. Fentanyl
   D. Midazolam
   E. Propfol
IV. What is the evidence?
   A. Ketamine vs. Etomidate
   B. Propofol vs. Dexmedetomidine
V. What is the new evidence?
VI. What is the most common practice?
Septic Shock: Update for the Anesthesiologist

Jason Brainard, MD

Learning Objectives

1) Discuss the epidemiology of sepsis and septic shock
2) Define sepsis, severe sepsis, and septic shock
3) Review the physiology of shock
4) Outline the surviving sepsis guidelines and applicability to intraoperative care
   a) Initial resuscitation
   b) Antibiotics
   c) Adjunctive therapies
5) Examine the impact of recently published “ProCESS” and “ARISE” trials

Discussion

Septic shock is a leading cause of morbidity and mortality in the United States and the most common cause of hospital death in non-coronary intensive care units. Septic patients are commonly encountered in the operating room and present a high-risk encounter for Anesthesiologists. Substantial data is available to help guide therapy for these patients and help Anesthesiologists improve patient care as part of the core perioperative team. In this presentation, we will discuss the current guidelines for care of these patients and the impact of recently published clinical trials.
CRASH 2015 – Critical Care Symposium

Speaker: Karsten Bartels, MD

Acute kidney injury and continuous renal replacement therapy for the Operating Room - An update for Anesthesiologists

Learning Objectives:

1) Overview of current terminology: Acute Renal Failure, pre-renal azotemia, Acute Tubular Necrosis, Post-renal Failure, Acute Kidney Injury
2) AKI and risk of death – does it matter?
3) New biomarkers for AKI, limitations and future indications
4) Goals-directed fluid therapy for AKI
5) “Do no harm” How to protect kidney function from iatrogenic injury
6) Management of renal replacement therapy patients in the operating room

Discussion:

Acute kidney injury (AKI) remains one of the most common causes for perioperative morbidity. Its incidence is associated with an elevated risk of death in most major surgeries. New AKI biomarkers enable earlier detection of renal injury. We will discuss their potential role in perioperative care. We will review new and old approaches to renal protection and the evidence that supports their application. Lastly, we will provide practical advice for patients coming to the operating room while on renal replacement therapy.
Friday, March 6
WHAT’S NEW IN OBSTETRIC ANESTHESIA FROM 2014?

Joy L. Hawkins, M.D.
University of Colorado SOM
(* I have no conflicts to disclose. *)

GOALS & OBJECTIVES
Upon completion of this lecture, participants should be able to:
• Discuss how recent research is changing clinical practice in obstetric anesthesia via new guidelines and policies
• Cite maternal and fetal effects of analgesic and anesthetic best-practice techniques.
• Optimize and expedite management of obstetric and anesthetic complications.

WHAT’S NEW IN THESE AREAS OF PRACTICE?
• Guidelines & Policies
• Labor Analgesia
• Cesarean Anesthesia
• Anesthetic Complications
• Obstetric Complications
• The Fetus and Newborn

GUIDELINES AND POLICIES

MATERNAL MORTALITY
• The latest pregnancy-related mortality ratio continues to increase to 15.8 deaths per 100K live births from 2006-9. Highest in 2009 (17.8) related to the H1N1 flu pandemic.
• Racial disparity: 11.7 for white women, 35.6 for black, and 17.6 for other races.
• Reasons for ↑ mortality ratio may be better coding and identification or more co-morbidities (HTN, DM, cardiac conditions).

www.cdc.gov 5/5/14
MATERNAL MORTALITY
The Global Burden of Disease Study 2013 measures maternal mortality levels and trends worldwide.
- Increases in U.S. rates are a deviation from the downward trend in developed countries.
- 2013 U.S. rate of 18.5 per 100K is double Saudi Arabia and Canada and triple the U.K.
- 55% of U.S. deaths occur > 24 hours after delivery. Better early ICU care after hemorrhage?
  Lancet 2014; 384: 980

PREVENTING C/S
Joint ACOG/SMFM Consensus Statement:
“…the rapid increase in the rate of cesarean births without evidence of concomitant decreases in maternal or neonatal morbidity or mortality raises significant concern that cesarean delivery is overused. Therefore, it is important for health care providers to understand…the safe and appropriate opportunities to prevent overuse of cesarean delivery, particularly primary cesarean delivery.”

PREVENTING C/S
• 19 recommendations are presented for first and second stages of labor, fetal heart rate monitoring, induction, fetal malpresentation and macrosomia, excessive maternal weight gain, twins, and for research going forward.
  Obstet Gynecol 2014; 123: 693

PREVENTING C/S
Does an obstetrician’s delivery volume affect a patient’s risk for cesarean delivery?
- Nulliparous patients with term singleton vertex-presenting fetus at a single hospital
- Median = 60 deliveries per year
- Lowest volume → 18% cesarean rate versus 9% for the highest
- Is there a role for volume in credentialing?
  Obstet Gynecol 2014; 124: 697

PREVENTING C/S
Meta analysis of whether the risk of cesarean is higher following induction of labor → 157 RCT
- Risk of C/S was 12% lower with induction of term and post-term gestations (not preterm)
- Risk of fetal death (RR 0.5) or admission to ICU (RR 0.86) was lower with induction
- No impact on maternal death

PATIENT SAFETY
ACOG: Preparing for Clinical Emergencies in Obstetrics and Gynecology:
- Tools: emergency supplies available, develop an RRT, protocols with clinical triggers, SBAR, implement emergency drills and simulations (inpatient and outpatient settings).
- Examples: shoulder dystocia, hemorrhage, anaphylactic reaction in the clinic.
  Obstet Gynecol 2014; 123: 722
PATIENT SAFETY
Yale implemented a comprehensive patient safety program in 2003. They look at liability before and after, compared to the state market.
• Median annual claims dropped: 1.31 → 0.64
• Median payments per 1000 deliveries decreased: $1,141,638 → $63,470
• Amount per case: $632,262 → $216,815
• CT market had stable claims and ↑ cost/claim.
  Am J Obstet Gynecol October, 2014

30-MINUTE RULE
Meta analysis of decision-incision times and neonatal outcomes; 34 studies:
• 79% of emergent and 36% of urgent deliveries were achieved in < 30 min
• No difference by delivery time in admission to newborn ICU
• 30-minute rule not achieved in many cases; what does the guideline mean?
  Obstet Gynecol 2014; 123: 536

30-MINUTE RULE
The effect of a program to shorten the D-I interval for emergent cesarean section:
• Comprehensive program to identify obstacles and debrief all emergencies
• D-I decreased by about 9 minutes
• Rate of cord pH < 7.1 and Apgar < 7 and composite neonatal outcome improved
• Maternal outcomes no different but more GA
  Am J Obstet Gynecol 2014; 210: 224

WATER BIRTHS
ACOG Committee Opinion: Immersion in Water During Labor and Delivery:
“...the safety and efficacy of immersion in water during the second stage of labor have not been established...case reports of rare but serious adverse effects in the newborn...underwater delivery should be considered an experimental procedure that only should be performed within the context of an appropriately designed clinical trial with informed consent.”
  Obstet Gynecol 2014; 123: 912

2014 ASA OSA GUIDELINES
• Supplemental oxygen should be administered, but may increase the duration of apneic episodes and may hinder detection of atelectasis, transient apnea, and hypoventilation by pulse oximetry.
• Patients should be kept in non-supine positions.
• Hospitalized patients at risk of obstruction from OSA should have continuous pulse oximetry after PACU.
• Intermittent pulse oximetry, or continuous bedside oximetry without continuous observation, does not provide the same level of safety. Stepdown units?
  Anesthesiology 2014; 120: 268

ANALGESIA FOR LABOR
Hawkins, Joy L., MD
What’s New in Obstetric Anesthesia From 2014?
**WOMEN’S PREFERENCES**

40 healthy women scheduled for induction were asked their preference for ↓ pain intensity or ↓ pain duration before and after labor and delivery.

- Scores showed a preference for ↓ pain intensity, even at the cost of longer pain duration.
- This preference was even greater post-delivery.
- So even if epidurals increase length of labor….

Br J Anaesth 2014; 113: 468

**WOMEN’S PREFERENCES**

“Listening to Women” survey review of responses specific to labor epidural use (n=914)

- Positive: effective pain relief is appreciated
- Negatives: waiting in pain to receive their epidural, receiving it too late in labor, feeling it wore off before delivery, having numb legs
- Unplanned epidurals perceived as negative; but 60% who plan un-medicated birth receive an epidural
- Better childbirth education by anesthesia providers would help with expectations and good information

Anesth Analg 2014; PAP

**PREDICTING PAIN**

Can psychological tests predict the labor pain experience?

- Outcomes: pain scores during labor, epidural use, and time to epidural request
- Not very well – some correlation with anxiety scales, personality traits such as extroversion and lying, confidence, and analgesia expectations

Anesth Analg 2014; 119:632

**REDUCED PP DEPRESSION**

Does epidural analgesia for labor decrease the risk of postpartum depression?

- 214 parturients were given the Edinburgh Depression Scale at 3 days and 6 weeks PP
- Depression occurred in 14% of women who received an epidural, vs. in 35% who did not.
- Childbirth classes and breast-feeding were also associated with ↓ depression.

Anesth Analg 2014; 119: 383

**CONSENT ISSUES**

When a woman’s birth plan says to ignore her wishes for an epidural in labor, can she consent?

- No advance directive can ethically or legally override the contemporaneous expressed wishes of an informed and competent patient.
- Competent patients have the right to change their mind about treatment decisions at any time.
- A woman is not giving truly informed consent until she is actually experiencing labor.

ASA Newsletter 2014; 78: 40

**REMIFENTANIL**

Favorable characteristics for labor analgesia:

- Rapid onset, short duration, and inactivated by plasma esterases → unaffected by renal or hepatic impairment
- Inferior analgesia to an epidural, but pain control is satisfactory → VAS 3.7 ± 2.8 after 30 minutes, PP satisfaction scores 8.6 ±1.4
- Monitor for desaturation, sedation and apnea

Anesth Analg 2014; 118: 589
**INHALED N₂O**

Systematic review of its use for labor analgesia:
- Currently used by at least 50% of women in the UK, Australia, Finland and Canada.
- Little effect on pain scores, but most women find benefit; use as a bridge?
- No adverse effects on uterine contractility or the neonate; nausea and dizziness can occur.
- Neurotoxicity? Environmental pollution?

Anesth Analg 2014; 118: 153

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**INHALED N₂O**

In 2012, the FDA approved equipment to deliver 50% N₂O with 50% oxygen.
- Often replaces fentanyl in early labor.
- Can be used while pushing rather than IV medications to avoid newborn effects.
- After an unmedicated birth, can be used for perineal repair or removal of the placenta.
- Must collaborate on a protocol and training.

OBG Management 2014; 26: 10

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**INHALED N₂O**

<table>
<thead>
<tr>
<th>% using N₂O</th>
<th>UCSF</th>
<th>UColorado</th>
</tr>
</thead>
<tbody>
<tr>
<td>N₂O→epidural</td>
<td>42%</td>
<td>54%</td>
</tr>
<tr>
<td>Epidural only</td>
<td>76%</td>
<td>75%</td>
</tr>
<tr>
<td>Adverse events</td>
<td>0</td>
<td>0</td>
</tr>
</tbody>
</table>

UCSF found N₂O use did not affect admission to NICU, 5-minute Apgars, maternal bleeding.

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**EARLY EPIDURAL**

Cochrane Review: Effectiveness and safety of early versus late initiation of epidural analgesia for labor using 9 RCT and > 15K women:
- Low risk of bias and high quality evidence.
- No difference in cesarean: RR 1.02.
- No difference in instrumental birth: RR 0.93.
- No difference in length of second stage.
- No difference in Apgar scores or umbilical pH.

CD 007238, 2014

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**EPIDURAL MAINTENANCE**

Meta-analysis assessed whether use of low concentration epidural infusions (≤ 0.1% B or 0.17% R) in labor ↓ the risk of assisted vaginal delivery (AVD) or other adverse outcomes:
- No difference in cesarean rates, pain scores, hypotension, NRFHT, or 5-minute Apgar < 7.
- Low concentration had ↓ AVD, ↓ motor block, ↓ ambulation, ↓ urinary retention, shorter 2nd stage, and fewer 1-minute Apgar scores < 7.

Can J Anaesth 2014; 60: 840

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**PROGRESS OF LABOR**

What is the length of the second stage of labor in modern-day practice? A review of 42,268 women with or without an epidural:
- 95th %ile duration in nulliparous women was 197 minutes without, 336 minutes with an epidural → difference of 2 hrs, 19 min.
- Multiparous women: 81 minutes without, 255 minutes with an epidural → 2 hrs, 54 min.

Obstet Gynecol 2014; 123: 527
**PAIN AFTER TL**

Meta-analysis of 20 RCT with 1095 women found use of local anesthetic significantly ↓ postoperative pain after laparoscopic tubal ligation.

- LA was given topically on the tubes, injected into the tubes, or administered intra-peritoneally → same for PPTL?
- Simple, inexpensive and quick

Obstet Gynecol 2014; 124: 68

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**OTHER L&D PROCEDURES**

Good review of anesthesia for non-delivery procedures on L&D:

- Cervical cerclage
- External cephalic version (ECV)
- Postpartum bilateral tubal ligation
- Dilation and evacuation (D&E)
- Fetoscopic laser photocoagulation

Sem Perinatol 2014; 38: 378

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**ANESTHESIA FOR CESAREAN DELIVERY**

A database review of over 1 million women who had a cesarean delivery examined rates of perioperative antibiotic use.

- Only 59.5% received abx on the day of surgery.
- 66% who did not labor vs. 44% who labored
- Large variation by geographic region; no influence of age, race or insurance status.

Obstet Gynecol 2014; 124: 338

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**ANTIBIOTIC PROPHYLAXIS**

**DELAYED CORD CLAMPING**

There is safety and benefit to delayed cord clamping at delivery; it should be routine:

- Preterm neonates: stabilizes transitional circulation, ↓ need for inotropes, ↓ blood transfusions, less NEC, less IVH
- Term neonates: less iron-deficient anemia, ↑ iron stores, ? improved neuro-development

Obstet Gynecol 2014; 123: 549

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**SKIN-TO-SKIN**

Do newborns develop hypothermia during intraop skin-to-skin bonding?

- 40 cesareans, randomized to forced-air warming or passive insulation with blankets
- 81% of blanketed infants became hypothermic
- 5% of forced-air infants had temp < 36.5° C
- Also improved maternal comfort, ↓ shivering

Anesth Analg 2014; 118: 997
SKIN CLOSURE

RCT comparing staple to suture for skin closure after cesarean:
• 8% overall had wound complications
• 11% in the staple group with 7.4% wound separation
• 5% in the suture group; mainly the result of only 1.6% wound separation
Obstet Gynecol 2014; 123: 1169

GENERAL ANESTHESIA

Findings of the 5th National Audit Program (NAP5) on accidental awareness:
• Overall incidence = 1:19,000
• Risk factors: female sex, younger adults, obesity, previous awareness, emergencies, and use of NMB agents.
• Obstetrics 10-fold over-represented, more than any other specialty; many risk factors
Br J Anaesth 2014; 113: 549

GENERAL ANESTHESIA

A review of options to prevent HTN and risk of CVA on induction in preeclampsia:
• Consider using: propofol, esmolol (1.5 mg/kg) and labetalol, NTG (2µg/kg), nicardipine, fentanyl and remifentanil
• Avoid: lidocaine (ineffective, seizures), magnesium (hypotonia), hydralazine (long onset) and nifedipine (PO only, tocolytic)
Anesth Analg 2014; 119: 1350

GENERAL ANESTHESIA

Does progesterone concentration affect anesthetic and analgesic requirement during and after cesarean?
• 90 women for elective cesarean had serum progesterone measured preop.
• Those with higher than median levels required less sevoflurane / hour and less 48-hour IV-PCA consumption postoperatively.
Anesth Analg 2014; 119: 901

GENERAL ANESTHESIA

The ENIGMA-II Trial evaluated the safety of nitrous oxide in general anesthetics in at-risk patients having non-cardiac surgery in an RCT.
• No difference in death or CV complications
• No difference in surgical site infections
• No difference in severe N&V: 15% with nitrous vs. 11% without (p<0.001) but was controlled with anti-emetic prophylaxis
• N<sub>2</sub>O reduced volatile anesthetic use.
Lancet 2014; 384: 1446
NEURAXIAL ANESTHESIA

What is optimal preloading?
- Comparison of 1L LR versus 500 ml 6% HES + 500 ml LR before spinal anesthesia for elective cesarean in healthy parturients.
- HES had less hypotension → 37% vs. 55%
- But there was no difference in pressor use, next-day Hgb, or neonatal outcomes.
- No detectable HES in cord blood samples.
  Br J Anaesth 2014; 113: 459

DELIVERY OF PRESSOR

Is a phenylephrine infusion better than bolus dosing to maintain maternal BP during CD?
- Double-blind comparison of P infusion starting at 0.75 µg/min versus boluses to keep BP within 20% of baseline.
- Use of infusion ↓ physician interventions, ↓ hypotensive episodes, ↓ maternal N/V, and kept BP closer to baseline.
  Anesth Analg 2014; 118: 611

NEURAXIAL ANESTHESIA

Is spinal anesthetic requirement different in preterm pregnancies? Database review of 5000 women having cesarean using spinal or CSE.
- 3.2% of spinals failed overall; 4.5% if preterm (OR 1.6) versus 2.2% if term
- Highest failure if < 30 weeks gestation (OR 3)
- Gestational age was the only significant predictor
  ASA Annual Meeting 2014: A1059

OXYTOCIN PROTOCOLS

What is the optimal way to dose oxytocin during cesarean delivery?
- Plasma half-life = 3-10 minutes → infusion
- ED 90 in low-risk, non-laboring women = 0.35 IU, after labor ED90 = 3 IU (9-fold ↑)
- Higher doses needed with chorio-amnionitis
- IV bolus > 5IU causes vasodilation, ↓ MAP
  Int Anesth Clinics 2014; 52: 48

OBESITY AND C/S

Which takes less time to initiate anesthesia in morbidly obese parturients: spinal or CSE?
- Elective C/S, 41 patients, mean BMI 49
- Compared times from inserting introducer or epidural needle to intrathecal injection
- Spinal = 210 seconds, CSE = 180 seconds (NS)
- Completed in < 10 minutes in 75% of spinals, 95% of CSE (NS)
  Anesth Analg 2014; 118: 168

OBESITY AND C/S

What is the relationship between BMI, median incision-to-delivery and median total op times?

<table>
<thead>
<tr>
<th>BMI Category</th>
<th>Incision-Delivery</th>
<th>Total Time</th>
</tr>
</thead>
<tbody>
<tr>
<td>Normal (&lt; 25)</td>
<td>9 minutes</td>
<td>43 minutes</td>
</tr>
<tr>
<td>Overweight</td>
<td>9 minutes</td>
<td>45 minutes</td>
</tr>
<tr>
<td>Obese (30-40)</td>
<td>10 minutes</td>
<td>48 minutes</td>
</tr>
<tr>
<td>Morbid obese</td>
<td>12 minutes</td>
<td>55 minutes</td>
</tr>
</tbody>
</table>
**OBESITY AND C/S**

The Anesthetic Approach to Operative Delivery of the Extremely Obese Parturient
Seminars in Perinatology 2014; 38: 341

**NON-INVASIVE MONITORS**

Is the ultrasound cardiac output monitor valid in the third-trimester of pregnancy?
- Doppler probe in the sternal notch compared to 3D-TTE > 25 weeks gestation
- % difference was ~ 32% for cardiac output and ~ 27% for stroke volume; acceptable?
- Positive bias with ultrasound may be due to the hyperdynamic pregnant state.
  Br J Anaesth 2014; 113: 669

**MEASURING BLOOD LOSS**

Can a visual aid improve accuracy of EBL after delivery? Given a pocket card with pictures of blood on common obstetric materials; then visited 6 stations with known volumes of blood.
- The visual aid improved both objective and subjective estimation of blood loss.
- Provider type and years of experience did not correlate with accuracy before or after.
  Obstet Gynecol 2014; 123: 982

**NEURAXIAL MORPHINE**

How does propofol ↓ pruritus after morphine?
- Rats were given intrathecal morphine, itching behavior was observed, then were randomized to control, saline, intralipid or propofol → sacrificed.
- Propofol abolished the scratching response.
- Brain histochemistry → ↑ expression of CB1 receptor in the anterior cingulate cortex.
  Anesth Analg 2014; 118: 303

**ANTI-EMETICS**

RCT of 160 women with hyperemesis given ondansetron or metoclopramide IV for 24 hours:
- No difference in well-being, vomiting episodes, nausea or length of hospital stay
- Metoclopramide → more drowsiness, xerostomia, and persistent ketonuria BUT…
- M was significantly less expensive than O
  Obstet Gynecol 2014; 123: 1272
**ORAL HSV REACTIVATION**
Case report of maternal neuraxial morphine during cesarean → oral HSV reactivation (cold sore) → neonatal HSV infection → mother recognized the lesions → baby received treatment and did well. Vertical transmission?
• Strong association between oral HSV reactivation after neuraxial morphine
• Should we ask in our preanesthetic evaluation?
  Anesth Analg Cases 2014; 2: 103

**TAP BLOCKS**
Do TAP blocks with ropivacaine improve early or late (2, 24, 48 hours) analgesia when combined with neuraxial morphine?
• US-guided, bilateral, 20 ml TAP blocks
• No difference in pain at any interval, quality of recovery scores, opioid consumption, nausea, vomiting, pruritus, urinary retention.
  Can J Anaesth 2014; 61: 631

**NORMAL PHYSIOLOGY**
168 women had thoracic impedance cardiography done 3 times from 20-40 weeks and at 24 and 48 hrs postpartum to establish “normal” for pregnancy.
• No unusual findings antepartum 20-40 weeks.
• Postpartum both VD and CD had ↑ thoracic fluid content and ↑ SVR above their baseline.
• Conclusion: Avoid excessive fluids postpartum.
• Use these values as a comparison for preeclamptic or complicated pregnancies.
  Obstet Gynecol 2014; 123: 318

**ANESTHETIC COMPLICATIONS**

**THE SOAP-SCORE PROJECT**
30 institutions submitted data on 257,000 obstetric anesthetics from 2004-9 to establish the incidence of serious cx in modern practice.
• 1:3000 patients had an anesthesia-related cx
• The most common complication was high block (“total” spinal) in 1:4336 anesthetics.
• 1:533 general anesthetics resulted in failed intubation, but no hypoxemic arrests or deaths.
• No cases of aspiration were reported (0/5000).

**SOAP-SCORE RESULTS**
• There were 2 cardiac arrests: 1 from LAST during TAP blocks and 1 after high neuraxial block in a morbidly obese patient. No deaths.
• There were 5 cases of anaphylaxis from drugs administered by anesthesia personnel (not anesthetic drugs): ampicillin, cefazolin, latex, metoclopramide and 1 unknown medication.
• The most common causes of death were hemorrhage, cardiac disease, HTN, embolism.
  Anesthesiology 2014; 120: 1505
DIFFICULT AIRWAY

Failed intubation in the surgical patient 1:2230
Failed intubation in the obstetric patient (1985) 1:280
Modern-day incidence of failed intubation (2014) 1:533

ASPIRATION RISK

Can bedside ultrasound reliably measure gastric contents in the 3rd trimester?
- Anesthesiologists were blinded to NPO status- fasting, clears or solid food- during bedside US in pregnant women ≥ 32 weeks
- Inter-rater reliability was 0.74
- Overall correct diagnosis was 87% → O.R. for solids was 17 versus fasting (empty)
  Br J Anaesth 2014; 113: 1018

ASPIRATION RISK

Using bedside US, what is gastric volume and emptying during labor?
- Antral cross-sectional area = volume
- 60 parturients measured at request for epidural and when fully dilated
- 50% had ↑ gastric volume (> 300 ml) in early labor versus only 13% at full dilation → gastric motility is maintained during labor.
  Br J Anaesth 2014; 112: 703

ASPIRATION RISK

For preop fasting guidelines, does milk in coffee or tea require a 6-hour delay?
- 10 healthy non-pregnant volunteers received 300 ml black tea + 50 ml whole milk → gastric US and paracetamol absorption
- Gastric emptying was 23 minutes without and 24 minutes with milk (p=NS)
- It may be acceptable to treat milk in coffee or tea same as clears for preop fasting.
  Br J Anaesth 2014; 112: 66

ANESTHESIA PSI ON L&D

AHRQ has patient safety indicators for preventable hospital complications. What is the prevalence of childbirth-related anesthesia complications (AC)?
- All childbirth admissions for 2009 in CA and complications from neuraxial and GETA
- Rate of AC for adult surgical patients = 0.13%; child-birth-specific rate = 0.31%
- Cesarean = 0.49% and vaginal delivery = 0.22%
- Hospital outliers could be identified.
  Anesth Analg 2014; 119: 911

PERIPARTUM CARDIAC ARREST

Using data from the National Inpatient Sample, 1998-2011, the incidence of peripartum maternal cardiac arrest was 1:12,000.
- Incidence is stable, outcome is improving.
- Most common etiologies: hemorrhage, heart failure, amniotic fluid embolism, and sepsis.
- 59% of women survived to hospital discharge, although neurologic status unknown.
  Anesthesiology 2014; 120: 810
CPR IN PREGNANCY

The Society for Obstetric Anesthesia and Perinatology Consensus Statement on the Management of Cardiac Arrest in Pregnancy

• Goal: to improve maternal resuscitation
• Includes POC checklists, operational strategies
• Expands on maternal and L&D aspects of the 2010 ACLS / AHA guidelines such as system errors, communication unique to L&D setting.

Anesth Analg 2014; 118: 1003

BIS AND CV COLLAPSE

Case report: G1 at 33 weeks having emergent cesarean for twins and PTL. BIS monitor = 98 prior to induction, 35-45 in the first 15 minutes of the case. It abruptly fell to 0 followed by ↓ saturation, ↓ ET CO₂, and unobtainable NIBP. BIS recovered with resuscitation. AFE or anaphylaxis or other cause?

• BIS may provide early warning of cardiovascular collapse.

Acta Anesthesiol Scand 2014; 58: 123

PDPH REVIEW

Post-dural puncture headache:
The worst common complication in obstetric anesthesia

Sem Perinatol 2014; 38: 386

INTRATHECAL CATHETER

After 128 witnessed accidental dural punctures with an 18-gauge needle, 89 had intrathecal catheter placement and 39 had an epidural at another level.

• IT catheter for 24 hours → 42% PDPH
• Epidural replacement → 62% PDPH
• Odds ratio = 2.3 (CI 1.04-4.86)

Acta Anaesthesiol Scand 2014; 58: 1233

PDPH AND DDX

Case series of 3 patients with persistent headache after PDPH treated by epidural blood patch who were diagnosed with cerebral venous sinus thrombosis.

• EBP resolved the postural component
• All had other neurologic symptoms
• All recovered with anti-coagulation

Can J Anesth 2014; 61: 1134
**LAST: LIPID RESCUE**
What is the mechanism of lipid rescue after bupivacaine cardiac arrest?
- Rat cardiac myocytes used to demonstrate lipid rescue on the single cell level
- Bupivacaine blocked the fast Na⁺ current
- Lipid emulsion ↑ the fast Na⁺ current
- Removing lipid also removed B → lipid sink

*Anesthesiology* 2014; 120: 724

**LAST: LIPID RESCUE**
Does lipid rescue work by other methods than just “lipid sink”?
- Rat model of bupivacaine toxicity
- 20% & 30% lipid, saline or control Rx
- Best model of recovery included a dose dependent lipid effect on both sequestration and inotropy

*Anesthesiology* 2014; 120: 915

**LAST: LIPID RESCUE**
An editorial reviews current understanding of the role of intralipid + epinephrine in resuscitation:
- If coronary perfusion is maintained, lipid alone has equal resuscitation outcome, ↓ arrhythmias, and better post-arrest metabolic parameters.
- With ↓ CP survival depends on epinephrine, so we should use epi + lipid in LAST.

*Br J Anaesth* 2014; 112: 622

**ANTI-COAGULATION**
If patient receives unfractionated heparin TID, should we check a PTT before neuraxial placement or catheter removal?
- In 714 non-obstetric patients, only 2.8% had PTT > 35 and none developed hematoma
- Probably not cost-effective to check PTT on everyone prior to epidural catheter removal

*Anesth Analg* 2014; 119: 1215

**ANTI-COAGULATION**
*ASRA guidelines for TID use of UFH:*
“The safety of neuraxial blockade in patients receiving doses greater than 10,000 U of UFH daily or more than twice-daily dosing has not been established….it is unclear whether there is an increased risk of spinal hematoma.”

*Reg Anesth Pain Med* 2010; 35: 73

**CHOLESTASIS RISK**
What is the incidence of coagulopathy in women with intra-hepatic cholestasis of pregnancy (ICP)? Should we check labs?
- Retrospective cohort review comparing use of coagulation testing versus no testing
- None tested had abnormal coagulation tests, even when LFTs were abnormal
- No difference in EBL or mode of delivery
- Routine coagulation tests are not necessary

*J Clin Anesth* 2014a; 26: 623
EPIDURALS AND FEVERS
An RCT of 400 nulliparous women having epidural analgesia randomized them to receive 2 gm cefoxitin or placebo prior to placement.
• 38% developed fever in both groups.
• About half in both groups had placental neutrophilic inflammation; abx had no effect.
• There was no difference in neonatal outcomes, no sepsis in either group, no deaths.
Anesth Analg 2014; 118: 604

EPIDURALS AND FEVERS
Where do we stand in our understanding of epidural-associated fevers:
• Affect 10-30% of nulliparous mothers
• Placentas show non-infectious inflammation
• Not infectious but fever may ↑ work-ups
• Fever itself may ↑ neonatal encephalopathy
• Can’t prevent epidural-related fever when we don’t understand the mechanism.
Anesth Analg 2014; 118: 494

PREGNANCY TESTING
New problem – EMRs allow us to cut-and-paste.
• Case: A woman presented for D&C due to a history of heavy menstrual bleeding. Pre-op pregnancy test was reportedly negative. At the time of D&C, an 8 week gestation was identified – a much desired pregnancy. It was later discovered that her preoperative assessment was populated with a previous negative test result, rather than the current positive pregnancy test.
ASA Newsletter; September 2014: 42

BREAST-FEEDING
What to tell a mother having surgery who wishes to breast-feed her baby in the perioperative period?
• Anesthetic drugs do transfer to breast milk but are clinically insignificant, posing little or no risk – no need to “pump and dump”.
• Minimize use of narcotics, benzodiazepines, and agents with active metabolites.
• Use regional anesthesia where possible and / or use shorter-acting agents.
Pediatric Anesthesia 2014; 24: 359

CANCER ON L&D
Case report: labor analgesia with leukemia. Neuraxial was avoided to prevent seeding malignant cells into the CNS. Describes use of fentanyl PCA and dexmedetomidine.
A&A Case Reports 2014; 3: 104
Case report: epidural analgesia followed by STAT cesarean and general anesthesia in a woman with metastatic terminal breast cancer. Ethics of mother vs. fetus?
A&D Case Reports 2014; 2: 48

OPIOID PRESCRIBING
In the general population about 2% regularly use prescription opioids. What about pregnancy?
• Using a national insurance plan, 14% of pregnant women were prescribed an opioid sometime during pregnancy.
• 1 in 20 were prescribed in 1st trimester.
• Lowest in northeast, highest in south.
Anesthesiology 2014; 120; 1216
**OPIOID PRESCRIBING**

- Most prescriptions were for back and joint pain, migraine, abdominal ligament pain, fibromyalgia – none are very responsive to opioids – why not NSAIDs which are safe?
- Risk of prescribed, short-term opioid use causing congenital malformations is minimal.
- Use in 3rd trimester is a risk factor for neonatal abstinence syndrome.

Anesthesiology 2014; 120: 1063 (editorial)

**OPIOID vs. NERVE BLOCKS**

Case series of 27 nerve blocks performed in 13 pregnant women for migraine therapy.
- Blocked greater occipital, auriculotemporal, supraorbital, and supratrochlear nerves.
- Used for status migrainosus (52%) or frequent headaches (48%) after failed oral and IV medications.
- Average pain ↓ was 3-4, no adverse events.

Obstet Gynecol 2014; 124: 1169

**OPIOID DEPENDENCE**

Effects of opioid abuse and dependence during pregnancy; used NIS database 1990-2011:
- Prevalence increased by 127%
- Associated with ↑ odds of maternal death (OR 4.6), cardiac arrest, IUGR, abruption, LOS > 7 days, PTL, oligo, transfusion, stillbirth, PROM, and cesarean delivery.
- Significant OB morbidity and mortality

Anesthesiology 2014; 121: 1158

**CHRONIC PAIN POSTPARTUM**

In a rat model of nerve injury, the recovery time course was no different between males and females, but was enhanced in postpartum group.

Anesthesiology 2014; 121: 1056

Is it oxytocin-related? Spinal receptors for oxytocin exist. Animal studies do not show neurotoxicity → clinical studies possible on preventing chronic pain after nerve injury.

Anesthesiology 2014; 120: 951

**NEUROTOXICITY**

Female mouse pups exposed to sevoflurane later had impaired maternal behaviors toward their own pups.

Anesthesiology 2014; 120: 403

Neonatal rats exposed to propofol had acutely ↑ cortocosterone levels. As adults they had behavioral abnormalities and exacerbated endocrine response to stress.

Anesthesiology 2014; 121: 1010

**NEUROTOXICITY**

Lab studies show definite neurotoxic effects when young animals are exposed to anesthetics. Human observational studies are less conclusive.
- Large studies that use insensitive tests of academic achievement are usually negative.
- Studies testing individual performance in speech and language are uniformly positive.
- Insight into phenotype?

Anesthesiology 2014; 120: 1303
OBSTETRIC COMPLICATIONS

U.S. NATIONAL DATA - CDC
Top 10 causes of maternal mortality after live birth:
1. Cardiomyopathy 15%
2. Cardiovascular conditions 14%
3. Infection 13%
4. Preeclampsia / Eclampsia 11%
5. Non-cardiovascular medical 10%
6. Hemorrhage 9%
7. Thrombotic pulm. embolism 9%
8. Amniotic fluid embolism 7%
9. Cerebrovascular accident 6%
10. Anesthesia complications 0.7%
Obstet Gynecol 2015; 125: 5

MATERNAL MORBIDITY
• Maternal deaths are the tip of the iceberg.
• We need to identify who experienced severe maternal morbidity – the “near miss”, review their care, and recommend methods of quality improvement in obstetrics.
• Indicators: transfusion of ≥ 4 units of blood and/or admission to an intensive care unit.
Obstet Gynecol 2014; 123: 978

MATERNAL MORBIDITY
Current SIRS criteria for sepsis overlap with normal physiology of pregnancy.
• Meta-analysis of 87 studies that included maternal values for components of SIRS
• All SIRS criteria overlapped with normal pregnant physiology except temperature: respiratory rate, pCO₂, HR and WBC.
• Need alternate criteria to diagnosis sepsis during pregnancy.
Obstet Gynecol 2014; 124: 535

MATERNAL MORBIDITY
The Maternal Early Warning System (MEWS):
• Systolic BP<90, >140; diastolic BP>100 mmHg
• Heart rate < 50 or > 120
• Respiratory rate < 10 or > 30
• Oxygen saturation at sea level < 95%
• Oliguria < 35 ml/hr for ≥ 2 hours
• Agitation, confusion or unresponsiveness
• Preeclampsia with non-remitting HA or SOB
Obstet Gynecol 2014; 124: 782
HOSPITAL NETWORK
Review of maternal deaths in Hospital Corporation of American (HCA) hospitals between 2000-6:
• Leading causes of death were preeclampsia, thromboembolism, AFE, hemorrhage, cardiac.
• Recommendation: the best chance of reducing maternal mortality is for all women having cesarean delivery to receive thromboembolism prophylaxis.
Am J Obstet Gynecol 2008;199:36

HOSPITAL NETWORK QI
Same group (HCA), 6 years later………..
• The authors instituted a policy of universal use of pneumatic stockings after CD → postop pulmonary embolism deaths dropped 7-fold.
• Another policy for automatic, rapid anti-HTN therapy for defined BPs ↓ deaths 5-fold
• Disease-specific protocols can decrease maternal mortality significantly.
Am J Obstet Gynecol 2014; 211: 32

SEVERE MORBIDITY
National cohort of 115,502 women and their neonates born in 25 U.S. hospitals examined severe morbidity (MFMU Network project):
• Incidence = 2.9 / 1000 deliveries
• Most often due to postpartum hemorrhage
• Morbidity is highly associated with placenta accreta, gestational age < 37 weeks, antepartum anti-coagulant use, and any HTN
Obstet Gynecol 2014; 123: 804

QUALITY INDICATORS
Do OB quality measures correlate with maternal or neonatal morbidity?
• All hospitals review elective deliveries < 39 weeks and cesareans in low-risk mothers.
• Rates vary widely among hospitals, as do rates of maternal and neonatal complications
• But there is no correlation between quality rates being measured and morbidity.
JAMA 2014: 312: 1531

HEMORRHAGE
The ASA Closed Claims Project reviewed 141 claims related to hemorrhage (4% of all claims):
• OB accounted for 30% of hemorrhage claims vs. 13% of all non-hemorrhage (NH) claims.
• Mortality was high; 77% vs 27% of all claims
• Substandard care in 55% vs. 38% of all claims
• Payments were higher; $607K vs. $276K
• Themes: lack of timely diagnosis & transfusion
Anesthesiology 2014; 121: 450

HEMORRHAGE
A review of medical advances in treating PPH:
• Develop an emergency hemorrhage panel with your lab that includes fibrinogen, PT, INR, platelets and Hgb for STAT turnaround. Consider TEG or ROTEM on L&D.
• Implement an obstetric hemorrhage protocol including high plasma to red cell ratios.
• Use tranexamic acid and fibrinogen.
Anesth Analg 2014; 119: 1140
HEMORRHAGE
A new device for tamponade of PP hemorrhage due to atony or abnormal placentation:
• Consider its use before surgical interventions
• Vaginal balloon anchors the uterine balloon
• Intra-uterine volume > 500 ml may be needed to effect hemostasis, especially during atony.
Am J Obstet Gynecol 2014; 210: 136

PREECLAMPSIA
What are contemporary risk factors for PEC?
• 2537 women enrolled < 15 weeks gestation
• 9% developed preeclampsia → risk factors:
  • Chronic HTN (OR 2.7), pre-gestation DM (OR 3.9), multiple gestation (OR 3), AA race (OR 1.9), prior preeclampsia (OR 3.6), nulliparity (OR 1.7), infertility techniques (OR 1.7), dose-response risk with ↑ BMI (> 40, OR 6)
Obstet Gynecol 2014; 124: 763

PREECLAMPSIA
Is maternal morbidity different in early-onset versus late-onset preeclampsia?
• Rates of early (0.3%) and late (2.7%) differed
• Maternal death rates per 100K deliveries → 42 with early, 11 with late, and 4 with no PEC
• Severe morbidity per 100 deliveries → 12.2 early, 5.5 late, and ~ 3 with no PEC
• Early onset disease has ↑↑ risk for cx
Obstet Gynecol 2014; 124: 771

PREECLAMPSIA
Is placental pathology different in early vs. late-onset preeclampsia?
• Early-onset disease characterized by hypoplasia, vascular lesions of insufficiency
• Late-onset disease was characterized by inflammation and placental hyperplasia.
• Early and late-onset preeclampsia appear to be different diseases.
Am J Obstet Gynecol 2014; 210: 66

PREECLAMPSIA
New guidelines from the US Preventive Services Task Force (USPSTF) state that women at increased risk of preeclampsia (e.g. PEC in a previous pregnancy) derive benefit > than harm from taking low-dose aspirin.
• 50-160 mg/day from 12-28 weeks gestation
• No ↑ abruption, PPH, IVH, perinatal mortality.
• Based on 21 RCT and 2 observational studies.
JAMA 2014; 311: 2055
**PREECLAMPSIA**
What is the frequency of lab abnormalities in preeclampsia? Are they related to bad outcomes?
- Abnormal labs occurred in 7.3% of women with HTN: 5% with mild, 9% with severe, and 12% with severe HTN + clinical signs of end-organ dysfunction.
- In women with mild HTN and no signs of severity, routine labs may not be beneficial or cost-effective since 95% will be normal.

*Obstet Gynecol 2014; 124: 933*

**CARDIAC DISEASE**
The Role of the Anesthesiologist in the Care of the Parturient with Cardiac Disease.
*Sem Perinatol 2014; 38: 252*

**CARDIAC DISEASE**
27-year old G1 at 25 weeks presents to the ER in respiratory distress. Work-up reveals pulmonary edema and TTE shows severe rheumatic mitral stenosis. Medical management fails and she undergoes balloon valvuloplasty. She then labored at term but required cesarean delivery. Physiologic changes of pregnancy may lead to acute decompensation with severe valvular disease.

*N Engl J Med 2014; 371:953*

**THROMBOEMBOLISM**
What is the risk of postpartum thromboembolism by number of weeks after delivery?
- Risk is highest during the first 3 weeks after delivery but present through 12th week.
- Increased risk seen after cesarean delivery, preeclampsia, hemorrhage, and postpartum infection – persisting through the 12 weeks.

*Obstet Gynecol 2014; 123: 987*

**THROMBOEMBOLISM**
How long does the risk of a postpartum thrombotic event persist?
- Includes ischemic stroke, acute MI or venous thromboembolism
- Compared to frequency of events 1 year later, highest risk in first 6 weeks: OR 11
- Still elevated 7-12 weeks postpartum: OR 2

*N Engl J Med 2014; 370: 1307*

**AMNIOTIC FLUID EMBOLISM**
Clinical Expert Series Review:
1. Syndrome is not amniotic fluid or embolism.
2. Timing of AFE suggests a breach between normal physiologic barrier of mother/fetus.
3. Coagulopathy likely related to trophoblastic-derived antigens – like abruption, accreta.
4. Clinical picture similar to SIRS, anaphylaxis
### AFE REVIEW (cont)

5. Syndrome is final common pathway of a unique maternal immunologic response to foreign antigens originating in the fetal compartment.
6. Not linked to induced or augmented labor.
7. Diagnosis is purely clinical – no markers.
8. The only treatment is supportive.

10. Mis-diagnosis hinders research – many cases labeled AFE are not. Must include triad of hypotension, hypoxia and coagulopathy.
11. Research is now clearly directed toward the role of antigenic response and endogenous or inflammatory mediators – not amniotic fluid per se and not embolism.

Obstet Gynecol 2014; 123: 337

### ACUTE FATTY LIVER

What is the mechanism of coagulopathy and hemorrhage in acute fatty liver of pregnancy?
- 80% have DIC that persists 4-5 days PP
- Diminished coagulant production by failing liver; median fibrinogen recovery is 4.2 days
- Hemolysis occurs and ↑ serum bilirubin

Obstet Gynecol 2014; 124: 40

### BREECH DELIVERY

Since the Term Breech Trial in 2000, ACOG and others have “banned” vaginal breech delivery.
- Unintended ↑ maternal complications, mortality
- Obstetricians worldwide have lost the skills to practice vaginal breech deliveries
- Medico-legal concerns now prevent its practice
- Version should be done for all suitable women + more use of neuraxial anesthesia to ↑ success rates.

Lancet 2014; 384: 1183

### BREACH DELIVERY

What happens after successful external cephalic version (ECV)?
- As compared with women presenting with cephalic presentation, successful ECV is still associated with higher C/S rate.
- OR 2.2 for cesarean for dystocia
- OR 2.2 for cesarean for fetal distress
- OR 1.4 for instrumental vaginal delivery

Obstet Gynecol 2014; 123: 1327

### CO-MORBIDITIES

Clinical Expert Series or Reviews:
- Diabetic Ketoacidosis in Pregnancy
  Obstet Gynecol 2014; 123: 167
- Multiple Sclerosis During Pregnancy
  Obstet Gynecol 2014; 124: 1157
- Intrahepatic Cholestasis of Pregnancy
  Obstet Gynecol 2014; 124: 120
OBESITY & IOL
If BMI > 40, does a planned cesarean provide better outcomes than induction of labor?
• One institution, 399 inductions, 262 cesareans
• No difference in maternal or neonatal morbidity associated with CD or IOL.
• Best outcomes: induction that resulted in VD
• Worst outcomes: induction resulting in CD.
Am J Obstet Gynecol 2014; 211: 700

OBESITY & STILLBIRTH
A retrospective cohort study of singleton pregnancies without anomalies found ↑ risk of stillbirth with ↑ BMI. Overall rate = 3 per 1000.
• BMI 30-35: OR 1.7 for stillbirth
• BMI 40-45: OR 2.5
• BMI > 50: OR 3.2
• 25% of stillbirths occurred after 37 weeks; plan early delivery before 39 weeks?
Am J Obstet Gynecol 2014; 210: 457

OBESITY & STILLBIRTH
What is the optimal BMI to prevent the increased risk of fetal death and stillbirth?
• Meta-analysis of 38 studies showed a linear increase in risk starting at BMI 20 (referent).
• For each 5-unit increase in BMI, RR ↑: fetal death = 1.21, stillbirth 1.24, perinatal death 1.16, neonatal death 1.15, infant death 1.18
JAMA 2014; 311: 1536

PREGNANCY WEIGHT LOSS
Should the super-obese (BMI of 50 or greater) follow IOM guidelines for weight gain?
• 1034 women, 38% with weight gain below IOM recommendation of 11-20 lbs, 24% at IOM, and 38% above IOM guidelines
• Lower weight gain was not associated with preterm birth or low birth weight, but was associated with less macrosomia
• ↑ weight gain = more HTN and cesareans
Obstet Gynecol 2014; 124: 1105

BARIATRIC SURGERY
Case series of 3 patients who conceived > 2 years after bariatric surgery and presented with abdominal pain that was mis-diagnosed.
• #1: Perforated gastric remnant: fetus died, mother had prolonged unstable ICU stay
• #2: Internal hernias and globally ischemic small bowel: preterm fetus with IVH, 21-day maternal hospital stay
• #3: Internal hernia reduced by laparoscopy
Obstet Gynecol 2014; 124: 464

POSTOPERATIVE RISKS
Extreme obesity is associated with significant increase in post-cesarean wound complications.
• 585 women, 14.5% with BMI > 45
• More diabetes, HTN, cesarean after labor, vertical skin incision, and ↑ operative duration
• Extremely obese patients had ↑ infectious complications (OR 2.7), ↑ wound infection alone (OR 3.4) and ↑ ED visits (OR 2.2)
Obstet Gynecol 2014; 124: 227
THE FETUS AND NEONATE

CERVICAL CERCLAGE
Current indications per ACOG:
1. Women with a current singleton pregnancy, prior spontaneous preterm birth at < 34 weeks, and short cervical length (less than 25 mm) at < 24 weeks.
2. History of 1 or more second-trimester losses related to painless cervical dilation.
3. Painless cervical dilation in 2nd trimester.
Obstet Gynecol 2014; 123: 372

OXYTOCIN & AUTISM
• Oxytocin deficiency may be associated with autism. Does synthetic oxytocin administered for induction or augmentation after fetal oxytocin receptors, predisposing to autism?
• Prior studies have limitations in identifying confounders, knowing the drugs used for induction, diagnosing autism (DSM criteria).
• Reducing oxytocin use would ↑ cesarean rate.
Obstet Gynecol 2014; 123: 1140

FETAL SURGERY
A review of fluid management during general anesthesia for fetal surgery for TTTS – before and after restriction:
• < 300 ml/hr, SBP > 100 with pressors
• Total fluids: 1634 ml → 485 ml
• Pulmonary edema: 5.5% → 0
• Any respiratory distress: 13% → 0
J Clin Anesth 2014; 26: 184

CORD GASES
Is umbilical cord lactate a better predictor than pH of neonatal morbidity?
• Consecutive births, immediate cord gases and lactate before knowing neonatal outcomes.
• 1.1% morbidity rate → lactate 6.5 versus 3.3 in healthy newborns, significantly more predictive than pH using a cut-off of 3.9.
• Sensitivity / specificity higher for lactate
Obstet Gynecol 2014; 124: 756

NEWBORN RESUSCITATION
• Maternal oxygen supplementation has not been shown to be beneficial to the fetus.
• By increasing free radical activity it may be harmful to the fetus.
• Until studied in an RCT, maternal oxygen should be reserved for maternal hypoxia and not considered an indicated intervention for non-reassuring fetal status.
Am J Obstet Gynecol 2014; 211: 124
APGAR SCORE

Is the Apgar score relevant? What is the relationship between 5-minute score and risk of infant mortality?
• Births in Scotland, 1992-2010
• 5-minute Apgar 0-3 → OR 359 for early death, OR 31 for late neonatal death, and OR 50 for infant death
• Best association was with term births.
  Lancet 2014; 384: 1749

COOLING FOR ASPHYXIA

How much and how long should cooling be done after neonatal hypoxic ischemic encephalopathy? Usual = 33.5°C for 72 hours.
• Comparisons: 32°C versus 33.5°C and 72 hours or 120 hours (4 groups)
• No advantage to longer cooling or deeper cooling or both → did not reduce ICU deaths.
  JAMA 2014; 312: 2629

COOLING FOR ASPHYXIA

What obstetric events preceded the need for cooling for neonatal encephalopathy?
• 1.1 per 1000 live births received cooling
• Catastrophic events: cord prolapse OR 14, abruption OR 17, uterine rupture OR 130
• Associations: age < 15, BMI > 40, diabetes, preeclampsia, chorioamnionitis, length of labor, mode of delivery, epidural analgesia
  Am J Obstet Gynecol 2014; 211: 155

COOLING FOR ASPHYXIA

After head cooling at birth, what is their neurologic outcome later in childhood?
• 325 newborns with asphyxial encephalopathy were randomized to cooling or usual care
• At 6-7 years of age → 52% of treated children survived with an IQ > 85 vs. 39% of controls
• 45% survived without neurologic abnormalities vs. 28% of controls, 21% cerebral palsy vs. 36%

AND WE’LL SEE WHAT’S NEW IN 2015!

THE END
Preoperative Evaluation: An Update

Presenter: Estee A. Piehl, MD

Disclosures: I have no financial conflicts of interest to disclose.

Learning Objectives:

1. Review the most recent Practice Guidelines or Practice Advisories relating to preanesthetic cardiac, pulmonary, laboratory and hematologic evaluation.
2. Discuss recent studies in preoperative evaluation and how they inform the current Practice Guidelines.
3. Address the need for standardization of preoperative evaluation and procedures in the face of current economic challenges

Outline:

1. Cardiac Evaluation for Non-cardiac Surgery
   a. Review Practice Guidelines from October 2007 and Practice Advisory on CIEDs from October 2011
   b. Discuss updates and recent studies
      i. Stents
      ii. Beta-blockers
      iii. ECGs
2. Pulmonary Evaluation including Obstructive Sleep Apnea
   a. Review Practice Guidelines from August 2014
   b. Discuss recent studies
3. Preanesthesia Evaluation and Laboratory Findings
   a. Review Practice Advisory from March 2012
   b. Discuss recent studies
4. Perioperative Blood Management
   a. Review Practice Guideline update from February 2015
5. Is a Standardized Preoperative Clinic necessary?