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Sunday, February 25
Afternoon
4:00-5:00 pm  Obesity, OSA, and Thoracic Anesthesia – Jay B. Brodsky, MD
5:00-6:00 pm  Anesthesia in Traumatic Brain Injury – Kenneth M. Brady, MD
6:00-6:30 pm  Q&A
6:30-7:30 pm  Opening Night Reception

Monday, February 26
Morning
7:00-8:00 am  What’s New in Obstetric Anesthesia from 2017? – Joy L. Hawkins, MD
8:00-9:00 am  Anesthesia for Bariatric Surgery – Jay B. Brodsky, MD
9:00-9:30 am  Q&A
9:30 am  Recess/View Exhibits
3:30 pm  View Exhibits/Après Ski

Afternoon
4:00-6:00 pm  OB Anesthesia Panel – Joy L. Hawkins, MD; Rachel Kacmar, MD
4:00-6:00 pm  ICU Panel – Jason Brainard, MD; Breandan Sullivan, MD; Thomas Scupp, MD
4:00-6:00 pm  Workshop: Comprehensive Airway Management – David Abts, MD; Bethany Benish, MD; Marina Shindell, DO; Brian Somerset, MD; Jennifer Zieg, MD

Tuesday, February 27
Morning
7:00 – 8:00 am  Neuromonitoring – What and When? – Kenneth M. Brady, MD
8:00 – 9:00 am  Anesthesia for the Chronic Pain Patient – Racheal Rzasa Lynn, MD
9:00 – 9:30 am  Q&A
9:30 am  Recess/View Exhibits
3:30 pm  View Exhibits/Après Ski
CRASH 2018 Program

Afternoon
4:00-6:00pm  Anesthesia Outside the OR Panel – Debnath Chatterjee, MD; Debra Faulk, MD; Barbara Wilkey, MD

4:00-6:00pm  Pain: The Opioid Epidemic Panel – Karsten Bartels, MD; Rachael Rsaza Lynn, MD; Myron Yaster, MD

4:00-6:00 pm Workshop: Ultrasound-Guided Regional Anesthesia for Beginners – Bethany Benish, MD; Christopher Ciarallo, MD; Seth Eisdorfer, MD; Roland Flores, MD; Kyle Marshall, MD; Glenn Merritt, MD; Olivia Romano, MD; Marina Shindell, DO

Wednesday, February 28

Morning
7:00 – 8:00 am  PACU Management of the Obese Patient – Jay B. Brodsky, MD

8:00 – 9:00 am  Anesthesia for Joint Replacement Surgery – Olivia Romano, MD

9:00 – 9:30 am  Q&A

9:30 am  Recess/View Exhibits
3:30 pm  View Exhibits/ Après Ski

Afternoon
4:00-6:00 pm  Wellness and QI: the Relationship Between Resilience and Quality—Alison Brainard, MD; Norah Janosy, MD; Gina Whitney, MD

4:00-6:00 pm  Pediatric Anesthesia Panel – Debnath Chatterjee, MD; Monica Hoagland, MD; Lawrence Schwartz, MD

4:00-7:00 pm  Workshop: Advanced Ultrasound-Guided Regional Anesthesia– Christopher Ciarallo, MD; Christopher Lace, MD, MBA; Seth Eisdorfer, MD; Roland Flores, MD; Kyle Marshall, MD; Glenn Merritt, MD; Olivia Romano, MD; Marina Shindell, DO MD; Christopher Lace, MD; Glenn Merritt, MD; Adrian Hendrickse, MD; Oliva Romano, MD
CRASH 2018 Program

Thursday, March 1

Morning
7:00 – 8:00 am  Update of Pediatric Anesthesia – Lawrence Schwartz, MD
8:00 – 9:00 am  Post-Operative Delirium – Kenneth M. Brady, MD
9:00 – 9:30 am  Q&A

Afternoon
4:00-6:00 pm  Healthcare Management Update – Randall Clark, MD; Brian Davidson, MD; Steven Zeichner, MD

4:00-6:00 pm  Cardiac Anesthesia Panel – Daniel Beck, MD, MS; Wayne Soong, MD; Mark Twite, MB

4:00-7:00 pm  Workshop: Wilderness Survival Medicine – Jay Lemery, MD; Todd Miner, Ed.D., FAWM

Friday, March 2

Morning
7:00 – 8:00 am  The Changing Landscape of Opioid Analgesics: An FDA Perspective – Jeffrey Galinkin, MD
8:00 – 9:00 am  Cardiac Anesthesia Update – Karsten Bartels, MD
9:00 – 9:30 am  Q&A
10:00 am  Adjourn
Disclosure of Relevant Financial Relationships

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<table>
<thead>
<tr>
<th>Name</th>
<th>Affiliation</th>
<th>Organization</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ken Brady</td>
<td>Co-Inventor of a Neuromonitoring Technology – not yet available</td>
<td>Medtronic</td>
</tr>
<tr>
<td>Jay Brodsky</td>
<td>Consultant</td>
<td>Ambu</td>
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Racheal Rzasa-Lynn and Olivia Romano have reported intentions to discuss unapproved uses for drug products and/or devices.
ACKNOWLEDGEMENT

We extend our appreciation to
Cook Medical
Fujifilm SonoSite
Karl Storz
Medtronic
Mindray
PAJUNK Medical Systems
Philips
Salter Labs
Verathon

for equipment provided for the workshops at

CRASH 2018
We also welcome our Exhibitors

Air Force Recruiting Service
Allied Powers
Belmont Instrument Corporation
Elsevier
Fujifilm SonoSite
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Salter Labs
Sharkey, Howes & Javer
USAP
Verathon Medical
Vyaire Medical
WilMarc Medical
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Obesity, Obstructive Sleep Apnea (OSA), and Thoracic Anesthesia

February 25, 2018

Disclosure
Ambu, DK
Airway Management Advisory Board

Goals and Objectives

- Learn the advantages and disadvantages of bronchial blockers (BB) and double-lumen tubes (DLT); Which is the best lung separation technique for your patient.
- Use of airway exchange catheters (AEC) for thoracic patients with difficult airways.
- Identify and manage obese thoracic surgical patients with Obstructive Sleep Apnea (OSA).
- Select the best technique(s) for postoperative pain management for the obese thoracic surgical patient.

INDICATIONS

LUNG SEPARATION/ISOLATION (“absolute”)
Protect healthy lung hemorrhage, empyema, lung lavage
Special procedures
broncho-pleural fistula, bronchial disruption, giant bullae or cysts, broncho-pulmonary lavage

SELECTIVE LUNG COLLAPSE (“relative”)
Improve Surgical Exposure
Thoracic Surgery: Lung and mediastinum
General Surgery: Esophagus
Cardiac Surgery: Heart and great vessels
Orthopedic Surgery: Spinal column – thoracic approach
Neurosurgery: Nerves and sympathetic chain

INDICATIONS

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Orthopedic Surgery: Spinal column – thoracic approach
Neurosurgery: Nerves and sympathetic chain

The DLT vs BB “Controversy”


Lung Isolation and Selective Collapse

Double-lumen tube
Bronchial blocker

Double-lumen tube
Bronchial blocker
For most patients either a DLT or BB can be safely used – the choice is one of personal preference

No significant differences in the quality of lung isolation

Both have advantages in specific clinical situations

Anesthesiologists should be skilled in both techniques

Once the trachea is intubated lung collapse is **ALWAYS** possible!

Single-lumen Tube (ETT) or SGA (LMA)

Bronchial Blocker (BB)

Double-lumen Tube (DLT)

Bronchial Blockers: Advantages

- Can be used with any endotracheal tube (oral, nasal, tracheostomy) or LMA
- Not necessary to change to ETT if *potential or planned* postoperative ventilation (“difficult airway”)
- Allows selective lobar blockade
- ETT fits in very small adult airways; technique of choice in pediatrics

Fiberoptic Bronchoscopy

Univent Tube (1980s)

Multiport Adaptor

Arndt® (Wire loop (WEB) control)
- FOB control positioning
- Balloon not visualized

Cohen® (Torque control)
- BB position observed with FOB
- Ability to reposition BB

Uniblocker

EZ-Blocker
• Minimal risk of dislocation
• Same EZ-Blocker can isolate either lung
• Allows either lung to be collapsed and re-expanded (sequential isolation) during surgery


EZ-Blocker is only BB that can be placed “blindly” without bronchoscopy
• Use in very small ETT (no pediatric FOB available)
• During emergencies (“blind” without FOB)
• When airway cannot be visualized ie hemorrhage


Bronchial Blocker - Contraindications
• Bronchial Obstruction
  Extrinsic – tumor, nodes, aortic aneurysm (left)
  Intrinsic – tumor, stenosis
• Procedure on Bronchus
  Broncho-pleural fistula, Sleeve resection,
  Single-lung transplant

DLT can always be positioned in the opposite bronchus

Tracheal Or Carinal Origin Of Right-upper Lobe Bronchus
(5% population)

BB cannot collapse entire right lung

Double-lumen Tubes
• Two tubes molded together
• Short lumen ends in the trachea
• Longer lumen ends in either the right or left main bronchus

(1950) Carlens (1962) Robertshaw
What is a Difficult Airway? *

"... difficult airway ... situation in which an anesthesiologist experiences problems with (a) face mask ventilation and/or (b) tracheal intubation” **


* <1993 “difficult airway” was called “difficult intubation”

** 2013 - difficulty with SGA placement/ventilation added

What’s the difference between a Difficult Airway and a Difficult Intubation?

Difficult Airway

Obesity (mask ventilation, DL)

OSA (MV, laryngoscopy)

Thoracic Surgery (special tubes)

Glidescope


Blue bronchial cuff immediately below carina in main-bronchus
No obstruction of upper-lobe bronchus


Quality of lung collapse over time

Number of Repositions

DLT or BB not in correct position fails to isolate the lung
- Lung will re-expand and interfere with surgery
- Inflated BB balloon in trachea obstructs ventilation to both lungs
- Healthy non-operated lung can be contaminated


Airway Injury

Sore Throat

Hoarseness

**Postoperative Ventilation - Double-lumen Tube**

- Ventilate with DLT or Exchange for ETT
- Deflate bronchial cuff or Deflate both cuffs
- Pull DLT above carina
- Re-inflate tracheal balloon

**Lubricate the AEC**

Test the fit between the AEC and tube before attempting tube exchange

**AEC with relatively large o.d. / DLT with relatively small i.d.**

- Never advance against resistance
- Do not insert past 25-26 cm at lips – risk of airway laceration

**Laryngoscopy lifts supraglottic tissue - facilitates tube passage at the glottis**

If passage is obstructed, rotate the tube 90° counter-clockwise to avoid arytenoid or vocal cord impingement

**Have rescue jet ventilation available if the airway is lost**
Conclusions of Surgery - Bronchial Blocker

- Withdraw BB
- Ventilate through ETT

Favors DLT
- Displacement less frequent
- CPAP easily applied
- Allows suctioning before re-inflation of operative lung
- Lungs can be re-expanded and collapsed during surgery
- Used for operations on contra-lateral lung if main bronchus is obstructed
- Faster and easier to place - "blind" placement possible
- More rapid lung deflation
- Sequential surgery
- Technique when lung isolation absolutely essential (eg bronchopulmonary lavage)
- "Split lung" ventilation in ICU

Favors BB
- Placed through ETT or LMA
- "Difficult airway" or when DLT impossible to use
- Can be used "in situ" ETT (no need to change to DL
- Better when tube exchange dangerous, especially if postoperative ventilation needed
- Multisport adaptor allows ventilation during placement
- Less potential for serious airway trauma
- Allows selective lobar isolation
- Allows small airways and pediatrics

Obstructive Sleep Apnea (OSA)

- Increased sensitivity to respiratory depressant effects of anesthetics and opioids
- Increased sensitivity to laryngo-pharyngeal dilator muscle tone to anesthetics and opioids

“Difficult airway” and OSA

70 - 90% of all patients scheduled for bariatric surgery have OSA
- Increased amount of pharyngeal tissue
- Obstruction during mask ventilation
- Increased tracheal intubation and extubation difficulties

Polysomnography (PSN) - “Sleep Study”

- # Desaturations (SpO2 > 4%) / hr
- Arousal Index (AI) - clinically or by EEG
- Apnea-Hypopnea Index (AHI) (events/hr)
  - Apnea – no airflow >10s despite continued efforts to breath against a closed airway
  - Hypopnea – airflow <50% for >10s
- Respiratory Disturbance Index (RDI)
  - AHI + AI

Sleep Study (Polysomnography) Cost Averages Around the Country

<table>
<thead>
<tr>
<th>Location</th>
<th>Average Cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>Phoenix, AZ</td>
<td>$2,180</td>
</tr>
<tr>
<td>New York, NY</td>
<td>$2,450</td>
</tr>
<tr>
<td>Houston, TX</td>
<td>$2,325</td>
</tr>
<tr>
<td>Chicago, IL</td>
<td>$2,180</td>
</tr>
<tr>
<td>Los Angeles, CA</td>
<td>$2,525</td>
</tr>
<tr>
<td>Denver, CO</td>
<td>$2,450</td>
</tr>
<tr>
<td>Alaska, AK</td>
<td>$2,180</td>
</tr>
<tr>
<td>Texas, TX</td>
<td>$2,450</td>
</tr>
</tbody>
</table>
American Society of Anesthesiologists Task Force on Perioperative Management of patients with obstructive sleep apnea. PRACTICE GUIDELINES FOR THE PERIOPERATIVE MANAGEMENT OF PATIENTS WITH OBSTRUCTIVE SLEEP APNEA
Anesthesiology 2006; 104:1081-93

A. Clinical signs and symptoms suggesting the possibility of OSA
1. Predispensing physical characteristics
   a. BMI 35 kg/m² (95th percentile for age and gender)
   b. Neck circumference 17 inches (men) or 16 inches (women)
   c. Craniofacial abnormalities affecting the airway
   d. Anatomical nasal obstruction
   e. Tonsils nearly touching or touching in the midline


- Avoid general anesthesia and sedatives where possible
- Use short acting opioid agents
- Use “depth of anesthesia” monitors to keep agents at minimum
- Use neuromuscular monitoring to maintain block and ensure complete reversal
- Maximal use of local anesthetics and multimodal opioid-sparing agents for postoperative analgesia
- Maintain the head-up position and monitor oxygen saturation postoperatively

Consensus Statement:
- Society of Obesity and Bariatric Anesthesia
- Obstetric Anesthesiologist’s Association
- Royal College of Anesthesiologists
- British Association of Day Surgery
- Resuscitation Council (UK)
- Difficult Airway Society
- Association of Anaesthetists of Great Britain & Ireland

STOP-BANG Questionnaire for Obstructive Sleep Apnea (OSA)

SNORE: Do you snore loudly? (Snoring heard through closed door)
TIRED: Do you feel tired, sleepy, fatigued, during daytime?
OBSERVED: Has anyone seen you stop breathing during sleep?
BLOOD PRESSURE: Do you have or are you being treated for high blood pressure?
BMI: Is your BMI > 35kg/m²?
AGE: Are you older than 50?
NECK CIRCUMFERENCE: Is your neck circumference > 40 cm? Size 16 collar
GENDER: Are you a male?

+3 probable OSA
+5 high likelihood OSA


“Restrictive” fluid management in thoracic surgery

(1984) Post-Pneumonectomy Pulmonary Edema (PPE)
10 cases of fatal acute lung injury following pneumonectomy

....the most important thing we (the surgeon) can do in terms of recognizing this problem (PPE) is to .... watch our anesthetists as they start loading the patient up with fluids ... don’t let them drown the patient”


Acute Lung Injury (ALI) - risk factors

- Preoperative alcohol abuse (p < 0.0001)
- High intraoperative ventilatory pressure (p = 0.001)
- Extent of lung resection (p = 0.002)
  (pneumonectomy 7.4% vs pulmonary resection 1.9%)
  * “Excessive” fluid infusion (p = 0.023)


(1999) ... It is not clear whether PPE is caused by excessive perioperative intravenous fluid as previously thought

Possible Mechanisms PPE

- Ischemia-reperfusion injury
- Oxidative stress injury
- Pulmonary capillary stress failure
- Ventilator-induced acute lung injury (VALI)


Hypotension associated with TEA.....is largely due to an unmasking of underlying hypovolemia.....and can usually be alleviated with appropriate fluid replacement.”


Restrictive (limited) fluid management for thoracic surgical patients results in hypovolemia and impaired tissue perfusion

Risk of acute kidney injury after lung resection is 6-24%


Goal Directed (GD) Fluid Management

Monitor for Inadequate Perfusion

- Non-invasive blood pressure
- Dynamic A-line BP and respiratory variability
- Pulse oximetry respiratory variability
- Stroke Volume Variation (SVV)
- Urinary output
- CVP, PAP, TEE, CI,
- Intraoperative lab data
- ABG, Lactate

Goal Directed (GD) Fluid Replacement

Meta-analysis 23 GD trials (non-thoracic surgery)
GD vs Liberal or vs restrictive fluid therapy
GD groups all received more fluid than restrictive groups

GD Replacement (using hemodynamic parameters)
- Less pneumonia
- Less renal complications
- Earlier return of bowel movement
- Shorter hospital stay

**Fluid Guidelines for Thoracic Surgery**

Use **Goal Directed** fluid replacement

Monitor hemodynamic parameters (ABG)

- **Crystalloids** – limit average adult to < 2.0 L during procedure (< 3.0 L during POD #1)
- **Colloids** – if additional fluid needed to maintain cardiovascular stability and renal function (intra-operatively and post-operatively)
- **Blood** - replace blood loss with blood

If increased tissue perfusion needed give additional fluids based on GD data

---

**Ultrasound imaging used to measure depth to epidural space**


![Ultrasound imaging](image)

**20 cm**

**15 cm**

**9 cm**

---

**During epidural placement the frequency of (a) multiple attempts, (b) vascular cannulation, (c) “wet” tap, and (d) failed block increases with increasing BMI**

![Graph](image)
Epidural catheter can pull out > 1 cm. Advance > 4 cm into epidural space


No evidence of major advantage for TEA
- TEA has rare (but serious) risks
- TEA only for high-risk patients

Recommend Intercostal nerve block (ICN) + opioid PCA + NSAIDs (multimodal analgesia)

Meta-analysis:
**Paravertebral Block (PVB) vs Thoracic Epidural Analgesia (TEA)**

Hypotension following thoracotomy

FAVORS PVB  FAVORS TEA

Postoperative Analgesia

Pain scores at 4-6 hrs and 24 hrs

<table>
<thead>
<tr>
<th>Group</th>
<th>Pain scores at 4-6 hrs</th>
<th>Pain scores at 24 hrs</th>
</tr>
</thead>
<tbody>
<tr>
<td>Group 1</td>
<td>7.8 (3.8)</td>
<td>4.2 (1.9)</td>
</tr>
<tr>
<td>Group 2</td>
<td>7.8 (3.8)</td>
<td>4.2 (1.9)</td>
</tr>
</tbody>
</table>

Post-Thoracotomy Analgesia

- **Systemic opioids**: Patient-controlled intravenous short-acting opioid analgesia (PCA)
- **Neural opioids**: Local anesthetic: Thoracic epidural analgesia (TEA)
- **Local anesthesia**:
  - Paravertebral block (PVB, single or continuous)
  - Infiltration or direct intercostal nerve block (ICN)
  - Interpleural administration (bolus or continuous infusion) through chest tube or catheter
- **Multi-modal analgesia**:
  - Non-steroidal anti-inflammatory drugs (NSAIDs)
  - I.v. lidocaine, ketamine
  - I.v. or p.o. acetaminophen
  - alpha-2 agonists
  - TENS

Do morbidly obese patients tolerate one-lung ventilation?

- In the lateral decubitus position?
- In the supine position?

One-Lung Ventilation

Benumof JL. Anesthesia for Thoracic Surgery. 2nd Ed. WB Saunders Co, 1996
Volume Controlled One-Lung Ventilation
(Controversy 2006)

Protective Low Volume Ventilation
Slinger P. Pro: Low tidal volume is indicated during one-lung ventilation. Anesth Analg. 2006;103: 268-70

Conventional High Volume Ventilation
Gal T.J. Con: Low tidal volumes are indicated during one-lung ventilation. Anesth Analg. 2006;103: 271-3

“Protective OLV” minimizes VALI
Volume controlled OLV
Low tidal volume (4-6 ml/kg/IBW)
Dependent-lung PEEP
Lowest FiO₂ (to maintain SpO₂)
Recruitment maneuvers dependent lung
Low ventilatory pressure

“Conventional” OLV (VT 10 ml/kg, FiO₂ 1.0 + 0 PEEP)
“Protective” OLV (VT 6 ml/kg, FiO₂ 0.5 + 5 cmH₂O PEEP)

• PaO₂ and PaO₂/FiO₂ higher in conventional group
• Interleukin-6 and malondialdehyde increased in both groups/No differences between groups
• No differences in post-operative abnormalities or CXR

• NO ADVANTAGE TO “PROTECTIVE” OLV


Position and PaO₂ During OLV

Obstructive Sleep Apnea
Anesthesia in Traumatic Brain Injury

Ken Brady, MD
Pediatrics, Anesthesia, Critical Care
Texas Children's Hospital
Baylor College of Medicine

Disclosures

• IP for monitoring technology licensed to Medtronic

Set up audience participation

1. Take out your silenced phone
2. Open a web browser
3. Go to: PollEv.com/kenbrady584

Test question

Case #1: Multi-system trauma

• 20-year old rollover MVA. Unconscious, 30 min to ED in Collar:
  – GCS 7: Eyes closed (1), unintelligible mumbling (2) and withdrawal to painful stimulus 4 extremities(4)
  – HR110; ABP 95/55; T 35.5°C
  – Pulmonary contusion (SpO2 90% on 100% NRB)
  – Angulated mid-shaft radius/ulnus fracture
  – Scalp laceration

Outline

• Case-based care-decisions:
  – ICP monitoring and management
  – Ventilation
  – Anesthetic agents
  – Temperature management
  – CPP management
  – Steroids
  – DVT prophylaxis
  – Seizure management and prophylaxis
Acute brain trauma management

- Step 1: Avoid herniation
  - Airway control
  - Oxygenation
  - Ventilation
  - ABP support
  - Anesthesia
  - Osmolar therapy

Evidence? Physiologic principles

Would you do a rapid sequence intubation?

Yes

No

Would you treat ICP empirically with osmolar therapy?

does not matter

Evidence?


Kenneth M. Brady, MD

Anesthesia in Traumatic Brain Injury
Brain Trauma Foundation Guidelines

12. INTRACRANIAL PRESSURE MONITORING

LEVEL I AND II A
There was insufficient evidence to support a Level I or II A recommendation for this topic.

LEVEL II B
Management of severe TBI patients using information from ICP monitoring is recommended to reduce in-hospital and 2-week post-injury mortality.

- Does this patient have severe TBI? Not defined in 4th edition!

ICP monitoring kerfuffle

- Alali et al: retrospective n = 10,000
  - OR of death compared to no ICP monitor: 0.44 (0.31 to 0.63)
- Chesnut et al: RCT n = 324
  - Mortality, GOS no difference
- Farahvar et al: retrospective n = 1,307
  - OR of 2-week mortality compared to no ICP monitor: 0.64 (0.41 – 1.00)
- Gerber et al: retrospective n = 2,320
  - Temporal improvements in guideline adherence (ICP monitoring) associated with temporal decrease in mortality
- Talving et al: prospective cohort, n = 216
  - OR of death 0.15 (-0.03 – 0.74) longer ICU/Hospital stay with ICP monitoring

Brain Trauma Foundation Guidelines

3rd edition

“Intracranial pressure (ICP) should be monitored in severe TBI (GCS 3-8 after resuscitation) and an abnormal computed tomography (CT) scan. An abnormal CT scan of the head is one that reveals hematomas, contusions, swelling, herniation, or compressed basal cisterns.”

Patient intubated, ICP monitor (EVD) and Licox monitor placed at bedside, trended on the Moberg system.

Now posted for angiography, vascular exploration and fasciotomy due to pulsatile hematoma in the forearm.
Elevated ICP

Frequent ICP elevations lasting 10-20 minutes with associated decrease in P_{\text{a}}\text{O}_2
- Sedated, paralyzed, 36.5°C
- Sp\text{\textsubscript{a}}O\text{\textsubscript{2}} 98%, TV 450, rate 12, PIP 24, PEEP 4, P_{\text{a}}\text{O}_2 40%
- HR 80, ICP, ABP, P_{\text{a}}\text{O}_2 shown on right.
- Na 142, Hb 10.3, 7.43/37/120
ICP is 45 mmHg positioning for angiography injection

BTF guidelines: Osmolar therapy

“The Committee is universal in its belief that hyperosmolar agents are useful in the care of patients with severe TBI. However, the literature does not currently support recommendations that meet the strict criteria for contemporary evidenced-based medicine approaches for guideline development.”

BTF guidelines: hypothermia

- Early (within 2.5 h), short-term (48 h post-injury), prophylactic hypothermia is not recommended to improve outcomes in patients with diffuse injury
BTF guidelines: Anesthetic

- Administration of barbiturates to induce burst suppression measured by EEG as prophylaxis against the development of intracranial hypertension is not recommended.

- High-dose barbiturate administration is recommended to control elevated ICP refractory to maximum standard medical and surgical treatment. Hemodynamic stability is essential before and during barbiturate therapy.

- Although propofol is recommended for the control of ICP, it is not recommended for improvement in mortality or 6-month outcomes. Caution is required as high-dose propofol can produce significant morbidity.

BTF guidelines: Ventilation

- Prolonged prophylactic hyperventilation with PaCO2 of ≤25 mm Hg is not recommended.

CO2 response 1: Vasoconstriction

CO2 response 2: Pressure Passive

CO2 response 3: Preserved CBF
CO2 response 4: hypercarbia

BTF guidelines: Ventilation

- Hyperventilation is recommended as a temporizing measure for the reduction of elevated ICP.
- Hyperventilation should be avoided during the first 24 h after injury when CBF often is reduced critically.
- If hyperventilation is used, SjO2 or BtpO2 measurements are recommended to monitor oxygen delivery.

BTF guidelines: steroids

- The use of steroids is not recommended for improving outcome or reducing ICP. In patients with severe TBI, high-dose methylprednisolone was associated with increased mortality and is contraindicated.

Case #2: DVT concerns

78 year old man falls from third stair.
- GCS 12: eyes open to voice(3) confused(4) localizes to pain(5).
- CT shown on right:
- Pelvic fracture of superior and inferior pubic rami.

How would you prevent DVT in this patient

- Pneumatic compression devices only
- LMWH or heparin at admission
- LMWH or heparin only after stable CT for 24-48 hrs
- Coumadin after stable CT for 24-48 hrs
- Aspirin only
BTF guidelines: DVT prophylaxis

- LMWH or low-dose unfractioned heparin may be used in combination with mechanical prophylaxis. However, there is an increased risk for expansion of intracranial hemorrhage.
- In addition to compression stockings, pharmacologic prophylaxis may be considered if the brain injury is stable and the benefit is considered to outweigh the risk of increased intracranial hemorrhage.
- There is insufficient evidence to support recommendations regarding the preferred agent, dose, or timing of pharmacologic prophylaxis for deep vein thrombosis.

Case #3: Surgery in setting of TBI

11 year old boy pedestrian struck.
- GCS 10: eyes open to pain(2) inapropriate words(3) locates pain(5)
- HR 130, ABP 145/95, R 45, S_O2 95% NRB
- Rib fractures on CXR
- CT shown
Admitted to the ICU for observation

11 year old boy pedestrian struck.
- Overnight his GCS fluctuates from 7 to 12, agitated and combative
- CXR in AM shows massive pleural effusion and mediastinal shift
- HR: 125; ABP 95/45; R 45; S_O2 90% NRB

Posted for thoracotomy/hematoma evacuation

How would you rank the effectiveness of the following recommendations?

- Place a chest tube at the bedside with local anesthetic and fentanyl
- Provide standard general anesthesia with ETT
- Provide general anesthesia with ETT after placement of an ICP monitor
- Provide general anesthesia with ETT using rapidly reversible agents (remifentanil)

Summary

- Wear a helmet when skiing
Monday
WHAT’S NEW IN OBSTETRIC ANESTHESIA FROM 2017?

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

GOALS & OBJECTIVES
Discuss how literature from the past year may:
1. Change clinical practice in obstetric anesthesia via new guidelines and policies.
2. Give best practices for analgesic and anesthetic techniques during labor and delivery.
3. Optimize and expedite management of obstetric and anesthetic complications.
4. Alter practices affecting the fetus and newborn.

NEW GUIDELINES AND POLICIES

BIRTH DATA – 2016
Provisional U.S. birth data from 2016:
• 3.9 million births, down 1%
• Birth rate for teenagers age 15-19 declined 9%
• 77% of women began prenatal care in the 1st trimester
• Cesarean delivery rate declined for the 4th year to 32%
• Preterm birth rate rose for the 2nd year to 9.8%
Natl Vital Statistics System #002, June 2017

MATERNAL MORTALITY
Why did maternal mortality rates (per 100K live births) increase in the United States?
• Retrospective review of deaths from 1993-2014.
• MMRs † from 7.55/100K in 1993 to 21.5/100K in 2014.
• Improvements in surveillance accounted for almost all of the change and highlight past under-estimation.
• Complete ascertainment of maternal deaths is a challenge.
Obstet Gynecol 2017; 129: 91

MATERNAL MORTALITY
The CDC published its 2011-13 update on U.S. pregnancy-related maternal mortality:
• 17 deaths per 100K live births (stable).
• 15% of births were to women > 35, but 30% of deaths were in this age group.
• Hemorrhage, HTN and anesthesia causes declined.
• Cardiovascular, CVA and other medical conditions †.
• African-American women’s death rates 3.4 times higher.
Obstet Gynecol 2017; 130: 366
MATERIAL MORTALITY

The case for a national maternal mortality review committee:

• There is no comprehensive, evidence-based national plan to collect data to base recommendations for improvement.
• Although we know categories of maternal death, e.g. cardiac disease, we don’t know the actual cause – social or cultural issues accessing care? Medical errors?
• 900 deaths per year in the U.S. need focused review to determine disease category, cause of death, and how they could have been prevented. This is a call to action!

Obstet Gynecol 2017; 130: 198

MATERIAL MORTALITY

Rural health care and the Maternal Health Compact:

• Over 60% of U.S. hospitals that provide obstetric care do < 1000 deliveries / year or < 3 / day.
• Rural, low-volume, non-teaching hospitals have higher maternal morbidity, perhaps related to maintenance of competencies and staff recruitment.
• Maternal Health Compact: formally link lower-resource hospitals with tertiary care hospitals for transports, to provide tele-health, and to assist in local QI activities.

N Engl J Med 2017; 376: 1304
Am J Obstet Gynecol 2017; 216: 179

TRAUMA MORTALITY

What is the impact of trauma on maternal mortality?

• Pregnant trauma patients had 1.6-fold higher rate of mortality than a non-pregnant cohort. More likely to be dead on arrival and to die during their hospital course.
• Less likely to undergo surgery and more likely to be transferred to another facility.
• More likely to experience violent trauma (homicide or assault) compared to non-pregnant: 16% vs. 10%.

Am J Obstet Gynecol 2017; 217: 590

MORTALITY DUE TO VIOLENCE

Illinois formed a second statewide maternal mortality review committee for deaths due to violence.

• Homicide, suicide and substance abuse accounted for one fourth of pregnancy-associated deaths 2002-13.
• Committee focused on opportunities to intervene and identify appropriate resources, social services.
• Change in focus from only reviewing deaths due to obstetric and medical causes.

Am J Obstet Gynecol 2017; 217: 556

DISASTER PREPAREDNESS

ACOG Committee Opinion: Hospital disaster preparedness for obstetricians and facilities providing maternity care.

• Hospitals should have a perinatal committee (OB, peds and anesthesia) and a designated obstetric team to call.
• Know ACOG’s levels of maternal care; have strategies to stabilize/transport obstetric patients, manage surge capacity.
• Designate a safe location for laboring women who can’t be transported because of imminent delivery.

Obstet Gynecol 2017; 130: e291

DIAGNOSTIC IMAGING

ACOG Committee Opinion: Guidelines for diagnostic imaging during pregnancy and lactation.

• Ultrasound and MRI do not have risk and are the imaging techniques of choice in pregnancy.
• X-rays, CT or nuclear medicine imaging should not be withheld if needed; their radiation dose is much lower than exposure associated with fetal harm.
• Gadolinium should be avoided in pregnancy but breast-feeding is safe and should not be interrupted.

Obstet Gynecol 2017; 130: e210
MARIJUANA USE

ACOG Committee Opinion: Marijuana use during pregnancy and lactation.
• At least 2-5% of pregnant women use marijuana.
• Counsel them to discourage use based on concerns for neurodevelopment and adverse effects of smoking.
• There is insufficient data to evaluate effects during breast-feeding, so use should be discouraged.

Obstet Gynecol 2017; 130: e205

DEALING WITH THE BIRTH PLAN
1. Initiate the discussion early – before labor begins.
2. Think of these as preferences; little in labor can be planned.
3. Standardize her options to a one-page checklist in clinic.
4. Establish realistic expectations that are focused on safety.
5. If you can’t honor a request, explain the scientific evidence behind why, and negotiate a compromise.
6. Share her preferences with the entire L&D team.
7. Acknowledge when deviations from her plan become necessary, explain why, and give her time to process.

Medscape.com/885375

HOME BIRTH

ACOG Committee Opinion: Planned home birth
• Hospitals and birth centers are the safest settings, but women have a right to make a medically informed decision about her delivery.
• Factors that reduce perinatal mortality and favorable birth outcomes: appropriate selection (no breech, twins, prior C/S), availability of a certified midwife or physician, access to consultation, access to safe and timely transport to a nearby hospital.

Obstet Gynecol 2017; 129: e117
Am J Obstet Gynecol 2017; 216: 401

VAGINAL SEEDING

ACOG Committee Opinion: Vaginal seeding
• Def’n: transferring vaginal fluids to the mouth, nose, or skin of a newborn infant to transfer bacteria to the baby’s gut biome. This might prevent atopic disease, asthma and immune disorders.
• ACOG does not support outside a study protocol.
• What about maternal infection or colonization with Group B strep, Chlamydia, gonorrhea, etc.?

Obstet Gynecol 2017; 130: e274

ANALGESIA FOR LABOR

ACOG PRACTICE BULLETIN
#177: Obstetric Analgesia and Anesthesia
• This document reviews medical options for analgesia during labor and anesthesia for surgical procedures.
• It was co-written by an obstetrician and an anesthesiologist from ASA’s Committee on OB Anesthesia and published through ACOG’s Committee on Obstetric Practice.
• A good collaborative review for anyone working on L&D.

Obstet Gynecol 2017; 129: e73
ACOG COMMITTEE OPINION

#687: Approaches to Limit Intervention During Labor & Birth

• Co-written by obstetricians and midwives.
• Recommends individualized labor management.
• If the patient requests, endorses use of intermittent FHR monitoring, oral fluids vs. IV, various methods of non-pharmacologic pain relief, delayed admission to L&D when status is reassuring, position changes during labor, delayed pushing once completely dilated, etc.

Obstet Gynecol 2017; 129: e20

RESOLVING OP POSITION

A study evaluated whether ultrasound evaluation of the fetal spine position would improve success of manual rotation from the OP to OA position.

• Knowledge of position improved success rates of manual rotation: 83% versus 41%.
• Spontaneous delivery rate improved: 69% vs. 28%.
• Maternal outcomes (blood loss, intact perineum) improved as well.

J Clin Ultrasound 2017; 45: 472

NPO STATUS IN LABOR

Meta analysis of RCTs comparing less-restrictive to more-restrictive food intake during labor (10 trials of 4000 women).

• There were no cases of aspiration during anesthesia.
• Labor was shorter by 16 minutes in less-restrictive group (CI -25 to -7).
• No other benefits or harms to mother or infant.

Obstet Gynecol 2017; 129: 473

INTRAVENOUS FLUIDS

Does glucose supplementation shorten labor course?

• 200 G1 randomized to 250 ml/hr D5NS or NS.
• Duration of labor was less in the D5 group.
• There was no difference in rate of cesarean, instrumented delivery, Apgar scores or cord pH.
• Given the low cost and safety, recommends D5 be the default intravenous fluid in labor.

Am J Obstet Gynecol 2017; 216: 508

(continued)

NITROUS OXIDE

An institution introduced nitrous oxide for labor analgesia using an FDA-approved delivery system. Because of staff concerns regarding environmental exposure, dosimeter badges were required to ensure levels were below NIOSH recommended 25 ppm.

• Despite numerous attempts to limit exposure, 48% of samples were above recommended thresholds, and use of nitrous on L&D was suspended.
**NITROUS OXIDE**

Response from the APSF Committee on Technology:
1. The patient must be educated to exhale into the mask for scavenging purposes.
2. There are requirements for labor room air turnover rate and the use of non-recirculated air; each labor room should have a very high fresh gas turnover rate using non-recirculated, conditioned (heat and humidity) air. Older L&D units may not have this.

Anesthesia Patient Safety Foundation Newsletter 6/17

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**NITROUS OXIDE**

What is the relationship between analgesic effectiveness and patient satisfaction comparing nitrous, CSE, both?
• Standardized survey on postpartum day 1 over 3 years
• Only half who used nitrous reported high analgesia scores.
• > 90% using neuraxial analgesia had high scores
• Women who had poor or intermediate analgesia scores while using nitrous still had high satisfaction scores.
• Analgesia is not the only contributor to satisfaction.

Anesth Analg 2017; 124: 548

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**NITROUS OXIDE**

There can be highly positive publicity surrounding introduction of nitrous oxide as an option for labor pain.

Example: Houston Chronicle 12/3/17 featured Memorial Hermann Hospital’s pilot program and interviewed some highly satisfied patients. They also had comments from other hospitals in the area who had chosen not to offer nitrous analgesia and held up epidurals as the gold standard.

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**REMIFENTANIL**

A study to identify monitoring that could be used as early warning alerts for apnea when using R-PCA in labor:
• 53% of women had apneic episodes.
• Pulse oximetry missed most episodes of apnea.
• ET CO2, respiratory rate, and integrated pulmonary index detected most apnea, but many false positives occurred.
• Continuous observation at bedside is best.

Anesth Analg 2017; 124: 1211

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**REMIFENTANIL**

Survey on use of remifentanil PCIA during labor in 84 academic teaching centers in the U.S.:
• 36% had used remifentanil in the last year, but most less than 5 times – not a frequently used modality.
• Reported 9 cases of respiratory depression, with 2 leading to cardiac arrest → a 4-13% morbidity rate.
• No consistency in how it was used, i.e. adjuncts allowed (IV narcotics?), pharmacy preparation, or PCA settings.

Anesth Analg 2017; 124: 1208

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**REMIFENTANIL**

Editorial: Is it really an option to consider?
• Since 2012 at least 3 case reports (+ these 9) have described intrapartum maternal cardio-respiratory arrest in labor. Other cases in medico-legal review are not yet published.
• Many arrests occurred with no obvious risk factors.
• Optimal monitoring for apnea (53% incidence) is unknown.
• Neonatal effects are mostly unknown.

Anesth Analg 2017; 124: 1029
**REMIFENTANIL**
A Cochrane review compared remifentanil for labor analgesia versus other forms of pain relief. Results:
- 20 poor quality RCTs with 3569 women.
- No conclusions can be drawn about side effects or comparisons with other analgesics.
- No studies compared R with nitrous or no analgesia.
- More research is needed on maternal and neonatal safety, i.e. apnea, respiratory depression, Apgars.
  Cochrane Database of Systematic Reviews 2017:CD011989

**USE OF NEURAXIAL**
When universal health care is available, is poverty associated with less that expected anesthetic care in pregnancy?
- French study; calculated a “deprivation index”
- Women who were deprived were less likely to complete an anesthesia pre-evaluation in 3rd trimester (the norm).
- They were just as likely to use neuraxial analgesia in labor.
- Why are they less likely to complete their antepartum care?
  Anesth Analg 2017; 125; 925

**EPIDURAL PLACEMENT**
Does use of music during epidural placement ↓ anxiety? **No**.
- Used patient-preferred music on Pandora® versus none.
- No difference in pain scores or patient satisfaction with the procedure between groups. Music group had ↑ anxiety scores after placement.
- In the music group, more wanted music for future epidural placements (84% vs 45%).
  Anesth Analg 2017; 124; 542

**EPIDURAL PLACEMENT**
**FDA Drug Safety Communication:**
“Rare but serious allergic reactions have been reported with the widely used skin antiseptic products containing chlorhexidine gluconate. Although rare,....has increased over the last several years. We are requesting the manufacturers of OTC antiseptic produces containing chlorhexidine gluconate to add a warning about this risk.”
- 43 cases reported worldwide with 2 anaphylactic deaths
  www.FDA.gov 2/2/2017

**EPIDURAL PLACEMENT**
Does high versus low epidural catheter placement change analgesic requirements during labor?
- 148 G1 laboring women randomized to ultrasound-confirmed L1-2 or L4-5 interspace for placement.
- L4-5 placement required more boluses in early labor for abdominal pain but had less perineal labor pain.
- No differences in PCEA requirements or satisfaction.
- Instrumental delivery rate: 15% low vs 5% high (p=.06)
  Anesth Analg 2017; 125; 1969

**EPIDURAL PLACEMENT**
Does loss of resistance to saline provide better labor analgesia at 30 minutes than loss of resistance to air?
- 400 parturients were randomized to LOR air or saline.
- There was no difference between groups in onset time, pain score reduction, degree of motor block, or overall efficacy of the block after 30 minutes.
  Anesth Analg 2018; 126; 532 (PAP 2017)
**DURAL PUNCTURE EPIDURAL**

Comparison of DPE, CSE (combined spinal-epidural), and E (epidural) techniques for labor analgesia:
- Speed of analgesia onset → CSE > DPE = E
- Bilateral sacral (S2) analgesia → DPE > E
- Asymmetric block → E > DPE
- Need for top-ups → E > DPE
- Pruritus, hypotension, uterine hypertonus → CSE > DPE
- DPE → better block quality than E; fewer side effects than CSE.

Anesth Analg 2017; 124: 560

**MAINTENANCE: PIEB**

Review article: *Epidural analgesia for labor; continuous infusion versus programmed intermittent bolus*
- PIEB benefits include lower local anesthetic requirements, less breakthrough pain, improved patient satisfaction, less motor block and instrumental delivery
- Optimal combinations of bolus volume, rate, time interval, and drug concentrations are not known.

Anesthesiol Clin 2017; 35: 1-14

**MAINTENANCE: PIEB**

What is the optimal time interval between boluses using programmed intermittent epidural bolus (PIEB) technique for maintenance during labor analgesia?
- Double-blind sequential allocation trial for ED90
- Bolus dose was fixed at 10 ml 0.0625% bupivacaine + 3.3 μg/ml fentanyl; first dose 1 hour after initial epidural bolus
- The optimal interval was about 40 minutes (versus 30, 50 or 60 minute intervals)

Anesth Analg 2017; 124: 537

**EPIDURAL & OUTCOMES**

Systematic review of epidural analgesia using low concentration local anesthetics versus non-epidural analgesia for labor analgesia:
- 10 small RCT of low quality using 1809 women
- No differences in duration of second stage, instrumental birth rate, cesarean delivery rate, or duration of the first stage of labor.

Anesth Analg 2017; 124: 1571

**EPIDURAL & OUTCOMES**

Should epidural infusions be maintained in the second stage of labor, or will pushing be prolonged?
- Double-blind RCT of 400 G1 patients
- All women had low-concentration epidural infusions for labor (0.08% ropivacaine + 0.4 μg/ml sufentanil)
- When completely dilated, infusion was maintained or changed to placebo (NS)
- No difference in duration of 2nd stage, rate of SVD

Obstet Gynecol 2017; 130: 1097

**EPIDURAL MEDICATIONS**

Epidural neostigmine reduces local anesthetic requirements similar to opioids. Compared to fentanyl:
- 4 groups → 0.125% bupivacaine + fentanyl 2μg/ml, or neostigmine 2, 4, or 8 μg/ml.
- No differences in the 4 groups in local anesthetic consumption and satisfaction was similar.
- Neostigmine is more expensive, now on production shortage, and has same effects as fentanyl.

Anesthesiology 2017; 127: 50
EPIDURAL MEDICATIONS
Case report: 36 year old nurse, G4P0 with multiple allergies including lidocaine, diagnosed by a dermatologist with skin testing that caused hives. She was being induced for preeclampsia and diabetes and requested epidural analgesia. 1.5% 2-chloroprocaine with fentanyl was bloused and infused during her labor and vaginal delivery. No back pain, sensory or motor complaints postpartum.
A&A Case Reports 2017; 8: 297

EPIDURAL & POSITION
Is it preferable for a woman to be upright in bed or lying down while pushing with an epidural? Will it improve spontaneous delivery rates?
• 3093 G1 were randomized to upright or lying position during the 2nd stage of labor.
• Spontaneous vaginal birth was 6% more likely in the lying-down group; no differences in other outcomes.
BMJ 2017; 359: 4471

EPIDURAL & PP DEPRESSION
If women intend to have epidural analgesia for labor but do not receive it, are they at higher risk for postpartum depression (PPD) due to untreated pain and unmet expectations?
• No ↑ in PPD if she planned an epidural but did not receive.
• ↓ protective effect for those who intended and received E.
• ↑ PPD if she did not plan for an epidural but received one.
• Was this due to a physically difficult delivery, a sense of personal failure, other issues?
Anesth Analg 2017; PAP (Orbach-Zinger)

POSTPARTUM OPIOIDS
How often do women with uncomplicated vaginal delivery fill a prescription for opioid medication?
• 164,720 Medicaid-enrolled women in Pennsylvania
• 12% filled a prescription and 14% of those filled a 2nd
• 28% had a PPTL or perineal laceration
• Predictors for opioids with no complicating reason for them → tobacco use, mental health condition.
Obstet Gynecol 2017; 129: 431

POSTPARTUM TUBAL LIGATION
Review: Postpartum tubal sterilization: making the case for urgency
• In 2016 ACOG reiterated: “The immediate postpartum period following vaginal delivery or at the time of cesarean delivery is the ideal time to perform sterilization because of technical ease and convenience for the woman.” Yet fewer than half of women who request the procedure actually obtain it.
• Unplanned repeat pregnancy is a large problem in the U.S.
• Anesthesiologists should advocate as perioperative physicians.
Anesth Analg 2017; PAP (Richardson)

ANESTHESIA FOR CESAREAN DELIVERY
**PREVENTING CESAREANS**

QI project to reduce cesareans in nulliparous, singleton, vertex pregnancies using guidelines from ACOG, SMFM, labor support practices:
- 434 women before, 401 women after implementation.
- Cesarean rate dropped from 28% to 20%.
- Provider compliance with guidelines improved from 86% to 92% and use of labor support measures also improved.
  Obstet Gynecol 2017; 130: 1082

**PREVENTING INFECTION**

Can use of SSI bundles reduce infection rates after cesarean?
- Systematic review although no RCTs.
- Pooled rates went from 6% → 2%.
- Rates of superficial or deep SSI went from 6% → 1%.
- Rates of endometritis were low and did not change.
  Obstet Gynecol 2017; 130: 735

**PREVENTING INFECTION**

An economic evaluation of adjunctive azithromycin prophylaxis for cesarean delivery:
- Used data from a prior trial that showed avoidance of endometritis (NNT 43) and wound infection (NNT 24).
- Use of azithro resulted in hospital savings of $360 per unscheduled cesarean.
- This antibiotic adjunct is likely to become routine for unscheduled cesarean deliveries.
  Obstet Gynecol 2017; 130: 328

**PREVENTING INFECTION**

Is adding azithromycin to standard cephalosporin regimens for cesarean prophylaxis cost-effective?
- Model based on 700,000 cesareans per year in the U.S. occurring during labor or after ROM.
- Adding azithromycin led to 16K fewer cases of endometritis, 17 fewer sepsis, 8 fewer VTE, and 1 less maternal death.
- Use of azithromycin led to ↓ costs and ↑ quality of life.
  Obstet Gynecol 2017; 130: 1279

**PREVENTING INFECTION**

The optimal perioperative antibiotic regimen for obese women having cesarean delivery is unknown. RCT of 403 women compared oral cepalexin and metronidazole vs. placebo for 48 hours postoperatively in addition to standard IV cephalosporin preoperatively.
- SSI ↓ to 6.4% in the oral abx group vs. 15% in placebo.
- No serious adverse events such as allergic reaction.
  JAMA 2017; 318: 1026

**PREVENTING INFECTION**

Does vaginal cleaning before cesarean reduce postoperative endometritis?
- Systematic review of 16 trials and 4837 women.
- Povidone-iodine on a sponge stick for 30 seconds.
- Cleansing ↓ rates of endometritis 4.5% vs. 9%
- Benefit limited to women in labor 8% vs. 14%) or with ruptured membranes (4% vs. 20%).
  Obstet Gynecol 2017; 130: 527
AORTO-CAVAL COMPRESSION

Is left uterine displacement still necessary to prevent aortocaval compression in modern practice?

• 100 healthy women having elective cesarean were randomized to 15% LUD or supine position after spinal.
• All received 10 ml/kg co-load and a phenylephrine infusion to keep BP at 100% of baseline.
• No difference in neonatal acid-base status.

Anesthesiology 2017; 127: 241 & 212

AORTO-CAVAL COMPRESSION

Review article: Aortocaval compression syndrome: time to revisit certain dogmas

• Caval obstruction is only relieved by > 30° left tilt.
• MRI reveals the aorta is not compressed when supine.
• Tilt may not be necessary if in healthy pregnancies if BP is supported with fluids and pressors, although BP and cardiac output were lower in the women placed supine and they required significantly more phenylephrine.

Anesth Analg 2017; 125: 1975

CHOICE OF ANESTHETIC

The National Anesthesiology Clinical Outcomes Registry (NACOR) was used to analyze anesthesia practice patterns for cesarean deliveries, 2010-5.

• 218,285 cases: 94% neuraxial and 6% general anesthesia.
• 15,282 were emergent: 85% neuraxial, 15% general anesthesia.
• The GA rate was highest at University hospitals (8.5%).

Anesth Analg 2017; 124: 1914

GENERAL ANESTHESIA

Review: The future of general anaesthesia in obstetrics

• Recent audit found the incidence of awareness during cesarean was 1:1200, accounting for 10% of all awareness cases. Methods to reduce risk are discussed.
• Difficult and failed intubation may contribute to maternal morbidity and mortality. Methods to optimize airway management and improve training are discussed.

BJA Education 2017; 17: 79

GENERAL ANESTHESIA

Case report: 27-year old pregnant with a viable fetus presented with respiratory distress due to pneumonia and right heart failure due to mitral stenosis. Oxygen saturation was 80% on room air. Emergency cesarean delivery was planned and pre-oxygenation was done with trans-nasal humidified rapid-insufflation ventilatory exchange (THRIVE). Oxygen saturation rose to 98% and was maintained during intubation. The high-flow nasal cannula can be left on during laryngoscopy and intubation.

A&A Case Reports 2017; 9: 216

GENERAL ANESTHESIA

Review: Cricoid pressure controversies

• Is cricoid pressure effective in preventing aspiration?
• How should it be performed most effectively?
• Does it affect the laryngoscopic view or use of supra-glottic airways?
• What are complications and contraindications?
• What is the best method to train in performing CP?

Anesth Analg 2017; 126: 738
GENERAL ANESTHESIA
Case report: 24-year old G1 with BMI 37 develops prolonged fetal bradycardia during induction of labor. BP 162/112 mmHg, heart rate 120, platelets 68K. Mallampati score II with facial edema. During RSI with remifentanil, propofol and succinylcholine, she could not be intubated after 2 attempts with a video-laryngoscope. An LMA was placed due to desaturation. After delivery it was replaced with an ETT using a flexible bronchoscope and exchange catheter.

SUGAMMADEX
Is Sugammadex appropriate to use during cesarean? Yes.
- Facilitates use of high-dose rocuronium for intubation if that option is preferred over succinylcholine.
- There are at least 3 case reports in the literature of successful use during cesarean.
- Animal studies show no adverse effects on the fetus / neonate (although delivery would occur before administration).
- Animal studies show some excretion into breast milk but oral absorption is low and no effects are expected.

RISK FACTORS FOR PPH
What are the associations between postpartum hemorrhage after an elective vs. intrapartum cesarean?
- Single center using EBL > 1500 ml or need for transfusion.
- Pre-labor or elective cesarean: highest odds ratios were general anesthesia (OR 22.3), multiple gestations (OR 8.0), and placenta previa (OR 6.3).
- Intrapartum: general anesthesia (OR 5.4), multiple gestations (OR 3.2), and predelivery Hgb < 10 g/dL (OR 3.0).

NEURAXIAL & ULTRASOUND
Double-blinded RCT of ultrasound vs. palpation (& sham ultrasound) for CSE placement prior to cesarean delivery.
- 108 non-obese women; single, experienced anesthesiologist doing all placements. Excluded known difficulties.
- No difference in success rate on first attempt, number of needle passes and skin punctures, or patient satisfaction.
- Ultrasound was slightly faster (median 30s difference).

NEURAXIAL & HYPOTENSION
Can a baseline toe perfusion index predict the incidence of hypotension (as a marker for aortocaval compression) after spinal for cesarean?
- 100 healthy parturients, results using right and left toe PI
- After induction of spinal anesthesia, toe PI did not change in hypotensive patients; increased in normotensive women.
- Good predictor that reflects amount of AC compression.

NEURAXIAL & HYPOTENSION
- Editorial + study showing that keeping a patient seated after spinal produces a lower block and less hypotension.
- The editorial points out effective ways to almost eliminate hypotension, without risking low block, intraoperative pain, or delay of surgery.
- It reviews the literature on fluid co-load, phenylephrine in preference to ephedrine, prophylactic infusions of phenylephrine, and promising work with norepinephrine which supports cardiac output.
- Ends with recent surveys showing a majority of anesthesiologists still prefer ephedrine, and only 15% use prophylactic infusions. Why?

Core Evidence 2013; 8: 57
Anesth Analg 2017; 125: 523
Anesth Analg 2017; 124: 851
Anesth Analg 2017; 125: 1560
Can J Anesth 2017; 64: 991
NEURAXIAL & PRESSORS
Do prophylactic phenylephrine infusions (low dose, fixed rate) lower the incidence of severe (<70% baseline) hypotension when compared to boluses?
• Context of low resource countries without access to pumps.
• A recent South African report found >50% of anesthetic maternal mortality was due to spinal hypotension.
• Risk of severe hypotension was ↓ with infusion: 47% vs. 62%, RR 0.84 with no ↑ risk of hypertension.
Anesth Analg 2017; 125: 904

NEURAXIAL & PRESSORS
Would computer-controlled boluses of phenylephrine give more precise control of BP than infusions?
• 214 healthy women having spinal for elective cesarean.
• Precision was greater in the bolus group and phenylephrine consumption was smaller.
• No difference in cardiac output, N&V, neonatal outcome.
• Bolus is an alternative but no real clinical differences.
Anesth Analg 2017; 125: 117

NEURAXIAL & PRESSORS
What is the relative potency of norepinephrine to phenylephrine for bolus treatment of hypotension?
• 180 healthy women having spinal for cesarean.
• NE: 4-12 µg or phenylephrine: 60-200 µg given in random allocation
• NE ED50 = 10 µg and phenylephrine ED50 = 137 µg
• Estimated relative potency ration = 13 P:1 NE
Anesthesiology 2017; 127: 934

NEURAXIAL & PRESSORS
What is the ED90 for norepinephrine as an intermittent bolus to prevent spinal hypotension during cesarean delivery?
• 40 healthy parturients having elective cesarean
• Prospective, double-blind, up-down sequential allocation of NE 3-8 µg dosed to keep maternal BP at 100% of baseline.
• ED90 = 6 µg
• Prior study found 7.6 µg NE = 100 µg phenylephrine.
Anesth Analg 2017; 125: 212

CRYSTALLOIDS & CESAREAN
Study compared LR to NS for perioperative fluid management during cesarean delivery.
• RCT of 500 women having spinal for cesarean
• Mean fluid volume = 2380 ml
• Incidence of acidosis (pH < 7.32) when discharged from PACU: 38% in NS group, 29% in LR group, p=.04
• 32% in NS group had venous pH < 7.32 vs. 19% in LR.
• No difference in maternal morbidity, neonatal outcomes.
Anesth Analg 2017; 125: 533

NEURAXIAL & OBESITY
What is the effect of maternal obesity on decision-to-delivery interval (DDI) and neuraxial failure?
• 842 emergency cesareans, BMI < 30 vs. BMI > 35
• ↑ BMI = longer DDI: 38 vs. 33 minutes
• Neuraxial failure was more common: 8.5% vs. 3.7%
• Epidural top-up was faster than initiating CSE.
Acta Anaesthe Scand 2017; 61: 609
NEURAXIAL & HEIGHT

Does patient height influence spinal dose requirement in parturients for cesarean?

- Chinese women divided into > 72 inches and all others; randomized to 9 doses of intrathecal ropivacaine from 7 mg to 15 mg.
- Height did not influence the ED50 or ED95 of spinal ropivacaine (~ 10 mg and 14 mg), but larger doses in shorter patients ↑ the incidence of hypotension.

Acta Anaesth Scand 2017; 61: 824

NEURAXIAL & PRURITUS

RCT to evaluate IV pentazocine (Talwin®) for preventing pruritus after cesarean with IT morphine.

- 119 women, 100 µg IT morphine, 15 mg pentazocine (kappa agonist and mu antagonist) or saline after cord clamp.
- Pentazocine ↓ incidence of pruritus in first 24 hrs, RR 0.69.
- No difference in N&V or pain scores postoperatively.

Anesth Analg 2017; 124: 1930

SPINAL EPINEPHRINE

Does adding epinephrine to spinal hyperbaric bupivacaine prolong the surgical block for cesarean?

- 60 patients received 0, 100 µg, or 200 µg epinephrine with 1.5 ml 0.75% bupivacaine
- Onset and side effects were similar between groups.
- Compared to no epinephrine, 200 µg prolonged time to T10 regression by 40 minutes (range 15-60) and also prolonged motor block.

Why not CSE?

Anesth Analg 2017; PAP (Katz)

NEURAXIAL FOR ECV

Editorial: Not too little, not too much: finding the Goldilocks zone for spinal anesthesia to facilitate ECV.

- No difference in ECV success rate between groups, but:
  - Pain was greater with 2.5 vs. 5-10 mg (12/100 vs. 4-5/100).
  - Time to discharge was longer with 7.5 or 10 mg vs. 2.5 mg.
  - If the plan is discharge regardless of success, use a lower dose.
  - If the plan is delivery regardless of outcome, use a higher dose to ↑ comfort, and consider CSE to allow for re-dosing for cesarean or to use during induction of labor.

Anesthesiology 2017; 127: 596

OXYTOCIN

Does the oxytocin infusion rate influence total EBL?

- 1 unit bolus was given after delivery followed by randomization to 2.5 U/hour or 15 U/hour during elective cesarean under spinal anesthesia.
- EBL did not differ between groups (median 634 ml with low dose vs. 512 ml with high dose).
- Uterine tone and rate of PPH did not differ.

Anesth Analg 2017; 124: 857
**OXYTOCIN**

Prolonged exposure to oxytocin during labor ↑ risk of uterine atony and PPH. What is the oxytocin recovery interval from cessation of oxytocin during labor and cesarean delivery? Retrospective review of 490 women.

- Mean EBL was 1341 ml, mean oxytocin recovery 65 min
- EBL was associated with amount and duration of oxytocin used in labor. Every 10 minute ↑ in recovery interval was associated with a 10 ml ↓ in EBL.

Can J Anesth 2017; 64: 820

**HYPOTHERMIA**

Description of the core temperature changes and temperature recovery during spinal anesthesia for elective cesarean delivery:

- Core temp ↓ 1.3°C (mean) after the spinal; 50% became hypothermic.
- Time to temp nadir was 1 hour.
- Recovery to baseline temp was > 8 hours in 29%; median of 4.6 hours in the rest.

Anesth Analg 2018; 126: 190

**HYPOTHERMIA**

What are the risk factors that a woman will become hypothermic during cesarean?

- Defined as temp < 36°C by infrared tympanic thermometer.
- Incidence was 23%
- Less risk with obesity, oxytocin augmentation during labor, and use of active forced-air warming.
- More risk with temp < 37 on arrival to O.R. and fluid administration > 650 ml.

Can J Anesth 2017; 64: 919

**POSTOPERATIVE PAIN**

If a patient is given a choice of low or high dose intrathecal morphine dose (100 vs. 200 μg), does it reflect her awareness of her analgesic needs? Yes.

- Deception: all were still randomized without consent.
- Patients choosing the larger dose did have higher pain scores and needed more rescue analgesics but had less N&V.
- Women choosing the lower dose had more N&V.
- Concern for pain or side effects influenced choices.

Br J Anaesth 2017; 118: 762

**INTRATHECAL MORPHINE**

What is the incidence of hypercapnic events (by TcCO2 monitoring) after IT morphine for cesarean?

- 108 healthy women, 150 μg morphine in their spinal.
- 32% had a sustained hypercapnic event (> 50 for > 2 min)
- Median time to the event was 5 hours.
- Higher baseline TcCO2 → more hypercapnic events (5% if < 31 mmHg, 23% if 32-38, and 77% if > 38)

Anesth Analg 2017; 124: 872

**LOCAL ANESTHETICS**

RCT of intrathecal morphine +/- continuous ropivacaine sub-fascial wound infusion for postop cesarean analgesia:

- After elective cesarean, 192 women were randomized to wound infusion with ropivacaine, 100 μg IT morphine, or neither (control). All had multi-modal adjuncts.
- Both IT morphine and wound infusion increased the duration (until IV morphine request) and quality of post-cesarean analgesia. No ↑ in incidence of side effects.

Anesth Analg 2017; 125: 907
**LOCAL ANESTHETICS**

RCT comparing bilateral, ultrasound-guided TAP blocks versus local anesthetic wound infiltration (both using 0.25% bupivacaine).

- No difference in postop opioid consumption, pain scores, or patient satisfaction.
- Incidence of side effects was low and no different.

*Anesth Analg* 2017; 124: 1291

**LOCAL ANESTHETICS**

RCT of intra-peritoneal lidocaine for cesarean analgesia.

- Elective cesarean, spinal anesthesia with morphine. Before peritoneal closure, 20 ml 2% lidocaine with epi or saline was instilled in the peritoneal cavity.
- Pain scores at 2 hours and use of opioids for breakthrough pain was lower in the lidocaine group.
- No difference in pain scores at 24 hours.

*Anesth Analg* 2017; 124: 554

**OPIOID PRESCRIPTIONS**

How are opioids used after discharge by women who had a cesarean delivery?

- 83% used opioids after discharge for median of 8 days.
- 75% had unused tablets and most (63%) stored them in an unlocked location.
- Women who used the most pills were more likely to be smokers; they consumed more morphine equivalents during their inpatient stay.

*Obstet Gynecol* 2017; 130: 36

**OPIOID PRESCRIPTIONS**

Study to define the amount of opioid prescribed and consumed after discharge from cesarean delivery.

- 6 academic medical centers; patients had a phone interview 2 weeks after discharge
- 85% filled an opioid prescription.
- Median number of tablets dispensed was 40; consumed was 20, 95% had not disposed of excess.
- Amount prescribed did not correlate with satisfaction, pain control or need to refill prescription.

*Obstet Gynecol* 2017; 130: 29

**POST-DELIVERY PAIN**

What is the natural course of pain resolution after vaginal delivery and cesarean delivery?

- 213 nulliparous patients were enrolled
- Vaginal delivery: 14 days for pain resolution, 0 days to opioid cessation, 11 days to end all analgesics.
- Cesarean delivery: 21 days until pain-free, 9 days to stop opioids, 16 days to end all analgesics
- Significant inter-patient variability.

*Anesthesiology* 2017; 127: 684

**BUPRENORPHINE**

Review: To stop or not, that is the question. Acute pain management for the patient on chronic buprenorphine

- Describes pain management approaches for patients on buprenorphine who present for elective and urgent/emergent surgery.
- Non-obstetric patients only; no L&D management.

*Anesthesiology* 2017; 126: 1180
ANESTHETIC COMPLICATIONS

MATERNAL ARREST - CANADA
The Canadian Institute for Health Information database was used to generate information about maternal cardiac arrest.
- Incidence of 1:12,500 over 13 years 2002-15.
- Common etiologies: postpartum hemorrhage, heart failure, AFE, and complications of anesthesia.
- 71% survived to hospital discharge overall, but 100% survival for anesthesia-related complications.
Anesth Analg 2017; 124: 890

MATERNAL MORTALITY
Anesthesia-related maternal mortality in low-income and middle-income countries (systematic review):
- Risk of death 1.2 per 1000 procedures
- Anesthesia accounted for 2.8% of all maternal deaths and 3.5% of direct maternal deaths and 13.8% of deaths after cesarean delivery.
- General anesthesia > neuraxial (OR 3.3)
Lancet Glob Health 2016; 4: e320

ASA CLOSED CLAIMS DATA
What is the anesthesiologist’s liability for newborn death and brain damage and in newborn resuscitation?
- 29% of OB anesthesia malpractice claims are for newborn death and brain damage (vs. 71% related to maternal care).
- Anesthesia care may have contributed in 33%: delay, poor communication (level of urgency), substandard care (mismanagement of difficult intubation or high block).
- Delay = not in hospital or inappropriate choice of regional anesthesia rather than general
- Most resuscitation claims dropped as “Good Samaritan”
ASA Monitor 2017; 81: 16 (February)

ASA CLOSED CLAIMS DATA
Review of OB anesthesia claims from 2000-2011 (vs. 1990s):
- 68% cesarean, 32% vaginal delivery; ↑ proportion C/S.
- Proportion association with GA ↑ from 19% to 25%.
- Respiratory events ↓, but CV events ↑ related to hemorrhage rather than maternal cardiac disease.
- Maternal death ↑ 13-24% and is the most common injury.
- ↑ claims paid, payments ↑, ↑ substandard care.
Clin Obstet Gynecol 2017; 60: 431

ASA CLOSED CLAIMS DATA

<table>
<thead>
<tr>
<th>CHARACTERISTICS</th>
<th>INCIDENCE PRE-2000</th>
<th>INCIDENCE 2000-II</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mother’s age &gt; 35 years ↑</td>
<td>14%</td>
<td>25%</td>
</tr>
<tr>
<td>Mother was obese ↓</td>
<td>55%</td>
<td>39%</td>
</tr>
<tr>
<td>Emergency case ↑</td>
<td>73%</td>
<td>49%</td>
</tr>
<tr>
<td>Patient condition / surgery ↑</td>
<td>12%</td>
<td>27%</td>
</tr>
<tr>
<td>Maternal death ↑</td>
<td>13%</td>
<td>24%</td>
</tr>
<tr>
<td>Maternal minor injuries ↓</td>
<td>32%</td>
<td>20%</td>
</tr>
<tr>
<td>Substandard care ↑</td>
<td>24%</td>
<td>35%</td>
</tr>
<tr>
<td>Claim was paid ↑</td>
<td>43%</td>
<td>55%</td>
</tr>
<tr>
<td>Median payment made ↑</td>
<td>$352,600</td>
<td>$570,000</td>
</tr>
</tbody>
</table>
### ASA CLOSED CLAIMS DATA

Major causes of maternal death by type of anesthesia:

<table>
<thead>
<tr>
<th>Neuraxial Anesthesia</th>
<th>General Anesthesia</th>
</tr>
</thead>
<tbody>
<tr>
<td>Excessive blood loss - 25%</td>
<td>Excessive blood loss – 53%</td>
</tr>
<tr>
<td>High block / total spinal – 20%</td>
<td>Embolic events – 16%</td>
</tr>
<tr>
<td>Embolic events – 20%</td>
<td>Difficult intubation – 6%</td>
</tr>
<tr>
<td>Neuraxial cardiac arrest – 5%</td>
<td>Other respiratory events – 6%</td>
</tr>
<tr>
<td></td>
<td>(aspiration, bronchospasm, etc.)</td>
</tr>
</tbody>
</table>

Other take-home points from the database:
- Hemorrhage: substandard anesthesia care in 68%, slow to recognize, slow to treat surgically, inadequate resuscitation.
- Substandard care in all cases of high block / total spinal: lack of CV support with pressors and delayed intubation.
- Nerve damage: inadvertently high placement with cord damage, paresthesias or pain during injection, abscess, arachnoiditis due to magnesium infusion in the epidural space.
- Pain / emotional distress: inadequate block for cesarean and delay in inducing GA, incision before GA, cesarean started with local.

### ASPIRATION RISK

Ultrasound assessment of gastric contents in labor:
- Observational study of 100 women in labor; gastric US performed after epidural placement.
- Using < 381 mm² as the cut-off for “empty stomach”, 65% in labor had a full stomach; 48% after delivery.
- No particular risk factors were associated with full stomach – e.g. pain, diabetes, smoking.

*Acta Scand Anaesth 2017; 61: 730*

### UPDATED PRACTICE GUIDELINES

Practice Guidelines for preoperative fasting and the use of pharmacologic agents to reduce the risk of pulmonary aspiration: application to healthy patients undergoing elective procedures.
- NPO unchanged: 2 hours for clear liquids, 4 hours breast milk, 6 hours light meal or non-human milk, 8 hours for fried foods, fatty foods or meat.

*Anesthesiology 2017; 126: 376*

### IT CATHETER MIGRATION

Case report: G3P1 for induction due to gestational HTN. CSE was performed with attempts at 2 interspaces – negative aspiration from the epidural catheter. Pump set for PIEB of 9 ml every 45 minutes; 0.0625% bupivacaine with sufentanil. After 3 hours, after receiving the 5th PIEB dose she developed hypotension, N&V, dyspnea, motor block and T3 sensory level → CSF aspirated at this time. Pump stopped until labor pain returned, then run at 2 ml/hr until delivery.

*A&A Case Reports 2017; 9: 357*

### INADVERTENT IT INJECTIONS

Review of reported events, sequelae, management.
- Dangerous substances: thiopental, potassium chloride, tranexamic acid
- Substances with no or mild reactions: labetalol, NMB drugs, magnesium
- Treatment: CSF lavage using slow aspiration of 20 ml, then replacement with preservative-free NS
- Prevention: human factors and technology

*Acta Anaesth Scand 2017; 61: 11*
NERVE INJURY
What are the risk factors for nerve injury after neuraxial anesthesia for labor and delivery?
- Case cohort study of 20,000 women; 19 had peripheral nerve injuries (1%); 15 associated with OB care.
- 4 cases of nerve root injury due to the Tuohy needle.
- Risk factors: gestational age > 41 weeks (OR 3.8), late initiation of block (OR 8.2), repeated anesthetic procedures (OR 2.8), forceps delivery (OR 9.8), birth weight > 3500 grams (OR 6.8).
Acta Anaesth Scand 2017; 61: 1203

RETAINED EPIDURAL CATHETER
Case report of difficult removal; after multiple attempts by the anesthetist it was recovered minus the distal 6 cm. What now?
- Perform prompt disclosure to your patient, group leaders and hospital risk manager.
- No RCTs available, but expert opinion is to leave the tip in place. Risks of removal are thought to outweigh any benefits.
- Resolution: CT showed the remaining catheter clearly; patient requested removal so taken to OR → GA → neurosurgery easily removed fragment under fluoro with a small incision.
ASA Monitor 2017; 81: 30

ANTI-COAGULATION
VTE is a major risk in OB patients. ACOG guidelines now recommend that women delivering via cesarean and those with risk factors receive mechanical and often pharmacologic prophylaxis. SOAP Consensus Statement on anesthetic mgt:
- Reviews PK and PD of anti-coagulants in pregnancy.
- Practical guide to mgt ante-, intra-, and post-partum when women are receiving LMWH or unfractionated heparin.
- Suggestions for multi-disciplinary communication.
Anesth Analg 2017; PAP (Leffert)

ANTI-COAGULATION
Systematic review of spinal-epidural hematoma to identify cases associated with neuraxial and thrombo-prophylaxis.
- None of the hematoma cases involved OB patients.
- They found 28 parturients who had neuraxial before the recommended ASRA time limit without complication.
- They found 52 parturients who had neuraxial while receiving LMWH without complication.
- Reassuring but need better registries and details.
Anesth Analg 2017; 125: 223

THROMBOCYTOPENIA
What is the risk of epidural hematoma requiring decompression in thrombocytopenic (defined as < 100K) parturients?
- Combined data from MPOG and a systematic review found 573 cases of thrombocytopenic parturients who received neuraxial block in MPOG + 1524 from the review.
- No cases of epidural hematoma were found.
- Upper limits of 95% CI: platelets 0-49K = 11% (highest estimated risk), 50-79K = 3% and 70-100K = 0.2%, although < 70K remains poorly defined.
Anesthesiology 2017; 126: 1053

THROMBOCYTOPENIA
Canadian experience with obstetric neuraxial anesthesia in the setting of immune thrombocytopenia (ITP):
- No complications of neuraxial in 136 pregnancies with ITP, with the lowest platelet count being 45K.
- Highlights the institutional variation in placement of neuraxial anesthesia at low platelet counts.
- Upper 95% CI for platelet counts < 100K = 5.5%.
Br J Anaesth 2017; ? :1067
**THROMBOCYTOSIS**

Case report: G2P1 with essential thrombocytosis (675-827K platelets) on aspirin therapy presented in active labor after receiving care at an outside hospital. A Plateletworks study provided reassuring results. Epidural placement and vaginal delivery were uneventful. The patient was placed on enoxaparin after her delivery.

A&A Case Reports 2017; 9: 172

**EPIDURAL HEMATOMA**

Case Report: 63-year old woman had an exploratory laparotomy with postoperative epidural analgesia. 13 hours after placement and 8 hours postop, she was placed on 5000 U subcu dalteparin every 24 hours. On postoperative day 2 she complained of inability to move her legs. Symptoms were relieved when blood was aspirated from the catheter. The epidural catheter was removed (?) and MRI showed an epidural collection from T4 to T7. Urgent decompressive thoracic laminectomy was performed; she was discharged with intact motor and sensory function.

A&A Case Reports 2017; 9: 123

**ABDOMINAL HEMATOMA**

Case report: Emergency cesarean delivery at 33 weeks due to HELLP syndrome; platelets 128K, normal PT and PTT. General anesthesia was performed and ultrasound-guided TAP blocks were placed at the end of the case before emergence. Labs worsened postop to platelets < 50K, INR 1.3 and Hgb < 7; she received PRBC, FFP and platelet transfusions. The patient complained of pain at the left TAP site and CT showed IM and subcu hematomas that resolved without treatment.

A&A Case Reports 2017; 8: 257

**LIPID EMULSION**

Meta analysis of 26 animal studies using lipid emulsion as a treatment of local anesthetic toxicity.

- Lipid emulsion reduced the odds of death in resuscitative animal models (OR 0.24).
- Analysis of outliers reinforced the need for good life support measures (securement of the airway and chest compressions) along with prompt treatment with lipid.
- RCTs to assess efficacy in humans are not practical.

Clin Tox 2017; 55: 617

**LIPID FOR AFE**

Case report: G1 at 41 weeks was induced and had a low-dose epidural for analgesia. Fetal decelerations and bleeding from the epidural site occurred intermittently for several hours before vacuum-assisted delivery, which was followed by postpartum hemorrhage. INR 2.0, PT 23 (nl 11-14). Dyspnea and confusion → cardiac arrest with presumed diagnosis of amniotic fluid embolism. No PE on TEE. No response to ACLS so intralipid administered as a last resort. Within 1 minute → ROSC → decompensated several minutes later → ROSC → transported to ICU → full recovery.

A&A Case Reports 2017; 8: 64

**UPDATED PRACTICE GUIDELINES**

An updated report….Practice advisory for the prevention, diagnosis, and management of infectious complications associated with neuraxial techniques

- Similar recommendations including aseptic technique: remove jewelry, wash hands, wear hat and mask (change masks between procedures), use sterile gloves and drapes.
- Use individual antiseptics for skin prep, e.g. chlorhexidine with alcohol and allow time to dry.

Anesthesiology 2017; 126: 585
**EPIDURAL FEVER**

An animal model of non-infectious inflammatory fever was used to simulate epidural-associated fever and investigate effects on the fetal brain.

- It was possible to induce fever using IL-6 injections at blood levels comparable to those seen during human epidural labor analgesia.
- This caused neuro-inflammation in the fetus, creating a model that can be used for future studies of epidural fever.

*Anesth Analg 2017; 125: 2134*

**EPIDURAL FEVER**

Fever can be infectious or inflammatory. Magnesium can attenuate interleukin 6-mediated fever in animals. Do parturients exposed to magnesium have a lower incidence of fever than non-exposed parturients? Yes.

- Retrospective review of 58K women; 10% had fever.
- Risk factors → G1, neuraxial analgesia, cesarean delivery.
- Magnesium exposure = 6% fever vs. no Mg**+** = 10.2%.

*Anesthesiology 2017; 127: 942*

**HEADACHE**

Review: What therapeutic options do we have to treat PDPH?

- **Non-invasive and conservative:**
  - Bedrest, prone positioning, abdominal binders
- **Non-invasive and pharmacologic:**
  - NSAIDs, caffeine and theophylline, ACTH (Cosyntropin®), gabapentin or Lyrica®, sumatriptan, methylergonovine
- **Invasive:** EBP, epidural morphine, acupuncture, occipital nerve blocks, sphenopalatine ganglion blocks

*Anesth Analg 2017; 124: 1219*

**HEADACHE**

Does the size and nature of the dural hole impact the incidence and severity of PDPH?

- Dural samples from fresh cadavers studied with electron microscopy after various punctures.
- Arachnoid layer damage seemed to be most important; dural fibers had sufficient “memory” to close the hole created by a spinal needle.

*Reg Anesth Pain Med 2017; 42: 709*

**HEADACHE**

Case Report: G1 received uneventful epidural for labor, then presented 5 days postpartum with headache, neck stiffness and nausea that woke her from sleep. Standing worsened the symptoms but no relief from EBP. Hypertension to 180/101 was followed by grand mal seizure → normal CT → magnesium therapy for presumed eclampsia. Unresolved symptoms → CT venogram negative for cerebral venous thrombosis → MR angiography showed reversible vascular vasocostriction syndrome that responded to nimodipine. MRA six weeks later was normal.

*A&A Case Reports 2017; 9: 289*

**HEADACHE**

Case Report: G2P0 had a wet tap during attempted CSE placement; re-sited at another level. Good analgesia for a vaginal twin delivery. Severe headache just 4 hours after CSE placement initially responded to conservative therapy but required EBP the next day. HA resolved and she was discharged, but returned the next day with headache. CT → enlarged pituitary causing chiasmal compression but endocrine studies were normal. Treatment with prednisone → resolution of HA → diagnosis of lymphocytic adenohypophysitis (autoimmune inflammation of the pituitary).

*A&A Case Reports 2017; 9: 233*
HEADACHE
Case Report: G2P1 had uneventful epidural but experienced neck pain and postural headache PPD #1. Imaging showed cortical vein thrombosis and intracranial hypotension → treated with oral warfarin. Discharged home but headache and upper extremity paresthesias recurred a week later. MRI → bilateral subdural hematomas with midline shift and cerebellar tonsils below the foramen magnum. Treated with FFP and EBP performed with resolution of symptoms. Repeat CT showed gradual resolution of the SDH.
A&A Case Reports 2017; 8: 36

NON-OBSTETRIC SURGERY
ACOG Committee Opinion #696: Nonobstetric Surgery During Pregnancy (joint statement with ASA)
• Emphasizes obstetric consultation before surgery.
• Discusses fetal monitoring before and after viability.
• “No currently used anesthetic agents have been shown to have any teratogenic effects in humans when using standard concentrations at any gestational age.”
Obstet Gynecol 2017; 129: 777

PREGNANCY TESTING
ASA statement from the Committee on Quality Management and Departmental Administration (QMDA):
1. Indications for preoperative pregnancy screening
2. Accuracy of early pregnancy testing
3. Medicolegal concerns → “routine pregnancy testing may pose greater medicolegal risk to anesthesiologists due to failure to check the result or failure to document informed consent of risk of miscarriage prior to elective surgery.”
4. Ethical considerations
5. Recommendations

EPIDURAL & BREASTFEEDING
Controversial topic: does epidural analgesia for labor that includes fentanyl impair breast-feeding?
• RCT of term, multiparous women who had breastfed successfully before and who received epidural analgesia.
• Randomized to epidural bupivacaine alone, B + fentanyl 1 μg/ml, or B + fentanyl 2 μg/ml
• Frequency of breastfeeding at 6 weeks was > 94% and no different between groups.
Anesthesiology 2017; 127: 614

CASE REPORTS: ALLERGY
Epidural local anesthetic allergic reaction caused difficult intubation scenario in emergent cesarean.
A&A Case Reports 2017; 9: 84
Hairdresser with anaphylaxis to PCN during GA for cesarean had skin testing positive for muscle relaxants, opioids and midazolam. Cross-sensitization to hair products.
A&A Case Reports 2017; 9: 151

CASE REPORTS: RESPIRATORY
Massive hemothysis during emergency cesarean with GA → alveolar hemorrhage due to lupus.
A&A Case Reports
Airway arteriovenous malformation in pregnancy.
Can J Anesth 2017; 64: 1071
CASE REPORTS: CARDIAC
Chest pain and ECG changes of ischemia during cesarean → aberrant right coronary artery coursing between the aorta and pulmonary artery.
A&A Case Reports 2017; 9: 119

Cesarean for breech in a patient with Marfan’s s/p aortic dissection and aortic root replacement. She developed hypotension and syncpe that was only relieved by full lateral position under GETA.
A&A Case Reports 2017; 8: 93

CASE REPORTS: NEURO
GA for elective cesarean delivery for cavernous brainstem malformations s/p a stroke 4 years before. Intubated with opioids, extubated to an LMA before emergence to prevent hypertension and coughing.
A&A Case Reports 2017; 9: 54

Neurally mediated syncope and cardiac arrest during cesarean, precipitated by hypotension from regional, NTG, preeclampsia and fundal pressure.
A&A Case Reports 2017; 8: 96

CASE REPORTS: RARE SYNDROMES
Loeys-Dietz Syndrome → connective tissue disorder predisposing to aortic and arterial aneurysms; can have aortic dissection and uterine rupture.
A&A Case Reports 2017; 9: 182

MELAS Syndrome → mitochondrial encephalopathy, lactic acidosis, and stroke-like symptoms. G2P0 with very complicated peripartum course.
A&A Case Reports 2017; 9: 38

OBSTETRIC & MEDICAL COMPLICATIONS

COSTS OF PREECLAMPSIA
What is the annual health and cost burden of preeclampsia to mothers and infants in the U.S.?
• Epidemiologic analysis of multiple databases.
• PEC ↑ adverse events from 4.6% to 10% in mothers; from 7.8% to 15% in infants.
• Cost burden during the first year was $1.03 billion for mothers and $1.15 billion for infants = $2.18 billion.
• The cost burden for infants ↑ as gestation age ↑.

PREECLAMPSIA SCREENING
USPSTF recommendations: Women should be screened for PEC with BP measurements throughout pregnancy.
• Preeclampsia is not yet preventable.
• Early diagnosis and management may prevent maternal sequelae, e.g. seizures, organ failure.
• Early delivery is the only effective treatment, but often necessitates preterm birth.
    JAMA 2017; 317: 1661/1629/1668/1700
PREECLAMPSIA PREVENTION
What has the effect been of the USPSTF 2014 recommendations for aspirin for PEC prevention?
• Retrospective cohort study of 2 academic institutions before/after aspirin was used to prevent recurrent PEC.
• Confounders were accounted for in multivariate analysis.
• Rates of recurrent preeclampsia were decreased by 30%.
  Am J Obstet Gynecol 2017; 217: 365

Does low-dose aspirin during pregnancy reduce the risk of preterm preeclampsia? Yes.
• 1776 women at high risk for preeclampsia were randomized to 150 mg aspirin daily or placebo at < 14 weeks gestation.
• Preterm PEC occurred in 1.6% in the aspirin group vs. 4.3% in the placebo group, OR 0.38 (95% CI 0.20-0.74, p=0.004).
• Good adherence, no differences in other adverse events.
  N Engl J Med 2017; 377: 613

HYPERTENSION TREATMENT
National Partnership for Maternal Safety: Consensus Bundle on Severe Hypertension During Pregnancy and the Postpartum Period
• Published concurrently in major journals for anesthesiologists, obstetricians, midwives, L&D nursing.
• Includes sections on Readiness, Recognition & Prevention, Response, and Reporting & Systems Learning
  Anesth Analg 2017; 125: 540

Editorial: Key considerations for the anesthesiologist.
• BP > 160/110 is a hypertensive emergency that requires treatment within 30 minutes to prevent hemorrhagic stroke.
• Important role in management of eclamptic seizure.
• Promote neuraxial if possible, but manage GETA safely.
• Continue magnesium during cesarean delivery to avoid sub-therapeutic levels that ↑ risk for eclampsia.
• Be involved in safe disposition post-delivery (BP control).
  Anesth Analg 2017; 125: 383

LATE CONSEQUENCES OF PEC
What is the association between recurrent PEC and cardiovascular hospitalizations later in life?
• Quebec database identified women up to 25 years after a pregnancy with recurrent, non-recurrent or no PEC.
• Women with recurrent PEC had higher incidence of CV hospitalization than women with non-recurrent or no PEC: 281/1000 vs. 168/1000 vs. 73/1000.
• Recurrent PEC → 2x the risk of heart disease and 3x the risk of cerebrovascular disease compared with no PEC.
  Heart 2017; 103: 235

HEMORRHAGE
ACOG Practice Bulletin: Postpartum Hemorrhage
• Have guidelines for routine use of uterotonic.
• Escalate quickly to other interventions if uterotonics fail.
• Consider TXA when initial medical therapy fails.
• Have a multi-disciplinary response team, an escalating PPH protocol, and a functioning massive transfusion protocol.
• Transfuse fixed ratios of PRBC, FFP and platelets.
• Adopt and implement a hemorrhage bundle.
  Obstet Gynecol 2017; 130: e168
AMNIOTIC FLUID EMBOLISM

Current research in AFE with implications:
- Insulin-like growth factor binding protein-1 is the only lab test that can confirm a diagnosis of AFE.
- An Australia-New Zealand reported “only” a 15% mortality rate in 33 AFE cases – improving survival.
- Report of 3 cases where AFE presented as isolated coagulopathy without cardiovascular collapse.
- 90% of parturients transfused with FFP:PRBC > 1 survived compared with only 40% survival if transfusion ratio < 1.

Obstet Gynecol 2017; 129: 941

REBOA FOR PPH?

Resuscitative endovascular balloon occlusion of the aorta (REBOA) is being used in trauma with data gathered from clinical registries and retrospective case descriptions. This review provides principles and considerations for the anesthesiologist.
- Could this be a rare but lifesaving technique to consider in life-threatening postpartum hemorrhage?

Anesth Analg 2017; 125: 884 & 715 (graphic)

THE WOMAN TRIAL

Early administration of TXA reduces death in bleeding trauma patients. What are the effects in postpartum hemorrhage?
- 20K women, 193 hospitals in 21 countries randomized to receive 1 gram TXA or placebo + usual care during PPH after vaginal delivery or CS.
- Death due to bleeding ↓ 19% overall (1.5% vs. 1.9%), RR 0.81.
- Death ↓ 31% if given within 3 hours (1.2% vs. 1.7%), RR 0.69.
- No difference in hysterectomy or other causes of death.
- No difference in venous or arterial thromboembolic events.

Lancet 2017; 389: 2105

TXA IN OBSTETRICS

Byproducts of fibrinolysis (D-dimer and plasmin-antiplasmin complexes) are ↑ in bleeding parturients.
- Increases are attenuated by TXA — good rationale for use.
- The WOMAN Trial showed efficacy and no adverse events.
- However, most subjects were from Central Africa and South Asia. 7% were not even transfused before death. Interventions such as Bakri balloon or B-Lynch sutures were uncommon.
- Are the results generalizable to high resource countries?
- Adverse effects can occur — death after accidental neuraxial injection, thrombosis, seizures.

APSF Newsletter 2017; October: 34

TXA AND THROMBOSIS

Case report: G3P2 underwent urgent cesarean hysterectomy for bleeding due to complete previa and suspicion for placenta percreta. IR placed bilateral iliac balloons and TXA was given prophylactically. Surgery lasted 2 hours with 800 ml blood loss. Two days postop she developed cold, blue feet with bilateral external iliac artery thrombus. Bilateral sortitillae embolectomy was required. Multiple risk factors for thrombosis: IR catheters, TXA, prothrombotic state of pregnancy and surgery.

A&A Case Reports 2017; 9: 90

OBESITY

What is the association between maternal obesity and major intraoperative complications during cesarean?
- 51K women stratified by BMI up to BMI ≥ 50
- Complications: blood transfusion, intraop injury (e.g. bowel or ureter), atony, repeat laparotomy, hysterectomy.
- In contrast to the risk for postoperative complications, risk of intraoperative complication was not increased in obese or even super-obese women.

## Substance Abuse

ACOG: Opioid Use and Opioid Use Disorder in Pregnancy

- Early universal screening, brief intervention, and referral for treatment improves maternal and infant outcomes.
- Routine screening should use validated questionnaires.
- For chronic pain, use alternative and non-opioid treatments.
- For opioid use disorder, opioid agonist pharmacotherapy (e.g. methadone) is the recommended therapy.
- Evaluate infants for NAS; encourage breastfeeding.
- Contraceptive counseling and access should be routine.

*Obstet Gynecol* 2017; 130: e81

## Opioid Dependence

Review article from a specialized pregnancy program within a methadone/buprenorphine treatment program:

- Types of pregnant opioid dependence: active and untreated, pain management, and medication-assisted treatment.
- Discrepancies between research findings and clinical practices of physicians: don’t encourage withdrawal → acute risks of fetal hypoxia and long-term risks of fetal epigenetic programming related to catecholamine and steroid surges.
- Encourage maternal comforting in NAS → rooming-in vs. NICU

*AM J Obstet Gynecol* 2017; 216: 226

## Buprenorphine Dosing

Pharmacokinetic study on buprenorphine dosing during pregnancy:

- 14 pregnancy and postpartum women + 62 followed in the clinic.
- Plasma concentrations were sub-therapeutic for 50-80% of the 12-hour dosing interval on BID doses.
- When dosing interval was determined by patient preference, 68% chose TID or QID dosing.
- More frequent dosing may be required during pregnancy to prevent withdrawal symptoms and to ↑ maternal adherence.

*Am J Obstet Gynecol* 2017; 217: 459

## Marijuana Use

Trends in prenatal marijuana use 2009-16:

- Prevalence increased significantly over time from 4% to 7%, especially ≤ age 24.
- 22% < age 18 and 19% age 18-24 tested positive by toxicology
- 79% reported perceiving little to no harm in prenatal use.

*JAMA* 2017; 318: 2490

## Marijuana Risks

Is marijuana use in pregnancy associated with adverse pregnancy outcomes and neonatal morbidity?

- Used live-born controls in the Stillbirth Collaborative
- Adverse pregnancy outcomes were not ↑ in marijuana users, aOR 1.29; 95% CI 0.56-2.96.
- Composite neonatal morbidity was ↑ (aOR 3.11; 95% CI 1.40-6.91) mainly due to infectious and neurologic morbidity

*Am J Obstet Gynecol* 2017; 217: 478
**MARIJUANA RISKS**

- Data suggest that pregnant women use marijuana as an anti-emetic, especially first trimester when fetal risks are greatest.
- Marijuana available today is more concentrated and used in ways that expose the user to higher THC concentrations different than when earlier teratogenicity studies were done.
- The potential for marijuana to interfere with neurodevelopment is theoretical but justified the endocannabinoid system is present from 16 days gestation.

*JAMA 2017; 317: 129*

**MENTAL HEALTH**

*Consensus Bundle on Maternal Mental Health: perinatal depression and anxiety.*

- Perinatal mood disorders affect 1 in 7 and can have profound effects on mothers and their infants, even up to suicide and infanticide significant patient safety issue.
- Joint publication with ACOG, AWHONN and Midwifery.

*Obstet Gynecol 2017; 129: 422*

**CONGENITAL HEART DISEASE**

*Management of Pregnancy in Patients with Complex Congenital Heart Disease: a Scientific Statement for Healthcare Professionals from the American Heart Association*

*Circulation 2017; 135: e50-e87*

**CARDIAC ULTRASOUND**

Comparison of simultaneous cardiac output measurements using bioreactance (NICOM®) versus echocardiography:

- Paired SV and CO readings over 15 min in 35 healthy women at 26-34 weeks gestation.
- Measurements were comparable; acceptable levels of agreement.
- Increased maternal BMI negatively impacts LV diastolic function measured using tissue Doppler imaging.

*Br J Anaesth 2017; 118: 527*

**CARDIAC CASE REPORTS**

1. Emergency cesarean → CPR → Takotsubo Syndrome.
   *Obstet Gynecol 2017; 129: 521*

2. Cardiac arrest at home → peri-mortem cesarean after 27 minutes → ROSC → mother died, infant with cerebral palsy.
   *A&A Case Reports 2017; 8: 72*

3. Patient with Fontan physiology s/p emergency cesarean for cardiac decompensation → 6 weeks postpartum presented wit IVC thrombus and bilateral pulmonary emboli → survived.
   *A&A Case Reports 2017; 9: 136*
CARDIAC CASE REPORTS (2)

4. G10P9 with known cardiomyopathy (LVEF 20%) associated with methamphetamine use presented at 20 weeks with newly diagnosed triplet pregnancy → planned D&E. General anesthesia was performed with cannulas placed for standby veno-arterial ECMO.

A&A Case Reports 2017; 8: 105

PULMONARY HYPERTENSION

Does etiology and severity of pulmonary hypertension affect outcomes? Do current therapies influence outcomes?
• 4 institutions, 49 women included.
• Mortality rate was 16%; all occurred postpartum.
• ↑ mortality with ↑ severity of disease (WHO group 1) and with cesarean (4/22) > vaginal delivery (1/19)
• No anesthetic adverse events using neuraxial for most cases.
• Severe disease required more inotropes, pulmonary vasodilators, ECMO (19 of 26 patients).

Obstet Gynecol 2017; 129: 511

ARDS IN PREGNANCY

The 2006-2012 Nationwide Inpatient Sample was used to find a cohort of 2808 pregnant women ventilated for ARDS:
• 9% mortality rate.
• Rate of ARDS ↑ over time from 36.5 per 100K to 60.
• Factors that were associated with higher death rate = prolonged mechanical ventilation, renal failure requiring hemodialysis, liver failure, AFE, influenza, septic obstetric emboli and puerperal infection.

Obstet Gynecol 2017; 129: 530

INFECTION

Surviving Sepsis Campaign: International Guidelines for Management of Sepsis and Septic Shock
• Administer broad-spectrum antibiotics within 1 hour of recognition; assess daily for narrower therapy based on cultures and clinical improvement. Obtain anatomic source control.
• Provide 30 ml/kg IV crystalloid within 3 hours. Keep MAP > 65 mmHg. If vasopressors needed, use norepinephrine 1st.
• Ventilation for ARDS → 6 ml/kg TV, plateau < 30 cmH2O.
• Based on trials, there is no more early goal-directed therapy.

JAMA 2017; 317: 847

MATERNAL ECMO

Single-center report of 11 maternal cases that used ECMO:
• Causes of maternal collapse: 55% infection, 27% embolism (AFE, thrombotic), 18% cardiac.
• Median 6 days of support. 36% mortality (4 deaths).
• Unique clinical challenges → need to maintain high peripartum cardiac outputs and balancing anticoagulation vs. hemostasis in the presence of DIC.

Anesth Analg 2017; 125: 1275

ZIKA CONSIDERATIONS

Article reviews guidance for the evaluation and anesthetic management of pregnant women and their infants with congenital ZIKA infection.
Authors are based at University of Miami / Jackson Memorial Hospital.

Anesth Analg 2017; 124: 1918
**VACCINATION**
A Danish registry examined women who had the quadrivalent HPV vaccine during pregnancy. Vaccination during pregnancy was not associated with a significantly higher risk of adverse pregnancy outcomes than no such exposure.

N Engl J Med 2017; 376: 1223
Review article on current maternal immunization recommendations. Includes immunology of pregnancy.

N Engl J Med 2017; 376: 1256

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**THE FETUS AND NEONATE**

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**TERATOGENICITY**
Does use of lithium in early pregnancy increase the incidence of cardiac anomalies, specifically Ebstein’s?

• 1.3 million women via Medicaid database
• Higher risk with lithium than control or versus use of lamotrigine, but lower than previously reported: aOR 1.65 (95% CI 1.02-2.68).
• ↑ risk of cardiac defects must be weight against the 66% risk of postpartum recurrence of bipolar disorder in those who don’t received treatment.

N Engl J Med 2017; 376: 2245

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**SSRI USE & AUTISM**
Does SSRI use in pregnancy ↑ risk of childhood autism spectrum disorder?

• Yes: Quebec registry of 145K full term infants → 2nd or 3rd trimester exposure associated with aOR 1.87.
  JAMA Pediatr 2016; 170: 117
• No: Ontario registry of 36K term infants → no significant association compared to unexposed children or to unexposed siblings.
  JAMA 2017; 317: 1544

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**SSRI USE & AUTISM**
• No: Swedish registry 1.6 million offspring of women with 1st trimester exposure compared to unexposed cohort → small ↑ risk of preterm birth but no ↑ risk of autism spectrum or ADHD.
  JAMA 2017; 317: 1553
• Editorial: Essential to distinguish risk from SSRI treatment vs. risk from severe depression requiring treatment. Children of mothers with depression are at risk for developmental disturbances.
  JAMA 2017; 317: 1533

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**TERATOGENICITY**
Is maternal use of anti-epileptic drugs during pregnancy associated with major congenital malformations in children?

• 50 studies published between 1974 and 2014.
• Offspring of women without epilepsy were used as baseline → 2.5% incidence of congenital anomalies.
• Lamotrigine (Lamictal®) at 2.3% and levetiracetam (Keppra®) at 1.8% had lowest risk while valproate (Depakote®) at 11% had the highest risk.
  JAMA 2017; 318: 1700
**TERATOGENICITY**

What is the association between ACE inhibitor exposure in 1st trimester and risk of anomalies?
- 1.3 million pregnancies in Medicaid database.
- Initial results showed ↑ risk of overall malformations, cardiac and CNS specifically.
- After adjusting for chronic HTN and other confounders, there was no significant risk in any congenital malformations.

Obstet Gynecol 2017; 129: 174

**TERATOGENICITY**

The USPSTF issued updated guidelines supporting folic acid consumption before and during pregnancy to prevent neural tube defects.
- Applies to all women of child-bearing age; pregnancies may be unplanned and the neural tube closes (or not) by 28 days.
- Significant benefits in reducing risk of fetal NTD and no negative side effects from supplementation.
- Grade A evidence: take 400-800 μg daily.

JAMA 2017; 317: 183

**FETAL SURGERY**

ACOG Committee Opinion: Maternal-Fetal Surgery for Myelomeningocele
- Open surgery for MMC repair improves pediatric outcomes but ↑ procedure-associated maternal and fetal risks.
- Counsel women in a non-directive fashion about all options.
- Interested candidates should be referred to a fetal therapy center with the appropriate expertise.

Obstet Gynecol 2017; 130: e164

**FETAL SURGERY**

Case report: Healthy G1 at 25 weeks having open MMC repair using high-dose sevoflurane (2.5 MAC) for uterine relaxation. Hemodynamically stable. 3 episodes of grand mal seizures that responded to benzodiazepines or propofol. No postop neurologic deficits and no history of seizures or neurologic problems could be elicited.
- Sevoflurane can cause epileptiform activity; risk factors female, rapid onset, high alveolar concentration.

Br J Anaesth 2017; 118: 634

**FETAL SURGERY**

Description of one site’s anesthetic management for 59 minimally invasive fetoscopic surgeries for spinal bifida, using a pulse contour analysis system (PiCCO) to guide fluid and vasopressor management.
- < 1 MAC desflurane, remifentanil infusion, preop atosiban.
- Achieved adequate fetal anesthesia and uterine relaxation with no need for postoperative tocolytics.
- No intraoperative pulmonary edema; 1 mild postop case.

Anesth Analg 2017; 125: 219

**SCREENING FOR PRETERM DELIVERY**

Would universal screening by serial cervical length and/or vaginal fetal fibronectin predict spontaneous preterm birth in nulliparous women? No.
- 9410 women: 91% term births, 4% medically indicated preterm deliveries, 5% spontaneous preterm deliveries.
- Neither test had good predictive accuracy for PT birth.
- Findings do not support routine use of these tests.

JAMA 2017; 317: 1047
SCREENING FOR PRETERM DELIVERY

Editorial: The U.S. has the highest expenditures but poor health care outcomes, including infant mortality. Excessive costs are attributable to greater use of medical technology and higher prices. Re this study, charges associated with routine screening for cervical length might be $350 million per year! And that doesn’t include costs of consequent procedures (e.g. cerclage) or therapies (e.g. vaginal progesterone).

Conclusion: Don’t legitimize new interventions until it’s certain they will have clinical utility!

JAMA 2017; 317: 1025

PRETERM DELIVERY: PESSARY

Would an “old” technique, cervical pessary reduce the risk of spontaneous preterm delivery?

• 300 with asymptomatic short cervical length (22 mm or less at 18 weeks gestation) on ultrasound were randomized to pessary or no; otherwise usual care.

• 7.3% in the pessary group delivered < 34 weeks vs. 15% in the control group.

JAMA 2017; 318: 2317, 2299

PRETERM DELIVERY: PROGESTERONE

Does progesterone reduce the risk of recurrent unexplained pregnancy loss (> 2 subsequent pregnancies)?

• Meta analysis of 10 RCT with 1586 patients

• First trimester use reduced miscarriage risk: RR 0.72.

• Synthetic progesterone > natural

• Oral, IM > vaginal administration

• No impact on preterm birth or neonatal mortality.

Fertil Steril 2017; 107: 430

PRETERM DELIVERY: GENETICS

Are there genetic associations with risk of preterm birth?

• Large data set of 43K women of European ancestry.

• Gestational duration used as a continuous trait and preterm birth < 37 weeks as a dichotomous outcome.

• Variants at 6 loci were associated with length of gestation.

• Variants at 3 loci were associated with preterm birth.

• These genes were previously found to have roles in uterine development, maternal nutrition and vascular control.

N Engl J Med 2017; 377: 1156

DELAYED CORD CLAMPING

ACOG Opinion: Delayed umbilical cord clamping after birth

• Term infants: ↑ Hgb levels and improves iron stores and may have developmental benefits. May ↑ jaundice, so monitor.

• Preterm infants → improved transitional circulation, better red blood cell volume, ↓ need for transfusion, ↓ risk of NEC, IVH.

• No ↑ risk of postpartum hemorrhage for the mother.

• ACOG recommends a delay of at least 30-60 seconds after birth for all vigorous infants.

Obstet Gynecol 2017; 2017; 129: e5

MECONIUM STAINING

ACOG Committee Opinion: Delivery of a newborn with meconium-stained amniotic fluid

• Do not routinely provide intrapartum suctioning whether vigorous or not.

• Full Pediatrics team should be present in case intubation is needed.

• Resuscitation should follow the same principles whether meconium-stained or not.

Obstet Gynecol 2017; 129: e33
HEAD COOLING
Hypothermia for 72 hours at 33.5 degrees C for neonatal encephalopathy reduces death and disability. Would cooling longer (120 hours) or colder (32.0 degrees C) improve outcomes even more?
• 364 term neonates randomized to one of 4 groups
• Trial stopped early (planned 726 infants) for futility
• No difference in death or moderate to severe disability at 18 months. Underpowered?
  JAMA 2017; 318: 57

HEAD COOLING
Hypothermia initiated < 6 hours after birth reduces death and disability for term infants (> 36 weeks) with encephalopathy. What about initiating at 6-24 hours?
• 83 infants maintained at 33.5 degrees C for 96 hours and 85 infants were maintained at 37 degrees.
• Small 3.5% improvement in death or disability at 18 months. 76% probability of any reduction in death or disability, 64% of at least 2% less death/disability.
  JAMA 2017; 318: 1550

NEWBORN SCREENING
Has state implementation of screening for critical congenital heart disease improved infant death rates?
• State policies may be mandatory or voluntary.
• In mandatory screening states: early infant deaths from heart disease ↓ by 33.4% or 3.9 deaths / 100K births.
• No decrease was seen with voluntary screening.
  JAMA 2017; 318: 2111

STILLBIRTH
Which diagnostic tests are most useful in the work-up for causes of a stillbirth?
• Database of 512 stillbirths with extensive work-ups.
• % of time each test provided a cause of death: placental pathology 65%, fetal autopsy 42%, genetic testing 12%, testing for anti-phospholipid antibodies 11%. Others test were helpful < 10% of the time.
  Obstet Gynecol 2017; 129: 699

STILLBIRTH
Is there a difference in sleep practices in women who experience a stillbirth compared to live pregnancies at a similar gestation?
• 291 women with stillbirth > 28 weeks gestation.
• Supine sleep the night before the stillbirth ↑ risk 2.3-fold compared to left side sleep.
• Other findings in stillbirth group: more likely to sleep < 5.5 hours, get up to the bathroom, take a daily daytime nap.
  BJOG 2018; 125: 254

EXTREME PREMATURITY
Demonstration of an extracorporeal device used to support extremely premature fetal lambs for up to 4 weeks without apparent physiologic derangement or organ failure.
• Pumpless AV circuit
• Closed sterile environment
• Umbilical vascular access
  Nat Commun 2017; 8: 15112
Biobag system design

b. Lamb at 107 days gestation on day 4 of support.
c. Same lamb on day 28 of support with growth and maturation.

EXTREME PREMATURITY
What is the expected survival and neuro-developmental outcome for infants born at 22-24 weeks gestation?
- 4274 infants at 11 centers comparing 2000-3 to 2008-11
  - Survival † from 30% to 36%.
  - Survival without impairment † 16% to 20%.
  - Survival with disability did not change: 15% to 16%.
  N Engl J Med 2017; 376: 617

EXTREME PREMATURITY
What is the educational performance for infants born at 23-24 weeks gestation compared to term?
  - 65% born 23-24 wks were ready to start kindergarten.
  - 1.8% considered gifted were born 23-24 weeks.
  - 33.5% considered low-performing were born early.
  - FCAT test scores were 0.66 lower compared to full term.
  JAMA Pediatr 2017; 171: 764

BMI AND CEREBRAL PALSY
Is risk of CP increased with maternal overweight and obesity?
- Swedish population-based retrospective cohort study.
  - 1.4 million children, CP in 2.13 per 1000 live births.
  - The adjusted HR of CP were overweight: 1.22, obesity grade 1: 1.28, obesity grade 2: 1.54, obesity grade 3: 2.02.
  - Association was limited to term births and partly mediated through asphyxia-related neonatal complications.
  JAMA 2017; 317: 925

NEWBORN INFECTION
Case report (Oregon): Infant with respiratory distress diagnosed as having GBS infection at birth. Treated and discharged. Recurrence 5 days later – same sensitivities as initial infection. Woman had asked to keep her placenta, and registered with a company that turns it into “pills” to be taken like vitamins for mood and energy boosts. She was taking 2-3/day, and cultures showed the same GBS cultured from the baby — “high maternal colonization from consumption of GBS-infected placental tissue”.
  JAMA 2017; 318: 511
NEWBORN INFECTION
Case report (Arizona): 2 cases of Legionnaires’ Disease in newborns that presented with severe respiratory distress and abnormal chest x-ray. Both had been home water births in tubs filled with municipal tap water. Cultures and antigen testing revealed Legionella, probably related to its growth in plumbing systems and warm water. Both survived after treatment with azithromycin. An additional case was identified in Texas.
CDC MMWR 2017; 66: 590

ETHICS & DRUG ABUSE
Commentary on the screening of pregnant women for drug use and neonatal abstinence syndrome. Unlike other medical conditions, the results of the diagnosis may result in child removal, maternal arrest, prosecution and punishment. If voluntary screening is done as a public health strategy, there must also be social support and additional care services for pregnancy. Only 19 states have specialty drug treatment programs for pregnant women, only 12 give them priority access to treatment, and only 4 prohibit discrimination against pregnant women.
Obstet Gynecol 2017; 129: 164

NEONATAL ABSTINENCE SYNDROME
Is buprenorphine a better treatment than morphine for NAS?
• Double-blind RCT of 63 infants with signs of NAS
• Duration of treatment was shorter with B: 15 vs. 28 days.
• Median length of stay was shorter with B: 21 vs. 33 days.
• 15% needed adjunct phenobarbital in the B group vs. 23% in the morphine group.
N Engl J Med 2017; 376: 2341

NEUROTOXICITY - CLINICAL
What is the association between anesthesia and surgery before age 4 and academic performance at 16 + IQ testing at military conscription (Sweden)?
• 2 million children born from 1973-1993; compared those with 1 surgical exposure before age 4 to unexposed children.
• Mean difference of 0.41% lower school grades and 0.97% lower IQ scores in the exposed group.
• The surgery vs. no surgery differences were markedly less than the differences associated with sex, maternal educational level, or month of birth during the same year.
JAMA Pediatr 2017; 171: e163470

NEUROTOXICITY: REVIEWS & EDITORIALS
• Curr Opin Anesthesiol 2017; 30: 452-7 (Bilotta)
• Fetal Diagn Ther 2018; 43: 1-11 (Andropoulos)
• Anesthesiology 2018; PAP (Todorovic)
• Br J Anaesth 2017; 119: 455-7 (Todorovic)
• Br J Anaesth 2017; 119: 458-64 (O’Leary)
• Lancet 2017; 389: 2174 (Polaner)
• ASA Monitor 2017; 81: 6-8 (Mason)
• JAMA Pediatr 2017; 171: 1135 (Todorovic)

OPIOID EPIDEMIC
Opioid Use in Pregnancy, Neonatal Abstinence Syndrome, and Childhood Outcomes – Executive Summary
• Joint workshop with ACOG, AAP, SMFM, CDC and March of Dimes to review the evidence, make recommendations, and identify areas for further research.
• Excellent section on peripartum pain management (p. 15).
• Suggestions for management of prenatal care including methadone vs. buprenorphine, intrapartum/postpartum care, and neonatal care.
Obstet Gynecol 2017; 130: 10
NEUROTOXICITY - CLINICAL

Is exposure to general anesthesia before age 3 associated with adverse neurodevelopmental outcomes?
• Multiple exposures (but not single) were associated with ADHD and learning disabilities: HR = 2.17.
• Single exposures ↓ reading and language achievement.

Anesthesiology 2017; 127: 227

NEUROTOXICITY - CLINICAL

What is the vulnerable age in children for exposure to anesthetics versus that seen in animal studies?
• Observational cohort study from Medicaid claims; single exposure < age 5 to common surgeries matched to an unexposed cohort (1 exposed to 5 propensity-matched).
• ↑ risk of mental disorder (developmental delay, ADHD) at all ages of exposure; overall HR 1.26 (95% CI 1.22-1.30).
• Small but significant ↑ risk; timing doesn’t matter.

NEUROTOXICITY - CLINICAL

What does MRI imaging show when children have received general anesthesia during infancy?
• MRI scans done at age 12-15 years in 17 healthy children who had GA in infancy vs. 17 who weren’t exposed.
• Exposed children → broadly distributed ↓ white matter integrity and volume (1.5 percentage points).
• Is this functionally significant? No inference about causality.
Anesthesiology 2017; 127: 788

NEUROTOXICITY - ANIMAL

Does dexmedetomidine provide protection in the developing brain against anesthesia with sevoflurane?
• Infant rats received 2.5% sevoflurane + dexmedetomidine in varying doses.
• Co-administration of dex 1 μg/kg with sevoflurane significantly reduced apoptosis in all brain areas.
• Dex 5 μg/kg or higher plus S increased mortality.
Br J Anaesth 2017; 119: 506

NEUROTOXICITY - ANIMAL

Could dexmedetomidine be an alternative anesthetic or adjunct to avoid neurotoxicity?
• Neonatal rats were exposed to varying doses of dexmedetomidine or sevoflurane.
• D did not cause brain injury but did not mitigate S-associated injury.
• D provided less anesthesia and pain control.
Br J Anaesth 2017; 119: 492

AND WE’LL SEE WHAT’S NEW IN 2018!

THE END
Anesthesia for Bariatric Surgery

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February 26, 2018

Anesthesia for Bariatric Surgery: Goals and Objectives

- Define “ideal” and “lean” body weight for appropriate drug dosing and ventilator management.
- Select the optimal position for an obese surgical patient for direct laryngoscopy and to maximize “safe apnea time”.
- Recognize the risk factors for a “difficult” airway in obesity.
- Identify which morbidly obese patients require a rapid sequence induction and which do not.
- Choose the safest airway management technique for the obese patient.

Why is “Ideal Body Weight” Important?

- Controlled ventilation (Vt) is based on “Predicted” or Ideal Body Weight (IBW)
- Anesthetic drugs are administered by IBW or Lean Body Weight (LBW); Not actual total body weight (TBW)

Vecuronium IBW
Rocuronium IBW
Cis-Atracurium IBW
Propofol (induction) LBW
Fentanyl LBW
Sufentanil LBW
Remifentanil LBW
Succinylcholine TBW
Sugammadex TBW (IBW, LBW)
There is no physiologic basis for IBW

“Ideal Body Weight” – in 1942 Metropolitan Life Insurance Co. published height and weight tables associated with lowest mortality rates among policy holders!

Uninsured (with health problems) were excluded *

* Met Life not representative of general population - between 1911-1937 life expectancy for Met Life policyholders increased +17.0 years vs +11.5 years for entire US population

Met Life - Ideal Body Weight Tables

- Data only from insured, healthy adults 25-59 year old
- Height and weight obtained while applicants wore shoes and clothing
- No standardized measuring equipment
- Self-reported height and weight accepted
  - women underestimated weight
  - men overestimated height

Ideal Body Weight Tables

Metropolitan Life Insurance Company (1942-1943)

<table>
<thead>
<tr>
<th>Height (cm) –</th>
<th>100</th>
<th>102</th>
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<tbody>
<tr>
<td>Weight (kg) –</td>
<td>50 kg (60 in)</td>
<td>+ 2.3 kg/in</td>
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<tr>
<td></td>
<td>52 kg (60 in)</td>
<td>+ 1.9 kg/in</td>
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<td>56.2 kg (60 in)</td>
<td>+ 1.41 kg/in</td>
</tr>
</tbody>
</table>

Ideal Body Weight (kg) Formulas

MEN

- Height (cm) – 100
- Weight (kg) = 22 x M²

WOMEN

- Height (cm) – 110
- Weight (kg) = 22 x M²

Lean Body Weight (LBW) in a normal weight patient

(Men) LBW = 80% IBW
(Women) LBW = 75% IBW

Ideal Body Weight (kg) = (22)(m²)


Anesthesia for Bariatric Surgery
Janmahasatian Formula

LBW (kg) = \( \frac{9270 \times TBW (kg)}{6680 + (216 \times BMI \ (kg/m^2))} \) (men)

LBW (kg) = \( \frac{9270 \times TBW (kg)}{8789 + (244 \times BMI \ (kg/m^2))} \) (women)

**LBW in Obesity (BMI > 30 kg/m²)**

\[ IBW + 20 - 30\% \]

What is “OBESITY”?

Fat comprises *greater than normal* percentage of body weight

Why are 2 out of 3 American women “overweight”?

Body Mass Index (BMI = kg/m²)

- 18.5 - 25: Ideal, Normal, Desirable, Predicted, Healthy
- 25 - 29: Overweight
- 30 - 39: Obese
- ≥ 40: Morbid Obesity
- ≥ 50: Super-Obese
- > 60: Super-Super-Obese

World Health Organization Classification by BMI (1998)

<table>
<thead>
<tr>
<th>Classification</th>
<th>BMI (kg/m²)</th>
<th>Risk of co-morbidities</th>
</tr>
</thead>
<tbody>
<tr>
<td>Underweight</td>
<td>&lt; 18.5</td>
<td>Low</td>
</tr>
<tr>
<td>NORMAL range</td>
<td>18.5 – 24.9</td>
<td>Average</td>
</tr>
<tr>
<td>Overweight (pre-obese)</td>
<td>25.0 – 29.9</td>
<td>Increased</td>
</tr>
<tr>
<td>Obese</td>
<td>≥ 30.0</td>
<td></td>
</tr>
<tr>
<td>Class I</td>
<td>30.0 – 34.9</td>
<td>Moderate</td>
</tr>
<tr>
<td>Class II</td>
<td>35.0 – 39.9</td>
<td>Severe</td>
</tr>
<tr>
<td>Class III</td>
<td>≥ 40.0</td>
<td>Very severe</td>
</tr>
</tbody>
</table>
June 17, 1998

National Heart, Lung, and Blood Institute (NHLBI) declared previous BMI standards too lenient

Changed “over-weight” cutoffs from BMI (> 27.8 men, > 27.3 women) to ≥ 25 for both men and women

Overnight prevalence of “overweight” increased from 33% to 59% (men) and 36% to 51% (women)

Without gaining a pound, Americans with a “normal” BMI on June 16, 1998 woke up the next day to learn that their health was now in danger

By simply changing the definition, the number of over-weight adults in USA increased by 35.4 million in one day!

BMI measures weight

BMI is not a direct measure of obesity!

Distribution and type of fat

Metabolic Syndrome

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Criteria</th>
</tr>
</thead>
<tbody>
<tr>
<td>Waist Circumference</td>
<td>&gt;102 cm (men) and &gt;88 cm (women)</td>
</tr>
<tr>
<td>Serum triglycerides</td>
<td>≤ 150 mg/dl</td>
</tr>
<tr>
<td>HDL cholesterol</td>
<td>&lt; 40 mg/dl (men) and &lt; 50 mg/dl (women)</td>
</tr>
<tr>
<td>Systolic blood pressure</td>
<td>&gt; 130 mmHg and/or diastolic ≥ 85 mmHg or on treatment for hypertension</td>
</tr>
<tr>
<td>Fasting serum glucose</td>
<td>≥ 110 mg/dl or on treatment for diabetes</td>
</tr>
</tbody>
</table>

Distribution (and type) of fat is most important

Peripheral
- hips
- buttocks
- thighs
  (female)

Central
- upper body
- waist
  (male)

CENTRAL OBESITY
Visceral (central) fat is an endocrine organ releasing peptides, metabolites, hormones, FFA, cytokinase, and other compounds throughout the body.

### BMI

<table>
<thead>
<tr>
<th>BMI</th>
<th>Weigh less than or equal to 40 lbs (men) or 35 lbs (women)</th>
<th>Weigh greater than 40 lbs (men) or 35 lbs (women)</th>
</tr>
</thead>
<tbody>
<tr>
<td>18.5 or less</td>
<td>Underweight</td>
<td>N/A</td>
</tr>
<tr>
<td>18.5 - 24.9</td>
<td>Normal</td>
<td>N/A</td>
</tr>
<tr>
<td>25.0 - 29.9</td>
<td>Overweight</td>
<td>Increased</td>
</tr>
<tr>
<td>30.0 - 34.9</td>
<td>Obese I</td>
<td>High</td>
</tr>
<tr>
<td>35.0 - 39.9</td>
<td>Obese II</td>
<td>Very High</td>
</tr>
<tr>
<td>40 or greater</td>
<td>Obese III</td>
<td>Extremely High</td>
</tr>
</tbody>
</table>

**MYTH:**
Being overweight/obese is *always* bad for your health.

**Obesity Paradox** is the medical hypothesis that obesity may be protective and associated with greater survival in certain groups of people.

**Obesity Paradox**

60 day hospital mortality


4046 MZ twin pairs discordant BMIs (difference > 0.01)

Obesity was not associated with increased risks of MI or death in genetically identical patients

Jay B. Brodsky, MD
Anesthesia for Bariatric Surgery

Pad all pressure points and support extremities

Indications - LMA

- Short (<1 hr) elective procedures
- ASA-PS 1 or 2 patients

To be used in:

- Spontaneously breathing patients
- Supine or lithotomy positions only

LMA: Contra-indications

- Decreased pulmonary compliance (present in all obese patients)
- High risk of aspiration

FRC (ERV) decreases with increasing BMI

Published May 16, 2011: A comment on NAP4 from The Society of Bariatric Anaesthetists (SOBA) Nightingale CE, et al.

"... obese patients should not be allowed to breathe spontaneously for anything other than the shortest procedure."

Potential Risk Factors for Gastric Aspiration in Obesity

- Delayed gastric emptying
- Decreased pH gastric fluid
- Increased gastric fluid volume
- High incidence hiatal hernia and GERD
- Diabetic with gastroparesis
- Increased abdominal pressure (laparoscopy, lithotomy)
- Previous gastric banding

Approximately 2.9 million anaesthetics in UK

- 42% pts who experienced a major airway complication (death, brain damage, emergency surgical airway, or ICU admission) were obese
- Obese pts had 2X risk of serious airway problems during anesthesia
- "Severe" obesity 4X more likely to have airway problems


- Morbidly obese at increased risk of regurgitation and aspiration (50% of deaths in NAP-4)
- Obese patients had increased frequency of aspiration associated with use of supraglottic devices (LMAs)....
• ETT achieves the best protection against aspiration and can enable increased pressure during ventilation

• .... second-generation SGAs with improved seal may be safer in obesity – but (in 2011) no evidence available

Role of 2nd Generation SGAs in Obesity?

Published May 16, 2011
A comment on NAP4 from The Society of Bariatric Anaesthetists (SOBA)
Nightingale CE, et al.

• SOBA recommends tracheal intubation for patients with BMI > 35 kg/m²

• ETT should be the default airway (in obesity) with justification for the use of a SGA

What is a Difficult Airway?

“difficult airway .... clinical situation in which a conventionally trained anesthesiologist experiences problems with face mask ventilation and/or tracheal intubation”


... intubation “problems” are 3 times more likely to occur in obese compared to normal weight patients!

Jay B. Brodsky, MD
Anesthesia for Bariatric Surgery


**Face Mask Ventilation (MV)**

<table>
<thead>
<tr>
<th>Grade</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Ventilated by mask</td>
</tr>
<tr>
<td>2</td>
<td>Ventilated by mask with oral airway/adjunct with or without muscle relaxant</td>
</tr>
<tr>
<td>3</td>
<td>Difficult ventilation (inadequate, unstable, or requiring two providers) with or without muscle relaxant</td>
</tr>
<tr>
<td>4</td>
<td>Unable to mask ventilate with or without muscle relaxant</td>
</tr>
</tbody>
</table>

**Grade 3 MV** – Unstable, inadequate and/or requiring 2 providers

- Body mass index > 30 kg/m²
- Mallampati III or IV
- Age > 57 yrs
- Jaw protrusion—severely limited
- Snoring

**Table 5. Airway Outcome Independent Predictors**

<table>
<thead>
<tr>
<th>Factor</th>
<th>P Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Grade 3 mask ventilation</td>
<td>&lt; 0.001</td>
</tr>
<tr>
<td>Body mass index &lt; 30 kg/m²</td>
<td>&lt; 0.001</td>
</tr>
<tr>
<td>Mallampati III or IV</td>
<td>&lt; 0.001</td>
</tr>
<tr>
<td>Age &gt; 57 yrs</td>
<td>0.002</td>
</tr>
<tr>
<td>Jaw protrusion—severely limited</td>
<td>0.018</td>
</tr>
<tr>
<td>Snoring</td>
<td>0.019</td>
</tr>
<tr>
<td>Grade 3 or 4 mask ventilation and difficult intubation</td>
<td>0.001</td>
</tr>
<tr>
<td>Thin/thick/obese neck anatomy</td>
<td>0.019</td>
</tr>
<tr>
<td>Sleep apnea</td>
<td>0.006</td>
</tr>
<tr>
<td>Body mass index ≥ 30 kg/m²</td>
<td>0.995</td>
</tr>
</tbody>
</table>

**“Intubation” Difficulty Score (IDS)**

- Number of additional attempts at intubation
- Number of additional operators
- Number of alternate intubation techniques used
- Glottic exposure (Grade 2-4 Cormack-Lehane view)
- “Lifting force” applied during laryngoscopy
- Need to apply external laryngeal pressure
- Position of the vocal cords at intubation

**IDS**

<table>
<thead>
<tr>
<th>IDS</th>
<th>Lean (BMI &lt; 30)</th>
<th>Obese (BMI &gt; 35)</th>
</tr>
</thead>
<tbody>
<tr>
<td>&gt; 5</td>
<td>61.9% (n=134)</td>
<td>43.3% (n=128)</td>
</tr>
<tr>
<td>&lt; 5</td>
<td>35.8%</td>
<td>41.1%</td>
</tr>
<tr>
<td>≥ 5</td>
<td>2.3% (n=3)</td>
<td>15.5% (n=20)</td>
</tr>
</tbody>
</table>

- Cormack-Lehane (III/IV) views identical
- 10.4% (lean group) vs 10.1% (obese group)
- All patients in both groups were intubated by direct laryngoscopy
- BMI was not an independent risk factor for difficult intubation

**Potential “Difficult” Tracheal Intubation Predictors**

- **ABNORMAL FACIAL ANATOMY and/or DEVELOPMENT**
  - Small mouth and/or large tongue
  - Dental abnormality, prominent incisors, poor dentition
  - Prognathia
  - Acromegaly
  - Congenital syndrome (eg Treacher-Collins)

- **INABILITY TO OPEN MOUTH**
  - Masseter muscle spasm
  - Temporo-mandibular joint dysfunction
  - Facial burns
  - Post-radiation fibrosis
  - Sclerosis

- **CERVICAL IMMOBILITY/ABNORMALITY**
  - Short neck or sandy + large neck circumference
  - Poor cervical mobility (eg arthrosis spondylosis)
  - Previous cervical spine and/or neck surgery
  - Presence of cervical collar
  - Post-radiation fibrosis

- **PHARYNGEAL and/or LARYNGEAL ABNORMALITY**
  - High or anterior larynx
  - Deep vallecula (inability to reach base of epiglottis with blade)
  - Anatomic abnormality of epiglottis/hypopharynx (eg tumor)
  - Subglottic stenosis
  - Obstructive Sleep Apnea


Jay B. Brodsky, MD Anesthesia for Bariatric Surgery

72
**Stanford Anesthesia Residents – Direct Laryngoscopy**

100 Consecutive Morbidly Obese Patients

<table>
<thead>
<tr>
<th>Attempt</th>
<th>Percentage</th>
<th>Number</th>
</tr>
</thead>
<tbody>
<tr>
<td>1st</td>
<td>92% (92/100)</td>
<td></td>
</tr>
<tr>
<td>2nd</td>
<td>5% (5/100)</td>
<td></td>
</tr>
<tr>
<td>3rd</td>
<td>2% (2/100)</td>
<td></td>
</tr>
<tr>
<td>Failed</td>
<td>1% (1/100)</td>
<td></td>
</tr>
</tbody>
</table>


**Direct Laryngoscopy (Cormack-Lehane View)**


**What Should You Look For?**

Always be prepared for a difficult tracheal intubation

**Routine Position Anesthetic Induction – Supine**

- Increased intra-abdominal pressure
- Reduced chest wall compliance
- Decreased lung volumes

378/379 pts (4 studies) successfully intubated by conventional direct laryngoscopy!

All 4 studies stated... "magnitude of obesity did not influence laryngoscopy difficulty!"
Pre-oxygenation

Normally patients are pre-oxygenated with 100% oxygen via a tight-fitting facemask for:
- 3 min at tidal volume ventilation
- 8 vital capacity breaths within 60 s

FRC and SAP inversely proportional to BMI

Safe Apnea Period (SAP)

Time_{1min} to SpO₂ 90 - 92%

Position and SAP and SpO₂ Recovery Times in Morbidly Obese Patients

Transnasal Humidified Rapid-Insufflation Ventilatory Exchange (THRIVE)

Obese patients desaturate rapidly – time from anesthetic induction to assisted ventilation should be minimised, and efforts should be made to increase “Safe Apnea Period” (SAP)
Nasal Oxygen Insufflation and SAP

Morbidly obese patients
25° head-up position
Pre-oxygenation with facemask - FiO₂ 1.0 at 10L/min for 3 min
Paralyzed with succinylcholine

• 5 L/min nasal O₂ during laryngoscopy
• 16/17 pts – SpO₂ 100% after 4 mins apnea


Standard Preoxygenation (N=20) Buccal Oxygenation (N=20)

Positive Pressure Face Mask and P-LMA Ventilation and SAP

<table>
<thead>
<tr>
<th></th>
<th>FM (n=52)</th>
<th>PLMA (n=48)</th>
</tr>
</thead>
<tbody>
<tr>
<td>SAP (seconds)</td>
<td>260.0±48.2</td>
<td>337.4±61.0</td>
</tr>
<tr>
<td>Range</td>
<td>96-520</td>
<td>176-456</td>
</tr>
<tr>
<td>Recovery time (seconds)</td>
<td>49.7±6</td>
<td>42.1±5</td>
</tr>
<tr>
<td>Range</td>
<td>36-68</td>
<td>30-56</td>
</tr>
<tr>
<td>Lowest SpO₂ (%)</td>
<td>63.4±7</td>
<td>62.6±6.4</td>
</tr>
<tr>
<td>Range</td>
<td>43-79</td>
<td>49-74</td>
</tr>
</tbody>
</table>


• 40 patients, BMI 30-40 kg m²
• Face-mask preoxygenation until ET-O₂ = .8
• 20 pts - 10 L/min O₂ via buccal RAE tube
• Intubation with Glidescope 150 secs after paralysis
• Maintained laryngoscopy until SpO₂ < 95%, or 750 secs (12.5 mins) elapsed


“Ideal” Position for Morbidly Obese Patient

Improves view during direct laryngoscopy

Increases safe apnea time
Mechanical Ventilation and Obesity

Reduce atelectasis during and after anesthetic induction

- FiO2 < 0.8 - may prevent absorption atelectasis/hypoxia
- Positive-pressure ventilation during induction - increases "safe apnea period" for intubation
- Recruitment maneuver (RM) immediately after intubation using a sustained (8-10 seconds) pressure > 50 cm H₂O

Supine

Increased intra-abdominal pressure (IAP) decreased chest wall compliance and lung volume

Lithotomy

Further reduction in chest wall compliance and lung volumes

Trendelenburg

Greatest reduction in chest wall compliance and lung volumes

Effects of Capnoperitoneum during Laparoscopy

Avoid Lung Overdistention

- Tidal volume ventilation (6 - 8 ml/kg/"IBW")
  - use even smaller VT for "protective lung ventilation"
  - avoid larger VT and/or high ventilatory pressures
- Increase ventilator rate for excessive hypercapnia
  - adjust ventilator to maintain physiologic end-tidal CO₂
  - consider "permissive hypercapnia"
- Keep end-inspiratory (plateau) pressure < 30 cm H₂O
Keep lungs expanded

- PEEP (10 cm H₂O)
  - Monitor for adverse effects of PEEP: bradycardia, hypotension
  - Hypotension or decreasing SpO₂ may be due to PEEP increasing pulmonary shunt fraction
- Prevent re-occurrence of atelectasis with intermittent recruitment maneuvers (RM)

Maintain post-operative lung expansion

- CPAP or BIPAP immediately after tracheal extubation
- Keep patient’s upper body elevated
- Supplemental nasal or mask oxygen
- Maintain good pain control (limit opioids)
- Use incentive spirometry
- Encourage early ambulation

Is there a “best” anesthetic for morbidly obese patients?
Desflurane is least fat soluble - less deposition in fat - ? faster recovery from anesthesia

<table>
<thead>
<tr>
<th>Solubility of Inhaled Anesthetics</th>
</tr>
</thead>
<tbody>
<tr>
<td>Desflurane</td>
</tr>
<tr>
<td>Fat</td>
</tr>
<tr>
<td>Blood</td>
</tr>
<tr>
<td>Brain</td>
</tr>
<tr>
<td>Heart</td>
</tr>
<tr>
<td>Liver</td>
</tr>
<tr>
<td>Kidney</td>
</tr>
<tr>
<td>Muscle</td>
</tr>
</tbody>
</table>


Remifentanil

<table>
<thead>
<tr>
<th>Table 2. Recovery profile (min): duration to achieve required stages of post-anesthesia recovery from ending of surgery and discontinuation of propofol infusion</th>
</tr>
</thead>
<tbody>
<tr>
<td>Group F</td>
</tr>
<tr>
<td>--------</td>
</tr>
<tr>
<td>Response to verbal command</td>
</tr>
<tr>
<td>Spontaneous respiration</td>
</tr>
<tr>
<td>Adequate respiration</td>
</tr>
<tr>
<td>Safe extubation</td>
</tr>
</tbody>
</table>

Values are mean ± SD; *P<0.05 compared with Group F

**Remifentanil**

- Ultra-short acting opioid – half life 3-6 mins - hydrolyzed by non-specific blood and tissue esterases
- Quick recovery – no respiratory depression
- Blunts hemodynamic and cardiac responses to surgery

Administered by bolus or infusion

---

**Dexmedetomidine**

- Centrally acting alpha-2 agonist - hypnotic/ anxiolytic/ sympatholytic/ analgesic effects
- Minimal respiratory depression
- Cannot be used alone
- Loading dose can cause hypotension, especially when volume depleted
- Causes relative bradycardia
- Long duration (30-90 min)
- Expensive

---

**Remifentanil**

Administered with either propofol infusion or inhalational anesthetic (isoflurane)

Ideal for MO/OSA patients – eliminates concern about opioid induced post-operative respiratory depression

?? Increased post-operative pain
?? Increased nausea and vomiting

---

**Table 2.**

<table>
<thead>
<tr>
<th>Variable</th>
<th>Control (n = 20)</th>
<th>Dex 0.2 (n = 20)</th>
<th>Dex 0.4 (n = 20)</th>
<th>Dex 0.8 (n = 20)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Glasgow Coma Scale (x) (%)</td>
<td>4.2 ± 2.0</td>
<td>4.2 ± 2.0</td>
<td>4.2 ± 2.0</td>
<td>4.2 ± 2.0</td>
</tr>
<tr>
<td>Nausea (x %)</td>
<td>3.10 ± 1.05</td>
<td>3.10 ± 1.05</td>
<td>3.10 ± 1.05</td>
<td>3.10 ± 1.05</td>
</tr>
<tr>
<td>Time to drug free (min)</td>
<td>4 ± 3.3</td>
<td>4 ± 3.3</td>
<td>4 ± 3.3</td>
<td>4 ± 3.3</td>
</tr>
<tr>
<td>Time to return to normal (min)</td>
<td>7 ± 3.3</td>
<td>7 ± 3.3</td>
<td>7 ± 3.3</td>
<td>7 ± 3.3</td>
</tr>
<tr>
<td>Duration of the PACU (day)</td>
<td>10 ± 8.3</td>
<td>10 ± 8.3</td>
<td>10 ± 8.3</td>
<td>10 ± 8.3</td>
</tr>
</tbody>
</table>

Dexmedetomidine infusion rate of 0.2 g/ kg /h is recommended to facilitate early recovery while minimizing adverse perioperative cardiovascular side effects.

Colorado Review of Anesthesia for SurgiCenters and Hospitals
2018
Brendan L Sullivan MD
Co-Medical Director of Cardiothoracic Intensive Care Unit, UCH
Jason Brainard MD
Co-Medical Director Surgical and Trauma Intensive Care UCH
Thomas Scupp MD
Anesthesia and Emergency Medicine Critical Care Fellow, UCH

Intensive Care Unit Panel
Interactive Case Presentation:
44 year old man with a past medical history of spontaneous pneumothorax at age 18 presents to the emergency room with a necrotizing soft tissue infection of his chest wall. The patient rapidly develops septic shock and requires emergency surgical intervention. The anesthesiologist role in the resuscitation, mechanical ventilation, and hemodynamic monitoring is key to critically ill patient surviving. Necrotizing soft tissue infections are common deadly infections that require rapid intervention to improve survival

- Sepsis is defined as life-threatening organ dysfunction caused by dysregulated host response to infection
- Septic shock is a subset of sepsis with circulatory and cellular/metabolic dysfunction associated with high risk of mortality

Source Control Surgery
- Early diagnosis and surgical intervention improve mortality
- Intraoperative resuscitation
  - Laboratory data
  - Fluid responsiveness
    - Do devices help?

Fluid management with severe electrolyte disturbances
- Lactic acidemia
  - Goals of resuscitation
- Hypovolemic Hyponatremia
  - Sodium Correction in the critically ill
- Cardiogenic shock
  - Biomarkers, imaging, management
  - Careful management: fluids, mean arterial blood pressure, vasopressors

Bedside Anesthesia in the Intensive Care Unit
- When is a patient too sick to travel to the operating room?

Acute Respiratory Distress Syndrome
- Referral for Veno-venous ecmo?

1. Stevens, Dennis; Bryant Amy. Necrotizing Soft-Tissue Infections. N ENGL J MED 377;2353-65

Apneic Oxygenation

Brian Somerset DO
Anesthesiologist Denver Health Medical Center
Assistant Professor Department of Anesthesiology
University of Colorado School of Medicine

Objectives

• Review physiologic basis for apneic oxygenation
• Discuss guidelines for application of apneic oxygenation
• Provide evidence to consider adapting your practice to include apneic oxygenation

Steps in Anesthetic

• Transition from awake to anesthetized
• Patients respiration cease
• Most important goal during this process is maintaining oxygenation
• Typical scenario
  – Pre-oxygenation to denitrogenises the lungs and creates an alveolar oxygen reservoir
  – This oxygen reservoir provides apneic window in which attempts are made to secure an airway

Increase apneic window

• Preoxygenation
• Reduce dependent atelectasis through head-up position
• Raising mean airway pressure

Is there a way to increase apneic window during induction?

Disclosures

• None

Increase apneic window

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Increase apneic window

• Preoxygenation
• Reduce dependent atelectasis through head-up position
• Raising mean airway pressure

Is there a way to increase apneic window during induction?
Eight essentially healthy patients scheduled for variety minor procedures
Induced, intubated and than denitrogenated for 30 min
ETT, connected to circle apparatus, with 100% oxygen, and apnea was allowed to persist for 30-55 min
Reservoir bag
- moved -> more sure (avg 500mg)
- Emptied -> refilled with O2 – required 2-3 liters q 15 min

The effectiveness of apneic oxygenation during tracheal intubation in various clinical settings: a narrative review

Gas exchange during regular breathing

The effectiveness of apneic oxygenation during tracheal intubation in various clinical settings: a narrative review
High-flow nasal cannula oxygen therapy in adults

- Physiological effects
  - reduction of anatomical dead space
  - PEEP effect
  - constant fraction of inspired oxygen
  - humidification

Patel et al. The Royal National Throat Nose and Ear Hospital, London, UK
Anesthesia 2015, 70, 323–329

Extended apnea times in 25 patients with difficult airways (12 obese, 9 with stridor) undergoing hypopharyngeal or laryngo-tracheal surgery.

- Used HFNC oxygen, in 40º head-up position, initially for pre-oxygenation, and continuing during IV induction of anesthesia and neuromuscular blockade until a definitive airway was secured. Upper airway patency was maintained with jaw-thrust.
  - The median apnea time was 14 min
  - No patient desaturated < 90%.

NO DESAT

- N - nasal
- O – oxygenation
- D – during
- E – efforts
- S – securing
- A – a
- T - tube

The effectiveness of apneic oxygenation during tracheal intubation in various clinical settings: a narrative review

- 12 OR studies
  - Apneic oxygenation significantly prolonged the duration time to desaturation
- 5 ICU studies
  - 2 of 5 icu studies showed significantly smaller decline in oxygen saturation
- 2 ED / prehospital studies
  - showed lower incidence of desaturation
### Table: Results of Studies on Apneic Oxygenation

<table>
<thead>
<tr>
<th>Paper</th>
<th>Design</th>
<th>Setting / Situation</th>
<th>Sample Size</th>
<th>Control Group</th>
<th>Apneic (AO) Oxygenation</th>
<th>Results</th>
</tr>
</thead>
<tbody>
<tr>
<td>Macdonald et al 2020</td>
<td>RCT</td>
<td>Mohler surgery</td>
<td>18 – 15 control 136 intervention</td>
<td>No additional nasal O2</td>
<td>Nasal prongs off at 5.1 mm</td>
<td>1. Duration (mean ± std), lipid &lt; 95% D16, Mix insufflation</td>
</tr>
<tr>
<td>Wolfersdor et al 2003</td>
<td>RCT</td>
<td>Mohler surgery</td>
<td>18 – 15 control 136 intervention</td>
<td>Nasal O2 insufflation</td>
<td>Nasal prongs off at 5.1 mm</td>
<td>3. Lowest tidal volume &lt; 800 ml. Conclusion: RCT Elective Study Situations (difficult)</td>
</tr>
<tr>
<td>Li et al 2007</td>
<td>RCT</td>
<td>Urgent surgery</td>
<td>18 – 15 control 136 intervention</td>
<td>No additional nasal O2</td>
<td>Nasal prongs off at 5.1 mm</td>
<td>4. Lowest tidal volume &lt; 800 ml. Conclusion: RCT Elective Study Situations (difficult)</td>
</tr>
<tr>
<td>Paul et al</td>
<td>Prospective study</td>
<td>Difficult airways</td>
<td>18 – 15 male 18 female</td>
<td>None</td>
<td>WTV with O2 at 76% area</td>
<td>5. Median apnoea time = 3 min. No patient had apnoea for more than 5 min.</td>
</tr>
</tbody>
</table>

Adapted from Odero-Marah et al. 2017

---

### Conclusion
- 16 of 19 studies showed AO prolongs safe apneic time and reduces the incidence of arterial oxygen saturation.
- Prolonged AO with resultant hypercarbia can have risks and should be avoided in conditions like elevated ICP, metabolic acidosis, hyperkalemia, and pulmonary HTN.

---

### Difficult Airway Society 2015 guidelines for management of unanticipated difficult intubation in adults

- Preoxygenation using a 20–25° head-up position and continuous positive airway pressure has been shown to delay the onset of hypoventilation in obese patients.
- The duration of apnea without desaturation can also be prolonged by passive oxygenation during the apneic period (apneic oxygenation).
- This can be achieved by delivering up to 15 l/min of oxygen through nasal cannulae, although this may be uncomfortable for an awake patient.
References

Tuesday
Neuromonitoring – What and When?

Ken Brady, MD
Pediatrics, Anesthesia, Critical Care
Texas Children’s Hospital
Baylor College of Medicine

Disclosures

• IP for monitoring technology licensed to Medtronic

Set up audience participation

1. Take out your silenced phone
2. Open a web browser
3. Go to: PollEv.com/kenbrady584

Test question

Outline

• NIRS
  – Fun with Beer-Lambert
• Autoregulation
  – Lassen’s curves...
• EEG
  – Fourier Transforms!!!

Take your beta blockers and buckle in.

My opinion regarding NIRS monitoring

There is strong evidence to support NIRS monitoring, it is indicated for many of my patients.

The evidence for NIRS monitoring is weakest, it is indicated for some of my patients.

The evidence for NIRS monitoring is weakest, it is not indicated but may prove helpful in some cases.

NIRS is potentially harmful and a waste of money.
If you anesthetize for cardiac or high-risk vascular cases, do you use NIRS

- Always
- Most cases
- Some cases
- Rarely
- Never

Religion, Politics, and Neuromonitoring

- "...we found no evidence that pulse oximetry affects the outcome of anaesthesia for patients."
- "...a total of 22,992 participants had been allocated at random to be monitored or not monitored with a pulse oximeter."
- "...does not affect a person's cognitive function and does not reduce the risk of complications or of dying after anaesthesia."

There is evidence that pulse-oximetry monitoring for surgery improves patient outcome

- True
- False

Cochrane Database Review of Pulse-Oximetry

Pascal’s Wager and Neuromonitoring

- You’re Right!
- You’re Wrong!

Belief
- Eternal Joy
- Nothing

Atheism
- Nothing
- Eternal Suffering
Part I: Reflectance NIRS

Beer-Lambert Law: brains in cuvettes?

- $A$: Absorbance
- $I$: light intensity
- $e$: molar absorption coefficient
- $l$: light pathlength
- $c$: concentration

$$A = \log \frac{I_0}{I} = etc$$

Borrowing from the pulse-oximeter

- Proprietary algorithms that use multiple wavelengths.
- Ratio of Oxy- to deOxy-hemoglobin can be estimated, cancelling unknowns for both.
- Pulse oximeter subtracts non-pulsatile (venous) signal to report arterial sat.
- Cerebral oximeter reports all cerebral blood saturation (mostly venous)

CMRO2/CBF: Jugular Sat and NIRS

- Validation of NIRS monitors has been done against jugular venous oxygen saturation.

What do you consider to be a low NIRS?

- 10% reduction from baseline
- 20% reduction from baseline
- Saturation less than 45%
- Saturation less than 40%
- FOE (Arterial Sat - Cerebral NIRS)/(Arterial Sat) is more important
- None of these - NIRS is bogus and treating NIRS is harmful

What is a low Cerebral Oximetry?
Case: Cardiopulmonary Bypass

A 70 year old woman is having an aortic valve replacement and 2 vessel CABG for symptomatic valve insufficiency and CAD. She had left unilateral moderate carotid stenosis (<50% occluded). She is monitored with NIRS at initiation of bypass.

- Baseline NIRS: R: 65%; L: 68% on 0.21 FiO₂
- After starting bypass: R: 42%, L: 44%
- ABG: 7.35/37/150; Hb: 7.0; T: 53.9°C
- Pump flow 100% (2.4 L/m²), ABP: 55 mmHg

- What is your intervention?

What causes low cerebral oximetry?

\[
D_O_2 = CBF \times C_aO_2
\]
\[
CBF = \frac{ABP - ICP}{CVR}
\]
\[
C_aO_2 = (Hb \times 1.39 \times S_aO_2) + (PaO_2 \times 0.003)
\]

- Low CBF:
  - Hypotension
  - ICP
  - Hypocarbia
- Low Oxygen Content:
  - Hypoxia
  - Anemia
- High Extraction:
  - Hyperthermia

Part II: The autoregulation curve
The goal of autoregulation monitoring

The Cambridge Method

Single best answer: Cerebrovascular Pressure Autoregulation

Using PRx to find optimal pressure

Validated in animal models, replicated with modifications of NIRS

Autoreg monitoring in adult CPB

- RCCT
- R01 funded (Charles Hogue PI- year 8 of 10)
- Perfusionist to keep ABP>LLA vs standard
  - Increase flows primary
  - Vasoconstrictors secondary

- MRI data not yet available
### Autoreg monitoring in adult CPB

- Post-op delirium

*redacted*

<table>
<thead>
<tr>
<th>Safety monitoring data</th>
<th>Control (n=140)</th>
<th>Autoregulation (n=129)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Stroke (in-hospital)</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>Dialysis*</td>
<td>4</td>
<td>2</td>
</tr>
<tr>
<td>Renal Injury*</td>
<td>17</td>
<td>4</td>
</tr>
<tr>
<td>Sepsis*</td>
<td>7</td>
<td>0</td>
</tr>
<tr>
<td>Prolonged mechanical ventilation*</td>
<td>11</td>
<td>7</td>
</tr>
<tr>
<td>MECE*</td>
<td>5</td>
<td>0</td>
</tr>
<tr>
<td>Single inotrope 24 h</td>
<td>19</td>
<td>18</td>
</tr>
<tr>
<td>Multiple inotrope 48 h*</td>
<td>9</td>
<td>4</td>
</tr>
<tr>
<td>New IABP</td>
<td>12</td>
<td>9</td>
</tr>
<tr>
<td>Death (in-hospital)*</td>
<td>9</td>
<td>2</td>
</tr>
</tbody>
</table>

### Part III: EEG

![Image](AWAKE.jpg)

**What is depicted by these progressive EEG changes?**

- Anesthetic Depth
- Hypothermia
- Ischemia
- All of the above

### EEG Changes and Ischemia

<table>
<thead>
<tr>
<th>CBF (% of normal)</th>
<th>ECoG Change</th>
<th>Cellular Response</th>
</tr>
</thead>
<tbody>
<tr>
<td>25-30</td>
<td>Decreased amplitude</td>
<td>Increased collateral function</td>
</tr>
<tr>
<td>25-35</td>
<td>Loss of theta frequencies (2-4 Hz)</td>
<td>Metabolic dysfunction</td>
</tr>
<tr>
<td>20-21</td>
<td>Increasing lower frequencies (delta)</td>
<td>Low voltage, slow wave activity</td>
</tr>
<tr>
<td>10-16</td>
<td>Spike waves</td>
<td>Increased ionic currents</td>
</tr>
<tr>
<td>5-8</td>
<td>Increasing lower frequencies (delta)</td>
<td>Increased cortical excitability</td>
</tr>
<tr>
<td>3-2</td>
<td>Suppression</td>
<td>Reduced brain function</td>
</tr>
<tr>
<td>1.5-1</td>
<td>isolectricity</td>
<td>Increased brain function</td>
</tr>
<tr>
<td>1.0-0.5</td>
<td>1-second waves</td>
<td>Normal brain function</td>
</tr>
</tbody>
</table>

### Comparing Anesthetic Depth and Ischemic EEGs

- Increased ionic currents
- Increased cortical excitability
- Reduced brain function
- Normal brain function

*Figures 1*, *2*, *3*, *4* and *5* are reprinted from Critical Care 2012;16(2):216. doi:10.1186/cc11230.
EEG 101: Greek waves

<table>
<thead>
<tr>
<th>Wave Name</th>
<th>Wave Frequency (Hz)</th>
<th>Relevance to Anesthesia</th>
</tr>
</thead>
<tbody>
<tr>
<td>Slow</td>
<td>&lt;1</td>
<td>Increase in Amplitude during anesthesia</td>
</tr>
<tr>
<td>Delta</td>
<td>1-4</td>
<td>Increase in Amplitude during anesthesia</td>
</tr>
<tr>
<td>Theta</td>
<td>5-8</td>
<td>Increase in Amplitude during anesthesia</td>
</tr>
<tr>
<td>Alpha</td>
<td>9-12</td>
<td>Increase in Amplitude during anesthesia</td>
</tr>
<tr>
<td>Beta</td>
<td>13-25</td>
<td>Decrease in Amplitude during anesthesia</td>
</tr>
<tr>
<td>Gamma</td>
<td>26-80</td>
<td>Decrease in Amplitude during anesthesia</td>
</tr>
</tbody>
</table>

The Secret in the Secret Sauce

Unprocessed EEG | Requires a knowledge of all of the EEG waves, and how they change during anesthesia
Spectrogram | Shows waves as power, frequency and time. Shows exact frequencies of dominant waves. Facilitates pattern recognition, but still requires profound knowledge of EEG.
Spectral edge frequency | The upper 95% frequency boundary of EEG wave power. Spectral edge decreases with Anesthesia.
Burst Suppression Ratio | The % time (or probability) that EEG activity is silent.
Bispectral Coherence Index | Regression methods of selected EEG features correlated to observed states of patient arousal under anesthesia.
Narcotrend | Uses statistical classification of the awake state against visually categorized EEG recordings.
Entropy Algorithm | Quantifies the degree of disorder in the EEG: more entropy is more arousal.

The EEG spectogram

What happens to the EEG under GA?

Spectral edge decreases with propofol anesthesia

Propofol light sedation

Propofol deep sedation

During CPB with deep hypothermia at 18 degrees the EEG spectral pattern is shown. What is your interpretation?

Anesthesia is too deep causing burst suppression

The ABF is too low causing ischemic burst suppression

The brain is inadequately cooled and there is too much EEG activity
Burst Suppression Ratio

A patient under volatile anesthetic with low ABP has the EEG spectrum in A. Due to movement ketamine is given, resulting in B. What is your interpretation?

- The increased EEG power at 35 Hz is indicative of increased arousal.
- The decreased EEG power at 33 Hz is due to hypoxia.
- This is the normal BIS effect of ketamine.

BIS and Pediatrics

A 2 month old with pyloric stenosis has a BIS score of 55 on 2.5% Sevoflurane. After movement with incision vecuronium is given and the Sevoflurane is increased to 4%. The BIS level is now 60%. What is your interpretation?

- The high BIS is inaccurate due to BIS activity.
- The BIS is not reliable in infants.
- Higher sevoflurane concentration has been shown to correlate with higher BIS.
- The higher BIS is due to higher MAC concentrations in infants.

Summary

- NIRS: take it to church or leave it at home
  - Know how it works and how to respond to it.
- Autoreg: coming soon to an OR near you
  - Can only do 1 thing: support ABP optimization
- EEG: a contentious topic
  - Be careful with the confounders
Chronic Pain Management in the Perioperative Period

Rachael Rzasa Lynn, MD
Department of Anesthesiology
University of Colorado School of Medicine

Conflicts

• None

Learning Objectives

• Develop management strategies for surgical patients taking buprenorphine
• Understand the peri-operative implications of common implantable devices for pain
• Develop a peri-operative pain management plan for the chronic pain patient

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Chronic Pain

• Pain lasting >3 months or beyond the “normal time” of tissue healing

• In 2012, it was estimated that almost 40 million Americans have persistent pain that occurs daily or on most days
  – 1 out of 5 patients with chronic non-cancer pain is being treated with opioids

Management of Patient on Chronic Opioid Therapy

• Why is it challenging?
  – Tolerance and inadequate analgesia from standard opioid regimens
  – Fear of respiratory depression at high doses
  – Lower pain threshold among patients on chronic opioid therapy
  – Opioid-induced hyperalgesia?
  – Fear of relapse if history of OUD
  – No evidence that exposure to opioids for acute pain increases relapse risk
  – Has been suggested that the stress of uncontrolled pain may trigger relapse
  – Concern about diversion

• Important part of pre-operative evaluation includes Expectations
  – What is patient’s pre-operative pain baseline?
  – What is patient’s target number?
  • 0/10 is not a reasonable goal
  • Focus on function (ambulation, PT, sleep) rather than #
Management of Patient with OUD

- No RCTs of acute pain management in patients on maintenance therapy for OUD
- Has not actually been studied in opioid-tolerant patients, but it is widely recommended to use a multimodal approach in such patients where opioids may be ineffective
  - regional anesthesia
  - NSAIDs or COX-2 Inhibitors
  - acetaminophen
  - NMDA antagonists
  - α₂ agonists
  - anti-convulsants

Opioid Overdose Deaths

- The opioid prescribing rate has dropped since its peak in 2012, but the rate of death due to opioid overdose is on the rise

Methadone

- Long-acting
  - Half-life is >1 day (15-40 hours)
  - Highly lipophilic
  - High bioavailability (56-100%)
  - Protein bound: α1-acid glycoprotein
  - Metabolized by CYP450 → inactive metabolites (fetal and renal clearance)
  - High inter-individual variability!
  - 2 isomers
    - R-isomer is NMDA receptor antagonist
      - 40% of pain relief from methadone is via non-opioid activity (ie, can’t block with naloxone)
    - S-isomer is an agonist at mu and delta opioid receptors
      - Binding at mu receptor prevents withdrawal, reduces craving
      - Causes tolerance that reduces euphoria with additional-opioid use
Methadone

- Variable opioid conversion
- Higher doses of chronic opioid equivalent to less methadone/MED than lower doses

<table>
<thead>
<tr>
<th>MED/day</th>
<th>100</th>
<th>200</th>
<th>300</th>
<th>400</th>
<th>500</th>
<th>600</th>
<th>800</th>
<th>1000</th>
</tr>
</thead>
<tbody>
<tr>
<td>MED/methadone</td>
<td>1-1</td>
<td>1-1</td>
<td>1-1</td>
<td>1-1</td>
<td>1-1</td>
<td>1-1</td>
<td>1-1</td>
<td>1-1</td>
</tr>
</tbody>
</table>

Methadone: Perioperative Management

- Continue daily dose before, during and after surgery
  - Verify correct dose with prescribing physician
  - If cannot take daily PO methadone post-op, can give IV:
    - Given high but wide-ranging bioavailability (30-100%), variable pharmacokinetics, use 2:1 ratio for oral/IV
      - May need to escalate to 3:2, 1:1 or even 1:2
      - Best to divide parenteral dose into 800 to 900
    - Rapid onset IV (4 min) despite long half-life
  - Commonly held that duration of analgesic effect is 8 hr vs 24 hr dosing for OUD maintenance/withdrawal avoidance
  - Thus may divide single daily dose into TID to help with pain
  - Pharmacokinetics suggest that a single large dose (>200 mg IV) provides a prolonged analgesic effect (but in opioid-naïve patients)
  - Relationship between elimination half-life and effect depends on dose

Methadone Pharmacokinetics: Dose and duration of analgesic effect

- Buprenorphine
  - Growing in use with the rise in OUD
    - Buprenorphine prescriptions increased from 48,000 in 2003 → 1.9 million in 2007 → >9 million in 2012 and 2013
  - Why?

Pharmacokinetics:
Big dose/long interval vs Small dose/short interval

Buprenorphine

- 33 times as potent at morphine (IV to IV)
  - Antagonist at kappa-opioid receptors
  - May be involved in efficacy in opioid-induced hyperalgesia, but this phenomenon only studied in healthy volunteers
    - Partial agonist at mu-opioid receptors
  - High affinity for the receptor: binds tightly, but doesn’t activate fully
    - Slow dissociation (1000x), 10 min vs 7 min for fentanyl; 50% by 3 hr vs 60% by 1 hr
  - Plasma levels may not parallel clinical effects
  - Less respiratory depression
  - Ceiling effect (no increase in agonist effects at dose >32 mg/day)
    - 30 mg fentanyl 75-90% of μ-opioid receptors but doses 84-32 mg do not result in greater opioid effect despite >90% receptor occupancy
    - Reduced risk of respiratory depression vs full μ-opioid receptor agonists
  - Can precipitate withdrawal in opioid-dependent patient

Buprenorphine

- Long half-life, highly variable (24-60 hours)
  - 20-30 hours (buccal, transdermal or SL) vs 3-5 hours IV
- Used as maintenance therapy for OUD, most commonly SL:
  - Subutex or Suboxone (buprenorphine:naloxone in 4:1 ratio) film
  - Relatively easy to get a Waiver to rx for OUD
  - Can be prescribed for chronic pain with “opioid dependence”

Buprenorphine for Pain

- Butrans
  - transdermal patch
  - 5-20mg/hr dose
  - Patch worn for 7 days
    - Single application Cmax for 20mcg/hr patch 0.48mg/ml
    - Steady state achieved after 3 days
    - For 10mg/hr patch, steady state Cmax 0.2mg/ml
  - Must taper to ≤30mg MED
    - “may not provide adequate analgesia” for patients requiring >80 MED/day

- Belbuca
  - buccal film
  - 75-900mg
  - Bioavailability 46-51%
  - Mean Cmax 1200mcg 1.43–0.45mg/ml
  - Once to twice daily
    - T1/2 4-15 hours
  - Must taper to ≤30mg MED
    - “may not provide adequate analgesia” for patients requiring >160 mg MED/day

Buprenorphine Induction

- Patient must be in withdrawal from chronic opioid use:
  - “first dose of buprenorphine SL should only be administered when objective and clear signs of moderate opioid withdrawal appear, and not less than 4 hours after the patient last used an opioid.” (Subutex website)
  - 24 hours if using long-acting opioid like methadone
  - 8-16mg/day is approximately equivalent to methadone 60mg/day

Buprenorphine: perioperative challenges

- High affinity, only partial agonism → acute pain difficult to treat with other opioids
- Case reports
  - 47 y/o woman with chronic pain on bup/nal 16mg BID, gabapentin, SNRI and nabilone (synthetic THC) having thoracic surgery. Bup/Nal continued
    - Good pain control until PODs with epidural, intraoperative ketamine and hydromorphone PCA, worsening. By POD11, in addition to bup/nal using ~1300 MED per day in hydromorphone (PO + IV)
      - Bup/nal dose halved to QD and pain control improved immediately; IVPCA q4h 50 days later and Bup/nal halved again with transition to PO hydromorphone
    - Yet buprenorphine has been shown to reduce hyperalgesia and central sensitization in addition to direct analgesic effects!
Buprenorphine Can Make Post-Operative Pain Difficult to Control

- Numerous other case reports of patients maintained on buprenorphine whose pain could not be controlled
  - Continued peri-operatively with severe pain; control improved greatly when buprenorphine discontinued or dose reduced
  - Uncontrollable pain if buprenorphine taken day of surgery even if not continued post-operatively
    - Direct effect of buprenorphine?
    - Opioid tolerance?
    - Opioid-induced hyperalgesia?
    - Evidence of sensitization?
      - (Remind me why they ended up on SL buprenorphine for pain...?)

Adjunctive Medications to Reduce Pain in Patients Maintained on BUP

- Dexmedetomidine
  - Has been used to treat pain unresponsive to high doses of hydromorphone PCA (Bremmert, 2009)
    - 0.5μg/kg bolus, then 0.5μg/kg/hr
- Use ketamine infusion
  - Shown to reduce post-operative opioid requirement specifically in opioid-tolerant surgical patients!
    - 0.5mg/kg bolus at induction plus infusion of 10μg/kg/min before incision until closure complete
- Maximize other multimodal treatments: scheduled APAP, NSAIDs, gabapentinoids, local anesthetic techniques

Buprenorphine: Perioperative Management

- Coordinate with prescribing provider for procedures that are non-emergent
- Decide whether to continue or hold
  - Consider continuing for
    - Surgeries with only mild to moderate pain expected
    - Procedure and pain amenable to continuous local anesthetic techniques
    - Patients at high risk for relapse
      - OUD with chronic pain associated with more craving possibly getting at high risk for relapse, but may also have most difficult to control pain
    - May require monitored setting if continued
  - Theoretical risk for respiratory depression if BUP held and given full μ-receptor agonist

Buprenorphine: Perioperative Management

- Strategy 1: Discontinue buprenorphine prior to surgery
  - Gradual taper over 2–3 weeks w/ decrease by 2mg/day and off 72 hours before surgery (Sen, 2016)
    - Can taper rapidly over 3 days but higher relapse rates (Sen, 2016)
    - If can’t tolerate withdrawal, replace with methadone or other opioid
  - Goal window without buprenorphine depends on dose (Anderson, 2017)
    - 0–4mg per day  →  step 24 hours before surgery
    - >4–6mg per day  → step 48 hours before surgery
    - >6–12mg per day  → surgery prep plan with buprenorphine
  - OR transition to oral methadone in ratio of 1:1; typically 10–40mg/day
  - Tolerate methadone 5–10mg/day
  - Use additional full mu agonists for acute pain
  - Post-op:
    - Discharge on pure opioid agonist with plan to taper and resume buprenorphine w/ outpatient maintenance clinic
    - OR inpatient induction with buprenorphine once acute pain controlled
  - Reschedule elective case if patient doesn’t hold?

Buprenorphine: Perioperative Management

- Strategy 2: Continue buprenorphine throughout the perioperative period
  - Discontinuation of buprenorphine in stressful pre-operative period may risk relapse
  - Numerous case reports of successful pain management despite concomitant 5L buprenorphine treatment.
    - Treat acute pain with higher-than-usual doses of opioid agonists
      - Use opioids with higher intrinsic affinity for the receptor: hydromorphone, fentanyl, morphine

Buprenorphine
Buprenorphine: Perioperative Management

- Strategy 2: Continue buprenorphine throughout the perioperative period
  - Discontinuation of buprenorphine in stressful pre-operative period may risk relapse
  - Numerous case reports of successful pain management despite concomitant SL buprenorphine treatment. Tactics include:
    - Treat acute pain with higher-than-usual doses of opioid agonists
      - Use opioids with higher intrinsic affinity for the receptor
    - Use PCA
    - Divide once daily dose of buprenorphine (opioid maintenance) into TID or QID dosing to better match the pharmacodynamics of analgesia
    - Half-life for effective analgesia shorter than half-life of the drug
    - Only for mild to moderate pain due to ceiling effect at doses >62mg/day SL
    - Consider additional sublingual or IV buprenorphine
      - 0.3mg IV = 12mg morphine IV; usually 0.3-0.6mg IV intraoperatively
    - Employ multimodal pain management

Post-operative pain management on continuous buprenorphine

- Case series (2010): Successful post-operative pain management with continuation of buprenorphine
  - None of the 5 patients (7 surgeries) used bup/nal for chronic pain
  - Maximum pre-operative daily bup dose was 24mg
    - Some patients who remained on bup had dose increased for post-op pain, max from 24 to 32mg
    - Not continued post-op in all cases but held (or dose reduced) until several days after surgery
  - All received multimodal analgesia: epidural or surgical site catheter with pump, ±ketamine, morphine or hydromorphone PCA

Post-operative pain management in patients on buprenorphine

- Use regional anesthesia when possible
  - Case series of 4 patients on buprenorphine undergoing C/S or post-partum BTL
    - Buprenorphine continued at home dose and schedule
    - All patients administered ketorolac 30mg Q6 hours x 24 hours; then PO NSAID (ibuprofen 800mg PO TID)
      - 2/4 also received epidural infusion of bupivacaine 0.0625% maintained for 48 hours
        - Pain maintained at 0/10 and 2/10
      - 2/4 administered intrathecal bupivacaine ± opioid
        - Pain at 5/10 (c/s) and 1-2/10 (BTL)

Perinatal buprenorphine management

- Both methadone and buprenorphine are category C
  - Methadone used since 1970s
  - Metabolism is increased during pregnancy so need dosing adjustment
  - Safety of buprenorphine not yet proven so has been recommended to transition to methadone
    - Methadone in pregnancy associated with better treatment retention
    - Better maternal and fetal outcomes with buprenorphine
    - Same rate of NA but less severe with buprenorphine
  - Neonatal abstinence syndrome (NAS)
    - OK to breastfeed, but due to poor bioavailability infant buprenorphine exposure not sufficient to prevent NAS
  - Hyperalgesia may require more and stronger analgesics than opioid-naive
    - Women on methadone required ~70% more opioid in the first 24hr after c/s

Perinatal buprenorphine management

- In general, adequate postpartum pain management possible despite continued BUP
  - 20 women randomly assigned to methadone or buprenorphine (blinded)
    - All achieved adequate pain control with additional opioid agonist then transition to ibuprofen, although the patients on methadone required more NSAID
Perinatal buprenorphine management

- Neuraxial anesthesia safe and preferred
  - IT opioids are fine but may not be enough to prevent withdrawal if maintenance opioid discontinued

- Avoid mixed (κ)agonist-(μ)antagonists like nalbuphine, butorphanol and pentazocine, which can precipitate withdrawal

- Regional techniques (TAP blocks) as adjunct to IT as needed for pain in first 24 hours

Buprenorphine: Legal Issues

- A physician may not provide a prescription of buprenorphine for opioid dependence without obtaining a DATA 2000 Waiver
  - A Waiver is NOT required to prescribe or administer buprenorphine for pain
  - Currently high interest in increasing the number of physicians with a Waiver, many states have programs to support training (8 hours)
    - https://www.samhsa.gov/medication-assisted-treatment/training-resources/buprenorphine-Physician-training
  - However, special circumstances do exist...

Buprenorphine: Legal Issues

- Providers without a Waiver MAY provide buprenorphine to treat withdrawal in patients with opioid dependency or OUD in the course of a hospitalization for another medical issue. According to SAMHSA:
  - “A patient with an opioid dependency who is admitted to a hospital for a primary medical problem other than opioid dependency, such as myocardial infarction, may be administered opioid agonist medications such as methadone and buprenorphine to prevent opioid withdrawal that would complicate the primary medical problem.”

Buprenorphine: Continue or Hold?

- 37 y/o woman on buprenorphine (8mg SL TID) for chronic pelvic pain who underwent 2 surgeries
  - Also on chronic ibuprofen 800mg QID
  - 1st: buprenorphine continued:
    - pt reported uncontrolled pain
  - 2nd: buprenorphine discontinued 5 days prior and replaced with hydromorphone 4mg Q6-8 hrs (max 20mg/d)
  - Pain control on hydromorphone adequate before surgery
    - Ventral canal exploration: patient tolerant to effects, remaining alert and conversant after 1000mg IV
    - Given ketorolac intrap, also additional 1000ug fentanyl required 1000ug more fentanyl prior to arrival in ICU
    - Complaining of pain but appeared comfortable
    - Hydromorphone PCA and ketorolac continued post-op
    - Discharged home on hydromorphone with plan to follow-up with buprenorphine provider

- Tolerance? Hyperalgiesia? Both?

Buprenorphine: Continue or Hold?

Opioid-Induced Hyperalgesia

- First described in animals
  - Chronic opioid exposure results in lower pain threshold in most pain models tested

- Data in humans more limited
  - Unknown what minimum daily MED will cause tolerance or OIH
    - Described within one month of chronic oral morphine use (range 30-120mg/day)
  - Clearly described for remifentanil
  - Reports of pain improving following opioid detoxification

[Sen, 2016; Goodman and Gilman Pharmacological Basis of Therapeutics 13th Ed. 2018; Driscoll 2017.10.10]
Opioid-Induced Hyperalgesia

• Clinical data
  – Patients on methadone maintenance display hyperalgesia
  – Patients on methadone (or buprenorphine) for OUD had lower tolerance for experimental cold (but not mechanical or electrical) pain than those with OUD not on opioid
  – Patients receiving high-dose fentanyl infusion in OR have higher pain scores for first 8 hours after surgery and require more fentanyl in first 16 hours post-op
  – Conversely, numerous reports of opioid-sparing anesthesia with β-blocker infusion resulting in lower pain scores and opioid consumption for 12-24 hours after surgery

Pre-operative Opioid Weaning

• Numerous studies documenting poor outcomes in patients on chronic opioid therapy
  – Infection
    • Odds increased by 50% in highest opioid use vs lowest
  – GI complications
  – Illness
  – Respiratory complications
    • Respiratory depression with atelectasis and pneumonia
  – Increased length of stay, discharge to rehab facility and cost
  – DVT
  – Compromised wound healing
  – Reduced arthroplasty or intervertebral fusion success
  • Less pain relief from the intervention in the case of TKA

Other adjuncts: Anticonvulsants

• Gabapentinoids: pregabalin and gabapentin
  – Bind α6 subunit of N-type voltage-gated Ca²⁺ channel to reduce neuronal excitability
  – May also impact immune pathways in pain
  – These effects may explain animal evidence and reports of reduction in opioid-induced hyperalgesia
  – Typical doses:
    • Gabapentin 300-1200mg pre-op (300-600mg TID)
    • Pregabalin 75-300mg (75-150mg BID)

Opioid-Induced Hyperalgesia: Possible Treatments

• NMDA antagonists: ketamine, memantine
  – Glutamate receptor and ion channel
  – Activated in setting of prolonged morphine
    • Activated allows flux of cations (Na⁺, K⁺, Ca²⁺)
  – NMDA receptor mediated neuronal apoptosis in the dorsal horn
• Adrenergic blockade?
  • Alpha: successful use of dexmedetomidine (clonidine?) to treat refractory pain in opioid tolerant patients
  • Beta blockers?
    – Propranolol reduces secondary hyperalgesia seen with remifentanil
    – Can be used for opioid-sparing anesthetic

Preoperative Reduction of Opioid Use Before Total Joint Arthroplasty

• 3 cohorts of patients prior to joint arthroplasty:
  – Patients who weaned chronic opioid by 50% before surgery
  – Patients who maintained baseline chronic opioid dose
  – Opioid-naïve patients
• Functional outcomes
  – Patients who weaned fared better on all measures than those who did not pre-med opioid.
  – Opioid-naïve outcomes comparable to opioid-naïve patients

Other adjuncts: Gabapentinoids

• Single dose pre-operatively or several doses peri-operatively can reduce post-operative pain scores
  – Pregabalin shown to reduce incidence of chronic pain after TKA when continued for 14 days post-op
  – Gabapentin also shown to reduce pain at 6 months after orthopedic, ENT, breast and abdominal/pelvic surgery
    • In a recent RCT, gabapentin did not accelerate cessation of post-operative pain, but increased probability of opioid cessation after surgery (by 24%) and reduced duration of post-operative opioid therapy (mean 25 days vs 32 days for placebo)
    • Less constipation but may be associated with more post-op sedation, delirium, rash, visual disturbances
Multimodal Pain Management: Membrane stabilizers

• APS/ASRA/ASA Panel Recommendations:
  – Consider use of gabapentin or pregabalin as part of a multimodal analgesia regimen (strong recommendation, moderate-quality evidence)
    • Both are associated with reduced opioid requirement after major or minor surgery
    • Some reports of lower post-operative pain scores
    • Administer as a dose of 600 or 1200mg of gabapentin or 150 or 300mg of pregabalin given 1-2 hours pre-operatively
    • Some trials also postoperative dosing to be effective (gabapentin 600 mg as a single or in multiple doses and pregabalin 150 or 300 mg after 12 hours)
    • Higher doses may be more effective but also may be more sedating
    • Particularly for opioid-tolerant patients

Reduce doses in renal dysfunction

Multimodal Pre-treatment: COX-2 Inhibitor

• APS/ASRA/ASA Panel Recommendations:
  – Consider giving a preoperative dose of oral celecoxib in adult patients without contraindications (strong recommendation, moderate-quality evidence)
    • Preoperative celecoxib in patients who undergo major surgery (200 - 400 mg, 30-60 min, preoperatively)
    • Associated with reduced opioid requirements after surgery
    • Some studies reported lower postoperative pain scores
    – May not reduce opioid use per day in opioid tolerant patients like it does in opioid-naive patients, but does significantly reduce pain scores

Celecoxib: gastrointestinal bleeding and ulceration, cardiovascular history, sulfa allergy

Use of Acetaminophen and/or NSAIDs as part of a multi-modal regimen

• APS/ASRA/ASA Panel Recommendations:
  – Clinicians provide acetaminophen and/or nonsteroidal anti-inflammatory drugs (NSAIDs) as part of multimodal analgesia for management of postoperative pain in patients without contraindications (strong recommendation, high-quality evidence)
    • Round-the-clock, scheduled
  – Most studies show use of acetaminophen or NSAIDs in conjunction with opioids is associated with less postoperative pain or opioid consumption than opioids alone
    • Evidence that a single pre-emptive dose of APAP prior to surgery reduces pain scores 6 hours after surgery (Khalil et al 2013)
  – Acetaminophen and NSAIDs have different mechanisms of action and the combination of acetaminophen with NSAIDs may be more effective than either drug alone
    • NNT<2

NSAIDs

• Act both peripherally and centrally
  – In peripheral, afferent pathway: block COX, preventing conversion of arachidonic acid to prostaglandins
    • Prevents sensitization of pain receptors after injury
  – In central pathways:
    • Block COX-2 facilitated production of PGE2 in the spinal dorsal horn
    • Activate medullary and cortical areas involved in descending inhibition

NSAID Precautions

• Renal
  – 2007 Cochrane review found only transient, clinically insignificant reduction in renal function in adults without pre-operative renal impairment (Lee, 2007)
• Hematologic
  – Bleeding risk: a 2007 meta-analysis found no significant difference in postoperative bleeding between ketorolac and control group (Gobble, 2014)
    • However, there may be a greater risk of bleeding (GI and operative) among patients ≥75 years old, with a dose-response relationship (Strom, 1998)
    • Lower OR of GI but not surgical bleeding when ketorolac given <5 days
  – ASA-induced asthma
  – Cardiovascular
    • COX-2 inhibition leads to reduction in PG synthesis and relative overproduction of thromboxane A2 → increased vasoconstriction without reduced platelet aggregation (COX-1)
Indications for Intrathecal Drug Delivery

- Pain unresponsive to high doses of opioids (VAS ≥ 5 despite ≥2000mg MED)
- Intolerable side effects from opioids
  - Chronic non-cancer pain
  - Postherpetic neuralgia
  - Peripheral neuropathy
  - Failed back surgery syndrome
  - CRPS
  - Visceral pain (e.g., pancreatitis)
- Cancer pain
  - Life expectancy >3 months

- CLEAR pain diagnosis
- Failure of conservative treatment
Intrathecal Drug Delivery for Pain
Common Medications

- **Side port** bypasses reservoir, connects directly to catheter
  - Filled with very concentrated opioid
  - In theory could leak through port but must aspirate first
  - Risk of infection, etc.
  - Preferable to perform single shot spinal below IT entry

IT Pump Placement

Implications for Anesthesia

- Neuraxial anesthetic techniques
  - Risk of damage to catheter
  - Infection
  - Communication between epidural and intrathecal around catheter?
- Numerous case reports of successful epidural analgesia for labor in patients with IDDS
- Entry described both above and below IT catheter entry
- Use of ultrasound: identify and avoid catheter as well as dural puncture?
- Prophylactic antibiotics?

Other IT Pump Issues

- MRI
  - Causes pump to stop
    - Normally will resume function within 20min to 2 hours but needs to be interrogated to verify particularly if baclofen
- Chronic management
  - Recent dose changes?
  - Last refill?
  - Next refill? Battery?

Spinal Cord Stimulation
How does it work?

- The neurostimulator delivers mild electrical impulses to the leads located within the epidural space.
  - Stimulation targets dorsal column neurons to spinal cord, not the nerve roots.
  - Lead location does not follow typical dermatomal locations.
- This disrupts pain signals traveling between the spinal cord and brain, providing pain relief.
- Typical, “paresthesia-based” stimulation produces paresthesias in the area normally affected by pain.
- Newer, “high frequency” programs deliver stimulation at a frequency below the threshold of detection for the patient.

Indications: Chronic Pain

- Failed Back Surgery Syndrome (FBSS)
- Post-Laminectomy Pain
- Radicular Pain
- Complex Regional Pain Syndrome
- Epidural Fibrosis
- Arachnoiditis

SCS: Epidural Anatomical Considerations

- Puddle: Placed through incisions at level of electrodes.
- Requires laminectomy.
- Percutaneous:
  - Typically enter the epidural space at least 2 leads below entry level of lead.
  - Most commonly between T12/L1 or L5/S1.
  - Access to supraspinal targets are at levels above entry.
- Final position of contacts determined by pain relief:
  - Pelvis: T2-S4
  - Legs: T9-L3
  - Low back: T8-T12
  - Abdomen: T5-T7
  - Chest, axilla: C5-T2
  - Arms: C4-T1
  - Leads terminating in thoracic or cervical space may enter supraspinal space via epidural space, or be tunneled subcutaneously from hip/buttock. Use care to enter epidural space at thoracolumbar junction.
- Also may be placed subcutaneously along peripheral nerves.
  - Hip, axilla, face, sciatic nerve.

SCS: Anatomical Considerations

- IPG
  - Leads tunnel subcutaneously from midline supraspinal incision to IPG.
  - IPG location typically flank or buttock.
- Abdomen, chest, also possible.

Electromagnetic Interference

- Sources of EMF:
  - Cautery, lithotripsy, defibrillation, endoscopy with biopsy, ECT, nerve stimulation.
- Possible consequences of EMI:
  - Turning device on/off.
  - Changing settings/programming (frequency, amplitude).
  - Transmission of current along electrodes.
  - Damage to battery power/destruction of IPG.
Perioperative Sources of EMI

- Electrocautery
  - Bipolar OK
    - Monopolar is incompatible
      - If monopolar use monopolar (endoscopy, EKG, lab)
        - Turn SCS OFF
        - Turn voltage to "0"
        - Place grounding pad far from SCS and leads
        - Interrogate after surgery
- INCOMPATIBLE with:
  - Diathermy
  - Lithotripsy
  - TMS
- Interrogate post-op

- Imaging
  - CT scans OK but can cause temporary increase in stimulation
    - Turn voltage to "0" and device OFF
  - MRI
    - Most devices INCOMPATIBLE
    - Several newer devices MRI CONDITIONAL
      (head/extremities vs full body)
      - Must only at 1.5 Tesla
  - Ultrasound
  - Don’t place directly over IPG
  - Defibrillation:
    - Place paddles as far from device as possible and perpendicular to leads

Neuraxial Anesthesia and SCS

- Single shot spinal or catheter OK BELOW level where SCS leads enter
  - Ultrasound
- Lumbar epidural OK BELOW cervical SCS IF cervical epidural entry
- Epidural catheter could disrupt stimulator leads

Neuraxial Anesthesia and SCS

- Epidural catheter could disrupt stimulator leads
  - Lead migration is a common complication
    - Rotation
      - Place inner catheter on side remote from lead site
      - 5 cm distance 1.5 Tesla, smaller
      - Big catheter 1.8 Tesla
    - Epidural anesthetics have been used successfully w/ SCS complication for labor analgesia
    - SCS leads placed from T12 to L1 do not enter epidural space from low lumbar
- Risk of infection of SCS hardware
- Risk/Benefit of neuraxial
- Discuss with chronic pain physician

Conclusions

- Chronic pain can make management of acute pain challenging
  - Implanted devices may limit neuraxial anesthetic
  - Caution with EMF
  - Opioid use is not diminishing despite drop in prescriptions
    - For OUD, continue methadone through perioperative period
    - Consider continuing buprenorphine depending upon indication, dose, pain history and surgical procedure
      - Use high-affinity short-acting opioids as needed
      - If discontinuing, hold for 72 hours before surgery
    - Strongly consider weaning chronic opioids for pain before elective surgery
      - Many patients find even chronic pain unchanged or improved on a lower dose!
  - Maximize multimodal therapies
    - Use regional/neuraxial when possible
    - Administer non-opioid analgesics
      - On a SCHEDULED basis
IMPROVING OPIOID PRESCRIPTION SAFETY AFTER SURGERY

Karsten Bartels, M.D.
Conflicts of Interest

None
Funding

NIH / NIDA #K23DA040923

Improving Opioid Prescription Safety After Surgery
Primum Non Nocere

Peter Pronovost, MD  The Fairmont Copley Plaza, Boston MA
Definition of Pain

“An unpleasant sensory and emotional experience associated with actual or potential tissue damage, or described in terms of such damage.”

Chronic pain is pain that persists or recurs for longer than three months.
Epidemiology / Women

In developed countries, chronic pain is present in:
- 30.4 % of women aged 18-35
- 42.6 % of women aged 36-50
- 55 % of women aged 51-65
- 63.1 % of women aged >66
Epidemiology / Men

In developed countries, chronic pain is present in:

- 20.9 % of men aged 18-35
- 31.5 % of men aged 36-50
- 42.5 % of men aged 51-65
- 47.2 % of men aged >66
Chronic Pain Syndromes (ICD-11)

- Chronic Pain
- Chronic Primary Pain
- Chronic Cancer Pain
- Chronic Postsurgical and Posttraumatic Pain
- Chronic Neuropathic Pain
- Chronic Headache and Chronic Orofacial Pain
- Chronic Visceral Pain
- Chronic Muskuloskeletal Pain

Pharmacologic Therapy

• Nonsteroidal anti-inflammatory drugs (NSAIDs)
• Antidepressants
  – Tricyclic antidepressants
  – Selective Serotonin and Norepinephrine Reuptake Inhibitors
• Anticonvulsants
• Opioids
• Others
Efficacy

The Number Needed to Treat (NNT) for pharmacologic therapy to significantly reduce neuropathic pain (e.g. 20% reduction on a pain VAS) is between 2-5.
Opioids

- Routes of administration include IV, IM, oral, rectal, intranasal and sublingual
- Receptors, namely mu (\(\mu\)), delta (\(\delta\)), and kappa (\(\kappa\))
- Agonists (e.g. morphine, hydromorphone)
- Antagonists (e.g. naloxone, naltrexone)
- Partial agonists (e.g. buprenorphine)
<table>
<thead>
<tr>
<th>Opioids side effects</th>
<th>Mood effects (e.g. euphoria)</th>
<th>Sedation</th>
<th>Nausea / vomiting</th>
<th>Constipation</th>
<th>Respiratory depression</th>
<th>Miosis</th>
<th>Antitussive effect</th>
</tr>
</thead>
</table>
CNS-mediated effects

- Tolerance
- Dependence
- Addiction

1990s...
“Half of all do not get adequate relief.”

“Agnostic prevention of pain is better than treatment because, once established, pain is more difficult to suppress.”

“Patients have a right to treatment that includes prevention of or adequate relief from pain.”

AHRQ 1992 Clinical Practice Guideline for Surgical Pain
AHRQ 1992 Clinical Practice Guideline for Surgical Pain

“Physicians need to develop pain control plans before surgery and inform the patient what to expect in terms of pain during and after surgery.”

“Fears of postsurgical addiction to opioids are generally groundless.”

Daniel B. Carr, M.D., Massachusetts General Hospital's Division of Pain Management, and Ada Jacox, Ph.D., R.N., Johns Hopkins University School of Nursing. Guideline Release Date: March 5, 1992.
## Medicare Part D: OxyContin® - Cost

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<tr>
<th>Drug Name</th>
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OxyContin

1.92M

$945M
Medicare Part D: Vicodin® - Prescriptions

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</tr>
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#4 HYDROCODONE-ACETAMINOPHEN
Hydrocodone

• On August 22, 2014, the Drug Enforcement Administration (DEA) published the final rule in the Federal Register to rescheduling hydrocodone combination products to Schedule II of the Controlled Substances Act

• Need to be converted into active metabolites (hydromorphone) via CYP2D6
Hydrocodone & Codeine Metabolism

• 5% to 10% of white people possess allelic variants of the CYP2D6 gene that are associated with reduced clearance

• 1% to 7% of white people carry CYP2D6 allelic variants associated with rapid metabolism

• African populations are highly variable in their (0%-34%) in regards to reduced clearance


presented by Nora D. Volkow, M.D.; Senate Caucus on International Narcotics Control
"The Annual direct costs from opioid pain relievers to insurance companies are more than double the total NIH budget or about 70x the annual NIDA budget."
May 8, 2012

John H. Stewart
President and Chief Executive Officer
Purdue Pharma L.P.
One Stamford Forum
201 Tresser Boulevard
Stamford, Connecticut 06901-3431

Dear Mr. Stewart:

As Chairman and a senior member of the Senate Finance Committee, we have a responsibility to the more than 100 million Americans who receive health care under Medicare, Medicaid, and CHIP. As part of that responsibility, this Committee has investigated the
Photo of a typical death scene investigated by the Milwaukee County Medical Examiners Office. The office has finalized it statistics from 2015 and found a record-high 255 drug deaths compared to 251 in 2014.

By of the Milwaukee Journal Sentinel
Age-adjusted rates per 100,000 population for opioid pain releaver (OPR) deaths, crude rates per 10,000 population for OPR abuse treatment admissions, and crude rates per 10,000 population for kilograms of OPR sold.

Prescription Opioid Abuse – an “American Epidemic”

- Accidents (unintentional injuries) were the 5th leading cause of death in the US in 2010.
- Among persons 1-44 years of age accidents represented #1 cause of death.
- Within this group, pharmaceuticals were the #1 cause of death

Prescription Opioid Abuse – an “American Epidemic”

- Of the 22,134 medication induced deaths in 2010, 75.2% included opioid analgesics.
- Average health care costs for patients abusing opioids are 8 times higher - $55.7 billion/year


December 17, 2015

Morphine Equivalents Policy and PA Criteria
In alignment with the Governor’s initiative to decrease the misuse and abuse of prescription opioids, the Department will implement a limit on total daily morphine equivalents of 300mg effective 2/1/2016. This includes opioid-containing products where conversion calculations are applied. Prescriptions that cause the member’s drug regimen to exceed the maximum daily limit of 300 milligrams of morphine equivalents (MME) will be denied. In addition, the current policy that limits short-acting opioids to four per day, except for acute pain situations, will continue to be in effect.
AMA seeks move toward opioid alternatives

By Steven Ross Johnson  | June 15, 2016

The largest medical society in the nation is calling for a bevy of actions that would ease physicians' prescriptions of alternatives to opioids and support tools for preventing overdose.

On the last day of the American Medical Association's annual meeting in Chicago, 500 delegates representing 192 entities throughout the country voted on a number of resolutions aimed at helping curb the effect of opioid abuse and misuse in the country.

Dr. Andrew Gurman, who Wednesday was sworn in as the new president of the association, acknowledged physicians have played a role in creating the epidemic.

“We have taken ownership of that, and physicians have taken ownership of being part of the solution,” Gurman said. “But it doesn't happen in a vacuum.”

The AMA House of Delegates called for the group to oppose any barriers that could limit patient access to evidence-based non-opioid and non-pharmacological pain therapies.
Dear Colleague,

I am asking for your help to solve an urgent health crisis facing America: the opioid epidemic. Everywhere I travel, I see communities devastated by opioid overdoses. I meet families too ashamed to seek treatment for addiction. And I will never forget my own patient whose opioid use disorder began with a course of morphine after a routine procedure.

It is important to recognize that we arrived at this place on a path paved with good intentions. Nearly two decades ago, we were encouraged to be more aggressive about treating pain, often without enough training and support to do so safely. This coincided with heavy marketing of opioids to doctors. Many of us were even taught – incorrectly – that opioids are not addictive when prescribed for legitimate pain.

The results have been devastating. Since 1999, opioid overdose deaths have quadrupled and opioid prescriptions have increased markedly – almost enough for every adult in America to have a bottle of pills. Yet the amount of pain reported by Americans has not changed. Now, nearly two million people in America have a prescription opioid use disorder, contributing to increased heroin use and the spread of HIV and hepatitis C.
TO THE EDITOR

Recently, we examined our current files to determine the incidence of narcotic addiction in 39,946 hospitalized medical patients who were monitored consecutively. Although there were 11,882 patients who received at least one narcotic preparation, there were only four cases of reasonably well documented addiction in patients who had no history of addiction. The addiction was considered major in only one instance. The drugs implicated were meperidine in two patients, Percodan in one, and hydromorphone in one. We conclude that despite widespread use of narcotic drugs in hospitals, the development of addiction is rare in medical patients with no history of addiction.

Jane Porter
Hershel Jick, M.D.
Boston Collaborative Drug Surveillance Program Boston University Medical Center

Likelihood to Recommend

3.4

5 responses

Likelihood to Recommend, Prescription Drug Abuse, and Potential Unintended Consequences

Aleksandra Zgierska, MD, PhD; Michael Miller, MD; David Rabago, MD

Perceived impact of Incentives tied to formal patient satisfaction scores

*Preliminary data will be presented here – not for public distribution*
Who is at risk for long-term (>90 days) opioid prescription after surgery?

39,140 opioid naïve geriatric patients in Canada:

- younger age
- lower household income
- comorbidities
- type of surgical procedure

Clarke H, Soneji N, Ko DT, Yun L, Wijeysundera DN. Rates and risk factors for prolonged opioid use after major surgery: population based cohort study. BMJ. 2014;348:g1251
Risk Factors for long-term opioid prescribing after surgery

- 391,139 ambulatory surgery patients ≥66 y/o
- Newly prescribed 7.1% within 7 days of being discharged from the hospital
- Opioids were prescribed to 7.7% at 1 year
- Patients receiving an opioid prescription within 7 days of surgery were 44% more likely to become long-term opioid users within 1 year

Risk Factors for long-term opioid prescribing after surgery

- Combination of two databases: Epic/Clarity & CO APCD
- All adult patients who underwent inpatient surgery at the U. Colorado Hospital within a two-year time frame will be screened for inclusion using the EPIC database.
- Extraction of APCD opioid prescription data for 1-30, 61-90, and 151-180 days post-operation
Long-Term Opioid Use After Inpatient Surgery
– A Retrospective Cohort Study

Preliminary data will be presented here
– not for public distribution
Active opioid ingredients in the post discharge opioid prescriptions in a cohort of 652 patients after Cesarean section.
Cumulative opioid dose in oral morphine equivalents (OME) prescribed to 652 patients upon hospital discharge after Cesarean section.
Bartels K et al.; Opioid Use and Storage Patterns by Patients after Hospital Discharge following Surgery. PLoSOne 2016
After Surgery in Germany, I Wanted Vicodin, Not Herbal Tea

BY FIBROCEPHALOUS JAN. 27, 2018

Rosalie Streser
Thank you!
“Houston we have a problem!”
The epidemic of non medical use of prescription opioids

Myron Yaster, MD
Professor,
Department of Anesthesiology
myron.yaster@childrenscolorado.org

Disclosure
- I have participated/consulted in funded ("sponsored") research by the following "pharmas"
  - Purdue (oxycodone, oxycontin, hydromorphone)
  - Endo (oxymorphone)
- Since very few analgesic drugs have been studied in children, this lecture will include “off label” use of drugs.

Objectives
- Describe a process of discovery and quality improvement in the delivery of medical care that can be used in your own practice
- Describe how we went from the undertreatment of pain to an epidemic of opioid abuse and how this affects your practice
- What are the alternatives?

"The world is full of obvious things which nobody by any chance ever observes."
Sherlock Holmes - The Hound of the Baskervilles
Sir Arthur Conan Doyle

It all started with an observation

An Analysis of 34,218 Pediatric Outpatient Controlled Substance Prescriptions
Jessica A. George, MD,* Paul S. Perk, BS,* Joanne Hurwitz, MD,* Joanne E. Shaji, MD,* Christoph L. Lehmann, MD,‡ Elizabeth O. White, RN,* Benjamin K. Lee, MD, MPH,* and Myron Yaster, MD§

Anesthesia and Analgesia. 2016;122(3):807-813
Analysis of Controlled Substance Prescriptions: Summary of Results

Regardless of the opioid prescribed, providers wrote for very large quantities of drug to be dispensed.

Research Study Questions:

- How well is post-op pain managed?
- How much of the controlled substance prescription remains after 10-14 days at home?
- Is opioid therapy required at 10-14 days? At 6 months post-discharge?
- What do parents know about safe disposal of unused opioids?
Research Study Questions:

- Were they given instructions on how to dispose of leftover meds?
- Who informed them (physician, nurse, pharmacist)?
- Did they dispose of unused meds?
- Are there at-risk individuals in the home? (Adolescents and risk of NMUPO; young children and risk of accidental ingestion.)

Opioid Prescribing for the Treatment of Acute Pain in Children on Hospital Discharge


Parental perception of pain management

Doses Dispensed

Doses Remaining

Myron Yaster, MD

The Epidemic of Non-Medical Use of Prescription Opioids

157
**Storage and Disposal of Morphine at the End of Treatment**

<table>
<thead>
<tr>
<th>Storage, n (%)</th>
<th>Room</th>
<th>Kitchen</th>
<th>Bathroom</th>
<th>Parent's bedroom</th>
<th>Child's bedroom</th>
<th>Other</th>
<th>Open or closed space</th>
<th>Open</th>
<th>Closed</th>
</tr>
</thead>
<tbody>
<tr>
<td>Storage, n (%)</td>
<td></td>
<td>115 (65)</td>
<td>27 (15)</td>
<td>18 (10)</td>
<td>9 (6)</td>
<td>8 (5)</td>
<td>76 (44)</td>
<td>96 (56)</td>
<td></td>
</tr>
<tr>
<td>Disposal of morphine at the end of treatment, n (%)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Return to pharmacy</td>
<td>93 (55)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Throw away</td>
<td>45 (27)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Keep at home</td>
<td>16 (9)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Do not know</td>
<td>16 (9)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**NMUPO and Adolescents**

- 27% mistakenly believe that misusing and abusing prescription drugs is safer than using street drugs.
- 33% say they believe “it’s okay to use prescription drugs that were not prescribed to me to deal with an injury, illness or physical pain.”


2012 Partnership Attitude Tracking Study (PATS)-MetLife Foundation

Myron Yaster, MD

The Epidemic of Non-Medical Use of Prescription Opioids
**Opioids, Pain, and Surgery**

- 51 million Americans undergo surgery/year
- For moderate to severe pain, opioids remain the gold standard for pain management

---

**“Duh!”**

- 80% of patients receive opioids after surgery
- > 80% receive either oxycodone or hydrocodone
- Surgical patients routinely receive the opioids most commonly implicated in overdose deaths

---

**Haven’t we seen this before?**

Pain is the 5th vital sign

---

**Disposition of “left over” opioid**

![Graph showing disposition of leftover opioid](image)

- Told how to dispose
- Actually disposed

---

**Opioidphobia**

Myron Yaster, MD

The Epidemic of Non-Medical Use of Prescription Opioids
We need DATA!

- Type of surgical procedure
- Preoperative patient characteristics
  - Age
  - Gender
  - Race
  - Language
  - Prior opioid or alcohol use/abuse
  - Preoperative medication use (antidepressants, benzodiazepines)

Strategies to limit opioid use after surgery

The “Usual Suspects”

- Regional and Neuraxial Anesthesia
- Multimodal analgesia
  - Acetaminophen
  - NSAIDs
  - Gabapentenoids
- Non pharmacologic approaches

PK it’s not just for exams

Acetaminophen AND Ibuprofen

Current and Future Targets

- **NMDA Receptor Blockade**
  - Ketamine, Methadone, Dextromethorphan

- **Opioid Receptor**
  - Mu, Kappa, Delta, Neuropeptide nociception
  - Peripherally active agonists
  - Biased ligands

- **Alpha 2 agonists**
  - Clonidine, Tizanidine, Dexmedetomine

Peripherally restricted opioids

- Reduced side effect profile and minimum abuse and drug seeking behavior

- **Kappa** peripherally restricted agonists are in phase 2 and 3 trials and are effective for acute, chronic, inflammatory and visceral pain as well as pruritus

Biased Ligand Opioids

- Combine a classic mu agonist with a beta arrestin molecule modulating opioid side effects. Specifically reducing:
  - Tolerance
  - Respiratory depression
  - Pruritus

  - In phase 2 trials

Cannabinoids

- Cannabinoid receptors (CB1 and CB2) are G protein coupled receptors (like opioids).

  - CB1 receptors are in spinal cord neurons, particularly dorsal root ganglia
  - CB2 are in spinal cord microglia

- Psychotropic and abuse potential effects are CB1, analgesia are CB1 and CB2

Cannabinoids

- There is NO postoperative data

- There is A LOT of anectodal data, particularly for opioid substitution

- There is evidence that it may be effective in neuropathic pain

- We NEED data but there are enormous hurdles in studying a Class 1 drug
Conclusions Future Directions

- Need to identify reasons for overprescribing of these meds and mitigate risk to patient by behavior change and data-driven practices
- Develop new methods of disposal

**BUT**

- We can’t forget the need for humane pain management which for moderate to severe pain almost always requires opioids

A Journey of Discovery

“Houston we have a problem!”
The epidemic of non medical use of prescription opioids

Myron Yaster, MD
Professor,
Department of Anesthesiology
myron.yaster@childrenscolorado.org
The Opioid Crisis: Addiction and Anesthesia

Rachael Rzasa Lynn, MD
Department of Anesthesiology
University of Colorado School of Medicine

Addiction

- Chronic disease of reward, motivation and memory
- Biological, psychological, social and spiritual manifestations
- Characterized by:
  - Inability to abstain from use
  - Loss of control of use of the substance
  - Compulsion and craving for the substance
  - Persistent use of the substance despite possible harmful consequences
- Cycles of relapse and remission

Pseudoaddiction?

- The idea that drug-seeking behaviors typically associated with addiction may reflect undertreated pain rather than addiction
  - Defined based upon the patient’s motivation in seeking opioid: pain relief (pseudo-) vs euphoria (addiction)
  - No evidence to support this phenomenon
  - Pain and addiction co-exist!
    - Pain is one of the most common symptoms of opioid withdrawal
    - Chronic pain is associated with more opioid craving among patients on opioid maintenance for OUD
- However, tolerance is a well-described and researched phenomenon and must be treated adequately

Conflicts

- None

Evaluation of Patient for OUD

CAGE-AID (Adapted to Include Drugs):
1. In the last three months, have you felt you should cut down or stop drinking or using drugs?
2. In the last three months, has anyone annoyed you or gotten on your nerves by telling you to cut down or stop drinking or using drugs?
3. In the last three months, have you felt guilty or bad about how much you drink or use drugs?
4. In the last three months, have you been waking up wanting to have an alcoholic drink or use drugs?

DSM-5 Diagnosis of Opioid Use Disorder (OUD)

2 or more of the following within 12 months:
- Using larger amounts of opioids or over longer time than intended
- Persistent desire to cut down or failure to control use
- Inordinate time spent obtaining, using, or recovering from use
- Craving, or a strong desire or urge to use substance
- Failure to fulfill major role obligations at work, school, or home due to recurrent opioid use
- Continued use despite recurrent or persistent social or interpersonal problems caused or exacerbated by opioid use
- Giving up or reducing social, occupational, or recreational activities due to opioid use
- Recurrent opioid use in physically hazardous situations
- Continued opioid use despite physical or psychological problems caused or exacerbated by its use
- *Tolerance (marked increase in amounts; marked decrease in effect)
- Withdrawal syndrome with cessation of opioids or use of opioids (or related substance) to relieve or avoid withdrawal symptoms.
Evaluation of Patient with OUD

- Obtain a comprehensive history
  - Establish trust and effective communication to obtain an honest history; remain non-judgmental
  - Dosage
  - Frequency
  - Time of last dose
  - Illicit drug use
  - When possible, verify dosing regimen with opioid maintenance provider
- Consider urine drug screen (UDS)
  - If negative, patient may be diverting medication
  - False positives possible, time consuming to verify
  - Will not give any information about past misuse

Identifying Who Is at Risk

- Screening
  - Self report Questionnaires
    - Assess risk of abuse with chronic opioid therapy
- Urine Drug Screening
- Check the state Prescription Drug Monitoring Program

Factors for Opioid Addiction or Abuse

- Risk Factors among adults on ≥ 90 days of COT
  - Not being married (population of reference)
  - Younger age
  - Current Mental Health Disorder
  - Current physical disorder
  - High level of pain (e.g., > 6/10)
  - Chronic pain due to patients on multidrug therapy
  - Back pain
  - Migraine
  - High levels of health care visits or “poor” health
  - History of opioid abuse
  - Current non-opioid use disorder
  - Having an Rx for ≥ 21-day supply in 12 months
  - Treatment with short acting opioid
  - Treatment with long acting opioid

- Additional Risk Factors
  - Genetics
  - Certain medications in genome for the α, γ, or δ opioid receptor

- Protective Factors
  - Positive well being
  - Better employment
  - Having health insurance
  - Among adults on ≥ 90 days of COT:
    - Lower prescribed dosage
    - Longer prescribed supply

SOAPP-1.0 SF (Short Form)

- Scale 0 = Never, 1 = Seldom, 2 = Sometimes, 3 = Often, 4 = Very Often
  1. How often do you have mood swings?
  2. How often do you smoke a cigarette within an hour after you wake up?
  3. How often have you taken medication other than the way that it was prescribed?
  4. How often have you used illegal drugs (for example, marijuana, cocaine, etc.) in the past five years?
  5. How often, in your lifetime, have you had legal problems or been arrested?
- Score ≥ 4 is Positive (86% sensitivity, 67% specificity; 69% PPV and 85% NPV)

Opioid Risk Tool

| Score of ≤3 = low risk for future opioid abuse |
| Score of 4 to 7 = moderate risk for opioid abuse |
| Score of ≥8 = high risk for opioid abuse |

<table>
<thead>
<tr>
<th>Measure</th>
<th>Scale</th>
</tr>
</thead>
<tbody>
<tr>
<td>Family history of substance abuse</td>
<td>1 3</td>
</tr>
<tr>
<td>Regular use of alcohol</td>
<td>2 4</td>
</tr>
<tr>
<td>History of substance abuse</td>
<td>3 4</td>
</tr>
<tr>
<td>Age between 35–45 years</td>
<td>1 5</td>
</tr>
<tr>
<td>History of substance abuse</td>
<td>3 5</td>
</tr>
<tr>
<td>Psychological issues</td>
<td>2 5</td>
</tr>
</tbody>
</table>

Importance of Perioperative Pain Management

- More than 80% of surgical patients experience postoperative pain, and 86% of these patients rated the pain as moderate, severe or extreme
  - Untreated pain risks persistent post-operative pain
    - Supported by both retrospective (recall bias) and prospective studies
  - Patients who attribute pain to trauma or surgery experience more emotional distress and higher pain than those whose pain was not associated with acute event
**CDC Guideline for Prescribing Opioids for Chronic Pain — United States, 2016**

**Regarding Acute Pain:**
- “Long-term opioid use often begins with treatment of acute pain. When opioids are used for acute pain, clinicians should prescribe the lowest effective dose of immediate-release opioids and should prescribe no greater quantity than needed for the expected duration of pain severe enough to require opioids. Three days or less will often be sufficient; more than seven days will rarely be needed (recommendation category: A; evidence type: 4).”

**CDC Guideline for Prescribing Opioids for Chronic Pain — United States, 2016**

- Regarding Acute Pain:
  - “A greater amount of early opioid exposure is associated with greater risk for long-term use (KZS).”
  - “Limiting days of opioids prescribed also should minimize the need to taper.”
  - “Each day of unnecessary opioid use increases likelihood of physical dependence without adding benefit.”
  - “When opioids are needed for acute pain, clinicians should prescribe opioids at the lowest effective dose and for no longer than the expected duration of pain severe enough to require opioids.”
  - “In most cases of acute pain not related to surgery or trauma, a ≤3 days’ supply of opioids will be sufficient.”
  - “Acute pain can often be managed without opioids.”
  - “Given longer half-lives and longer duration of effects (e.g., respiratory depression) with ER/LA opioids, clinicians should not prescribe ER/LA opioids for the treatment of acute pain.”

---

**Opioid Crisis: Role of Prescription Opioids**

- In 2013, 1.9 million people abused or dependent upon prescription opioid (DSM-IV dx criteria)
- Having a history of opioid analgesic rx increases risk for overdose and OUD
  - 1/550 patients died from opioid-related overdose at median of 2.6 yrs from first opioid rx
  - 1/32 patients on >200 MME died from opioid overdose

---

**Reducing Long-Term Use**

- Use of opioid for acute pain associated with long-term use
- Higher initial exposure (dose, duration/days supplied) also associated with long-term use
- Not all acute pain requires treatment with opioids!
- Why do we care what our patients do for pain long-term?

---

**Risk Factors for OUD**

- The use of prescription opioids for chronic non-cancer pain was a strong risk factor for OUD
  - BUT duration of therapy was a greater determinant of OUD development than daily dose
    - <0.2% on low-dose/acute opioids vs 6% on high dose/chronic
      - >120mg MED/90 days
Do Chronic Pain and Opioid Use Disorder Coexist?

- Estimates of OUD prevalence among patients on COT for chronic pain vary
  - Several studies have quoted <1-5%
  - A large meta-analysis concluded that addiction was present in 8-12% of patients on COT for chronic pain
  - Still others have estimated the prevalence of OUD at 20-35%
- Far more people use these drugs for intended medical purposes than misuse/abuse them!

Opioids Change the Brain!

- One month of morphine for chronic pain led to morphologic changes on MRI that were not seen with placebo treatment
  - Amygdala, medial orbitofrontal gyrus, hypothalamus, midcingulate, inferior frontal gyrus, ventral posterior cingulate, caudal pons, and dorsal posterior cingulate
- These changes persisted several months after morphine was tapered

Non-Pharmacologic Interventions for Pain

- Expectations
  - What is patient’s pre-operative pain baseline?
  - What is patient’s target number?
  - 0/10 is not a reasonable goal!
  - Focus on function (ambulation, PT, sleep) rather than #
- Interventions
  - Most low cost, few if any adverse effects
    - Aromatherapy
    - Lavender for post-operative pain
    - Music therapy
    - Progressive pain, post-operative pain, obstetric
    - Relaxation breathing
    - Acupuncture
- Joint Commission Standards Effective January 1, 2018

Relationship between opioid dependence and addiction

- One month of morphine for chronic pain led to morphologic changes on MRI that were not seen with placebo treatment
  - Amygdala, medial orbitofrontal gyrus, hypothalamus, midcingulate, inferior frontal gyrus, ventral posterior cingulate, caudal pons, and dorsal posterior cingulate
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- These changes persisted several months after morphine was tapered

Non-Pharmacologic Interventions for Pain

- TENS
  - 80-150 Hz
  - Meta-analysis found TENS reduced opioid consumption vs placebo at 12, 24 and 48-hours after TKA
- Acupuncture
  - May increase time until first opioid dose after TKA and reduce pain
  - No impact on post-operative opioid dose
  - May reduce pain in first 2 days after TKA and THA
Non-Pharmacologic Interventions for Pain

- Structured attentive behavior ± self hypnosis
  - Attentive, encouraging, provision of sense of control, neutral descriptors/avoidance of negative suggestions ± script for breathing, self-guided imagery
  - Stable rating of pain throughout procedure in hypnosis group vs linear increase 4/7 time in others
  - Shorter procedure time for hypnosis than standard
  - Less PCA (0.5mg midaz/25ug fentanyl) required per demand use in attention and hypnosis groups: 1.9 units vs 0.8 and 0.9 units, respectively

Hyperalgesia

- Natural phenomenon after injury that serves to facilitate healing
- Central sensitization may lead to pathological persistent pain hyperalgesia
  - Increased CNS hyperexcitability to stimuli

The Impact of Intra-Operative Opioids

- In animal model of spinal nerve injury, exposure to morphine after trauma leads to sensitization, allostynia
  - Lower threshold for mechanical stimulation of paws
  - May be via immune activation of glial cells

Hyperalgesia

- In human studies, techniques that are opioid-sparing (multimodal) associated with less post-operative pain and opioid use
  - Avoidance of intra-operative opioid with use of beta-blocker infusion results in lower post-op pain scores and opioid use
  - In some studies, even results in less chronic neuropathic pain

Do Non-Opioid Adjuncts Impact Long-Term Pain or Opioid Outcomes?

- Gabapentinoids
  - Single pre-operative pregabalin dose or continued administration peri-operatively can reduce post-operative pain scores
  - Randomized, placebo-controlled trial of 240 patients given pregabalin pre-op and for 14 days after surgery
    - Lower post-operative opioid consumption than placebo
    - Earlier achievement of hospital discharge criteria (~9 hrs)
    - Greater active ROM (functional)
    - Lower incidence of neuropathic pain at 3 and 6 months post-op
      - 0% vs 8.7 and 5.2%

Do Non-Opioid Adjuncts Impact Long-Term Pain or Opioid Outcomes?

- Gabapentinoids
  - Gabapentin has similarly been shown to reduce pain at 6 months after orthopedic, ENT, breast and abdominal/pelvic surgery
  - In a recent RCT, gabapentin did not accelerate cessation of post-operative pain, but increased probability of opioid cessation after surgery (by 24%) and reduced duration of opioid therapy (mean 25 days vs 32 days for placebo)
Do Non-Opioid Adjuncts Impact Long-Term Pain or Opioid Outcomes?

- Local Anesthetic Techniques

Management of Patient with OUD

- No RCTs of acute pain management in patients on maintenance therapy for OUD
  - No evidence that exposure to opioids for acute pain increases relapse risk
    - Suggested that the stress of uncontrolled pain may trigger relapse

Management of Patient with OUD

- Has not been studied in opioid-tolerant patients
  - Still WIDELY recommended to use a multi-modal approach in such patients where opioids may be ineffective (tolerance, OIH, etc.)
    - regional anesthesia
    - NSAIDs or COX-2 Inhibitors
    - acetaminophen
    - NMDA antagonists
    - α2 agonists
    - anti-convulsants
Ultrasound machines produce sound waves
- They listen for what returns and create an image

- Denser tissues reflect more waves
  - tissues are more “hyperechoic” or white
- Less dense tissues allow them to pass through
  - Tissues which are “hypoechoic” reflect waves poorly or not at all

- High frequency waves (short wavelength)
  - Penetrates minimally into tissues
  - Excellent resolution
  - Great for shallow structures (up to about 6cm)
  - Linear probe
  - 99% of use

- Low frequency waves
  - Penetrate deep into tissues
  - Resolution not as good
  - Great for deep structures
  - Curvilinear probe
  - Appropriate for deep (>5cm) U/S blocks

Preferred Ultrasound Machine
- High Frequency: 10MHz – 15MHz
- Depth 1-6 cm (for linear probe)
- Needle finding technology
- Color capability for vascular structures
- Time Gain Compensation
- Wireless capability for Medical Record upload
- As few buttons as possible/necessary

Disclosures
- There are NO disclosures for any of the faculty participating.

Kyle Marshall, MD
Ultrasound-Guided Regional Anesthesia for Beginners

Ultrasound-Guided Regional Anesthesia Workshop
**Ultrasound Basics**

- **Depth**
  - Find ideal depth!
    - Use as little depth as needed for a block, it will improve your picture of the structures you want
  - Increased depth, means decreased frequency will be needed to have a good picture
    - Due to low frequency, resolution will suffer!

**How to use a Probe**

- **Gel**: Allows for transmission of sound waves
- **Always support your hand against the patient**

  **Anisotropy**:
  - Small changes in tilt of probe can vastly improve picture

**Ultrasound and Needle**

**Principles of UGRA**

- **Before the Block**:
  - Know how to manage Local Anesthetic Toxicity!
  - Practice hand/eye coordination
  - Know your anatomy
  - Be patient and optimize picture (depth/gain)
  - Position your patient to optimize view and ergonomics

- **Block Time**:
  - Use in-plane view when possible
  - Don’t advance needle if unsure of position
  - Do not penetrate nerve
    - Paresthesia, pain or difficult injection? Pull back, re-direct
  - Ensure good local anesthetic spread
  - Use less local anesthetic if block looks good

**Gain**:

- Amplifies returning sound waves, to make signal brighter or darker... Need to get it JUUUST right.
- Newer machines are optimized, don’t change

**How to use a Probe & Needle**

- Find your favorite view, and stick with it!
- Only small changes in anisotropy

- Don’t chase your needle!
  - Finding it in “no man’s land” does not help
  - Improve needle placement
    - So that changes in anisotropy will make it visible
  - Look at your hands, before the screen
  - Practice!
New Format for CRASH 2018

- Two Nights!
- Beginner

- Advanced
- 8 stations with models
- Blue Phantom/needle station for practice!
  - If you are beginner, this is a great place to start!

CRASH 2018 Faculty

- Kyle Marshall, MD  UCH
- Beth Bennish, MD  DH
- Chris Ciarallo, MD  DH/CHC
- Seth Eisdorfer, MD  CHC
- Roland Flores, MD  UCH
- Chris Lace, MD  UCH
- Glenn Merritt, MD  CHC
- Olivia Romano, MD  UCH
- Marina Shindell, DO  UCH
- Fellows: Matt Lyman, MD & Thomas Brinkley, MD

Thank you to our Vendors!

- Mindray: Darryl Wilson
- Philips: Aaron Rhoades
- Sonosite: Kristi Howe
Wednesday
Goals and Objectives: Following the lecture, the audience should:

PACU Management of the Obese Patient

- Use goal directed fluid management to minimize postoperative complications.
- Improve oxygenation after surgery
  - including the safe use CPAP and BiPAP following gastric bypass procedures.
- Diagnose gastric leak syndrome.
- Recognize and treat rhabdomyolysis.
**PACU: Anastomotic Leak – Gastric Bypass**

- 1-2% after RYGBP
- Diagnosis often difficult – subtle clinical signs
  - 10-20% mortality
  - Mortality related to delayed diagnosis and treatment


---

**Anastomotic Leak**

- Failure to improve
- Abdominal pain
- Increased iv fluid requirements
- Hiccups
- Progresses rapidly to overwhelming sepsis, necrotizing soft tissue infection, multi-system organ failure, and death
- Pulmonary dysfunction (symptoms may be confused with PE)

---

**Thromboembolism - DVT/PE Risk in Obesity**

- Postoperative immobilization
- Large blood volume
- Relative polycythemia
- High serum lipid and fatty acid levels
- Diabetes
- Pneumoperitoneum

- PE (1-2%)
- Most common cause of perioperative death (1/3 fatal)
- Symptomatic DVT < 1 %
- DVT prophylaxis with compression boots and SQ Heparin
- Early ambulation
- Prophylactic IVC filter (???)
- Differential diagnosis in PACU is anastomotic leak

---

**“Bariatric Leak Syndrome”**

- Sinus tachycardia (>120 bpm)
- Tachypnea (>30 rpm)
- Fever (may be absent)
- Absence of typical findings of peritonitis
- Feeling of anxiety-impending doom

---


---

**Out-patient Gastric Bypass (2005)**

- N = 2000 patients
- Length of Hospital Stay
  - PACU:
    - Anastomotic Leak
      - Gastric Bypass
        - 1-2% after RYGBP
        - Diagnosis often difficult – subtle clinical signs
          - 10-20% mortality
          - Mortality related to delayed diagnosis and treatment

---

Jay B. Brodsky, MD PACU Management of the Obese Patient

---

**Thromboembolism - DVT/PE Risk in Obesity**

- PE (1-2%)
- Most common cause of perioperative death (1/3 fatal)
- Symptomatic DVT < 1 %
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- Early ambulation
- Prophylactic IVC filter (???)
- Differential diagnosis in PACU is anastomotic leak
Management Of Leaks Following Gastric Bypass Surgery


Sleeve Gastroctomy


Bariatric Procedures – United States

<table>
<thead>
<tr>
<th>Year</th>
<th>Total</th>
<th>RNY</th>
<th>Band</th>
<th>Sleeve</th>
<th>RNYDS</th>
<th>Other</th>
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<tr>
<td>2011</td>
<td>138,000</td>
<td>36.7%</td>
<td>35.4%</td>
<td>17.8%</td>
<td>9.9%</td>
<td>6.0%</td>
</tr>
<tr>
<td>2012</td>
<td>173,000</td>
<td>35.5%</td>
<td>20.2%</td>
<td>33.0%</td>
<td>7.0%</td>
<td>6.0%</td>
</tr>
<tr>
<td>2013</td>
<td>179,000</td>
<td>34.2%</td>
<td>14.0%</td>
<td>42.1%</td>
<td>1%</td>
<td>6.0%</td>
</tr>
<tr>
<td>2014</td>
<td>193,000</td>
<td>26.8%</td>
<td>9.5%</td>
<td>51.7%</td>
<td>11.0%</td>
<td>1%</td>
</tr>
<tr>
<td>2015</td>
<td>196,000</td>
<td>23.1%</td>
<td>5.7%</td>
<td>53.8%</td>
<td>13.6%</td>
<td>3.2%</td>
</tr>
</tbody>
</table>

Minimally and Non-Invasive Bariatric Procedures

Intra-Gastric Balloon

Type 1: Single Balloon

Type 2: Dual-Balloon

Natural Orifice Trans-Endoluminal Surgery (NOTES)

Endoluminal Transoral Gastroplasty
**EndoBarrier** "gastric condom" - an impermeable sleeve that lines the first 60 cm of the small intestine

**AspireAssist**

**Risk Score for Postoperative Nausea and Vomiting (PONV)**

<table>
<thead>
<tr>
<th>Risk factors</th>
<th>Points</th>
</tr>
</thead>
<tbody>
<tr>
<td>Female gender</td>
<td>1</td>
</tr>
<tr>
<td>Non-smoker</td>
<td>1</td>
</tr>
<tr>
<td>History of PONV</td>
<td>1</td>
</tr>
<tr>
<td>Postoperative opus</td>
<td>1</td>
</tr>
</tbody>
</table>

**PACU: Obesity and PONV - calculated risk**

<table>
<thead>
<tr>
<th>Risk factors</th>
<th>Underweight n=67</th>
<th>Normal weight n=203</th>
<th>Overweight n=113</th>
<th>Obesity n=32</th>
<th>BMI</th>
<th>Postoperative vomiting (PV)</th>
<th>Postoperative nausea (PN)</th>
<th>Nausea and vomiting (PONV)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Female gender</td>
<td>18.5 (20.8)</td>
<td>27.8 (27.0)</td>
<td>27.8 (23.2)</td>
<td>30.4 (27.9)</td>
<td>19.0</td>
<td>27.8</td>
<td>27.8</td>
<td>27.8</td>
</tr>
<tr>
<td>History of PONV</td>
<td>0.0 (0.0)</td>
<td>0.0 (0.0)</td>
<td>0.0 (0.0)</td>
<td>0.0 (0.0)</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
</tr>
<tr>
<td>Adiposity</td>
<td>0.0 (0.0)</td>
<td>0.0 (0.0)</td>
<td>0.0 (0.0)</td>
<td>0.0 (0.0)</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
</tr>
<tr>
<td>Age</td>
<td>0.0 (0.0)</td>
<td>0.0 (0.0)</td>
<td>0.0 (0.0)</td>
<td>0.0 (0.0)</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
</tr>
<tr>
<td>Age (category)</td>
<td>0.0 (0.0)</td>
<td>0.0 (0.0)</td>
<td>0.0 (0.0)</td>
<td>0.0 (0.0)</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
</tr>
</tbody>
</table>

**PACU: Obesity and PONV - incidence**

<table>
<thead>
<tr>
<th>Risk factors</th>
<th>Underweight</th>
<th>Normal weight</th>
<th>Overweight</th>
<th>Obesity</th>
</tr>
</thead>
<tbody>
<tr>
<td>PV 0-24 h</td>
<td>15.0</td>
<td>17.8</td>
<td>27.4</td>
<td>29.3</td>
</tr>
<tr>
<td>PN 0-24 h</td>
<td>30.2</td>
<td>26.0</td>
<td>26.0</td>
<td>26.0</td>
</tr>
<tr>
<td>PONV 0-24 h</td>
<td>39.4</td>
<td>46.6</td>
<td>39.4</td>
<td>46.6</td>
</tr>
<tr>
<td>PV 24-72 h</td>
<td>30.2</td>
<td>26.0</td>
<td>26.0</td>
<td>26.0</td>
</tr>
<tr>
<td>PN 24-72 h</td>
<td>30.2</td>
<td>26.0</td>
<td>26.0</td>
<td>26.0</td>
</tr>
<tr>
<td>PONV 24-72 h</td>
<td>30.2</td>
<td>26.0</td>
<td>26.0</td>
<td>26.0</td>
</tr>
</tbody>
</table>

**PACU: Obesity is NOT a risk factor for PONV - incidence**

<table>
<thead>
<tr>
<th>Risk factors</th>
<th>Underweight</th>
<th>Normal weight</th>
<th>Overweight</th>
<th>Obesity</th>
</tr>
</thead>
<tbody>
<tr>
<td>PV 0-24 h</td>
<td>15.0</td>
<td>17.8</td>
<td>27.4</td>
<td>29.3</td>
</tr>
<tr>
<td>PN 0-24 h</td>
<td>30.2</td>
<td>26.0</td>
<td>26.0</td>
<td>26.0</td>
</tr>
<tr>
<td>PONV 0-24 h</td>
<td>39.4</td>
<td>46.6</td>
<td>39.4</td>
<td>46.6</td>
</tr>
</tbody>
</table>

Jay B. Brodsky, MD

PACU Management of the Obese Patient

Multi-Modal Prophylactic Management

- DEX = dexamethasone
- DROP = droperidol
- OND = ondansetron

**Efficiency can be improved with combination prophylactic antiemetic therapy:**
- Blocking more than 1 of the 4 major serotonin receptors (5-HT₁, 5-HT₂, 5-HT₃, 5-HT₄)
- DEX interacts with serotonin 5-HT₃ receptor
- GABA receptor
- Anti-emetic sensitivity isn’t reduced by addition of an anti-emetic

**Aprepitant (Emend™)**
- Blocks the neurokinin 1 receptor
- Aprepitant’s prophylactic efficacy in decreasing postoperative nausea and vomiting

**Conclusion:** In morbidly obese patients undergoing laparoscopic bariatric surgery, addition of aprepitant to ondansetron can significantly delay vomiting episodes.


**Agent**
- Aprepitant
- Ondansetron
- DEX
- Dexamethasone
- Mirtazapine
- Droperidol
- Metoclopramide

**Receptor**
- Dopamine type 2 (D₂)
- Serotonin type 3 (5-HT₃)
- Serotonin type 1 (5-HT₁)
- Dopamine type 4 (D₄)

**Location**
- Stomach, small intestine, C12, area postrema and NTS
- NTS, CTZ, area postrema and NTS

**Table 3**

<table>
<thead>
<tr>
<th>Group</th>
<th>Aprepitant</th>
<th>No Aprepitant</th>
</tr>
</thead>
<tbody>
<tr>
<td>In PACU</td>
<td>19 (1)</td>
<td>20 (1)</td>
</tr>
<tr>
<td>1h after PACU</td>
<td>19 (1)</td>
<td>20 (1)</td>
</tr>
<tr>
<td>2 h after PACU</td>
<td>19 (1)</td>
<td>20 (1)</td>
</tr>
<tr>
<td>3 h after PACU</td>
<td>19 (1)</td>
<td>20 (1)</td>
</tr>
<tr>
<td>6 h after PACU</td>
<td>19 (1)</td>
<td>20 (1)</td>
</tr>
<tr>
<td>12 h after PACU</td>
<td>19 (1)</td>
<td>20 (1)</td>
</tr>
</tbody>
</table>

**Conclusion:** Addition of aprepitant to a multimodal antiemetic prophylactic regimens may be associated with significant reduction of PONV during early recovery and potentially with reduced incidence of vomiting during the first 48 postoperative hours.

Emend (Merck) average cost $102/pill


**Strategies To Reduce PON(V)**

- Multimodal intraoperative prophylaxis
- Use regional anesthetic techniques
- Propofol for induction and maintenance of anesthesia
  - avoid nitrous oxide and volatile anesthetics (ie T.I.V.A.)
- Minimize perioperative opioids
- Avoid neostigmine (use sugammadex)
- Adequate hydration

- 338 pts received triple antiemetics (dexamethasone, droperidol, ondansetron *)
- 172 (51%) received aprepitant (40 mg.q.i.v.) vs 166 (49%) control
- Rates of PONV in the PACU were 11% (aprepitant) vs 17% (control) (P = .09)
- 1 h after PACU discharge, fewer patients in the aprepitant group (19%) had PONV vs control (31%)
- During the first 48 postoperative hours, PONV rates were similar between the groups (38 vs 36%)
- All patients were discharged on antiemetics
  - * some patients had TIVA (propofol), some had scopolamine patch, no N₂O
**PONV PACU - N (%)**

<table>
<thead>
<tr>
<th></th>
<th>Group R</th>
<th>Group A</th>
<th>Group F</th>
</tr>
</thead>
<tbody>
<tr>
<td>No nausea or vomiting</td>
<td>14/70.0*</td>
<td>12/80.0</td>
<td>19/86.36</td>
</tr>
<tr>
<td>Nausea</td>
<td>5/25.0*</td>
<td>3/20.0</td>
<td>3/13.64</td>
</tr>
<tr>
<td>Vomiting</td>
<td>1/5.0*</td>
<td>0/0</td>
<td>0/0</td>
</tr>
</tbody>
</table>

Values are mean ± SD; *P<0.05 compared with Group F.

Gaszynski et al. Post-anesthesia recovery after infusion of propofol with remifentanil or alfentanil or fentanyl in morbidly obese patients. Obes Surg 2004; 14: 498-504

**Sugammadex (S) vs Neostigmine (N)**

Conclusion: Neostigmine (N) associated with increased PONV in PACU and required more anesthetic rescue medication during the postoperative 24 hours.


**Fluid Management in Morbid Obesity**


**Intraoperative administration of 40 mL/kg vs 15 mL/kg LR**

Improved postoperative organ functions and recovery and shortened hospital stay after laparoscopic cholecystectomy


**Dose from Ideal Body Weight (%)**

- Improved exercise capacity
  - Less orthostatic hypotension
  - Earlier ambulation
  - Less PONV

TABLE 5. Effects of Pneumoperitoneum on Intraoperative Urine Output and Postoperative Renal Function in the Morbidly Obese

<table>
<thead>
<tr>
<th>Function</th>
<th>Status</th>
</tr>
</thead>
<tbody>
<tr>
<td>Intraoperative urine output</td>
<td>Decreased</td>
</tr>
<tr>
<td>Intraoperative hormonal changes</td>
<td></td>
</tr>
<tr>
<td>Antidiuretic hormone</td>
<td>Increased</td>
</tr>
<tr>
<td>Aldosterone</td>
<td>Increased</td>
</tr>
<tr>
<td>Plasma renin activity</td>
<td>Increased</td>
</tr>
<tr>
<td>Postoperative renal function</td>
<td></td>
</tr>
<tr>
<td>Blood urea nitrogen</td>
<td>Decreased</td>
</tr>
<tr>
<td>Creatinine</td>
<td>Decreased</td>
</tr>
<tr>
<td>Creatinine clearance</td>
<td>Unchanged</td>
</tr>
</tbody>
</table>


Fluid Replacement in Obese Patients

- No “evidence based” studies on obese patients - practice recommendations based on studies of non-obese patients
- Use “liberal” amounts of crystalloid in laparoscopic procedures
- Use goal directed amounts of colloid in open (laparotomy) procedures
- Aggressive crystalloid administration for long duration surgery (avoid rhabdomyolysis)

Postoperative Pulmonary Complications


Obstructive Sleep Apnea

Supine Position

Inovcs increased intra-abdominal pressure (IAP) decreased chest wall compliance and lung volume
CPAP after RYGB does not result in increased the morbidity


Pain after Laparoscopy

Morphine requirements 24 hrs after laparoscopic vs laparotomy gastric bypass


CPAP did not increase transmural gastric pouch pressure in laparoscopic bariatric patients

CPAP following RYGB did not pose a risk for pouch distension


Laparoscopy is more painful in PACU (0-4 hrs); after 24 hrs laparoscopy is relatively "painless"


PACU pain following Laparoscopy: somatic + visceral

Peritoneal irritation:

- CO₂ in the abdomen - carbonic acid (air, helium, xenon)
- Higher intra-peritoneal pressure is associated with more intense pain than lower pressure
- Cold gas
- Dry gas
- Blood left in the abdomen after surgery
- Diaphragmatic irritation (retained gas)
- Intraoperative pressure on capillary beds in the abdominal and possibly retroperitoneal viscera, causing nociception
- Peritoneal stretching

Heated CO₂ Insufflation - PAIN

Intraoperative intranasal nicotine as an analgesic

<table>
<thead>
<tr>
<th>Group</th>
<th>No nicotine (n=24)</th>
<th>Nicotine (n=24)</th>
<th>P value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pain score</td>
<td>3.3 (2.0)</td>
<td>2.1 (1.5)</td>
<td>0.028</td>
</tr>
<tr>
<td>Morphine use</td>
<td>4 (2.9%)</td>
<td>1 (0.8%)</td>
<td>0.05</td>
</tr>
<tr>
<td>Mucous membranes</td>
<td>9 (6.3%)</td>
<td>2 (1.5%)</td>
<td>0.056</td>
</tr>
<tr>
<td>Oral intake of fluids before surgery</td>
<td>42 (76.4%)</td>
<td>19 (34.5%)</td>
<td>0.001</td>
</tr>
<tr>
<td>Early mobilization ability (6 h after surgery)</td>
<td>46 (72.7%)</td>
<td>14 (25.7%)</td>
<td>0.001</td>
</tr>
</tbody>
</table>

Conclusion: Intraoperative intranasal nicotine did not exhibit opioid sparing effect in non-smoking bariatric female patients. Despite antiemetic prophylaxis, nicotine was associated with the higher frequency of the use of rescue antiemetics in PACU.


PAIN in PACU – TIVA ANESTHESIA

<table>
<thead>
<tr>
<th>VAS</th>
<th>Pain</th>
<th>Group R</th>
<th>Group A</th>
<th>Group F</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>No pain</td>
<td>0/0</td>
<td>0/0</td>
<td>0/0</td>
</tr>
<tr>
<td>1</td>
<td>Small</td>
<td>6/30.0*</td>
<td>6/40.0</td>
<td>11/50.0</td>
</tr>
<tr>
<td>2</td>
<td>Mild</td>
<td>9/45.0</td>
<td>7/46.7</td>
<td>10/45.5</td>
</tr>
<tr>
<td>3</td>
<td>Disturbing</td>
<td>5/25.0*</td>
<td>2/13.3</td>
<td>1/4.5</td>
</tr>
<tr>
<td>4</td>
<td>Strong</td>
<td>0/0</td>
<td>0/0</td>
<td>0/0</td>
</tr>
<tr>
<td>≥5</td>
<td>Severe</td>
<td>0/0</td>
<td>0/0</td>
<td>0/0</td>
</tr>
</tbody>
</table>

Values are mean ± SD; *P<0.05 compared with Group F.

Szegedyi et al. Post-anesthesia recovery after infusion of propofol with remifentanil or alfentanil or fentanyl in morbidly obese patients. Obes Surg 2004; 14: 498-504

110 Bariatric Patients

EXP Group: 300 mg ropivacaine in 200 ml NS instilled intraabdominally before closure

CONT Group: 200 ml NS

<table>
<thead>
<tr>
<th>Group</th>
<th>Experimental</th>
<th>Control</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pain (NRS: mm)</td>
<td>13.3 (10.9)</td>
<td>21.7 (14.5)</td>
</tr>
<tr>
<td>Morphine use</td>
<td>4 (2.9%)</td>
<td>12 (33.9%)</td>
</tr>
<tr>
<td>Mucous membranes</td>
<td>9 (6.3%)</td>
<td>2 (1.5%)</td>
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<td>42 (76.4%)</td>
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<tr>
<td>Early mobilization ability (6 h after surgery)</td>
<td>46 (72.7%)</td>
<td>14 (25.7%)</td>
</tr>
</tbody>
</table>


Sugammadex vs Neostigmine - laparoscopic bariatric surgery

Sugammadex
- Less PONV
- Less postoperative pain
- Reduced rescue opioids
- Shorter PACU stay

<table>
<thead>
<tr>
<th>Sugammadex</th>
<th>Neostigmine</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pain</td>
<td>Group R</td>
</tr>
<tr>
<td>0</td>
<td>No pain</td>
</tr>
<tr>
<td>1</td>
<td>Small</td>
</tr>
<tr>
<td>2</td>
<td>Mild</td>
</tr>
<tr>
<td>3</td>
<td>Disturbing</td>
</tr>
<tr>
<td>4</td>
<td>Strong</td>
</tr>
<tr>
<td>≥5</td>
<td>Severe</td>
</tr>
</tbody>
</table>

Multi-Modal Analgesia

Reduce or eliminate opioids
Avoid long-acting opioids

Rhabdomyolysis (RML)
- Skeletal muscle (*rhabdomyo*) + rapid breakdown (*lysis*) due to injury
- Muscle damage may be caused by physical, chemical, or biological factors
- Destruction of the muscle leads to the release of breakdown products into the bloodstream

Rhabdomyolysis (RML) in Obesity

High muscle pressure
Diabetes, hypertension
Peripheral vascular disease
Muscle ischemia
Long operative time

Rhabdomyolysis

Diagnosis and treatment

Case Reports RML and Bariatric Surgery


Case Series RML and Bariatric Surgery

Dependent areas affected in morbidly obese patients

Rhabdomyolysis

Shoulders
Lumbar area
Buttocks and thighs
**RML – Clinical Features**

- Muscle pain and tenderness
- Swelling
- Bruising
- Weakness

---

**RML - CLINICAL FEATURES**

**Dark Urine** (brown, tea color)
- Anuria
- Fever, Malaise
- Nausea/Vomiting
- Agitation/Confusion/Delirium

---

**RML Diagnosis**

**Creatine kinase (CK)-M chain**
- Elevated in the blood in RML

**CK = 1,000 IU = RML**
- Serum level 5x normal

---

**CK**

**Myoglobin**

Electrolyte Disturbances (early)

Potassium leaves muscle → hyperkalemia
- dysrhythmias
- cardiac arrest
Chloride and Calcium enter injured muscle
- serum hypocalcemia
- calcium retention in muscles and renal tissue
Phosphate leaves cells
- hyperphosphatemia
Metabolic acidosis
- lactic acid into the circulation

RML: Late complications

- Acute renal failure from myoglobinuria (CK > 6,000 IU)
- Disseminated intravascular coagulation
- Compartment syndrome

Prevention

- Discontinue statin therapy
- Reduce weight before bariatric surgery
- Use pneumatic bed
- Change patient position intra- and postoperatively
- Limit operative time
- Perform long duration procedures in 2 stages
- Early postoperative ambulation
- Pad all pressure areas
- Optimal position of patient on OR table
- Aggressive perioperative fluid replacement ***

RML – Intraoperative prevention

- Short operative time < 2-3 hrs
- Hydration > 13 ml/kg/hr
- Encourage postop diuresis > 2.3 ml/kg/hr

8% developed RML (CK > 1,000 IU)

1 clinically significant RML (CK > 5,000 IU)

<table>
<thead>
<tr>
<th>Group</th>
<th>CK (IU)</th>
<th>Sex</th>
<th>Age (yr)</th>
<th>BMI (kg/m²)</th>
<th>Co-morbidities</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>3,141</td>
<td>Female</td>
<td>41</td>
<td>65</td>
<td>Hypertension</td>
</tr>
<tr>
<td>A</td>
<td>2,402</td>
<td>Female</td>
<td>54</td>
<td>50</td>
<td>Diabetes</td>
</tr>
<tr>
<td>A</td>
<td>1,094</td>
<td>Female</td>
<td>61</td>
<td>40</td>
<td>Congestive heart failure</td>
</tr>
<tr>
<td>A</td>
<td>6,244</td>
<td>Female</td>
<td>54</td>
<td>54</td>
<td>Hypertension</td>
</tr>
<tr>
<td>B</td>
<td>1,090</td>
<td>Female</td>
<td>24</td>
<td>57</td>
<td>Diabetes</td>
</tr>
<tr>
<td>A</td>
<td>2,330</td>
<td>Female</td>
<td>41</td>
<td>61</td>
<td>Hypertension</td>
</tr>
<tr>
<td>B</td>
<td>1,453</td>
<td>Male</td>
<td>31</td>
<td>50</td>
<td>Hypertension</td>
</tr>
</tbody>
</table>

Compartment Syndrome

Large volumes of intravascular fluid (up to 12 liters) leaves circulation and enters injured muscle

- Hypovolemia
- Hemodynamic instability
- Shock (further compromise of renal function)

Compartment Syndrome Requiring Fasciotomy

During surgery and postoperatively - iv fluid to maintain diuresis

Morbid Obese Patient

Rhabdomyolysis
Anesthesia for Total Joint Replacement Surgery

Olivia Romano, MD
Assistant Professor
UCH Acute Pain Service Director
University of Colorado School of Medicine

Disclosures
- No financial disclosures
- Will discuss several off-label uses of medications

Objectives
- Discuss multimodal analgesia and regional anesthesia options for joint replacement surgery.
- Discuss elements of Early Recovery After Surgery (ERAS) programs for joint replacement surgery.

Goals of a Clinical Pathway
- Morbidity
- Pain
- Cost
- Length of Stay
- Falls
- Blood transfusion
- Use of Resources
- Surgical Site Infection
- Functional Outcomes

Designing a Clinical Pathway
- RCTs
- Database Studies
- Metanalyses

Many decision points
- Complete Management Plan
Choice of anesthesia

Large database TKA study: SA vs. GA
Pugely, et al.
Results (unadjusted, all p <0.01):
- Complication rate: SA 10.72% vs GA 12.34%
- Superficial wound infection: SA 0.68% vs GA 0.92%
- Blood transfusion: SA 5.02% vs GA 6.07%
- Duration of hospital stay: SA 3.45d vs GA 3.77d

Results (adjusted):
Independent risk factors for complications (all p < 0.05):
- Age 70-79y: OR 1.531
- Age > 80y: OR 2.173
- Female vs male sex: OR 1.176
- Black vs white race: OR 1.678
- Serum creatinine > 1.2 mg/dL: OR 1.474
- ASA class 3 or 4: OR 1.204
- General vs spinal anesthesia: OR 1.129

Large database THA study: RA vs. GA
Helwani, et al.
Results (after matching with controls): RA vs GA
- 30-day mortality: 0.29% vs 0.37% (OR 0.78 CI 0.4 to 1.4) - NOT statistically significant
- Assoc. factors: Revision THA, age > 70y, ASA class 3 or 4, IDDM
- Deep Infection: OR 0.38 (CI 0.20 to 0.72, p < 0.01)
- Assoc. factors: Revision THA, age > 70y & IDDM
- Average hospital LOS: 3.2 vs 3.4 days
- Prolonged hospital LOS: 5% vs 6.6%

Systematic review: TKA & THA pts
Neuraxial vs general anaesthesia for total hip and total knee arthroplasty: a systematic review of comparative-effectiveness research
R. L. Johnson*, S. L. Koop, C. M. Burke, C. M. Driscoll, A. K. Jacob, P. J. Drasin, M. H. Mund and C. B. Montilla

Abstract
Background: "[text...]

Methods: [text...]

Results: [text...]

Conclusion: [text...]

187
Systematic review: TKA & THA pts

- A 2016 systematic review of published RCTs or prospective observational studies comparing outcomes in spinal or epidural vs GA for THA or TKA pts.
- 29 studies from 1989 to 2015
  - RA (spinal or epidural) 2776 pts vs GA 7712 pts
- Results:
  - Hospital stay: slight decrease (-0.4d) with RA
  - No other statistically significant differences between groups

Choice of anesthesia - TKA

- RCT comparing GA (target-controlled infusion of propofol plus remifentanil) vs SA (intrathecal bupivacaine) for TKA in a fast-track setting in Sweden.
- Design:
  - N = 120 pts
  - ASA class 1-3
  - Age 45-85y
  - Exclusions: revision TKA, BMI > 35, rheumatoid arthritis, impaired respiration, allergy to study drugs, preop opioids or steroids, hx of stroke or psych disease that could affect the perception of pain
- Measures:
  - Primary = hospital length of stay
  - Secondary = Actual discharge time, postoperative pain, intraop blood loss, PACU LOS, dizziness, PONV, need for urinary catheterization, patient satisfaction

RCT of TKA protocol: TIVA vs SA

- Preop meds: celecoxib 400mg PO, APAP 1g PO
- Intraop:
  - No tourniquet or drains
  - Tranexamic acid 1g IV, abx prophylaxis; 2L LR over first 24h
  - Randomized to two groups:
    - SA: Bupivacaine 0.5% 3mL intrathecal at L4-5; propofol gtt for light sedation with 2L NC O2
    - GA: Propofol target-controlled infusion (TCI) 10mg/mL plus remifentanil 40mcg/mL
  - Rocuronium 0.6mg/kg for intubation
  - Neostigmine 2.5mg plus glycopyrrolate 0.5mg for NMB reversal
  - Oxycodone 10mg IV 20 min before end of surgery
- Measures:
  - High-volume LIA: Ropiv 0.2% 150mL w epi 10mcg/mL
  - Postop:
    - Celecoxib 400mg PO q 12h, APAP 1g PO q6h
    - IV PCA morphine for 24h at 20mcg/kg 10 min lockout
    - 4h IV hydrocodone 10mg q4h and oxycod. 15mg prn
    - Q6h bladder scans with bladder catheterization protocol

RCT of THA protocol: TIVA vs SA

- Results:
  - No difference in subject characteristics or surgical data
  - LOS: GA group 46h vs SA group 52h (p = 0.001)
  - No difference in actual day of discharge
  - Lower initial pain scores in SA group, but after 6h higher pain scores were seen in GA group
  - 24h morphine consumption: GA 19mg vs SA 54mg
  - Rates of dizziness, ability to walk 5m at 6h & 10h, and need for bladder catheterization showed benefit in the GA group
  - No difference in PE (one pt in each group), blood loss or patient satisfaction

RCT of THA protocol: TIVA vs SA

- Similar RCT comparing GA (target-controlled infusion of propofol plus remifentanil) vs SA (intrathecal bupivacaine) for THA in a fast-track setting in Sweden.
- Nearly identical protocol as TKA (but no LIA)
- Results:
  - LOS: GA 26h vs SA 30h
  - No difference in actual day of discharge
  - Lower initial pain scores in SA group, but after 6h higher pain scores were seen vs GA group
  - GA group had less dizziness & nausea, better ability to walk at 6h, & shorter PACU LOS
  - No difference was seen in blood loss, morphine consumption, need for bladder catheterization

Systematic Review: Cognitive Dysfunction

- Systematic review looking postoperative cognitive dysfunction in elective joint replacement.
- RA showed benefit for first 7 days postoperatively
- Optimize depth of anesthesia with GA - mixed evidence
- Other techniques that may improve PCD:
  - Non-opioid pain management techniques
  - Oral opioid preparations only
  - Avoid all morphine

Summary: Choice of anesthesia

- Overall complication rates are low
- Neuraxial anesthesia probably underutilized
- Patients with multiple comorbidities
- Great outcomes with general anesthesia at some centers
- Specialized fast-track or enhanced recovery after surgery (ERAS) protocols may play a large role in outcomes differences

Choice of analgesia

Multimodal analgesia

- NSAIDs
- APAP
- Ketamine
- Gabapentinoids
- Local anesthetics
- Opioids
THA Regional Analgesia
- Epidural
- Peripheral Nerve Block
- Intrathecal Morphine
- LIA (Local Infiltration Analgesia)

TKA Regional Analgesia
- Entire Knee
- Anterior Knee
- Posterior Knee
- IPACK Block

IPACK Block

Local Infiltration Analgesia (LIA)
- THA infiltration sites
  1. Acetabular capsule, adductor mm, gluteus medius m
  2. External rotators
- TKA infiltration sites
  1. Posterior capsule structures
  2. Periprosthetic structures
  3. Fascia and subcutaneous tissues

Sample recipe (aseptic preparation):
- 200mg ropivacaine
- 30mg ketorolac
- 0.5mg epinephrine
- Dilute with isotonic saline to 100-150mL

Adjuncts
- Liposomal bupivacaine
- Catheter in-situ

Enhanced Recovery Pathways after Total Joint Surgery

Early mobility
- Decreased complications
- Adequate pain control
- Targeted sensory block

Fall Risk
- Motor weakness
- High dose opioids

Olivia Romano, MD
Anesthesia for Total Joint Replacement Surgery
Changes in practice

- Shorter stays - “Fast-Track”
- More aggressive rehabilitation programs
- Partnerships between Acute Pain Medicine specialists and Orthopedic surgeons
- Emphasis on function over “no pain”
- Decreased use of opioids

Other elements of ERAS

- Decreased number of drains & tubes
- Temperature management
- Glucose control
- POIV
- Urinary retention
- Infection risk
- Blood loss
- DVT prophylaxis

Summary

- Changes in practice toward early recovery programs has shifted priorities in care
- Function over no pain
- Decreased reliance on opioids
- Evidence-based choices for anesthesia especially in high risk populations
- Neuropathic pain
- Multimodal analgesics
- Regional anesthesia that works for your institution & practice model

References


Other references

References


CRASH 2018
The Relationship Between Wellness, Resilience and Quality
Alison Brainard MD; Norah Janosy MD; Gina Whitney MD
February, 2018

Objectives
- Understand the connection between provider wellness, quality and safety culture.
- Understand burnout – risk factors, signs and symptoms.
- Experience resilience techniques that are shown to decrease burnout and increase resilience.
- Investigate the national and regional available resources surrounding quality improvement and wellness.

Overview

| Introductions | Literature Overview of Burnout, Quality and Resilience | Use of Root Cause Analysis /Fishbone, PDSA cycle to address Burnout | Individual Assessments, Institutional Algorithms | Individual Resilience Techniques |

Acknowledgments

Jenny Reese, MD
Abbie Beachum, PhD
Vesna Jevtovic-Todorovic, MD, PhD, MBA

How do you define burnout?
“Burnout is the sum total of hundreds of tiny betrayals of purpose, each one so minute that it hardly attracts notice.”

–Richard Gunderman, MD, PhD

Impact of Burnout in Health Care

- Medical Error and Mortality
- Impaired professionalism
- Reduced patient satisfaction
- Staff turnover and reduced hours
- Depression and Suicidal ideation
- Motor vehicle crashes and near misses

Prevalence

- 54% of Physicians report at least one symptom of burnout
- 50% of nurses are emotionally exhausted
- 2 in 3 have difficulty sleeping
- 1 in 4 are clinically depressed

Key Drivers of Burnout and Engagement

- Workload and job demands
- Control and flexibility
- Meaning at work
- Efficiency and innovation
- Organization culture and values
- Social support and community of work
- Work-life integration


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What is a “second victim”?  
- First described by Albert Wu in 2000  
- “… although patients are the first and obvious victims of medical mistakes, doctors are wounded by the same errors: they are the second victims.”

Formal definition:  
- “A health-care provider involved in an unanticipated adverse patient event, medical error and/or a patient-related injury who becomes victimized in the sense that the provider is traumatized by the event.”  
  (Scott et al., 2009)

Quality Improvement  
- “Quality improvement (QI) consists of systematic and continuous actions that lead to measurable improvement in health care services and the health status of targeted patient groups. The Institute of Medicine (IOM), which is a recognized leader and advisor on improving the Nation’s health care, defines quality in health care as a direct correlation between the level of improved health services and the desired health outcomes of individuals and populations.”

Safety Culture  
- “A culture of safety can be defined as an integrated pattern of individual and organizational behavior based upon shared beliefs and values, that continuously seeks to minimize patient harm that may result from processes of care delivery.”

Just Culture  
- “A strategy to develop a just culture employs two complementary ideas. First, it creates a system that encourages reporting of injuries and near misses and keeps individuals safe from blame, shame, and retaliation. Next, the value imparted by open reporting promotes the creation of reliable care processes, which goes beyond vigilance.”

What does it mean to be well?
What is Resilience?

Resilience

- Resilience is the process of negotiating, managing and adapting to significant sources of stress or trauma.
- Assets and resources within the individual, their life and environment facilitate this capacity for adaptation and “bouncing back” in the face of adversity.
- Across the life course, the experience of resilience will vary.

Resilience Measurement Scales

Subjective Rating of Sleep Quality

Please rate your sleep quality over the previous month

<p>| | | | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>Very Good</td>
<td></td>
<td></td>
<td>Very Bad</td>
</tr>
</tbody>
</table>


Perceived Stress Scale - 4 Item

Instructions: The questions in this scale ask you about your feelings and thoughts during the last month. In each case, please indicate with a check how often you felt or thought a certain way.

1. In the last month, how often have you felt that you were unable to control the important things in your life?
   
   _0=never_  _1=almost never_  _2=sometimes_  _3=fairly often_  _4=very often_

2. In the last month, how often have you felt confident about your ability to handle your personal problems?
   
   _0=never_  _1=almost never_  _2=sometimes_  _3=fairly often_  _4=very often_

3. In the last month, how often have you felt that things were going your way?
   
   _0=never_  _1=almost never_  _2=sometimes_  _3=fairly often_  _4=very often_

4. In the last month, how often have you felt difficulties were piling up so high that you could not overcome them?
   
   _0=never_  _1=almost never_  _2=sometimes_  _3=fairly often_  _4=very often_

Mini-Z Burnout Survey

AMA STEPS

https://www.stepsforward.org/modules/physician-burnout-survey
INDIVIDUAL RESILIENCE

"It's a matter of direction. You have choices. You might be surprised or amazed."

Alison Brainard, MD; Norah Janosy, MD; Gina Whitney, MD
The Relationship Between Wellness, Resilience and Quality
**Disclosures**

- There are NO disclosures for any of the faculty participating.

**New Format for CRASH 2018**

- **GOAL:** increase hands-on Ultrasound usage
  - Increase exposure to Faculty
  - 5 blocks
    - Advanced: ICV, SAP, PVB, PECs, QL/ESP
  - 8 stations/models
  - Blue Phantom/needle station for practice!
  - Ask the Faculty anything, at anytime

**CRASH 2018 Faculty**

- Kyle Marshall, MD  UCH
- Beth Bennish, MD   DH
- Chris Ciarallo, MD DH/CHC
- Seth Eisdorfer, MD CHC
- Roland Flores, MD   UCH
- Chris Lace, MD      UCH
- Glenn Merritt, MD   CHC
- Olivia Romano, MD   UCH
- Marina Shindell, DO UCH

  Fellows: Matt Lyman, MD & Thomas Brinkley, MD

**Thank you to our Vendors!**

- Mindray: Darryl Wilson
- Philips: Aaron Rhoades
- Sonosite: Kristi Howe
Thursday
Post-operative Delirium

Ken Brady, MD
Pediatrics, Anesthesia, Critical Care
Texas Children’s Hospital
Baylor College of Medicine

Disclosures

- IP for monitoring technology licensed to Medtronic

Set up audience participation

1. Take out your silenced phone
2. Open a web browser
3. Go to: PollEv.com/kenbrady584

Delirium Definitions

- DSM
  - Altered level of consciousness
  - Impaired cognition
  - Acute onset, fluctuating course
  - Direct consequence of general medical condition

- CAM
  - Fluctuating course
  - Inattention
  - Disorganized thinking
  - Altered level of consciousness

Incidence of Delirium

- Occurs in 15-55% of hospitalized patients, and in the ICU from 40-80%, depending on patient population (Inouye NEJM 2006)

<table>
<thead>
<tr>
<th>Surgery</th>
<th>Incidence of Delirium (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Abdominal aortic aneurysm</td>
<td>33-54</td>
</tr>
<tr>
<td>Abdominal</td>
<td>5-51</td>
</tr>
<tr>
<td>Cataract</td>
<td>4</td>
</tr>
<tr>
<td>Coronary artery bypass</td>
<td>37-52</td>
</tr>
<tr>
<td>Graft surgery</td>
<td>35-65</td>
</tr>
<tr>
<td>Elective orthopedic</td>
<td>9-15</td>
</tr>
<tr>
<td>Head and neck (major)</td>
<td>17</td>
</tr>
<tr>
<td>Hip fracture</td>
<td>30-48</td>
</tr>
<tr>
<td>Peripheral vascular</td>
<td>4-7</td>
</tr>
<tr>
<td>Urologic</td>
<td>7</td>
</tr>
</tbody>
</table>

which of the following features define delirium (single best)?

- Depressed level of consciousness or cognition
- Auditory or visual hallucinations
- Fluctuating level of consciousness or cognition
- Grandiose or paranoid ideations
- Combative or agitation
Risk of Post-op Delirium

- Vulnerability + Insult → Post-op Delirium

Patient Vulnerability

Non-Cardiac Risk Factors
- Age
- Baseline cognitive impairment
- Multiple co-morbidities
- Poor functional status
- Alcohol use
- Electrolyte abnormalities

Cardiac Risk Factors
- MMSE,
- Depression,
- Albumin,
- Stroke history

Incidence of Delirium

<table>
<thead>
<tr>
<th># Risk Factors</th>
<th>Incidence of Delirium</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>18%</td>
</tr>
<tr>
<td>1</td>
<td>43%</td>
</tr>
<tr>
<td>2</td>
<td>60%</td>
</tr>
<tr>
<td>3</td>
<td>87%</td>
</tr>
</tbody>
</table>

An 85 year old presents for cataract surgery

- He was previously unable to lie still for a “no anesthesia” cataract excision.
- PMH: 3V CABG; CHF NYHA II; ex-smoker
- Enalapril, metoprolol, ASA, Lasix
- Na 134 Meq/L; glucose 95 mg/dL; Albumin 2.6; Cr 2.8 mg/dL.
- HR 64; 143/92; 94%
- Affable; Oriented to person and place-confused about the date; Poor hearing and vision; daughter is holding his glasses, hearing aid and walker.

What risk factors for post-op delirium did you find in this history?

An 85 year old presents for cataract surgery

- He was previously unable to lie still for a “no anesthesia” cataract excision.
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- HR 64; 143/92; 94%
- Affable; Oriented to person and place-confused about the date; Poor hearing and vision; daughter is holding his glasses, hearing aid and walker.
Pathophysiology

- Neurotransmitters
  - Acetylcholine deficiency
  - Dopamine excess
- Neuroinflammation
- Metabolic disorders
- Cerebrovascular
- Drugs
  - Physiologic stressors
    - Cortisol
    - Ischemia/hypoxia
- Baseline vulnerability
  - Genetic
  - Cognitive reserve

Inouye et al. Lancet 2013

Delirium Subtypes

- Hyperactive
  - Easy to diagnose
  - Combative/agitated
- Hypoactive
  - Easy to miss
  - Psychomotor slowing
Symptoms Associated with Delirium

1. Change in level of arousal: drowsiness or decreased arousal* or increased arousal with hypervigilance
2. Delirium awakening from anesthesia*
3. Abrupt change in cognitive function (worsening confusion over hours or days), including problems with attention, difficulty concentrating, new memory problems, new disorientation
4. Difficulty tracking conversations and following instructions
5. Thinking and speech that is more disorganized, difficult to follow, slow*, or rapid
6. Quick changing emotions, way irritability, fearfulness, uncharacteristic restlessness, new to engage with postoperative care
7. Expression of new paranoid thoughts or delusions (ie, fixed false beliefs)
8. New perceptual disturbances (eg, illusions, hallucinations)
9. Motor changes such as slowed or decreased movements, new purposes fidgeting or restlessness, new difficulties in maintaining posture such as sitting or standing*
10. Sleep/wake cycle changes such as sleeping during the day* and/or awake and active at night
11. Decreased appetite*
12. New incontinence of urine or stool*
13. Fluctuating symptoms and/or level of arousal over the course of minutes to hours

Octogenarian for Hip Replacement

- An 83 year old woman with daughter for pre-op consultation.
- Mild memory loss
- HTN- HCTZ
- Unable to self care due to hip pain
- Will this surgery cause cognitive decline?

Which is true regarding the risk of cognitive decline

- This patient at risk for preventable delirium, not cognitive decline.
- The use of regional anesthesia is shown to decrease the risk of cognitive decline.
- The use of deep anesthesia has been shown to increase the risk of cognitive decline.
- Psychotropic medications are an option to consider.

Deliurn and Cognitive Decline

Cognitive decline accelerates after post-operative delirium

Regional Anesthesia

Regional should help:
- Pain control
- Less GA

Regional Anesthesia has not been shown to reduce the risk of post-operative delirium.

Does regional mean less general?

Without monitoring, many “sedated” patients are receiving general anesthesia.
**Best Practice Statement from the American Geriatrics Society**

“A health care professional trained in regional anesthetic injection may consider providing regional anesthetic at the time of surgery and postoperatively to improve pain control and prevent delirium in older adults.”

**Cochrane Database Review**

“There is moderate-quality evidence that Bispectral Index (BIS)-guided anesthesia reduces the incidence of delirium compared to BIS-blinded anaesthesia or clinical judgement (RR 0.71, 95% CI 0.60 to 0.85; two studies; 2057 participants).”

**Prophylactic antipsychotics**

<table>
<thead>
<tr>
<th>Negative Studies</th>
<th>Positive Studies</th>
</tr>
</thead>
<tbody>
<tr>
<td>Haldol 0.5mg tid in elderly hip surgery</td>
<td>Haldol in non-cardiac surgery (23 vs. 15%)</td>
</tr>
<tr>
<td>MINDS trial: Haldol or Ziprasidone in mixed ICU</td>
<td>Haldol 1mg tid in high risk ICU patients reduced delirium from 75% to 65%</td>
</tr>
<tr>
<td>Risperidone (1mg SL) reduced delirium from 32% to 11%</td>
<td>Prakanrattana et al. Anaesth Int Care 2007</td>
</tr>
</tbody>
</table>

**Depth of Anesthesia**

**Best Practice Statement from the American Geriatrics Society**

“There is insufficient evidence to recommend for or against the use of antipsychotic medications prophylactically in older surgical patients to prevent delirium.”

**Best Practice Statement from the American Geriatrics Society**

“The anesthesia practitioner may use processed electroencephalographic monitors of anesthetic depth during intravenous sedation or general anesthesia of older patients to reduce postoperative delirium.”
Comparing Agents: no difference

<table>
<thead>
<tr>
<th>Study</th>
<th>Surgery</th>
<th>Intervention</th>
<th>Result</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nishikawa 2004</td>
<td>Abdominal</td>
<td>Propofol vs. Sevo (all with epidural)</td>
<td>No difference (delirium)</td>
</tr>
<tr>
<td>Hudetz 2009</td>
<td>Cardiac</td>
<td>Additional Ketamine (0.5 mg/kg)</td>
<td>3.4% vs. 31% (delirium)</td>
</tr>
<tr>
<td>Royse 2011</td>
<td>Cardiac</td>
<td>Propofol vs. Des</td>
<td>No difference (POCD)</td>
</tr>
<tr>
<td>Leung 2006</td>
<td>Non-cardiac</td>
<td>Additional nitrous</td>
<td>No difference (delirium &amp; POCD)</td>
</tr>
</tbody>
</table>

Dexmedetomidine

• Dexmedetomidine has been extensively studied as a post-operative sedative to reduce delirium.

Following uneventful hip replacement with regional and light sedation, the patient is awake, conversant and comfortable. Which is true?

The patient is at an ongoing risk of developing post-op delirium

Delirium presents in the immediate post-op period

On post-op day 1:

It is time to assess for physical therapy and ambulation to prevent delirium

- Short-acting opiate PCA with demand-only administration facilitates ambulation and prevents delirium

Care pathways with a geriatric specialist are more effective than general medical care to prevent delirium

The first line of therapy for acute confusion and agitation is a newer generation anti-psychotic

Pain and post-op delirium

Oral opioids vs IVPCA:

(OR, 0.4; 95% CI 0.2 to 0.7)

<table>
<thead>
<tr>
<th>Pain Severity</th>
<th>Risk of Delirium</th>
</tr>
</thead>
<tbody>
<tr>
<td>Moderate</td>
<td>OR 2.2 (1.2 – 4)</td>
</tr>
<tr>
<td>Severe</td>
<td>OR 3.7 (1.5 – 9)</td>
</tr>
</tbody>
</table>
Geriatrician consult

- Marcantonio et al
  - 126 patients > 65 y/o admitted for emergent surgical repair of a hip fracture
  - Geriatrician vs. usual care

- Result: Improved rates of delirium in the intervention arm (32% vs. 50%; p=0.04)

<table>
<thead>
<tr>
<th>Most effective prevention: non-pharmacologic</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Sensory enhancement (glasses, hearing aids)</td>
</tr>
<tr>
<td>2. Mobility enhancement (ambulating)</td>
</tr>
<tr>
<td>3. Cognitive orientation and therapeutic activities</td>
</tr>
<tr>
<td>4. Pain control</td>
</tr>
<tr>
<td>5. Cognitive stimulation</td>
</tr>
<tr>
<td>6. Communication standards to prevent the escalation of behaviors</td>
</tr>
<tr>
<td>7. Nutrition and fluid repletion</td>
</tr>
<tr>
<td>8. Sleep enhancement (nonpharmacologic)</td>
</tr>
<tr>
<td>9. Medication review</td>
</tr>
<tr>
<td>10. Daily rounding by an interdisciplinary team to reinforce the interventions</td>
</tr>
</tbody>
</table>

In the event of acute delirium:

1. First line: Non-pharmacologic interventions
2. When pt is not agitated, medications are not indicated.
3. Agitated self harming pts failing non-pharmacologic interventions
   - Lowest effective dose antipsychotic
   - Lowest effective dose benzo if antipsychotic fails

Take-home

- Delirium: common
- Delirium: harmful
- Delirium: preventable

Thank You!
Update on Governmental and Other Regulations Affecting Anesthesiology

Randall M. Clark, M.D.
Department of Anesthesiology
University of Colorado School of Medicine
Board of Directors, American Society of Anesthesiologists
Chair – ASA Section on Professional Standards

Disclosures
- No financial conflicts of interest to disclose
- The opinions expressed are my own and not necessarily those of the University of Colorado or the American Society of Anesthesiologists

Objectives
- Provide updates on governmental action at the federal level affecting health care delivery and payment for anesthesia services
- Understand how the American Society of Anesthesiologists is responding to the challenges created by health care reform
- Learn what you can do at the group, department, and individual level to prepare for MACRA and MIPS

The Imperative: Improving Value in Health Care Delivery

TRIPLE AIM
- High Quality
- Patient Experience
- Low Cost
- Affordability
- Access
- Healthier Living

The Triple Aim

Progress Towards Achieving Better Care, Smarter Spending, Healthier People

Jan 26, 2015
By: Sylvia Mathews Burwell, HHS Secretary
Since my very first days as Secretary, you’ve heard me talk about improving our nation’s health delivery system to better meet the needs and expectations of the people of America. Whether you happen to be a patient, a provider, a business, a health plan or a taxpayer, it’s in our common interest to build a health care delivery system that’s better, smarter and healthier – a system that delivers better care; a system that spends health care dollars more wisely; and a system that makes our communities healthier.

Our first goal is for 30% of all Medicare provider payments to be in alternative payment models that are tied to how well providers care for their patients, instead of how much care they provide – and to do it by 2016. Our goal would then be to get to 50% by 2018.
The new administration and new Congress will accelerate these efforts.

**SGR Repeal and Medicare Provider Payment Modernization Act of 2015 (MACRA)**
- SGR Repealed
- 2015 Updates
  - July – December - 0.5%
- Further Updates
  - 2016 through 2019: 0.5%
  - 2020 through 2025: 0.0%
  - 2026 - forward: 0.5%
- APM 2026 – forward: 1%
- PQRS, VBM, EHR MU Consolidated

**MIPS Adjustments**
- Losers – Negative Adjustments
  - 2019: Up to -4.0%
  - 2020: Up to -5.0%
  - 2021: Up to -7.0%
  - 2022: Up to -9.0%
- Winners – Positive Adjustments
- Based on funds available from losers i.e. lots of losers means larger adjustments for winners, fewer losers means smaller adjustments for winners.

**Setting and Competing Against Threshold**

**Anesthesia Quality Institute – National Anesthesia Clinical Outcomes Registry**
- Received designation as a Qualified Clinical Data Registry in 2014.
- Allows AQI to specify the outcomes to be measured without complicated NQF process
- Easily incorporated into other AQI reporting
What is the Perioperative Surgical Home?

- The PSH model is a physician-led, patient-centric, team-based system of coordinated care that guides patients through the entire surgical experience, from the decision to undergo surgery to discharge and beyond, with the goal of providing cost-effective, high quality perioperative care and exceptional patient experiences.

- Achieved through shared decision-making and seamless continuity of care for surgical patients.

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PSH Learning Collaborative 2.0 Timeline

Two-year timeline provides time to collaborate, transform, and measure performance to demonstrate success.

- April 1, 2016 – Launch date
- Spring 2016 – First in-person all-member meeting
- Summer 2016 – First Advanced Cohort PI sprint
- Fall 2016 – Second in-person all-member meeting
- Winter 2017 – Second Advanced Cohort PI sprint
- Spring 2017 – Third in-person all-member meeting
- Summer 2017 – Third Advanced Cohort PI sprint
- Fall 2017 – Fourth in-person all-member meeting
- Winter 2018 – Fourth Advanced Cohort PI sprint
- March 31, 2018 – PSH 2.0 end date

Key benefits of participation include:
- Peer-to-peer networking and shared learning opportunities
- Access to subject matter experts on a variety of topics
- Tools and resources to support successful implementation and performance optimization

More Information

- ASA White Paper on Perioperative Surgical Home
- 2014 - 2017 Practice Management Conferences
- 3rd ASA PSH Meeting
- 2nd ASA Quality Meeting
- ASA Website: https://www.asahq.org/psh
- Special thanks to Zeev Kain, MD (UC Irvine), Stan Stead, MD (ASA VP Professional Affairs), and Mike Schweitzer, MD (now managing Population Health for Premiere, Inc.)

Ongoing Outreach Efforts

- ASA
- 3rd ASA PSH Meeting
- 2nd ASA Quality Meeting
- ASA Website: https://www.asahq.org/psh
- Special thanks to Zeev Kain, MD (UC Irvine), Stan Stead, MD (ASA VP Professional Affairs), and Mike Schweitzer, MD (now managing Population Health for Premiere, Inc.)

Alternative Payment Models

Payment Reform Accelerating New Models

- Independent
- Alignment
- Integration
- Accountability

- Value-Based Reimbursement
- Risk-Based Reimbursement
- Population Health
- Clinical Integration
- Financial Alignment
- Shared Savings/Shared Risk

- Value-Based Reimbursement
- Risk-Based Reimbursement
- Population Health
- Clinical Integration
- Financial Alignment
- Shared Savings/Shared Risk
**CMS Innovation (2016)**

- 8.9 million seniors in Medicare shared savings, Pioneer or Next Generation ACOs representing $85 billion in spending
- 415 hospitals, 305 physician groups, and 723 skilled nursing facilities in BPCI accounting for $10 billion in spending
- CJR program to add another $3 billion
- 30% target met in March 2016

### Table: Benefitted Payments for Care Improvement Initiative Model Characteristics

<table>
<thead>
<tr>
<th>Model</th>
<th>Episode</th>
<th>Conditions</th>
<th>Episode minimums</th>
<th>Medicare discount</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Important care (hospital readmission)</td>
<td>All demographics-related groups (DRGs)</td>
<td>Acute care hospitals</td>
<td>Year 1: 6-0.4 months, Year 2: 5.5%</td>
</tr>
<tr>
<td>2</td>
<td>Important care (30, 60, or 90 days post discharge)</td>
<td>Observations of all episodes based on frequency of DRGs (participant’s record)</td>
<td>Acute care hospitals or physician group practices</td>
<td>Year 1: 3.0 months, Year 2: 2.0%</td>
</tr>
<tr>
<td>3</td>
<td>Important care (30, 60, or 90 days post discharge)</td>
<td>Participants’ record of postacute care following hospitalization</td>
<td>Postacute care provider (hospital or long-term care hospital or nursing home)</td>
<td>Year 1: 3.0 months, Year 2: 2.0%</td>
</tr>
<tr>
<td>4</td>
<td>Important care (excluding procedure services)</td>
<td>Observations of all episodes based on frequency of DRGs (participant’s record)</td>
<td>Acute care hospitals or physician group practices</td>
<td>Year 1: 3.0 months, Year 2: 2.0%</td>
</tr>
</tbody>
</table>

### Figure 31: Accountable Care Organizations (ACOs) in Medicare, 2015

[Map of ACOs in Medicare, 2015]

**Source:** Centers for Medicare & Medicaid Services

**Note:** The map includes all ACOs participating in Medicare Shared Savings Program (MSSP) in 2015.

---

**The Results**

- $2.3 million saved in the first year
- 10% reduction in readmissions
- 20% reduction in skilled nursing utilization
- 22% reduction in inpatient daily utilization

**2016 BPCI Participation**

[Map showing BPCI participation in 2016]

**Source:** Centers for Medicare & Medicaid Services

**Note:** The map highlights the participation of various healthcare providers in the BPCI program in 2016.
### 2017 ASA Conference on Practice Management

- MACRA/MIPS Update
- Understanding Alternative Payment Models:

  [https://education.asahq.org/totara/pluginfile.php/147276/mod_page/content/44/Alt_Payment_Models%20and%20PSH_Stead.pdf](https://education.asahq.org/totara/pluginfile.php/147276/mod_page/content/44/Alt_Payment_Models%20and%20PSH_Stead.pdf)

### Definition

- The population health approach is positioned as a unifying force for the entire spectrum of health system interventions -- from prevention and promotion to health protection, diagnosis, treatment and care -- and integrates and balances action between them.
- This will be the framework for all future action in government funded health care, and soon thereafter, all American health care.

### ASA Committee on Future Models of Anesthesia Practice

- Oversaw initial roll-out of Perioperative Surgical Home
- Now studying the role of the anesthesiologist in population health management
- Recognizes the unique role of anesthesiology – the unifying factor in the care of all surgical patients
- Publishing a white paper and action plan for ASA leadership, Board of Directors, and House of Delegates

### References

- Intersection of Population Health and Anesthesiology
  - Email me at randall.clark@childrenscolorado.org
  - Currently preparing upcoming publication in A&A
- [http://journals.lww.com/anesthesia-analgesia/Fulltext/2016/09000/The_Perioperative_Surgical_Home_More_Than_Smoke_2.aspx](http://journals.lww.com/anesthesia-analgesia/Fulltext/2016/09000/The_Perioperative_Surgical_Home_More_Than_Smoke_2.aspx)
Population Health Action Plan

- Educate yourself on PSH and Population Health
- Understand what your institutions (surgical specialties, hospital, health system, academic medical center) are planning in the realm of population health
- Appoint a lead coordinator to facilitate communication with the external entities
- Participate in any discussion on how the financial pillar will be handled and how it will affect anesthesiology
Anesthesia Demographics: Past, Present and Future?

Steven J. Zeichner, MD
Assistant professor of Anesthesiology
University of Colorado School of Medicine

Objectives:
• Understand the changing demographic of anesthesia practice in the US
• Anticipate positioning your practice for the future
• Understanding the cultural history of anesthesia practices and planning for the necessary changes the future will bring
• Strategic planning for anesthesia group practice future

Conflicts of interest:
• I have no disclaimers

Data Sources
• ASA
  – From surveys of graduating residents
• MGMA
  – Surveys of members
• CU Resident Graduates
  – Recently obtained
  – Preliminary study
  – unpublished

Background:
• I spent the first 27 years of my professional career in private practice in South Florida
• I am presently (for the past three and one half years) endeavoring to be an academic anesthesiologist at the University of Colorado School of medicine in Denver Colorado

Currently-
• As of April of 2017 eight entities employed more than 22 percent of all anesthesia providers in the US

• Greenfield, MD and Locke, MA; ABA Communiqué, Volume 22, Issue 3
• Evolution
  • One person (man) individual practices that coordinated to cover facility sites and call.
  • Encouraged (read coerced) by hospitals to form group practices
    — Facilitates negotiations on behalf of hospitals

Evolution
  • Culturally the tradition of individuality persists
  • Tension:
    • Individuals make clinical decisions
    • Group makes practice decisions

Traditionally anesthesia groups:
  • Owned by MD providers
  • Niche Market, i.e. local
    — One or more hospitals
    — Ambulatory centers
    — Physician offices
  • Lean overhead
    — Billing expenses
    — Malpractice insurance
  • Primary objective
    — Job security
    — Preservation of income and lifestyle
    — Maintenance of status quo

Group Ownership: Physician vs. Hospital

<table>
<thead>
<tr>
<th>Year</th>
<th>Physician Ly</th>
<th>Physician Ho</th>
<th>Hospital Ly</th>
<th>Hospital Ho</th>
</tr>
</thead>
<tbody>
<tr>
<td>2012</td>
<td>52</td>
<td>519</td>
<td>61</td>
<td>650</td>
</tr>
<tr>
<td>2013</td>
<td>94</td>
<td>1905</td>
<td>69</td>
<td>660</td>
</tr>
<tr>
<td>2014</td>
<td>72</td>
<td>1699</td>
<td>64</td>
<td>483</td>
</tr>
<tr>
<td>2015</td>
<td>72</td>
<td>1699</td>
<td>62</td>
<td>528</td>
</tr>
<tr>
<td>2016</td>
<td>53</td>
<td>1578</td>
<td>65</td>
<td>670</td>
</tr>
</tbody>
</table>
**Practice Ownership: Groups**

**CU Residents Entering Job Market vs. Pursuing Fellowship, 2011-2017**

Of the 90 resident physicians who graduated from 2011-2017:
- 54% chose to enter the job market
- 46% chose to pursue a fellowship

**CU Percentage of Residents Joining Private Practice vs. Academic Practice, 2011-2017**

**MGMA: Anesthesia groups by size 2010-2016**

<table>
<thead>
<tr>
<th>Year</th>
<th>10 or less</th>
<th>11-25</th>
<th>26-50</th>
<th>51-75</th>
<th>&gt;75</th>
</tr>
</thead>
<tbody>
<tr>
<td>2010</td>
<td>266</td>
<td>579</td>
<td>797</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2011</td>
<td>266</td>
<td>579</td>
<td>797</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2012</td>
<td>175</td>
<td>280</td>
<td>686</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2013</td>
<td>155</td>
<td>320</td>
<td>655</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2014</td>
<td>155</td>
<td>320</td>
<td>655</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2015</td>
<td>155</td>
<td>320</td>
<td>655</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2016</td>
<td>155</td>
<td>320</td>
<td>655</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Is BIG better?

- Better contracts with insurance provider
- More leverage in negotiations with facilities
- Cost of billing and compliance
- More health care facilities are part of large networks
- Greater security due to size and scope
- Greater Flexibility

The market for anesthesia services in the US has been traditionally bound by regional “cultural” differences

- The anesthesia care team model were more common in the South and East, much less so in the West.
- Anesthesia groups in the Mid-Atlantic region actively pursued opportunities to provide services endoscopic for endoscopy and endoscopic centers. Practices in the west, particularly California, avoided.
Growth

- Challenges the fundamental nature of anesthesia groups
- Anesthesia practices traditionally were professional associations with limited business and professional management
- Managing a practice of 100+ providers is drastically different from 10-20 (old mom & pop shop)

Professional Management

- Size does not guarantee success
- Goal no longer income and lifestyle
- Security and Predictability (long term goals) prioritized

Strategic Planning

- Anesthesia could, in the past, be summarized as the service of safely managing patients during surgery
- Quality was defined as safely and comfortably getting the patient through surgery

Strategic Planning

- Moving into the future we should be engaging ourselves as strategic partners with our hospitals and health systems
- Leveraging our greatest attributes:
  - The ability to keep the patient comfortable and secure throughout the surgical experience
  - Anesthesiology has the greatest potential to positively influence the patients experience

Strategic Partnership

- Hospitals: “We will provide you with work”
- Anesthesiologists: “We can provide optimized quality experience for your patients and facilitate your opportunities to attract more patients-increase your market share”

What hospitals think of us-

- Over-payed
  - Make a lot of $$
- “Carpetbaggers”
  - We don’t have to go out and solicit business, just comes to us (through them)
- Lazy
  - All we do is sit there, surgeon does all the work
**Strategic Partnership**

- We must seek to offer Value in our relationships with hospitals and health care institutions
- We must make sure these same hospitals and health care institutions are aware of our contributions

**Strategic Partners**

- Anesthesia groups should have a thorough understanding and command of data relative to our sites of service
  - Including, but not limited to OR's, L&D suites, endoscopy, CVCU, Radiology suites and any other non traditional places we provide service
- Anesthesia must share this data with the hospitals and health care systems we partner with to optimally prove our value.

**Leverage Anesthesia group brings to hospital:**

- Data
  - Manage Database
  - Run OR’s and off OR sites efficiently
  - Work 1:1 with surgeons
  - Improve efficiency
- Customer Satisfaction
- Quality
  - No longer anecdotal
  - Must be empirical and measurable

**Historically we have focused on what we do in the OR**
- We must shift our focus to include what is happening outside the OR as well
- What happens outside the OR increasingly has more to do with the success of our practices

**The second law of thermodynamics = US Health Care**

**Resources:**

Learning Objectives

1. Understand the operational and financial drivers in the perioperative arena that are important to hospital leaders.
2. Review common pitfalls and successful techniques related to negotiations with hospitals.
3. Demonstrate the changing landscape of physician and physician leadership in the healthcare marketplace.

The Situation

“An increasing number of physicians are embarking on a pathway from clinical practice to senior leadership positions that historically have been held by nonmedical or allied health professionals”

John Henson, MD, FACHE - Chief of Cardiology
Piedmont Healthcare, Atlanta, GA

Physicians also called upon to lead in mixed roles:
- Medical Director
- Department Chair
- Chief Medical Officer
- Medical Societies
- Industry

Disclosures

Employed by SCL Health System
Broomfield, CO

SCL Health

Why Should I Care?

“Caring is a business, with revenues and expenses, not just a calling.”

“Healing is an art, medicine is a profession, and healthcare is a business.”

“Lead or be led, the only other option is fruitless resistance.”
Why The Best Hospitals Are Managed by Doctors

...and how can training make them better ones.

"social skills...physicians are not taught to be team players."

Trained in “command and control” and “heroic lone healer” culture

“Conspires against great leadership....clear need to train physicians more systematically.”

How?
• Formal leadership training programs
• Core curriculum “Emotional intelligence”
• “Teambuilding, conflict resolution, situational leadership.”

Wild Ride: My Own Leadership Journey

July 2014

From: Univ. of Colorado as Vice Chair, Anesthesiology & Assoc. Medical Director of perioperative services
To: Chief Medical Officer at St. Mary’s Medical Center in Grand Junction, CO

September 2015
• Become Interim President, SMMC
• Dual roles for seven months

May 2016
• Selected as permanent president after national search

Why The Physician Executive Route?
• Broader healthcare system interests
• Too few physicians at the table
• Physician-hospital alignment
• Increasingly complicated environment
• Administrators ≠ Clinical experience

St. Mary’s Medical Center

346-Bed, $430M
12 ORs + 4 ASC
10,500 surgeries
Level II Trauma
Cardiac Surgery
NICU Level III
Blood Bank
44k ED visits
100+ mile area
Aeromedical

2,200+ Associates
380+ Medical Staff
500+ Volunteers
How did you prepare?

**Formal Education/Practice:**
- Administrative Fellowship (2 yrs.) – UC Health University
- MBA in Healthcare Administration – U. of CO Denver
- Graduate Certificate, Quality/Safety – Regis Univ.
- Certified Physician Executive – Amer. Assoc. Physician Executives

**Organizational/Community Leadership Opportunities:**
- Associate Medical Director Perioperative Svcs.
- Vice Chair, Quality/Safety/Improvement, Anesthesiology
- Medical Board, UC Health University
- Board of Directors, Univ. Physicians Inc.
- CO State Dental Board, public member
- State-wide public office candidate

---

**Models For Physician Leadership**

<table>
<thead>
<tr>
<th>Dyads</th>
<th>Cross Train</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Physician &amp; administrator</td>
<td>• Physician as administrator</td>
</tr>
<tr>
<td>• Different job descriptions</td>
<td>• Adopts job description</td>
</tr>
<tr>
<td>• Partner for results</td>
<td>• Responsible for results</td>
</tr>
<tr>
<td>• Mutual respect</td>
<td>• Identity challenges</td>
</tr>
<tr>
<td>• Complimentary skills</td>
<td>• Awareness of weaknesses</td>
</tr>
<tr>
<td>• Variable training</td>
<td>• Significant training</td>
</tr>
<tr>
<td>• Develop with experience</td>
<td>• Prior experience required</td>
</tr>
</tbody>
</table>

**Competencies**

**Technical**
- Finance & economics
- Operations science
- Human resources
- Informatics/technology
- Healthcare/business law
- Change management

**Interpersonal**
- Emotional Intelligence
  - Awareness of self & others
  - Emotional control
- Relationship management
- Diplomacy
- Organization-over-self
- Time management

---

**Leadership Competencies**

<table>
<thead>
<tr>
<th>Traditional View</th>
<th>Updated View</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Hierarchy-based</td>
<td>• Relationship-based</td>
</tr>
<tr>
<td>• Personal traits (charisma)</td>
<td>• Action &amp; accountability</td>
</tr>
<tr>
<td>• Innate in a few</td>
<td>• Facilitation</td>
</tr>
<tr>
<td>• “Touchy feely”</td>
<td>• Developed, not innate</td>
</tr>
<tr>
<td><strong>Developing Leaders in Anesthesiology</strong></td>
<td>• Expected from everyone</td>
</tr>
<tr>
<td><strong>A Practical Partnership</strong></td>
<td>• Studied scientifically</td>
</tr>
</tbody>
</table>

---

**Anesthesiology & Leadership**

---

The 48th Annual Anesthesiology Lecture

**We Need Leaders**

“Leadership is helping people address problems that will make the world better...focusing on a goal and inviting everyone to help achieve it.”

“It is not about individualism; it is about teamwork”

“The patient should be the focus, not the clinician”

“We barely spend a penny on researching healthcare delivery for every dollar we spend on basic and clinical research”

“No is the time for anesthesiologists to take on leadership roles within their hospitals...be perioperative directors, chief medical officers, chief quality officers, chief executive officers, and deans”
Physician as Customer?

Employment increasing
- Predictability
- Physician financial risk

Single source contracting
- Predictability
- Increase hospital monopsony
- Reduce physician monopoly

Compensation subsidies
- Moving toward goal alignment
- Value, quality, efficiency

Hospital – Physician Economy

<table>
<thead>
<tr>
<th>Hospital (Buyer)</th>
<th>Physician (Seller)</th>
</tr>
</thead>
<tbody>
<tr>
<td>9 Hospitals Æ Physicians</td>
<td>9 Physicians Æ Hospitals</td>
</tr>
</tbody>
</table>

Customers Æ Partners

Autonomy → Alignment

Autonomy
- Autocratic
- Medical profession

4 T’s:
- Time (when)
- Team (who)
- Task (what)
- Technique (how)

Financial Success
- Volume + payer mix
- Subjective “quality”
- $ Accounting
- Stay put
- Status quo

Alignment
- Collaborative leadership
- Other sectors

4 E’s:
- Equity
- Efficiency
- Evidence-based
- Engagement

Financial Success
- Value (quality / cost)
- Objective quality
- Accountability
- Throughput
- Maneuverability

Inconvenient Truths

Shared pressure
- Payment reduction
- Regulation
- Quality expectation
- Public reporting
- Cultural transition
- Consolidation

Hospital pressure
- Labor risk expense
- Physician specialization
- Ambulatory competition

Physician pressure
- Specialization
- Substitution
- Education loans
- Life style expectations

Learn to Negotiate

Separate people from problem
- Good people
- Two interests
- Techniques (diassociation)

Focus on interests, not positions
- Positioning = One interest
- Identify / empathize
- Befriend opposed positions

The negotiation problem
- Positions = bargaining
- Principled = negotiation

Invent options for mutual gain
- Understand counterparty needs
- Realize own capabilities

Use objective criteria
- Fair standards & metrics
- Reason → be open to reason
- Yield to principle, not pressure

Yes, BUT they...
- Have more power → BATNA
- Won’t play
- Use dirty tricks
Hospital Desires
Reduced total cost…period
- Safe patient care
- Reduced variation
- Efficient use of capital/personnel
- Per unit of service cost reduction

Improved quality
- Real: published metrics
- Perceived: satisfaction scores (HCAHPS)
- Raise your own expectations

Recruitment & Retention
- Positive environment
- Physician & staff

Success: My Own
Keep it professional. Respect is power!

Beware of claiming “higher quality” unless you can prove it

If you don’t want to be treated like a commodity, don’t represent yourself as one

Negotiating is better than bargaining

Overt lobbying is rarely useful

Beware playing politics with politicians

Professional Development
1. Today: The Case for Physician Leadership
3. Tone: The Significance of the Interpersonal Factor
4. Dialogue: Communicating for Understanding and Influence
5. Teamwork: The Foundations of Collective Synergy
6. Conflict: The Power of Respectful Conflict Encounters
7. Negotiations: Influence and Principled Outcomes
8. Motivation: Building Performance through People
10. Tomorrow: A Case for Possibility

References
We Need Leaders
Peter J. Pronovost, M.D., Ph.D.

Grooving M.D. Leaders
Carson T. Yang, FACP
American College of Healthcare Executives
Urban Health Systems: A Systematic Review of Physician Leadership and Emotional Intelligence
Journal of Graduate Medical Education, March 2018

Thank You!
Winner: 2016 Associate Photo Contest, Lucas Cahalan
Anesthetic considerations in Adults with Congenital Heart Disease

Dr. Mark Twite MA MB BChir FRCP
Director of Congenital Cardiac Anesthesiology
Associate Professor
Department of Anesthesiology
University of Colorado, Anschutz Medical Campus & Children’s Hospital Colorado

Objectives
Understand and Discuss the:
1. Changing epidemiology of congenital heart disease (CHD)
2. Current outcomes for patients with CHD
3. Perioperative anesthetic approach to adults with CHD undergoing non-cardiac surgery

Case
• 37yr old female in Atrial Flutter presents for TEE, EP study and ablation

- Tricuspid Atresia s/p Fontan
  - Non-alcoholic cirrhosis (elevated LFTs and low albumin)
  - Protein losing enteropathy
  - Hypoalbuminemia 75-85% in air, Polyethylene 80 Hz 65
  - Pacemaker Dual Chamber DDD at 70bpm

- Medications
  - Apixaban, Aspirin
  - L-Arginine
  - Digoxin, Quinapril, Sotalol
  - Furosemide, Spironolactone
  - Melatonin, Valium, Ambien, Tramadol

Echocardiogram 9/2016 TTE
1. History of Tricuspid atresia, status post initial class (RA to PA)Fontan, with subsequent Fontan conversion to intra-cardiac lateral tunnel Fontan through the RV body
2. Subjectively there remains normal LV systolic function.
3. Dilated IVC without respiratory collapse. Low velocity flow within IVC suggests IVC pressure is greater than 15 mm Hg.
4. The Glenn anastomosis is not well visualized, though there is normal respiratory variation in SVC flow suggestive of no obstruction within the Fontan pathway.
5. Trivial atrial regurgitation, mild mitral regurgitation (mean gradient 5-8 mmHg)
6. Mildly dilated left ventricle with subjectively normal function. Hypoplastic right ventricle is not well seen.
7. No pericardial effusion.
Case

- 37yr old female in Atrial Flutter presents for TEE, EP study and ablation

- Cardiac Cath
  
  CATH (Denver, 2010) no fenestration, unobstructed PA’s, Fontan 11-12 mmHg, no change with volume challenge; small angiographic right to left shunt seen likely from the suture line of the lateral tunnel.

  CATH (Denver, 2013) Fontan pressures 18 mmHg, PCWP 14 mmHg, small veno-venous collaterals off left innominate embolized, 100% FiO2 and improved Fontan pressure to 11 mmHg

  CATH (Denver, 2016) hepatic wedge 19 mmHg, hepatic vein 15 mmHg (transhepatic gradient 4 mmHg), Fontan 13, RPA 11, LPA 12, PCWP 9, Fick CO 5.06. 5L/min/kg bolus PA increased to 17, PCWP to 14, Fick CO 5.74. With 100% O2, PA pressure decreased to 13, PCWP to 12, Fick CO 5.69, with 40 ppm NO PA pressure 14, PCWP 13, CO 5.64

Congenital Heart Disease

- Most common congenital disorder of newborns
  - 1% of live births

- Leading cause of infant deaths in the USA

- Accounts for more than half of all deaths from congenital anomalies worldwide

- Estimated 1.5 million adults living in USA with CHD

- NIH funded CHD research from 2005 – 2015
  - 663 CHD research projects for a total cost of $991 million
  - 70% Basic science (Cardiac developmental biology most common)
  - 27% Clinical
  - 3% Both

Changing Epidemiology: Adults and Children in Quebec

<table>
<thead>
<tr>
<th>Year</th>
<th>Median Age (yrs)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1985</td>
<td>11</td>
</tr>
<tr>
<td>2000</td>
<td>17</td>
</tr>
<tr>
<td>2010</td>
<td>20</td>
</tr>
</tbody>
</table>

Khairy J Am Coll Cardiol 2010

Classification of CHD Complexity

<table>
<thead>
<tr>
<th>Simple</th>
<th>Moderate</th>
<th>Severe</th>
</tr>
</thead>
<tbody>
<tr>
<td>Atrial septal defect</td>
<td>Anomalous pulmonary venous drainage</td>
<td>Single ventricle palliation</td>
</tr>
<tr>
<td>Ventricular septal defect</td>
<td>Anterior interventricular artery defect</td>
<td>Transposition of the great arteries</td>
</tr>
<tr>
<td>Patent ductus arteriosus</td>
<td>Coarctation of the aorta</td>
<td>Truncus arteriosus</td>
</tr>
<tr>
<td>Tetralogy of Fallot</td>
<td>Tricuspid atresia</td>
<td>Pulmonary atresia</td>
</tr>
<tr>
<td>Eisenmenger syndrome</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Simple defects have a favorable natural history unless they are unrepaird with a significant L to R shunt which may then develop Eisenmenger syndrome
### Long term Survival by complexity of CHD

<table>
<thead>
<tr>
<th>Complexity</th>
<th>Survival Rate</th>
</tr>
</thead>
<tbody>
<tr>
<td>Simple</td>
<td>95%</td>
</tr>
<tr>
<td>Moderate</td>
<td>90%</td>
</tr>
<tr>
<td>Severe</td>
<td>80%</td>
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**Conditions:**
- Atrial septal defect
- Ventricular septal defect
- Patent ductus arteriosus
- Atrioventricular canal defect
- Patent foramen ovale
- Tetralogy of Fallot
- Pulmonary atresia
- Hypoplastic left heart syndrome

**Long term survival > 20 years**

**References:**
- Warnes, J Am Coll Cardiol. 2008

### CHD Pathophysiology

- **Valve stenosis & regurgitation**
- **Outflow stenosis, dilation, compression**
- **Pulmonary Hypertension**
- **Cyanosis & Bleeding**
- **Ventricular function, rhythm, geometry, residual lesions**

**Special Situations:**
- Pregnancy, laparoscopy, regional & neuraxial

**COMORBIDITIES:**
- Congenital & Acquired
- Thromboembolic
- Liver Dysfunction
- Pulmonary Hypertension
- Cyanosis & Bleeding

**Lesions Specific:**
1. **Single Ventricle**
   - Left vs Right, PLE
2. **Tetralogy of Fallot**
   - PI, RV Dilation
3. **TGA**
   - Baffle stenosis, coronary

### Changing Surgical techniques: TGA

- **1968 Senning-Mustard**
- **1975 Jatene Arterial Switch Operation**

### Changing Surgical techniques: TA Stage 1 BT Shunt

### Changing Surgical techniques: TA Stage 2 Glenn Shunt

**Mark Twite, MB**

*Anesthetic Considerations in Adults with Congenital Heart Disease*
**Changing Surgical techniques: TA Stage 3 Fontan**

- AtrioPulmonary
- Lateral Tunnel
- Extracardiac

**Effects of anesthetic agents**

<table>
<thead>
<tr>
<th>Anesthetic</th>
<th>Contractility</th>
<th>MAP</th>
<th>SVR</th>
<th>PAP</th>
<th>PVR</th>
<th>HR</th>
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<td>Vecuronium</td>
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<td>Rocuronium</td>
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<td>Propofol</td>
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<td>Ketamine</td>
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<td>↑</td>
<td>↑</td>
<td>↑</td>
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<td>↑</td>
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<tr>
<td>Fentanyl</td>
<td>↓↑</td>
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<tr>
<td>Remifentanil</td>
<td>↑↓</td>
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<tr>
<td>Nitrous oxide</td>
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<tr>
<td>Dexmedetomidine</td>
<td>↑↓</td>
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<tr>
<td>Anaesthetic</td>
<td>↑↓</td>
<td></td>
<td></td>
<td></td>
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</tr>
</tbody>
</table>

**Consensus Statements**

**AHA Scientific Statement**

- Circulation, October 2017
- Diagnosis and Management of Noncardiac Complications in Adults With Congenital Heart Disease

- Circulation, January 2017
- Management of Pregnancy in Patients With Complex Congenital Heart Disease

**Atrial Arrhythmias**

- Studied 482 adults with CHD from 12 centers in the USA
- Most common presenting arrhythmias:
  - Intra-atrial re-entrant tachycardia (IART) 61.6% (increased with CHD complexity)
  - Atrial fibrillation (AF) 28.8%, increased with age to surpass IART at 50yrs of age
  - Focal atrial tachycardia 9.5%

**Time-series analysis: referral to specialized ACHD centers and ACHD patient mortality**

- Mylotte SCV A 2014

**Risk factors for developing atrial arrhythmias:**

- Single ventricle
- Previous intracardiac repair
- Systemic right ventricle
- Pulmonary hypertension
Adults with CHD and atrial arrhythmias:
• x 4 increase of heart failure
• x 2 increase in death

Atrial arrhythmias frequent cause of sudden cardiac death (43%)
Increasing incidence with complexity of CHD
- Eisenmenger
- Transposition of great arteries (atrial switch)
- Single ventricles lesions palliated to Fontan circulation

Factors leading to arrhythmias in CHD

Risk estimates for arrythmias across CHD

Implantable Cardioverter-Defibrillator

Majority of SCD victims unrecognized with an area under the curve of 0.6 for the discriminative ability of current guidelines
Critical clinical reasoning essential when deciding on ICD placement in adult CHD patients
ACHD Heart Failure

- Single Ventricle palliated to Fontan
- Single ventricle has both the systemic and pulmonary resistances in series

Tetralogy of Fallot
- Pulmonary regurgitation causes RV dilation and dysfunction, abnormal septal configuration, altered RV-LV interaction and LV dysfunctio

Subsystemic RV
1. D-TGA palliated with a Mustard/Senning atrial switch
2. ccTGA

Heart Liver Transplant

- UNOS Database 1987 – 2015
- 61437 Heart Tx
  - 190 CHLT
    - 41 had CHD
    - 30 day, 1 and 5 year survival 95%, 86% and 83%
    - CHLT with and without CHD comparable
    - Trend towards better survival for CHLT compared with isolated Heart Tx for CHD

CHD Pathophysiology

- Arrhythmias
- Outflow stenosis, dilation, compression
- Cyanosis & Bleeding
- Pulmonary Hypertension
- Ventricular function, rhythm, geometry, residual lesions
- Valve stenosis & regurgitation

COMORBIDITIES

1. Single Ventricle
   - Left vs Right, PLE
2. Tetralogy of Fallot
   - PI, RV Dilation
3. TGA
   - Baffle stenosis, coronaries

Endocarditis prophylaxis

- CHD Specific
- Left vs Right, PLE
- Thrombembolic
- Liver Dysfunction

Special Situations

- Pregnancy, laparoscopy, regional & neuraxial
- Endocarditis prophylaxis

Mark.Twite@UCDenver.edu

Thank you
Swan Song in Cardiac Surgery?
Wayne Soong, MD, FCCP

Objectives

- Quantify and characterize the risks of PAC use
- Determine patient populations appropriate for PAC use in cardiac surgery
- Characterize surgical considerations in deciding on PAC use
- Describe the implications of institutional setting on PAC use

PAC in Cardiac Surgery

<table>
<thead>
<tr>
<th>Percentage of Patients Monitored with PAC</th>
<th>CPB (%)</th>
<th>OPCAB (%)</th>
<th>Minimally Invasive CABG (%)</th>
<th>Minimally Invasive Valve (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>100%</td>
<td>34.6</td>
<td>45.2</td>
<td>42.4</td>
<td>46.3</td>
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<td>75%–99%</td>
<td>33.6</td>
<td>22.5</td>
<td>16.2</td>
<td>17.3</td>
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<tr>
<td>50%–74%</td>
<td>7.1</td>
<td>5.5</td>
<td>6.8</td>
<td>5.4</td>
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<tr>
<td>25%–49%</td>
<td>6.1</td>
<td>3.5</td>
<td>6.0</td>
<td>2.8</td>
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<td>1%–24%</td>
<td>15.1</td>
<td>14.2</td>
<td>15.2</td>
<td>12.8</td>
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<tr>
<td>0%</td>
<td>3.5</td>
<td>9.2</td>
<td>13.6</td>
<td>15.3</td>
</tr>
</tbody>
</table>

PAC in Cardiac Surgery

- CABG 60.3%
- Aortic or mitral valve replacement 74.1%
- CABG + valve replacement 75.5%
- Other 70.9%

Outline

- History of the PAC
- Patient selection
- Surgical considerations
  - OPCAB
  - CPB
- Setting
  - Institutional norm
  - Accuracy
  - Interpretation
  - Treatment

Disclosures

I have no relationships with or investments in pertinent commercial interests to disclose.
History

- Central venous pressure
- Right ventricular pressure
- Pulmonary artery pressure
- Pulmonary artery occlusion pressure
- Spectrophotometric mixed venous oxygen saturation
- Thermodilution cardiac output

Should we use PACs in cardiac surgery?

In summary, there is conflicting evidence from controlled studies regarding the benefit that cardiac surgery patients receive from PA catheterization.
Procedural Risk

<table>
<thead>
<tr>
<th>Procedure</th>
<th>Weight</th>
<th>Hazard Ratio</th>
<th>Confidence Interval</th>
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<tbody>
<tr>
<td>Catheter</td>
<td>0.14</td>
<td>2.1</td>
<td>1.0-4.2</td>
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<tr>
<td>Procedural time</td>
<td>0.15</td>
<td>2.3</td>
<td>1.0-5.8</td>
</tr>
<tr>
<td>Anesthesiologist time</td>
<td>0.25</td>
<td>2.2</td>
<td>1.0-5.0</td>
</tr>
<tr>
<td>Infrastructure</td>
<td>0.20</td>
<td>2.0</td>
<td>1.0-4.1</td>
</tr>
<tr>
<td>Nursing care</td>
<td>0.15</td>
<td>2.1</td>
<td>1.0-4.2</td>
</tr>
<tr>
<td>Cost effectiveness</td>
<td>0.10</td>
<td>2.0</td>
<td>1.0-3.9</td>
</tr>
</tbody>
</table>

Cost

- Catheter
- Procedural time
- Anesthesiologist time
- Infrastructure
- Nursing care
- Cost effectiveness

Should we use PACs in cardiac surgery?

Patient Selection

Patient Selection

Wayne Soong, MD
Swan Song for Cardiac Surgery?
Wayne Soong, MD

Swan Song for Cardiac Surgery?

Patient Selection

- ASA 4 or 5
- Age > 80
- Ventricular dysfunction
- Pulmonary arterial hypertension
- Intracardiac shunt
- Pulmonary edema

Surgery

Off Pump

Clinical Outcomes of Low-Risk Patients Undergoing Beating-Heart Surgery: With or Without Pulmonary Artery Catheterization

Fernando G. Resano, M.D., F.A.C.C.; Robert E. Swischuk, M.D.; and Paul J. Cerreta, M.D.

Objective: To evaluate outcomes in low-risk patients undergoing beating-heart surgery (BHS) with or without pulmonary artery catheterization (PAC), which has been suggested as a safer alternative to traditional coronary artery bypass grafting (CABG).

Methods: We conducted a retrospective analysis of 500 consecutive patients who underwent CABG with or without PAC between 2000 and 2005. The primary outcomes of interest were hospital mortality and non-fatal complications (stroke, heart failure, renal failure, and major bleeding).

Results: There were no significant differences in hospital mortality or non-fatal complications between the PAC and non-PAC groups. The PAC group had a lower incidence of early and late heart failure and a trend towards lower incidence of stroke.

Conclusion: Beating-heart surgery with or without PAC is a safe and effective alternative to traditional CABG in low-risk patients.

On Pump

Post-CPB LV wall stiffness
• Ischemia
• Reperfusion injury
• Inflammatory mediators
• Sympathetic mediators

Setting

Surgery

• Reoperation
• Double- or triple-valve surgery
• Assist device
• Surgeon

Institutional Norm

Institutional Norm

Accuracy

Assessment of critical care nurses’ knowledge of the pulmonary artery catheter

Objectives: To assess the knowledge and understandings of the use of the pulmonary artery catheter among nurses attending the American Association of Critical Care Nurses’ National Teaching Institute conference.

Design: A 72-question multiple-choice examination of the knowledge regarding the use of the pulmonary artery catheter was administered to a group of nurses attending a national conference, who were unacquainted with the pulmonary artery catheter.

Methods: Sixty-six nurses completed the questionnaire. The mean test score was 66 ± 5.5 (48.6%). Test scores were significantly associated with nurses’ years of experience, critical care registered nurse certification, and responsibility for ordering and manipulating the catheter. Frequency of use, and self-assessment scores were also found to be associated with test scores.

References:

Chiang, 2015

Ramsey, 2000

Iberti, 1994
Accuracy

<table>
<thead>
<tr>
<th>Subtest Content</th>
<th>No. of Items</th>
<th>Score (mean ± SD)</th>
<th>%</th>
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<tbody>
<tr>
<td>Complications</td>
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<td>1.9 ± 0.9</td>
<td>63.3</td>
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<tr>
<td>Waveforms</td>
<td>6</td>
<td>3.7 ± 1.5</td>
<td>52.2</td>
</tr>
<tr>
<td>Patient management</td>
<td>5</td>
<td>2.5 ± 1.3</td>
<td>50.5</td>
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<tr>
<td>Insertion technique</td>
<td>4</td>
<td>2.0 ± 1.1</td>
<td>49.9</td>
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<tr>
<td>Positioning</td>
<td>4</td>
<td>1.9 ± 1.2</td>
<td>47.2</td>
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<tr>
<td>Calculations</td>
<td>6</td>
<td>2.3 ± 1.4</td>
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Accuracy and Precision

Interpretation

A Multicenter Study of Physicians' Knowledge of the Pulmonary Artery Catheter

Interpretation

Lack of Effectiveness of the Pulmonary Artery Catheter in Cardiac Surgery
Should we use PACs in cardiac surgery?
Goals and Objectives

1. Review right ventricle anatomy and function
2. Discuss the pathophysiology of right ventricular failure
3. Review the echocardiographic evaluation of the right ventricle
4. Identify risk factors for RV failure
5. Discuss management strategies for RV failure

Right Ventricle Anatomy

- Complex shape
- Right Ventricle divided into 3 main anatomic areas
  - Smooth muscular inflow (body or sinus)
  - Trabecular apical region
  - Outflow area (infundibulum or conus)
- Blood supply
  - RCA mediated Acute Marginal branches
  - PDA may supply RV inferior free wall

Right Ventricle Normal Function

- Larger than the RV by EDV
- Lower ejection fraction than LV by 10-15%
  - Lower end of normal values ~ 45%
- Mass regresses as PVR drops at birth
  - Adult 1/6th the LV mass
- Better adapted to handle volume overload

RV Dysfunction

- INTERMACS definition:
  - CVP > 16 cmH₂O
  - Dilated IVC with absence of respiratory variation by TTE
  - Associated clinical features of venous congestion
RV Basics
- Refractory RV failure post cardiac surgery needing prolonged ionotropic support or RVAD
  - 0.1% all comers
  - 2-3% Heart Transplants
  - 20-30% of patients with LVAD
- Survival Rates for post op RV failure ~ 25-30%
- RV systolic dysfunction or severe RV dilation
  - Present in almost ½ the patients with hemodynamic compromise

Costachescu 2002

2 year all cause mortality
- RVEF <20% 16.7%
- 20-30% 8.2%
- >30% 4.1%

Costachescu 2002
Bozmana et al. JVA 2017

Right Ventricle Pathophysiology
- Chronic volume overload
  - Progressive lengthening of base to apex and septum to free wall
  - D shaped LV in diastole
- Chronic pressure overload
  - D shaped LV short axis in systole

Pathophysiology

Perioperative RVD Risks
- Identify Patients at high risk
  - Long cardiopulmonary bypass runs (>150 min)
- Suboptimal Intraoperative myocardial protection
- Coronary Embolism or graft occlusion
- Lung Injury or mechanical ventilation induced lung injury
  - ARDS post cardiac surgery ~10%
- Heart Transplants
  - Donor heart ischemia or pre-op pulmonary vascular dysfunction

Right Ventricle Failure
- Need for inhaled vasodilator >48 hours
- Intravenous ionotropes > 14 days
- Right ventricular assist device
Avoiding RV Failure

- Appropriate Timing of Surgery
- Optimizing myocardial protection
- Selective Use of Pulmonary Vasodilators
- Avoiding liberal transfusion strategies
  - Avoiding old blood products

Timing

- Things out of our control
  - Valvular induced pre-op RV failure
    - Someone waited too long
  - Acute RV infarction
    - 1 month wait to allow for RV recovery

Surgical Technique

- Choice and route of cardioplegia
- Choice of bypass graft targets
  - For long term revascularization
  - Improve myocardial protection
- Addition of tricuspid repair
- Atrial and ventricular wires

Cardioplegia

- Beware the RCA obstruction
- Retrograde cardioplegia caveats
  - Thebesian vessels
- Data on choice of plegia still to come

Pulmonary Vasodilation

- Nitric Oxide
- Inhaled Prostaglandins
- Other inhaled agents
  - Timing of use

Nitric Oxide

- Primary pulmonary vasodilator
  - No effect on systemic circulation
- V-Q matching
- Reduced RV afterload
- Negatives
  - Methemoglobinemia
  - Cost
  - Weaning required
Inhaled Prostaglandins

- Epoprostenol (prostaglandin I₂)
  - Similar effects as NO
    - Longer half life

- Negative
  - Potential for impaired platelet aggregation

Inhaled Milrinone

- Phosphodiesterase type III inhibitor
- Inhaled has reduced effect on SVR and MAP
  - With maintaining increased CO, PAP, and PVR reduction
  - Limited studies

AV Synchrony

- Sinus Rhythm maintenance
  - Cardioversion
  - Anti-arrhythmics
- Atrial pacing wires in high risk patients

Ionotropic Support

- Is there evidence for one ionotropic agent?
- Pros/Cons
  - Dobutamine
  - Milrinone
  - Epinephrine
  - Vasopressin
  - Norepinephrine

Echocardiography

- Evaluating the RV
- Mid Esophageal
  - Modified 4 chamber
  - RV inflow-outflow
  - Bicaval (for tricuspid jet doppler)
- Transgastric
  - Short and long axis
  - Modified view
Esophageal Views

Transgastric Views

RV Assessment
- Tricuspid Annular Plane systolic excursion (TAPSE)
  - Modified deep transgastric long index
- RV Fractional Area Change (FAC)
- Tei index/ RV index of myocardial performance (RIMP)
  - Tissue doppler
- 3D TEE
- Speckle tracking and strain

TAPSE Image

Tei Index
- Image to be added

Echocardiography Caveats
- Imaging modality matters
- 2D vs 3D
  - Changes in RV long axis performance
Mechanical Support Options

- Impella
- RVAD
- ECMO
- Outcomes data

Summary

- RV failure is rare but can be catastrophic
- Beware of pre-operative RV dysfunction
- Many factors are under surgeon's control
- Intraoperative TEE will help guide your decision making
- Ionotropes and vasopressors each have pros and cons
- There is no perfect solution!
Friday
The Changing Landscape of Opioid Analgesics: An FDA Perspective

Jeffrey L. Galinkin MD, FAAP
Professor of Anesthesiology and Pediatrics
University of Colorado, AMC

Objectives

1. Understand the need for new formulations of opioids.
2. Develop an understanding of new opioid anti-abuse technologies.
3. Understand what REMS are and why they are needed.
4. Understand the rationale for naloxone dosing.

Disclosures

• Purdue Pharma
• Teva
• Novartis
• CPC Clinical Research
• Claro Scientific LLC

1.8 Million Full-Time Workers Have a Substance Use Disorder

Post-Month Illicit Drug Use among Persons Aged 12-17 in Colorado and the United States (2008-2012)
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.
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.

Leftover Medications

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

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

The FDA will:
- Re-examine the risk-benefit paradigm for opioids and ensure that the agency considers their wider public health effects,
- Convene an expert advisory committee before approving any new drug application for an opioid that does not have abuse-deterrent properties,
- Assemble and consult with the Pediatric Advisory Committee regarding a framework for pediatric opioid labeling before any new labeling is approved,
- Develop changes to immediate-release opioid labeling, including additional warnings and safety information that incorporate elements similar to the extended-release/long-acting (ER/LA) opioid analgesics labeling that is currently required,
- Support better pain management options, including alternative treatments.
The FDA will:
- Expand access to, and encourage the development of, abuse-deterrent formulations of opioid products;
- Update Risk Evaluation and Mitigation Strategy requirements for opioids after considering advisory committee recommendations and review of existing requirements;
- Improve access to naloxone and medication-assisted treatment options for patients with opioid use disorders; and

Making opioids safer
- “The development of abuse-deterrent opioid analgesics is a public health priority for the FDA,” Douglas Throckmorton, M.D., deputy director for regulatory programs CDER.

How Do You Reformulate Opioids to be “Abuse Deterrent”? 

Routes of Abuse
- Injection: Can you manipulate a pill and make easy to inject?
- Insufflation: (snorting) Can you manipulate a pill and make it easy to insufflate?
- Smoking: Can a pill be inhaled/smoked in either an intact or manipulated form?
- Ingestion: Does manipulating a pill make it more bioavailable when orally taken?

Approach to Evaluation
- Tier-based approach
- Performance based evaluation of abuse deterrence
- Most effective manipulation
- Sample selection after physical manipulation
- Comparing abuse deterrent formulation to reference product in extraction studies
- Statistical comparison of new to old formulation
Approaches to Reformulation

Make it really hard

Big pill difficult to crush

“OXYCONTIN is formulated with inactive ingredients intended to make the tablet more difficult to manipulate for misuse and abuse.”

Oxycontin Package Insert

In vitro physical and chemical tablet manipulation studies were performed to evaluate the success of different extraction methods in defeating the extended-release formulation.

- Increase in the ability of OXYCONTIN to resist crushing, breaking, and dissolution using a variety of tools and solvents.
- When subjected to an aqueous environment, OXYCONTIN gradually forms a viscous hydrogel (i.e., a gelatinous mass) that resists passage through a needle.

Microspheres Difficult to Crush

• XTAMPZA ER capsules contain microspheres formulated with inactive ingredients intended to make the formulation more difficult to manipulate for misuse and abuse.
• Relative to immediate-release oxycodone tablets, XTAMPZA ER is less susceptible to the effects of grinding, crushing, and extraction using a variety of tools and solvents.
• XTAMPZA ER resisted attempts to pass the melted capsule contents or the microspheres suspended in water through a hypodermic needle.
Oxycodone ER: Reformulated

“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.”

Douglas Throckmorton, MD

FDA news release April 16, 2013

Oxymorphone ER (Opana)

“...Increased ability of the reformulated version of Opana ER to resist crushing relative to the original formulation.

...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.”

FDA statement May 10, 2013

Roxybond

RoxyBond is the first and only FDA-approved immediate-release opioid medication with abuse-deterrent claims in its approved labeling language

SentryBond™ ....is formulated with inactive ingredients that make the tablet more difficult to manipulate for misuse and abuse, even if subjected to physical manipulation and/or chemical extraction.

Other Crush resistant formulations

• Morphabond ER (Morphine)
• Arymo ER (Morphine)
• Vantrela ER (12 hour Hydrocodone)
• Hysingla ER (24 hour Hydrocodone)

https://www.fda.gov/Drugs/DrugSafety/InformationbyDrugClass/ucm337066.htm

Combining an Opioid and Antagonist

Morphine/naltrexone (Embeda)

• Embda approved on November 4, 2013

https://www.fda.gov/Drugs/DrugSafety/InformationbyDrugClass/ucm337066.htm
Other products?

- Troxyca ER (Oxycodone/Naltrexone) and Targiniq (Oxycodone/Naloxone) have both been discontinued for now.

Other products?

- KemPharm tried to re-engineer hydrocodone to impart abuse-deterrent properties at a molecular level.
- Benzhydrocodone: Bonded hydrocodone to benzoic acid, a widely used food preservative.
- Benzhydrocodone was not pharmacologically active, but had to be metabolized into hydrocodone by enzymes in the intestinal tract to deliver its pharmacologic effects.

FDA’s Opioid Analgesic REMS Education Blueprint for Health Care Providers Involved in the Treatment and Monitoring of Patients with Pain (January 2018)
Opioid REMS

- To include both ER/LA products and IR products
- Intended to support other national efforts underway to address the misuse and abuse of prescription opioid analgesics

As part of the Opioid Analgesic REMS, all opioid analgesic companies must provide the following:
- Education for healthcare providers (HCPs) who participate in the treatment and monitoring of pain.
- Education will be offered through accredited continuing education (CE) activities via unrestricted educational grants from opioid analgesic companies.
- Information for HCPs to use when counseling patients about the risks of ER, LA, and IR opioid analgesic use.

Too Tall a Task?

- The fundamental concepts of pain management, including definitions and mechanisms of pain
- How to assess patients in pain, identifying risk factors for abuse and addiction
- The range of therapeutic options for managing pain, including nonpharmacologic approaches and pharmacologic (non-opioid and opioid analgesics) therapies
- How to integrate opioid analgesics into a pain treatment plan individualized to the needs of the patient
- How to safely and effectively manage patients on opioid analgesics in the acute and chronic pain settings, including initiating therapy, titrating, and discontinuing use of opioid analgesics
- How to counsel patients and caregivers about the safe use of opioid analgesics, including proper storage and disposal
- How to counsel patients and caregivers about the use of naloxone for opioid overdose
- When referral to a pain specialist is appropriate
- The fundamental elements of addiction medicine
- How to identify and manage patients with opioid use disorder

Result of REMS Trial

- Respondents were knowledgeable about management and counseling requirements for patients being considered for treatment or currently being treated with ER/LA opioid analgesics.
- Respondents were less knowledgeable about assessment of patients, initiation and modification of treatment, and general and product specific information for ER/LA opioid analgesics.
- Since participating in a REMS-compliant activity, respondents reported more often conducting appropriate prescriber behaviors.

Result of REMS Trial

- Half of respondents reported no changes in opioid prescribing behaviors since participating in the CE activity.
- 22% reported writing prescriptions for ER/LA opioid analgesics less often.
- 19% reported writing more ER/LA opioid analgesics prescriptions.
- 38% of respondents reported prescribing more non-opioid medications.
- 23% reported limiting which ER/LA opioid analgesics they prescribe.
- 32% of respondents reported no changes in the types of medications prescribed.

Clinical and Regulatory Perspectives on Naloxone Products Intended for Use in the Community

Joint Meeting of the Anesthetic and Analgesic Drug Products Advisory Committee and the Drug Safety and Risk Management Advisory Committee
October 5, 2010

Jennifer Nadel, MD
Medical Officer
FDA/CDER/OND
Division of Anesthesia, Analgesia, and Addiction Products
Inside the FDA meeting

• New concerns over high potency illicit opioids requiring higher doses of naloxone
• We now have companies approaching us about different dosing regimens for these products
• FDA is seeking advice on how to approach these new questions
  — Is our minimum standard high enough?
  — Is there a place for products of different doses/strengths?
  — How would we label a product so a prescriber would know which to choose?

Regulatory Path Forward

• Infeasible to study minimal effective dose, or conduct efficacy trial
  — Life-threatening nature of opioid overdose
  — Ethical and logistical issue
• Reliance on Agency’s previous findings for approved Naloxone Injection
• To establish a scientific bridge via relative bioavailability study between new product and the reference

Questions for the Committee

The current pharmacokinetic standard for the approval of naloxone products for use in the community requires demonstration of comparable or greater naloxone levels compared to a minimum dose of 0.4 mg of approved naloxone injection administered by one of the labeled routes of administration.
  — a. If you support a different pharmacokinetic standard, describe the rationale for this approach.
  — b. Discuss whether this minimum standard for approval is sufficient to address the management of the variety of opioid overdose situations arising in the community or if there is a role for more than one standard for different anticipated situations.

Concentration-time Profiles

• Similar $T_{\text{max}}$
• Higher $C_{\text{max}}$ and AUC (~5-fold) for 4 mg Nasal Spray

Questions for the Committee

Different sponsors have proposed different strength doses for their naloxone products intended for use in the community and some have proposed marketing more than one dose strength. Discuss whether there are factors that support different dosing strengths, and how that can be reflected in labeling to assist clinicians in product selection.

Questions for the Committee

Both children and adults may be at risk for opioid overdose in the home. The current approach has been to require that naloxone products for community use are appropriate for both adult and pediatric use to minimize the risk of product confusion when treating an overdose in the home. Strictly following the pediatric dosing recommendations from the American Academy of Pediatrics (AAP) would require a minimum dose of 2 mg, higher than the current standard for adult products.

a. Discuss whether there should be products specifically targeting naloxone dosing for children based on the AAP recommendations.
b. Discuss whether the standard for approval of naloxone products for use in the community should reflect pediatric dose requirements, and comment on the implications for use of these products in adults.
c. Discuss whether it is acceptable to have different adult and pediatric products available in the home, and how to weigh the risk for product confusion.
Results

• High degree of controversy over whether dose increase is necessary
• Overall the committee recommended increasing the standard dose.

Conclusions

• The FDA does have a plan to combat opioid diversion.
• The plan is limited in scope.
• REMS programs are going to become much more prevalent for all prescribers of opioids.
• We as anesthesiologists will have a duty to educate other providers as experts.
CRASH 2018
Update in Cardi thoracic Anesthesiology and Perioperative Care

Karsten Bartels, MD
Disclosures
The PAC Debate

  – RCT of “high-risk” scheduled for urgent or elective major surgery, followed by a stay in an ICU. No mortality difference. More PEs in the PAC group. (p=0.004). Goals for CI and DO₂ were met by 79% and 63% of patients, respectively, after surgery.

• Warszawski J et. al. JAMA 290: 2713, 2003 (676 patients)
  – RCT of patients who fulfilled the criteria for shock, ARDS, or both conducted in 36 French ICUs. Patients randomly assigned to PAC (n = 335) or not (n = 341). Treatment was left to the discretion of each individual physician. No significant differences in mortality at any time point.

• Harvey S et. al. Lancet 366: 472, 2005 (1041 patients)
  – RCT from 65 UK ICUs, assigned to management with (n=519) or without (n=522) a PAC. “Clinical management after randomization was at the discretion of the treating clinician.” No difference in mortality. 46 complications associated with insertion of a PAC, none of which was fatal.

All of these trials either failed to achieve the structured hemodynamic goals in the treatment group (Sandham), or worse, did not provide any guidance for the clinician in terms of how to actually use the device.
Central Thermodilution

- In Animals: Primarily compared using regression-based statistical methods

<table>
<thead>
<tr>
<th>Thermodilution versus...</th>
<th>Direct Fick $Q' = V'O_2/(CaO_2 - CvO_2)$</th>
<th>Electromagnetic Flowmeter</th>
<th>Transit Time Flow Probes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Correlation Coefficient (number of independent measurements)</td>
<td>0.96 (48)</td>
<td>0.98 (87)</td>
<td>0.90 (70)</td>
</tr>
<tr>
<td>0.96 (32)</td>
<td>0.97 (120)</td>
<td></td>
<td>0.90 (95)</td>
</tr>
<tr>
<td>0.94 (80)</td>
<td>0.95 (128)</td>
<td>0.93 (366)</td>
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</tr>
<tr>
<td>0.94 (130)</td>
<td>0.98 (82)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>0.97 (6)</td>
<td>0.92 (75)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>0.95 (52)</td>
<td>0.96 (62)</td>
<td></td>
<td></td>
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</tbody>
</table>
Central Thermodilution

- In Humans: Primarily compared using regression-based statistical methods

<table>
<thead>
<tr>
<th>Thermodilution versus...</th>
<th>Direct Fick</th>
<th>EMF</th>
<th>TT Flow Probe</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>0.90 (11)</td>
<td>0.96 (99)</td>
<td>0.80 (46)</td>
</tr>
<tr>
<td></td>
<td>0.70 (77)</td>
<td>0.68 (50)</td>
<td>0.55 (170)</td>
</tr>
<tr>
<td></td>
<td>0.91 (23)</td>
<td>0.81 (73)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>0.91 (26)</td>
<td>0.94 (180)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>0.83 (50)</td>
<td>0.85 (51)</td>
<td></td>
</tr>
<tr>
<td>Correlation Coefficient (and number of independent measurements)</td>
<td>0.86 (57)</td>
<td>0.85 (136)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>0.98 (43)</td>
<td>0.84 (48)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>0.92 (32)</td>
<td>0.84 (22)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>0.86 (237)</td>
<td>0.84 (42)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>0.95 (50)</td>
<td>0.84 (15)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>0.94 (42)</td>
<td>0.84 (30)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>0.83 (72)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Central Thermodilution

• Conclusions
  – Large number of studies in both animals models and humans
    • More than any other available technology
    • Across a range of hemodynamic conditions not possible in human volunteer studies
  – Extremely accurate when compared to invasive gold-standards
  – Accuracy ≠ utility
Doppler
SV = VTI * CSA

SV = Stroke Volume
VTI = Velocity Time Integral
CSA = Cross Sectional Area

## Doppler in Humans

<table>
<thead>
<tr>
<th>Doppler versus...</th>
<th>Direct Fick</th>
<th>Thermodilution</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>0.44 (18)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>0.94 (110)</td>
</tr>
<tr>
<td>Surface Doppler</td>
<td>0.83 (11)</td>
<td>0.91 (20)</td>
</tr>
<tr>
<td></td>
<td>0.98 (33)</td>
<td>0.94 (22)</td>
</tr>
<tr>
<td></td>
<td>0.78 (28)</td>
<td>0.90 (73)</td>
</tr>
<tr>
<td></td>
<td>0.89 (85)</td>
<td>0.89 (46)</td>
</tr>
<tr>
<td></td>
<td>0.76 (12)</td>
<td>0.96 (20)</td>
</tr>
<tr>
<td></td>
<td>0.85 (14)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>0.86 (52)</td>
<td></td>
</tr>
<tr>
<td>Esophageal Doppler</td>
<td>0.89 (67)</td>
<td>0.95 (136)</td>
</tr>
<tr>
<td></td>
<td>0.76 (12)</td>
<td>0.81 (40)</td>
</tr>
<tr>
<td></td>
<td>0.89 (46)</td>
<td>0.99 (96)</td>
</tr>
</tbody>
</table>
### TABLE 1. Simultaneous Comparisons of Thermodilution and Doppler to Reference Standards

<table>
<thead>
<tr>
<th>Study/Author</th>
<th>Subjects</th>
<th>( a )</th>
<th>Doppler</th>
<th>( n )</th>
<th>TDCO</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fick</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Welch (31)</td>
<td>Pigs</td>
<td>28</td>
<td>0.88</td>
<td>28</td>
<td>0.91</td>
</tr>
<tr>
<td>Christie (65)</td>
<td>Humans</td>
<td>42</td>
<td>0.81</td>
<td>42</td>
<td>0.94</td>
</tr>
<tr>
<td>Gola (55)</td>
<td>Humans</td>
<td>73</td>
<td>0.9</td>
<td>73</td>
<td>0.81</td>
</tr>
<tr>
<td>Electromagnetic flow meter</td>
<td></td>
<td></td>
<td></td>
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<td></td>
</tr>
<tr>
<td>Gregoretti (34)</td>
<td>Pigs</td>
<td>128</td>
<td>0.87</td>
<td>128</td>
<td>0.95</td>
</tr>
<tr>
<td>Segal (39)</td>
<td>Sheep</td>
<td>341</td>
<td>0.89</td>
<td>81</td>
<td>0.85</td>
</tr>
<tr>
<td>Heerdt (41)</td>
<td>Humans</td>
<td>46</td>
<td>0.64</td>
<td>46</td>
<td>0.8</td>
</tr>
<tr>
<td>Segal (269)</td>
<td>Humans</td>
<td>44</td>
<td>0.82</td>
<td>44</td>
<td>0.85</td>
</tr>
<tr>
<td>Transit time flow meter</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Wong (81)*</td>
<td>Dogs</td>
<td>95</td>
<td>0.74</td>
<td>95</td>
<td>0.9</td>
</tr>
<tr>
<td>Aadalh (44)</td>
<td>Pigs</td>
<td>70</td>
<td>0.73</td>
<td>70</td>
<td>0.9</td>
</tr>
<tr>
<td>Dicorte (46)</td>
<td>Humans</td>
<td>170</td>
<td>0.49</td>
<td>170</td>
<td>0.55</td>
</tr>
<tr>
<td>Bajorat (45)</td>
<td>Pigs</td>
<td>366</td>
<td>0.84</td>
<td>366</td>
<td>0.93</td>
</tr>
<tr>
<td><strong>Mean-weighted averages</strong></td>
<td></td>
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<tr>
<td></td>
<td></td>
<td></td>
<td><strong>0.80</strong></td>
<td></td>
<td><strong>0.85</strong></td>
</tr>
</tbody>
</table>

*Comparisons between changes in cardiac output, not absolute values. Boldface values are the larger values between Doppler and TDCO in the respective rows.
Bioimpedance & Biorectance

http://www.cheetah-medical.com

http://www.cardiacengineering.com

271
<table>
<thead>
<tr>
<th>Bioimpedance versus...</th>
<th>Fick</th>
<th>Thermodilution</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bioimpedance</td>
<td>0.70 (15)</td>
<td>0.61 (411)</td>
</tr>
<tr>
<td></td>
<td>0.84 (42)</td>
<td>0.78 (111)</td>
</tr>
<tr>
<td></td>
<td>0.90 (25)</td>
<td>0.87 (14)</td>
</tr>
<tr>
<td></td>
<td>0.84 (40)</td>
<td>0.87 (19)</td>
</tr>
<tr>
<td></td>
<td>0.84 (10)</td>
<td>0.63 (120)</td>
</tr>
<tr>
<td></td>
<td>0.61 (416)</td>
<td>0.43 (58)</td>
</tr>
<tr>
<td></td>
<td>0.73 (94)</td>
<td>0.86 (201)</td>
</tr>
<tr>
<td></td>
<td>0.80 (metaanalysis)</td>
<td>0.87 (27)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>0.84 (400)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>0.86 (842)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>0.89 (256)</td>
</tr>
<tr>
<td>Bioreactance</td>
<td></td>
<td>0.08 (24)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>0.85 (2192)</td>
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<tr>
<td></td>
<td></td>
<td>0.28 (109)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>0.83 (20)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>0.46 (33)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>0.35 (11)</td>
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<tr>
<td></td>
<td></td>
<td>0.41 (7)</td>
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<td></td>
<td></td>
<td>0.86 (129)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>0.49 (160)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>0.83 (metaanalysis)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>0.90 (27)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>0.79 (67)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>0.77 (33)</td>
</tr>
</tbody>
</table>
Partial Rebreathing
Partial Rebreathing

- Noninvasive
- Shunt fraction is estimated
- Long response time
# Partial Rebreathing

<table>
<thead>
<tr>
<th>Partial Rebreathing versus... (Humans)</th>
<th>Thermodilution</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>0.78 (20)</td>
</tr>
<tr>
<td></td>
<td>0.80 (112)</td>
</tr>
<tr>
<td></td>
<td>0.62 (36)</td>
</tr>
<tr>
<td></td>
<td>0.63-0.7 (225)</td>
</tr>
<tr>
<td></td>
<td>0.34-0.75 (150)</td>
</tr>
<tr>
<td></td>
<td>0.42 (140)</td>
</tr>
<tr>
<td></td>
<td>0.47-0.52 (294)</td>
</tr>
<tr>
<td></td>
<td>0.83 (111)</td>
</tr>
<tr>
<td></td>
<td>0.69 (42)</td>
</tr>
</tbody>
</table>
Arterial pressure waive form analysis

- Uncalibrated (Flotrac)
- Calibrated (LIDCOPlus), PiCCO
## Arterial Waveform

<table>
<thead>
<tr>
<th>Arterial Pressure Analysis (Humans)</th>
<th>Thermodilution</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>LiDCO</strong></td>
<td></td>
</tr>
<tr>
<td>0.89 (44)</td>
<td>Linton 1993</td>
</tr>
<tr>
<td>0.88 (151)</td>
<td>Costa 2008</td>
</tr>
<tr>
<td>0.82 (220)</td>
<td>Mora, 2011</td>
</tr>
<tr>
<td><strong>PICCO</strong></td>
<td></td>
</tr>
<tr>
<td>0.85 (216)</td>
<td>Goedje 1999</td>
</tr>
<tr>
<td>0.86 (186)</td>
<td>Della Rocca 2002</td>
</tr>
<tr>
<td>0.68 (400)</td>
<td>Hamzaei, 2008</td>
</tr>
<tr>
<td>0.88 (36)</td>
<td>Buhre, 1999</td>
</tr>
<tr>
<td>0.73 (375)</td>
<td>Gust 1998</td>
</tr>
<tr>
<td><strong>FloTrac / Vigeleo</strong></td>
<td></td>
</tr>
<tr>
<td>0.12 (24)</td>
<td>Opdam, 2007</td>
</tr>
<tr>
<td>0.66 (166)</td>
<td>Cannesson, 2007</td>
</tr>
<tr>
<td>0.51 (112)</td>
<td>Eleftheriadis, 2009</td>
</tr>
<tr>
<td>0.53 (120)</td>
<td>Sander, 2006</td>
</tr>
</tbody>
</table>
Photoplethysmography

- A finger bladder is inflated to maintain the artery in an “unstretched” state
- Finger blood pressure is the monitored continuously
- Pulse contour analysis principles are then applied to determine CO
# Photoplethysmographic BP measurement

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>Nexfin / ClearSight™</th>
<th>CNAP®</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of fingers used</td>
<td>1-2</td>
<td>2</td>
</tr>
<tr>
<td>Algorithm to account for changes in vasomotor tone</td>
<td>“Physiocal”</td>
<td>“VERIFI”</td>
</tr>
<tr>
<td>Algorithm for stroke volume estimation</td>
<td>Pulse contour analysis and biometric calibration</td>
<td>Pulse contour analysis using CNCO®-algorithm and biometric or manual calibration</td>
</tr>
</tbody>
</table>
When things get ugly...*

• Meng et al.
  – Vigileo-Flotrac vs. esophageal Doppler following hemodynamic manipulation
    • Phenylephrine (afterload)
    • Ephedrine (afterload, contractility)
    • Trendelenberg (preload)

*With special thanks to Bob Thiele, UVA

When things get ugly...

Concordance analysis. ΔCO = change in cardiac output.

When things get ugly...

\[ \text{inst esophageal Doppler based on 4-quadrant concordance analysis. } \Delta CO = \text{change in cardiac output}. \]

When things get ugly...

Figure 3. Trending ability of Vigileo-FloTrac against esophageal Doppler based on 4-quadrant concordance analysis. ΔCO = change in cardiac output (postintervention minus preintervention).
When things get ugly...

• Cooper and Muir
  – PulseCO (uncalibrated) vs. LiDCO (calibrated)
    • Twelve adult dogs
    • Hemorrhagic shock (MAP 30-40 mm Hg for 60 min)
    • Resuscitation with lactated Ringer’s solution (MAP 60-70 mm Hg)

Cooper ES and Muir WW. Crit Care Med 35: 1724, 2007
When things get ugly...

Figure 1. Bland-Altman plot of arterial pressure waveform analysis (PulseCO) and lithium indicator dilution (LiDCO) at various time points. Solid line indicates mean bias, dashed lines ±2 sd (limits of agreement). Top, posthemorrhage; middle, 10 mins postresuscitation; bottom, 120 mins postresuscitation.

Cooper ES and Muir WW. Crit Care Med 35: 1724, 2007
When things get ugly...

- Johansson and Chew
  - PiCCO (uncalibrated) vs. PiCCO (calibrated)
    - 15 pigs
    - Septic shock (endotoxemia)
    - CO measured before and after re-calibration (thermodilution)

When things get ugly...

Fig. 2. Bland Altman plots for the differences between TDCO and PCCO pre-calibration (PCCO₁) and post-calibration (PCCO₂), for control and endotoxin groups.
Invasiveness

- Doppler
- Bioimpedance / Bioreactance
- Partial Rebreathing
- Photoplethysmography
- Thermodilution

- Calibrated Pulse Contour
- Uncalibrated Pulse Contour
Accuracy

- Thermodilution
  - Doppler
  - Calibrated Pulse Contour

- Uncalibrated Pulse Contour
- Bioimpedance / Bioreactance
- Partial Rebreathing
- Photoplethysmography
Response Time

- Doppler
- Calibrated Pulse Contour
- Uncalibrated Pulse Contour
- Bioimpedance / Bioreactance
- Photoplethysmography
- Partial Rebreathing

- Thermodilution
Features

- Doppler
- Calibrated Pulse Contour
- Thermodilution
- Uncalibrated Pulse Contour
- Photoplethysmography
- Bioreactance/Bioimpedance
- Partial Rebreathing
Convenience

- Uncalibrated Pulse Contour
- Photoplethysmography
- Bioreactance/Biimpedance
- Calibrated Pulse Contour
- Thrombolysis
- Partial Rebreathing

School of Medicine
— Dr. William Harvey (1628)

*De Motu Cordis*
Case

• A 56 year-old women was intubated in the ER, an arterial and a central line was placed, and she received a 1 liter fluid bolus, prior to transfer to your ICU

• She had an ablation procedure for Afib 4 days ago at an OSH

• Increasing SOB and drowsiness over the last 24 hours
• VS: BP 90/40, HR 110, CVP 18, SaO₂ 97% on PCV 20/5, RR 16, TV 480ml

• HCO₃ 18 mEq/L, Hgb 9 g/dL
- R/S ratio > 1 in V1
- Persistent deep S waves in precordial leads
• Prominent pulmonary artery
• RV enlargement
• Peripheral hypovascularity

What is your next step?

A Give 500ml LR
B Start iNO
C Start epinephrine
D Something else
The Ability of Anesthesia Providers to Visually Estimate Systolic Pressure Variability Using the "Eyeball" Technique

Robert H. Thiele, MD, Douglas A. Colquhoun, MB ChB, MSc, Franziska E. Blum, MD, and Marcel E. Durieux, MD, PhD

Paul E. Marik, MD, FCCP; Michael S. Stewart, MD; Amyn Hirani, MD
The Right Ventricle

(...) it is crescent shaped...

From: Miller’s Anesthesia, 6th edition
Werner Forßmann
(1904–1979)

1956 Nobel Prize laureate
Physiology and Medicine

Hansson N, Der Urologe 3 · 2015
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