# CRASH 2016
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CRASH 2016 Program

Sunday – February 28, 2016

9:00 am – 7:00 pm Registration Open

**General Session**

4:00-5:00pm  Patient Selection for Outpatient Surgery
             Girish Joshi, MBBS, MD, FFARCSI

5:00-6:00pm  ICU Delirium
             Robert Sladen, MD

6:00-6:30pm  Questions & Answer
             Joshi and Sladen

6:30 – 7:30pm Opening Night Reception
CRASH 2016 Program
Monday – February 29, 2016

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

General Session
7:00-8:00am  Managing the Patient with Kidney Disease
              Robert Sladen, MBChB, FCCM

8:00-9:00am  Enhanced Recovery After Surgery
              Girish Joshi, MBBS, MD, FFARCSI

9:00-9:30am  Question & Answer
              Sladen and Joshi

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

Panel Discussions
4:00 – 7:00pm  Provider Wellness and Resilience
                Alison Brainard, MD; Norah Janosy, MD; Judit Szolnoki, MD

4:00 – 7:00pm  Business and Governmental Affairs
                Mergers & Acquisitions
                Randall Clark, MD; Peter Harkness, MD; Patrick Guffey, MD

Paid Workshop
4:00-7:00pm  Comprehensive Airway Management ($50.00)
              Daniel Janik, MD; Bethany Benish, MD; Marina Shindell, MD;
              Jeffrey Galinkin, MD; Aaron Murray, MD; Alma Juels, MD
CRASH 2016 Program

Tuesday – March 1, 2016

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

General Session
7:00-8:00am  Fluid Therapy for Major Surgery
Girish Joshi, MBBS, MD, FFARCSI

8:00-9:00am  Pediatric Update
Lawrence Schwartz, MD

9:00-9:30am  Question & Answer
Joshi and Schwartz

9:30am  View Exhibits/Recess
3:30pm  View Exhibits/Refreshments

Panel Discussion
4:00-7:00pm  Intraoperative Monitoring and Resuscitation – Intensivist Perspective and Case-Based Interactive Pro:Con Debate
Jason Brainard, MD; Breandan Sullivan, MD; Karsten Bartels, MD; Benjamin Scott, MD; Scott Wolf, MD

4:00-7:00pm  Pediatric Conundrums
Debra Faulk, MD; Arvind Mohanram, MD; Debnath Chatterjee, MD
Lawrence Schwartz, MD (moderator)

Paid Workshop
4:00-7:00pm  Introduction to Ultrasound-Guided Regional Anesthesia ($150.00)
Kyle Marshall, MD; Christopher Ciarallo, MD; Alan Bielsky, MD;
Glenn Merritt, MD; Olivia Romano, MD; Matthew Fiegel, MD;
Jeffrey Gonzales, MD; Christopher Lace, MD
CRASH 2016 Program
Wednesday, March 2, 2016

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

General Session
7:00-8:00am  Managing the Patient with Heart Failure
              Robert Sladen, MBChB, FCCM

8:00-9:00am  The Silver Tsunami: Are You Prepared?
              Stacy L. Fairbanks, MD

9:00-9:30am  Question & Answer
              Sladen; Fairbanks

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

Panel Discussions
4:00-7:00pm  Pitfalls with Remote Anesthesia
              Dan Beck, MD; Gina Whitney, MD; Alma Juels, MD

4:00-7:00pm  Outpatient Issues (Ambulatory Pain; Acute on Chronic Pain; Refractory
              Nausea and Vomiting)
              Tessa Mandler, MD; Dominque Schiffer, MD; Melissa Brooks, MD

Paid Workshop
4:00-7:00pm  Advanced Ultrasound-Guided Regional Anesthesia ($150.00)
              Kyle Marshall, MD; Christopher Ciarallo, MD; Alan Bielsky, MD;
              Glenn Merritt, MD; Olivia Romano, MD; Matthew Fiegel, MD;
              Jeffrey Gonzales, MD; Adrian Hendrickse, MD
CRASH 2016 Program

Thursday – March 3, 2016

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

**General Session**

7:00-8:00am  Cardiac Update 2016
Nathaen Weitzel, MD

8:00-9:00am  Analgesics and the Effects of Pharmacogenetics
Mindy Cohen, MD

9:00-9:30am  Question & Answer
Weitzel and Cohen

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

**Panel Discussions**

4:00-7:00pm  Spine Surgery Panel
Christopher Kleck, MD; Mindy Cohen. MD; Daniel Janik, MD

4:00-7:00pm  Cardiac/TEE Case Discussions
Dan Beck, MD; Nathaen Weitzel, MD; Bryan Ahlgren, DO;
Tamas Seres, MD, PhD

4:00-7:00 pm  Obstetric Anesthesia – Difficult Cases on the Labor Deck, and What to Do
With the Pregnant Surgical Patient
Joy L. Hawkins, MD; Rachel Kacmar, MD
CRASH 2016 Program
Friday – March 4, 2016

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

General Session
7:00-8:00am  What’s New in Obstetric Anesthesia for 2015?
              Joy L. Hawkins, MD

8:00-9:00am  Work-up of the Cardiac Patient for Non-Cardiac Surgery
              Robert Sladen, MBChB, FCCM

9:00-9:30am  Question & Answer
              Hawkins and Sladen

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

10:00am      Adjourn until 2017
Disclosure of Relevant Financial Relationships

CRASH

Colorado Review of Anesthesia for SurgiCenters and Hospitals

February 28-March 4, 2016 Vail, Colorado

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ACKNOWLEDGEMENT

We extend our appreciation to

Cook Critical Care
Karl Storz
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Verathon

for equipment provided for the workshops at

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Sunday, February 28
Patient Selection For Ambulatory Surgery: Can Any Patient Be an Outpatient?

Girish P. Joshi, MB, BS, MD, FFARCSI
Professor of Anesthesiology and Pain Management
Director of Perioperative Medicine and Ambulatory Anesthesia

Outline

- Describe the concerns of ambulatory surgery in challenging patients
- Understand the approach to determining patient selection for ambulatory surgery
- Justify appropriate selection of challenging adult patients scheduled for ambulatory surgery
  - Sick, elderly, obese, OSA, diabetes mellitus, cardiac implantable electronic devices

Reengineering in Surgical Paradigm

- In the US, ~ 70% surgical procedures performed on an outpatient basis
- Improvements in surgical and anesthetic techniques make more procedures possible in outpatient setting
- Complex surgical procedures are increasingly performed on complex patients

Patient Selection Influences Perioperative Outcome

- Delayed discharge home
- Reduced efficiency of the ASC
- Unplanned hospital admission
- Increased post-discharge complications
- Unplanned readmission
- Patient/family dissatisfaction
Suitability For Ambulatory Surgery: Complex and Dynamic Process

- Surgical procedure
  - Cataract, peripheral, cavity
- Patient’s preoperative health
  - ASA Physical status
- Proposed anesthetic technique
  - Local/regional anesthesia vs. GA
- Suitability of surgical facility
  - HOPD, ASC, Office-based
- Social considerations
  - Appropriate caregiver availability

Procedure Considerations

- Low risk of severe intra- or postop blood loss
- Tranexamic acid allowed TKA on outpatient basis
- Postoperative pain easily controlled
- No need for intensive or prolonged postop care
- Duration of procedure ??
- Surgeon’s expertise

Outpatient Total Knee Arthroplasty

- Outpatients were younger, had lower comorbidity burden
- TKA performed on an outpatient basis had lower risk of re-hospitalization
- Reasons for re-hospitalization
  - Inadequate pain control
  - Comorbidities, particularly HF

Laparoscopic Roux-En-Y Gastric Bypass

- Bariatric Outcomes Longitudinal Database (n=51,788) lap gastric bypass procedures
- Median age=45 years; BMI=46.3 kg/m²
- Patients discharged on an ambulatory basis had a 13-fold increased risk of 30-day mortality when compared with the LOS of 2 days
- Ambulatory discharge was associated with a trend toward increased serious complication

Patient Selection for Ambulatory Surgery: Predictors of Complications

- ACS-NSQIP database 2005-2010 (n=244,397)
- Predictors of 72-h perioperative morbidity:
  - High BMI
  - COPD
  - Previous PCI/cardiac surgery
  - Hypertension
  - H/o TIA/CVA
  - Prolonged operative time

Unplanned Admission After Ambulatory Surgery

- Length of surgery more than one hour
- High (≥3) ASA physical status classification
- Advanced age (>80 years)
- High BMI

Reliability of the ASA Physical Status Scale

- Inter-rater reliability assessed in a cohort of 10,864 patients
  - ASA 1=5.5%, ASA 2=42%, ASA 3=46.7%, ASA 4=5.8%
- ASA-PS scale had moderate ability to predict in-hospital mortality and cardiac complications
- Despite the inherent subjectivity, ASA-PS scale can be used as a measure of preoperative health


Patient Considerations

- Patients with ASA physical status 4 NOT suitable for ambulatory surgery
  - A patient with severe systemic disease that is a constant threat to life
- Patients with ASA physical status 3 consider other factors
  - A patient with severe systemic disease

Outpatient Laparoscopic Cholecystectomy in the Elderly

- Analysis of the NSQIP database (2007-2010)
- Elderly (>65 yr) undergoing elective lap chole on an outpatient basis (n=7499) compared with inpatients (n=7799)
- Predictors of inpatient admission and mortality
  - ASA 4, CHF, bleeding disorder, CRF on dialysis
- Factors that did not influence admission
  - Diabetes mellitus, BMI, smoking status


Age alone should not be used to determine suitability for ambulatory surgery.
Age and Ambulatory Surgery

- Age > 80 years is an indicator of increased perioperative risk
- Consider post-discharge issues
  - Increased need for supervision
  - Social issues such as elderly or debilitated partner

Obese Patients For Ambulatory Surgery

- Increased need for supervision
- Social issues such as elderly or debilitated partner

Ambulatory Surgery in Obese

Selection of Obese Patients Undergoing Ambulatory Surgery: A Systematic Review of the Literature

- 106,119 patients (prospective cohort trials = 62,476 and retrospective trials = 43,643)
- Bariatric surgery population = 39,548, and systematic review patients n=2549
- Obese had increased respiratory events
  - O₂ desaturation, need for O₂ supplementation
  - Stridor/laryngospasm, airway obstruction

Systematic Review: Results

- No differences in unanticipated admission rate
  - Obese and non-obese cohorts
  - Studies of bariatric and non-bariatric surgery
- BMI in non-bariatric surgery studies around 30
- BMI in bariatric surgery studies was around 40
  - Rigorous preoperative preparation
- Super obese (BMI>50) higher risk of complications

Selection of a Obese Patient For Ambulatory Surgery

- Preoperative Assessment & Identification of Comorbid Conditions
  - OSA, Hypoventilation, Cardiopulmonary, Difficulty in airway, BMI
- BMI 40-50 kg/m²
- BMI>50 kg/m²
- Not Suitable For Ambulatory Surgery

OSA Patients For Ambulatory Surgery

ASA-Scoring System For OSA Patients

A. Severity of OSA (0-3 pts)
B. Invasiveness of surgery/anesthesia (0-3 pts)
C. Requirements for postoperative opioids (0-3 pts)
   • Overall score (0-6): A + greater of B or C
     - Score ≤4 increased risk from OSA
     - Score 5 or 6 significantly increased risk from OSA
     - Intra-abdominal and upper airway surgery are not suitable for ambulatory surgery.

SAMBA-OSA Systematic Review

• No difference in complications between OSA and non-OSA patients undergoing ambulatory surgery
• Most studies used standardized, protocolized approach to patient care
  - Emphasis on preoperative diagnosis
  - Emphasis on use of non-opioid analgesics to minimize opioid use
  - Emphasis on postoperative care particularly use of CPAP after discharge.

Selection of a OSA Patient For Ambulatory Surgery

Practice Guidelines for the Perioperative Management of Patients with Obstructive Sleep Apnea

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

• Scientific literature on safety and perioperative management of OSA patients is sparse and of limited quality

ASA-Scoring System For OSA Patients

A. Severity of OSA (0-3 pts)
B. Invasiveness of surgery/anesthesia (0-3 pts)
C. Requirements for postoperative opioids (0-3 pts)
   • Overall score (0-6): A + greater of B or C
     - Score ≤4 increased risk from OSA
     - Score 5 or 6 significantly increased risk from OSA
     - Intra-abdominal and upper airway surgery are not suitable for ambulatory surgery.


SAMBA-OSA Systematic Review

• No difference in complications between OSA and non-OSA patients undergoing ambulatory surgery
• Most studies used standardized, protocolized approach to patient care
  - Emphasis on preoperative diagnosis
  - Emphasis on use of non-opioid analgesics to minimize opioid use
  - Emphasis on postoperative care particularly use of CPAP after discharge.


No guidance can be provided for airway surgery

Surgery For OSA in An Ambulatory Setting

- Systematic review of 18 studies (2160 patients)
- No deaths or major catastrophic events
- Overall adverse event rate = 5.3%
- Respiratory complications = 1.5%
  - Majority were O₂ desaturations, and were not clinically significant
- Readmission rate 0.4%
- OSA surgery performed on an outpatient basis is generally safe
- Exceptions: tongue base surgery, high AHI, high postop opioid requirements

Rotenberg B: Curr Anesthesiol Rep 2014; 4: 10-8

Laryngopharyngeal Surgery in OSA

- Analysis of the National Survey of Ambulatory Surgery
- No increase in airway surgery over a decade
- Unplanned readmission rate 4%
- No mortality or serious complications
- Minor complications: 9%


Diabetic Patients For Ambulatory Surgery

Glycemic Control Guidelines

Is there a preoperative blood glucose level above which one should postpone elective surgery?

- No evidence that any particular blood glucose level is harmful for outpatients
- First step in decision making: assess for significant complications of hyperglycemia such as severe dehydration, ketoacidosis, and hyperosmolar non-ketotic states
- Postpone surgery of these conditions are present

Preoperative Blood Glucose Level

- Good long-term control: proceed with surgery
- Poor long-term control: consider comorbidities and risks of surgical complications (e.g., delayed wound healing and wound infection)
- Decision to proceed made in conjunction with the surgeon
**Proceed After BGL Correction or Correct BGL in the Operating Room**

- Rapid correction of BGL not necessary
- Timing of BGL correction based upon available time in the preop period duration of surgery

**Perioperative Myocardial Infarction or Cardiac Arrest Risk Calculator**


**Perioperative Cardiac Assessment**

Fleisher L A et al: Circulation. 2014;130:2215-45

**ACS NSQIP: Surgical Risk Calculator**

http://www.riskcalculator.facs.org

**Patients With Cardiac Disease For Ambulatory Surgery**

**Patients With CIED For Ambulatory Surgery**
**Management of Pacemaker Patients**

- Rendering PM asynchronous, even in PM-dependent patients, not always required
- Render asynchronous, by programming or by a magnet, only if significant inhibition is observed
- Caution: pacemakers with special algorithms (e.g., rate responsive devices, MV sensors, search hysteresis/capture, battery extenders)

**Preoperative Considerations in Patients With Implantable Cardioverter Defibrillator**

- Is EMI likely?
  - Yes → Proceed With Surgery
  - No → Is the Procedure below umbilicus?
    - Yes → Proceed
    - No → Is the patient pacemaker-dependent?
      - Yes → Reprogram ICD
      - No → Use a Magnet

**Summary**

- Complex ambulatory surgical procedures will increasingly be performed on complex patients
- Patient selection is complex and dynamic process
- First step in determining appropriate patient selection includes preoperative assessment and identification of any comorbid conditions, which should be optimized to minimize risks
- Developing and implementing clinical pathways should improve the process of patient selection

**Future**

- Why is the patient in the hospital?
- Will hospitalization improve outcome?
ICU Delirium: The “New” Organ Failure

Robert N. Sladen, MBChB, FCCM
Allen Hyman Emeritus Professor of Critical Care Anesthesiology
College of Physicians & Surgeons Columbia University
New York, NY
No disclosures

What is Delirium?
- Fluctuating disturbance in consciousness
- Acute confusion
- Cognitive and perceptual dysfunction
- Develops over short length of time

Dementia: intellectual deterioration over prolonged length of time

How Does it Manifest?
- Hyperactive delirium
  - 1/3 of patients
- Hypoactive delirium
  - 2/3 of patients

What are the Signs?
- Patient may be awake and conversant, but ...
- Global cognitive dysfunction (may be subtle, missed)
  - loss of short-term memory, understanding
- Disorientation, inattention
  - unable to make sense of environment
  - unable to problem-solve, self-care
- Confuses reality, dream-state
  - visual, tactile, auditory hallucinations
  - abnormal movements, picking (hyperactive delirium)

What Increases Delirium Risk?
- Advanced age, cognitive impairment
- Co-morbidity (multisystem disease)
- Acute illness (sepsis, ARDS etc)
- Major surgery (cardiovascular)
- Medications with anticholinergic activity
  - opioids, benzodiazepines, GI agents
- Drug withdrawal syndromes
  - alcohol, nicotine; psychotropic medications

Patient and Illness Factors
- Anxiety and pain
- Overmedication
  - anxiolytics, sedatives, analgesics, antipsychotics
- Prolonged immobility
  - restraints, delayed mobilization
  - disuse, wasting, critical illness myopathy
- Consistent noise, noxious sensations
  - vital signs, laboratory tests, X-rays
  - loss of day-night/sleep-wake rhythm
  - disorientation for time, place, circumstances

Consequences of ICU Delirium
- Increased postoperative complications
- Increased ICU and hospital LOS
- Increased hospital mortality
- Increased one-year mortality
- Post intensive care syndrome (PICS)
One Year Mortality

- 919 hospitalized patients over 3-yr period
- 62% increase in risk of mortality
- 13% decrease in 1-yr survival

Post Intensive Care Syndrome (PICS)

- Prolonged effects after discharge
- Permanent cognitive dysfunction
- Impaired basic problem solving:
  - daily activities, multi-tasking, judgment
- Short term memory loss:
  - impaired attention, social conversation

Post Intensive Care Syndrome (PICS)
Girard TD et al & Myhren H et al. Crit Care Med 2010;38;1513-20, 1554-61

- Loss of independent daily self-care
- Unable to return to work (>50%)
- Depression (>45%)
- High risk of nursing home placement
- Increased burden on family, caregivers
- Financial cost to patient, family, survivors

How Do We Diagnose and Assess ICU Delirium?

Delirium Assessment

CAM-ICU

Richmond Agitation-Sedation Scale (RASS)

Step 1: Observe patient
alert, calm 0
restless, agitated, violent, combative +1 to +4

Step 2: Command eye contact
sustained eye contact (> 10 sec) -1
non sustained eye contact (< 10 sec) -2
moves but no eye contact -3

Step 3: Physical stimulation
movement response only -4
no response -5

CAM-ICU Positive

Acute or fluctuating decline in mental status

Inattention +

Disorganized Thinking or

Altered Level of Consciousness

Visual Attention

Delirium CRASH RNS 2-16 - February 13, 2016
### Disorganized Thinking

<table>
<thead>
<tr>
<th>Question</th>
<th>Answer</th>
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<tbody>
<tr>
<td>Will a leaf float on water?</td>
<td>Yes</td>
</tr>
<tr>
<td>Will a stone float on water?</td>
<td>No</td>
</tr>
<tr>
<td>Are there fish in the sea?</td>
<td>Yes</td>
</tr>
<tr>
<td>Are there elephants in the sea?</td>
<td>No</td>
</tr>
<tr>
<td>Does one pound weigh more than two pounds?</td>
<td>No</td>
</tr>
<tr>
<td>Does two pounds weigh more than one pound?</td>
<td>Yes</td>
</tr>
<tr>
<td>Can you use a hammer to pound a nail?</td>
<td>No</td>
</tr>
<tr>
<td>Can you use a hammer to cut wood?</td>
<td>Yes</td>
</tr>
</tbody>
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### ICDSC


<table>
<thead>
<tr>
<th>Component</th>
<th>No</th>
<th>Yes</th>
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<tbody>
<tr>
<td>1. Consciousness altered, agitation, somnolence (SAS or RASS)</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>3. Disorientation: “What kind of place is this?”</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>4. Hallucination, delusion, psychosis</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>5. Psychomotor agitation or retardation</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>6. Inappropriate speech or mood</td>
<td>0</td>
<td>1</td>
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<tr>
<td>7. Sleep-wake cycle disturbance</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>8. Fluctuation of symptoms</td>
<td>0</td>
<td>1</td>
</tr>
</tbody>
</table>

- RN summarizes score for entire shift
  - adds total number of positive components
  - one is positive even if it resolves during shift
- Excessive sedation - unable to assess
- List positive components (C, A, D, H, P, I, S, F)
- Score $\geq 4$ = delirium
- Score 1-3 = subsyndromal delirium (high risk)

### Treatment or Prevention of ICU Delirium

**Pharmacologic Therapy for Delirium**

**Non-pharmacologic**

- Multimodal analgesic therapy
- Benzodiazepines
- Antipsychotic medications
- Propofol
- Dexmedetomidine
- Clonidine, nicotine patch

### Assess and Treat Pain

<table>
<thead>
<tr>
<th>Pain Level</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Mild pain</td>
</tr>
<tr>
<td>2</td>
<td>Moderate pain</td>
</tr>
<tr>
<td>3</td>
<td>Severe pain</td>
</tr>
<tr>
<td>4-5</td>
<td>Very severe pain</td>
</tr>
<tr>
<td>6-10</td>
<td>Pain that is not tolerable</td>
</tr>
</tbody>
</table>

### Opioid-Sparing Multimodal Therapy

- Thoracic epidural analgesia
  - fentanyl-bupivacaine infusions
- Dexmedetomidine 0.1-0.7 mcg/kg/min
  - anxiolysis, analgesia
  - no respiratory depression (bradycardia)
- Lidocaine patch
- Ketamine infusion: 1-5 mcg/kg/min
- Gabapentin: start at 100 mg VT/PO q8hr

Delirium CRASH RNS 2-16 - February 13, 2016
Benzodiazepines

<table>
<thead>
<tr>
<th>Generic</th>
<th>Trade Names</th>
<th>Approved</th>
</tr>
</thead>
<tbody>
<tr>
<td>Chlordiazepoxide</td>
<td>Librium®</td>
<td>1965</td>
</tr>
<tr>
<td>Oxazepam</td>
<td>Serax®</td>
<td>1965</td>
</tr>
<tr>
<td>Lorazepam</td>
<td>Ativan®</td>
<td>1977</td>
</tr>
<tr>
<td>Temazepam</td>
<td>Restoril®</td>
<td>1981</td>
</tr>
<tr>
<td>Alprazolam</td>
<td>Xanax®</td>
<td>1981</td>
</tr>
<tr>
<td>Midazolam</td>
<td>Versed®</td>
<td>1985</td>
</tr>
<tr>
<td>Zolpidem</td>
<td>Ambien®</td>
<td>1992</td>
</tr>
</tbody>
</table>

The Safety and Efficacy of Dexmedetomidine Compared With Midazolam (SEDCOM)

Riker RR et al JAMA 2009; 301: 489-99

<table>
<thead>
<tr>
<th>Outcome</th>
<th>Dexmedetomidine (n = 244)</th>
<th>Midazolam (n = 122)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Time at target RASS</td>
<td>77.3%</td>
<td>75.1%</td>
</tr>
<tr>
<td>Median time to tracheal extubation</td>
<td>3.7 days</td>
<td>5.6 days*</td>
</tr>
<tr>
<td>ICU LOS</td>
<td>5.9 days</td>
<td>7.6 days</td>
</tr>
<tr>
<td>Delirium (CAM-ICU)</td>
<td>54%</td>
<td>76.6%*</td>
</tr>
</tbody>
</table>

Lorazepam and Delirium

Incremental risk of delirium increases with dose of lorazepam over prior 24 hrs

Dose ≥ 20 mg = 100% incidence

Postoperative Delirium

Maldonado JR et al. Psychosomatics 2009; 50:206-17

- 90 patients randomized to midazolam (M), propofol (P) or dexmedetomidine (D) infusions after sternal closure
- D continued post-extubation
- [1] Delirium by DSM-IV

Antipsychotics

<table>
<thead>
<tr>
<th>Generic</th>
<th>Trade Names</th>
<th>Approval</th>
</tr>
</thead>
<tbody>
<tr>
<td>Haloperidol</td>
<td>Haldol®</td>
<td>IM only</td>
</tr>
<tr>
<td>Droperidol</td>
<td>Inapsine®</td>
<td>Black Box</td>
</tr>
<tr>
<td>Aripiprazole</td>
<td>Abilify®</td>
<td>1992</td>
</tr>
<tr>
<td>Quetiapine</td>
<td>Seroquel®</td>
<td>1997</td>
</tr>
<tr>
<td>Olanzapine</td>
<td>Zyprexa®</td>
<td>2009</td>
</tr>
</tbody>
</table>

No antipsychotic is FDA-approved for delirium

Neurochemical Balance

Dopaminergic:
- Excess: hyperactivity
- Deficit: extrapyramidal syndromes

Cholinergic:
- Deficit: hyperactivity (anticholinergic drugs)

Receptor Binding Profiles

Adverse Effects of Antipsychotics

- Prolonged QT syndrome
- Torsades de Pointes (sudden death)
- Extrapyramidal syndromes
  - Parkinsonian symptoms (bradykinesia, rigidity)
  - Akathisia, tardive dyskinesia (abnormal movements)
- Neuroleptic malignant syndrome (NMS)
- Somnolence

Torsades de Pointes

"Twisting of the Points"

Multifocal ventricular tachycardia
Yap YG, Cam AJ. Heart 2003; 89: 1363-72

- Prolonged QT
- Low K, Mg
- Catecholamines
- Drugs
  - Haloperidol
  - Droperidol
Alpha-2 Adrenoceptors
- Decrease sympathetosis
- Decrease bradycardia
- Suppresses shivering
- Vasoconstriction
- Promotes diuresis
- Spinal cord (2c) analgesia

Dexmedetomidine and Non-REM Sleep
- Locus Coeruleus
- DEX
- GABA
- Progol
- Ventrolateral Preoptic Nucleus
- Tuberothamillary Nucleus

Dexmedetomidine and Delirium
Maldonado JR et al, Psychosomatics 2009; 50:206-17
- No GABAergic effects
- No anticholinergic actions
- Sedation more akin to natural sleep
- Opioid sparing effects
- Alpha agonists - anti-deliriogenic
  - block noradrenergic pathways
  - decrease 3-methoxy-4-hydrophenylglycol (MHPG)

Non-Pharmacologic Therapy for Delirium
- Decrease noise, light, interventions
- Restore natural sleep, day-night rhythm
- Enhance ICU ADL, avoid restraints
- Family exposure and support
- Early mobilization, PT, OT
- Enhance communication, orientation
- Cognitive stimulation (iPad Therapy)

ICU Activities of Daily Living (ADL)
- Communication with family, caregivers
- Self-feeding, grooming
- Oral suctioning, toilet
- Pressing a call bell, attracting attention
- Using smartphone, TV remote
- Incentive spirometry, exercise

“Tablet Therapy”
- Communication by touch screen, stylus
- Interactive apps (relaxing/stimulating programs)
  - music, breathing, muscle relaxation, meditation
  - leisure activities, spiritual needs
  - social / news media
- Manual dexterity, fine motor coordination
- Use propping devices (wedge pillow)
- Educational handbook
  - patients, family members, caregivers

Multicomponent Therapy
- 169 patients pre- and 171 post-intervention
- Multicomponent bundle of interventions
- Subjective ranking of noise, light, nurse interventions
- Delirium by CAM-ICU

rs543@cumc.columbia.edu
Monday, February 29
**Chronic Kidney Disease (CKD)**


- Functional or structural kidney damage
  - eGFR < 60 mL/min/1.73 m² for 3 months
- United States: > 20 m affected (7%)
  - 47% of individuals > 70 yrs
- End-stage renal disease (RRT): > 500 k
- Risk factors: diabetes; hypertension (90%)
  - Risk of dying of CV disease in older patients with CKD is greater than risk of needing RRT!

**Estimated GFR (eGFR)**

Modification of Diet in Renal Disease (MDRD)

National Kidney Disease Education Program


\[ eGFR = 186 \times (S_{cr})^{-1.154} \times (Age)^{-0.203} \times 0.742 \]

(\# female): \times 1.212 (\# African-American)

---

**Estimated GFR (MDRD)**

For example: 64 yr-old woman, baseline SCR 1.9 mg/dL

\[ eGFR = 186 \times (1.9)^{-1.154} \times (64)^{-0.203} \times 0.742 \]

\[ eGFR = 26.6 \text{ mL} / \text{ min} / 1.73 \text{ m}^2 \]

How severe is her CKD?

---

**National Kidney Foundation (NKF)**

Kidney Disease Outcomes QI Classification


<table>
<thead>
<tr>
<th>CKD Stage</th>
<th>eGFR (mL/min/1.73m²)</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>&gt; 90</td>
<td>Kidney damage with NL GFR</td>
</tr>
<tr>
<td>2</td>
<td>60 - 89</td>
<td>Mildly decreased GFR</td>
</tr>
<tr>
<td>3</td>
<td>45 - 59</td>
<td>Moderately decreased GFR</td>
</tr>
<tr>
<td>4</td>
<td>30 - 44</td>
<td>Sevarely decreased GFR</td>
</tr>
<tr>
<td>5</td>
<td>&lt; 15 (or RRT)</td>
<td>End-stage kidney disease</td>
</tr>
</tbody>
</table>

**Estimated GFR (MDRD)**

For example: 64 yr-old woman, baseline SCR 1.9 mg/dL

\[ eGFR = 186 \times (1.9)^{-1.154} \times (64)^{-0.203} \times 0.742 \]

\[ eGFR = 26.6 \text{ mL} / \text{ min} / 1.73 \text{ m}^2 \]

She has Stage 4 CKD ...

---

Death

Age-standardized rate of death from any cause (per 100,000 person-yr)

- Estimated GFR (mL/min/1.73 m²)
- No. of Events: 21,883, 11,593, 7300, 4498, 1540

---

http://www.mdcalc.com/mdrd-gfr-equation/

For example: 64 yr-old woman, baseline SCr 1.9 mg/dL

\[ eGFR = 186 \times (1.9)^{-1.154} \times (64)^{-0.203} \times 0.742 \]

\[ eGFR = 26.6 \text{ mL} / \text{ min} / 1.73 \text{ m}^2 \]
Renal Risk in CABG Surgery

Yeo KK et al. Am J Cardiol 2008; 101:1269-74

Limitations of eGFR
Sladen RN. Anesth Analg 2011;112:1277-9

- It is an estimated, not actual GFR!
- Provides reliable assessment of eGFR between 20 - 60 mL / min / 1.73 m² only
- GFR > 60 mL / min /1.73 m² is referred to as “normal”
- Largely dependent on Scr
  - affected by depleted muscle mass
  - cannot track acute changes in GFR!

How Should We Modify Our Perioperative Management?

Top Ten Caveats

Cardiorenal Syndrome (CRS)

<table>
<thead>
<tr>
<th>Type</th>
<th>Primary Disorder</th>
<th>Leading to …</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Acute CHF</td>
<td>CKD</td>
</tr>
<tr>
<td>2</td>
<td>Chronic CHF</td>
<td>CKD</td>
</tr>
<tr>
<td>3</td>
<td>AKI</td>
<td>adverse cardiac events</td>
</tr>
<tr>
<td>4</td>
<td>CKD</td>
<td>adverse cardiac events</td>
</tr>
<tr>
<td>5</td>
<td>Sepsis etc.</td>
<td>cardiac, renal injury</td>
</tr>
</tbody>
</table>

Cardiovascular Disease in CKD
Franczyk-Skora B et al. BMC Nephrol 2012; 13:162

- Causes 40% of all deaths in CKD
  - LVH, diffuse calcinosis, fibrosis, CAD
  - vitamin D deficiency contributes (Ca++)
  - high incidence of arrhythmias (worsen CKD)
  - increased thromboembolism, bleeding
- Silent ischemia (autonomic neuropathy)
- Risk of sudden cardiac death (20-40%)
  - increases with severity of CKD
  - reversed by renal transplant, but not by HD

Protein-Bound Uremic Toxins (PBUT)
Cardiorenal Syndrome (Organ Crosstalk)

- Indoxyl sulfate, p-cresol, homocysteine, ADMA
  - Highly protein bound, poorly dialyzed
  - Toxic to kidneys and heart
  - Induce oxidative stress, endothelial dysfunction
  - Vascular smooth muscle cell proliferation
  - Fibrogenic, pro-hypertrophic (LVH)
  - Promote atherosclerosis, adverse CV events

Indoxyl Sulfate Metabolism

- Indoxyl sulfate (from tryptophan in diet) accumulates in CKD
  - Cardiotoxic
  - AST-120 (Kremezin), an oral charcoal, absorbs indole in ileum
  - Improves cardiac and renal function in animal CKD

Endothelium
- L-arginine
- L-citrulline
- NOS
- NO
- GTP
- cGMP

Smooth muscle
- cGMP
**Diastolic Dysfunction in CKD**

- Common in CKD especially with HTN
  - LVH, diffuse calcinosis, fibrosis, CAD
  - increases with grade of CKD (85% stage 4-5)
- LV ejection fraction > 50%
  - impaired diastolic relaxation
  - evaluated by transthoracic echocardiogram
  - requires higher filling pressure, slower HR
- Increased risk of cardiac mortality

**Sudden Cardiac Death (SCD)**
Franczyk-Skora B et al. BMC Nephrol 2012; 13; 162.

- SV, V arrhythmias - 80-90% of patients on HD
  - cardiac fibrosis, sympathetic hyperactivity
- Exacerbated during HD and hours afterwards
  - 50% of all deaths in HD patients
- Prolonged QT - iron overload and deposition
  - Torsades des pointes, VF, asystole
  - electrolyte shifts - hypokalemia, hypomagnesemia
  - catecholamine bursts (hypovolemia, HD)
  - drugs: antidepressants, droperidol, ciprofloxacin

**Do A Cardiac Workup!**

- Careful history (DM, HTN, CAD, arrhythmias)
- Look for anemia (EPO, iron, folate, GIB)
- ECG (QT, conduction problems, arrhythmias)
- TTE (LVH, diastolic dysfunction, CHF)
- Perioperative beta blockade
- Cardioprotective anesthetic, emergence

**Autonomic Neuropathy in CKD**

- Delayed gastric emptying (aspiration risk)
- Silent myocardial ischemia
- Orthostatic hypotension

**Metabolic Acidosis in CKD**

- Early: hyperchloremic acidosis
  - tubular HCO₃ wasting
- Late: anion gap acidosis
  - sulfate, phosphate accumulation
- Acute on chronic acidosis
  - hypercarbia, shock, diarrhea, stress

**Torsades de Pointes**
“Twisting of the Points”
Yap YG, Cam AJ. Heart 2003; 89: 1363-72

- Prolonged QT
  - Low K, Mg
  - Catecholamines
  - Drugs
    - haloperidol
    - droperidol
Acid-Base Management
- Check preoperative HCO₃ and Cl
  - hyperchloremic vs. anion gap acidosis
- Support ventilatory compensation
  - increase minute ventilation in OR
  - consider postoperative ventilation
- Recognize relationship to potassium

Potassium Balance
$\Delta$ pH 0.1 $\rightarrow$ $\Delta$ K+ 0.5 mEq/L

Acute Hyperkalemia in CKD
- Acute acidosis
- Catabolic stress
- Major trauma, surgery, sepsis
- Drugs
  - NSAIDs, ACE inhibitors
  - K - sparing diuretics
  - β-blockers
  - Cyclosporin A, tacrolimus

Hyperkalemia Protocol
- Calcium chloride 1-2 g central IV
- NaHCO₃ 50 - 100 mEq
- Hyperventilate 0.1 pH = 0.5 K+
- Insulin + glucose 5u + 25g (50 mL 50%)
- Kayexalate enema 0.5 g/kg
- Emergency dialysis If K+ > 6.0 mEq/L

Depleted Fluid Reserve
- Anuria
  - excess Na: edema, HTN
  - excess H₂O: hyponatremia
- Nonoliguric, polyuric
  - unable to concentrate urine

Principles of Fluid Management
- Correct fluid deficits
- Restrict maintenance fluid
- Monitor appropriately
- Be careful post-operatively!
  - withdrawal of positive pressure
  - reversal of sympathetic block

Perioperative Acidosis
35 yr old diabetic, cadaveric renal transplant

<table>
<thead>
<tr>
<th></th>
<th>PaCO₂</th>
<th>pH</th>
<th>HCO₃</th>
<th>K+</th>
</tr>
</thead>
<tbody>
<tr>
<td>Preop</td>
<td>32</td>
<td>7.32</td>
<td>17</td>
<td>5</td>
</tr>
<tr>
<td>OR</td>
<td>40</td>
<td>7.25</td>
<td>18</td>
<td>5.3</td>
</tr>
<tr>
<td>PACU</td>
<td>44</td>
<td>7.21</td>
<td>19</td>
<td>5.6</td>
</tr>
<tr>
<td>PACU</td>
<td>48</td>
<td>7.18</td>
<td>19</td>
<td>5.9</td>
</tr>
</tbody>
</table>

4. Anticipate Acute Fluid Overload and Pulmonary Edema

5. Anticipate Anemia and Bleeding
Hematologic Impact of CKD

- Chronic anemia
  - erythropoietin deficiency
  - chronic blood loss (HD, GIB)
  - iron, folate deficiency
- Uremic thrombocytopenia
  - platelet dysfunction (normal count)
  - care with regional, axial anesthesia

Erythropoietin and CKD

Arcasoy M. Br J Haematol 2008; 141:14-31

- CKD-induced cardiac dysfunction
  - pro-inflammatory cytokines
  - anti-erythrocytic circulating factors
- Erythropoietin therapy
  - anti-inflammatory, anti-oxidative
  - decreased LVH, fibrosis, BNP
  - excess: CVA, MI, thrombosis, ESRD, death

Uremic Thrombocytopenia

Acquired von Willebrand's Disease

- vWF VIII

Desmopressin (DDAVP)

- 8-deamino D-arginine vasopressin (AVP)
  - vasodilator, long-acting
  - 0.3 μg/kg IV over 15-20 min (hypotension)
  - Improves platelet function for 1-12 hr
  - Releases vWF-VIII from endothelium
    - tachyphylaxis with repeat doses
    - not effective with ongoing pressor therapy

Cryoprecipitate

- Patients exposed to amines
  - NE, EPI, AVP
- Recent administration of DDAVP
- Contains VWF, Factor VIII
  - also fibrinogen, Factor XIII

Vitamin D Deficiency and CKD


- Vitamin D3 - cholecalciferol
  - 25-OH D < 30 ng/mL
    - Decreased intake of dairy products
      - phosphate restriction
    - Decreased sunlight exposure
    - Vitamin D loss with proteinuria
    - Vitamin D loss in dialysate

6. Anticipate

renal osteodystrophy

Vitamin D Deficiency and CKD


- Vitamin D3 - cholecalciferol
  - 25-OH D
    - less active
    - I-alpha hydroxylase (kidney)
  - 1,25-OH₂ D
    - more active
  - CVD infection osteoporosis
  - anti-inflammatory innate immunity
  - healthy bones & joints
Renal Bone Disease
- Vitamin D deficiency (20-80% of ESRD)
- Hypocalcemia (impaired GI absorption)
- Increased parathyroid hormone (PTH)
  - mobilization of calcium from bones
  - metastatic calcification, osteodystrophy
  - brittle bones and joints
  - cardiac fibrosis (increased risk of CVD)
- Careful positioning and pressure protection!

7. Anticipate the Impact of Dialysis
Renal replacement therapy (RRT)

Dialysis (diffusion)

Convection (ultrafiltration)

Renal Replacement Therapy (RRT)

Dialysis
- Diffusion
- Convection

Ultrafiltration

Dialysate

Blood

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What Dialysis Does Well

Controls manifestations of acute uremia

- Pulmonary edema
- Hyperkalemia, acidosis
- Acute uremia:
  - encephalopathy
  - enteropathy
  - serositis
  - thrombocytopenia

What Dialysis Does Poorly

Controls manifestations of chronic uremia

- Cardiovascular complications (SCD)
- Anemia
- Renal osteodystrophy
- Peripheral neuropathy
- Impaired resistance to sepsis
- Poor wound healing

Timing of Preoperative Dialysis

- Ideal: afternoon, the day before surgery!
- Adverse effects of dialysis:
  - AV shunt (low SVR)
  - hypovolemia, hypotension, SCD
  - electrolyte imbalance (K, Mg, Pi)
  - myocardial ischemia, arrhythmias
  - dysequilibration syndrome
  - residual anticoagulation

Renal Drug Disposition

- Few drugs are totally renal dependent
  - aminoglycosides, digoxin
- Many drugs are partially renal dependent (decrease maintenance doses)
  - metformin, cimetidine, penicillin, milrinone
  - pancuronium, vecuronium, rocuronium
  - atropine, glycopyrrolate, neostigmine
- Some drugs have active metabolites
  - morphine, meperidine, vecuronium

Rocuronium

Robertson EN et al. Eur J Anaesthesiol 2005; 22: 4-10

- Elimination is independent of renal function
- Pharmacodynamic data are conflicting
  - no difference, prolonged action, variable
- Immediately inactivated by sugammadex
  - complex is excreted by kidneys

Morphine

80%
Morphine-3-G
analgesic
10%
Morphine-6-G
antianalgesic (40 x potency)
Normorphine
neuroexcitatory
excreted in urine

Drugs Cleared in the Blood

<table>
<thead>
<tr>
<th>Drug</th>
<th>Mechanism</th>
</tr>
</thead>
<tbody>
<tr>
<td>succinylcholine</td>
<td>PChE</td>
</tr>
<tr>
<td>esmolol</td>
<td>RBC esterase</td>
</tr>
<tr>
<td>cisatracurium</td>
<td>Hoffman</td>
</tr>
<tr>
<td>remifentanil</td>
<td>esterase</td>
</tr>
<tr>
<td>clevidipine</td>
<td>esterase</td>
</tr>
</tbody>
</table>

8. Anticipate delayed emergence and persistent neuromuscular blockade

9. Anticipate nausea, vomiting, aspiration and perioperative GI bleeding
Gastrointestinal Disease and CKD
Thomas R et al. Ren Fail 2012 Oct 18 (ePub)
- Delayed gastric emptying (aspiration risk)
  - autonomic neuropathy
- GI Bleeding (increased risk and mortality):
  - peptic ulcer disease (25%)
  - erosive esophagitis, gastritis, duodenitis
  - ischemic colitis (IHD)
  - thrombocytopenia (normal count)
- Risk increases with stage of CKD

Postop Complications
- Acute kidney injury (AKI on CKD)
- Myocardial ischemia, arrhythmias
- Postoperative pneumonia
- Inability to tolerate hemodialysis
- Poor wound healing and wound infection
- Prolonged ICU length of stay

The Bottom Line
CKD is a multisystem disease - and can be a silent killer!

Be careful out there!

Good Luck!!

rs543@cumc.columbia.edu
Enhanced Recovery After Surgery: Role of Anesthesiologist

Girish P. Joshi, MB, BS, MD, FFARCSI
Professor of Anesthesiology and Pain Management

Changes in Healthcare Delivery
- Emphasis on cost containment
- Emphasis on evidence-based practice
  - Need to know what works and at what costs
- Rising patient expectations
  - Importance of patient satisfaction

Procedure Specific Best Practices Enhance Recovery After Surgery
- Decrease the incidence and severity of perioperative complications
- Shorten hospital length of stay
- Reduce postop readmission rates
- Allow early return to daily living
- Reduce healthcare costs without compromising patient care

Perioperative Management

Preoperative Considerations
**Preoperative Optimization Improves Perioperative Outcome**

- Suboptimal preoperative care (i.e., inadequate patient evaluation or incorrect preoperative management) is a major contributing factor to perioperative morbidity/mortality

**Preanesthesia Assessment**

- Preoperative screening and optimization of comorbidities
- Assessment of chronic medication use
  - β-blockade, ACE inhibitors, anti-platelet drugs, anti-coagulants, anti-diabetic drugs, statins
- Education and psychological preparation of the patient (and their caregivers)
  - Reduces anxiety and fear
  - Improves overall patient satisfaction

**Preoperative Risk Reduction Through “Pre-habilitation”**

- Preoperative training: muscle strengthening
  - Reduces frailty and disability
- Preoperative cardiovascular conditioning
  - Snowden CP, Minto G: Br J Anaesth 2015; 114: 186-9
- Avoidance of preoperative dehydration
  - Encourage water intake throughout the fasting period
- Nutritional support to boost periop immune function and accelerate convalescence
  - Preoperative carbohydrate loading
  - Gillis C, Carli F: Anesthesiology 2015; 123: 1455-72
- Preoperative psychological preparation
  - Avoid anxiety and fear

**European Society of Anesthesiologists Recommendations**

- It is safe for patients (including diabetics) to drink carbohydrate-rich drinks up to 2 h before elective surgery

**Preoperative Carbohydrate Load: Well-Controlled Diabetics Vs. Healthy**

- Routine screening tests are of no clinical benefit
  - Preop period is not for screening asymptomatic disease
- Unnecessary tests may cause anxiety, increase delays and cancellations, cause potential harm stemming from false-negative or false-positive results, and increase costs
- Tests guided by patient’s, clinical status, comorbidity (cardiovascular, pulmonary, and renal) and invasiveness of surgical procedure

**Preoperative Testing**

- Well-Controlled Diabetics: Insulin-treated, oral antidiabetic-treated, healthy
- Blank squares = healthy
- White triangles = insulin-treated
- White squares = oral antidiabetic-treated

**European Society of Anesthesiologists**

- Patients with obesity, gastrointestinal reflux, and diabetes can safely follow all of the above guidelines

**ASA Practice Advisory:** Anesthesiology 2002; 96: 485-96

Preoperative Testing Grid

Preoperative Testing Grid

Premedication Controversies

Avoid Benzodiazepine Premedication

Avoid routine preop sedative-hypnotics even in patients with significant anxiety
- Increases cognitive dysfunction
- Increases pharyngeal/laryngeal dysfunction - micro aspiration
- No evidence that pre-induction midazolam reduces awareness
  - Anesthesiology 2006; 104: 847

Intraoperative Considerations

Problems that plagues the practice of anesthesia is that the residual effects of hypnotic-sedative/opioids/muscle relaxants influence long-term outcomes

Residual Effects of Sedative-hypnotics/Opioids/NMBs

- Delays emergence from anesthesia
- Increases OT stay, PACU stay, ICU admission
- Compromises airway patency
- Increases pharyngeal dysfunction, aspiration
- Decreases ventilatory response to hypoxia and hypercarbia
- Increases hemodynamic instability
- Increases cognitive dysfunction
**Balanced General Anesthesia**

- Hemodynamic Stability (BP/HR)
- Muscle Relaxation (Peripheral Nerve Stimulator)
- Unconsciousness/Lack of Recall (MAC/EEG-based Monitoring)

**Desflurane Versus Sevoflurane**
- Meta-analysis of RCTs (n=29) comparing extubation times with des and sevo
- Anesthesia information management system data (n=32,792 cases) used model the time from end of surgery to extubation
- Des reduced average extubation time and variability of extubation time by 20%–25%


**Nitrous Oxide**

- Amnesia and analgesia
  - Anesthetic and opioid dose
  - Circulatory stability
- Facilitates emergence
- Persistent postop pain

De Vasconcellos K, Sneyd JR: Br J Anaesth 2014

**Nitrous Oxide and PONV**

- Systematic review and meta-analysis of RCTs
- 30 studies (2297 patients with N2O vs. 2301 patients without N2O)
- Avoiding N2O reduced risk of PONV, but overall impact was modest (absolute 33% vs 27%)
- Propofol induction negate emetic effects of N2O
- Prophylactic antiemetic therapy further negate emetic effects of N2O


**Avoid Deep Anesthesia**

Joshi, Girish, MB, BS, MD, FFARCSI Enhanced Recovery After Surgery
Inhaled Anesthetic Concentrations For Prevention of Recall

- Doses of inhaled required to prevent awareness (recall) are smaller (0.45 MAC) than those required for unconsciousness
- 0.6 to 0.8 MAC of inhaled anesthetics with or without N₂O, respectively

Dwyer et al: Anesthesiology 1992; 77: 888-96

Neuromuscular Blockade

- Residual paralysis in postop period is frequent and difficult to recognize clinically
- Even minimal paralysis (TOF < 0.9) increases postoperative complications and ICU admission
- Avoid /minimize muscle relaxants, if possible
- Reverse blockade unless there is unequivocal evidence of adequate function
- Neostigmine dose based on the degree of blockade at the time of reversal


Neuromuscular Monitoring Site and Residual Paralysis


High Dose Neostigmine and PACU Stay and Hospital LOS

Neostigmine Dose:
TOF Response at Ulnar Nerve

<table>
<thead>
<tr>
<th>TOF Response</th>
<th>Fade</th>
<th>Dose (µg/kg)</th>
</tr>
</thead>
<tbody>
<tr>
<td>4</td>
<td>-</td>
<td>20-30</td>
</tr>
<tr>
<td>3</td>
<td>++</td>
<td>40</td>
</tr>
<tr>
<td>2</td>
<td>+++</td>
<td>50</td>
</tr>
<tr>
<td>1</td>
<td>++++</td>
<td>60</td>
</tr>
<tr>
<td>None</td>
<td>-</td>
<td>Wait</td>
</tr>
</tbody>
</table>

Modified from Bevan et al: Anesthesiology 1992; 77: 785-805
Reverse unless there is unequivocal evidence of adequate function

Opioids

Opioids Reduce Propofol Requirements
- Opioids reduce propofol dose synergistically (approx 40-80%)
- Ceiling effect


Opioid Reduces MAC
- Moderate opioid doses reduce MAC synergistically (up to 75%)
- MAC reduction is not complete
- Ceiling effect

McEwan AI et al: Anesthesiology 1993; 78:864-9

"Front Loading" Opioids During Induction of Anesthesia
- Increases post-induction hypotension
- Increases potential for acute tolerance


Clinical Concepts and Commentary

Anesthesiology 2016; 124: Epub

Differential Opioid Tolerance and Opioid-induced Hyperalgesia
A Clinical Reality
Christina J. Hayhurst, M.D., Marcel O. Heylea, M.D., Ph.D.
Opioid Dosing at Induction:
Patient Controlled Analgesia Concept

Consider other causes of hemodynamic changes
Do not attempt to normalize or achieve "tight" control of hemodynamic variables (HR/BP)

Intraoperative Long-acting Opioids:
For Postoperative Analgesia
- Longer-acting opioid
  ~20 min prior to expected time to extubation
  - Morphine (0.1-0.15 mg/kg)
  - Hydromorphone (10-20 mcg/kg)

Procedure Specific Multimodal Pain Management

Multimodal Analgesic Techniques
(www.postoppain.org)
- Regional analgesic techniques
  - Wound infiltration
  - Peripheral nerve blocks
- NSAIDs/COX-2 inhibitors
- Acetaminophen
- Adjuvants
  - Dexamethasone
  - Ketamine
- Opioids (as rescue)

PONV Prophylaxis
Multimodal Prevention To Facilitate Implementation Of PONV Policies


Impact of Risk Assessments on Prophylactic Antiemetic

Implementation of PONV prophylaxis based on prediction models did not reduce the incidence of PONV despite increased antiemetic prescription in high-risk population.

Kappen TH, et al. Anesthesiology 2014; 120: 343-345

Optimal Multimodal Antiemetic Therapy

Optimal Multimodal Antiemetic Therapy

Intraoperative
- Dexamethasone 4-8 mg
- Ondansetron 4 mg (end of surgery)
- High risk population (add)
  - Droperidol 0.625–1.25 mg (intraop)
  - Transderm scopolamine (preop)
  - TIVA
- Postoperatively
  - Promethazine (Phenergan) 6.25 mg
  - Dimenhydrinate 1 mg/kg
  - Do not repeat ondansetron, use another 5HT3 antagonist

Mechanical Ventilation

Optimal lung protective ventilatory strategy
- Low TV (6-8 ml/kg, IBW)
- PEEP (5-10 cm H2O)
- Initial respiratory rate 8/min
- Maintain ETCO2 ~ 40 mm Hg
  - Mild hypercapnia (PaCO2 = 50 mmHg) improves tissue O2

Intraoperative Ventilation: Avoid Hyperventilation

Intraoperative Ventilation: Allow Mild Hypercapnia

- Increase CO, vasodilatation, O2 off-loading from right shift of oxyhb dissociation curve
- Improves tissue oxygenation
  - Hager et al. Anesth Analg 2006; 103: 677-81,
  - Fleischmann et al. Anesthesiology 2006; 104: 944-9
- Protective effect against organ injury
  - Laffey JG, Kavanagh BP. Lancet 1999;354:1283-86
- Improves postop cognitive function
**Hypercapnia Reduces Systemic Inflammation and Improves Respiratory Function**

- Patients randomized to PaCO₂ 35 to 45 mmHg or 60 to 70 mmHg with CO₂ inhalation
- Patients with hypercapnia had improved respiratory function and reduced lung and systemic inflammation
- No severe adverse events related to hypercapnia


---

**Perioperative Fluid Therapy**

- Patients commonly receive large amounts of fluids
- Excessive fluids increase morbidity and mortality
- Eliminate algorithm use (i.e., preloading and replacement of "third space")
- Avoid fluid administration based upon static indicators (HR, MAP, CVP), use dynamic indicators
- Role of CO monitors in ERAS remain questionable
- Need to follow postop, avoid weight gain > 1kg

---

**Emergence Considerations**

- Primary aim should be to washout inhaled anesthetic, not build-up CO₂
- Pressure support ventilation to maintain FRC
- Nasal ventilation, superior to oral ventilation
  - Liang Y et al Anesthesiology 2008; 108: 998
- Semi-upright (30-40°) position

---

**Postoperative Care: Fast Track Rehabilitation**

- Avoid tubes, catheters, drains, restrictions
- Early mobilization and physical therapy
- Optimize pain relief
- Respiratory therapy
  - Extended lung expansion exercises
  - Early use of CPAP, non-invasive ventilation, early tracheal extubation
- Improve sleep
- Early oral feeding
- Early detection of complications
Summary

- ERAS clinical pathways improve periop outcome and enhances recovery
- Involves the entire periop period (pre-, intra-, and post)
- Anesthesiologists should take leadership in development and implementation of clinical pathways
- Improve communication and teamwork amongst caregivers
- Data-driven analytical process of continuous improvement

Thank You. Questions?

Insanity is doing the same things the same way and expecting different results.

Albert Einstein
CRASH 2016 Goals and Objectives  
Second Victim, Burnout, Resiliency  
Drs. Alison Brainard, Norah Janosy, and Judit Szolnoki

1. Second Victim – definition/awareness. Attendees will be able to define and will be given tools to recognize second victim phenomena in the work place.
2. Attendees will be able to describe implication of the second victim phenomenon on patient safety.
3. Burnout Prevention vs. Burnout Recovery – Attendees will be able to define burnout and given references describing the complexity and necessary steps to recover from and/or prevent burnout.
4. An interactive demonstration of HeartMath technology will show attendees how to use this technique for stress reduction.
5. Mindfulness will be explained and demonstrated. Attendees will have the opportunity to practice this technique and learn to apply mindfulness to daily practice.
6. Appreciative Inquiry (AI) will be demonstrated and then practiced in a safe, non-threatening manner; attendees will begin to develop his/her own AI vernacular.
7. At the conclusion of the workshop a personal wellness/resilience goal will be identified to be set into action within attendees’ home environment.

Timeline:
- Using an audience response system we will find out attendees’ previous exposure and experiences related to burnout, resilience, second victim and resiliency training.
- Brief introductions of the three panelists which will include the “why” behind their wellness work.
- Second Victim informative/interactive session.
- Burnout – facts and figures related to the field of medicine and anesthesiology specifically with an emphasis on the individual rather than the organizational level. Prevention and recovery focused.
- Resilience – a brief review of the literature primarily individual focused, then an interactive introduction to three tools that can enhance resilience: HeartMath, Mindfulness, and Appreciative Inquiry.
Improving the Quality of your practice

CRASH 2016

Patrick Guffey, MD
Assistant Professor, University of Colorado
Associate Medical Director, Dept. of Anesthesiology
ACMIO, Children’s Hospital Colorado
AQI AIRS Committee Chair

Objectives

1. Getting the data to understand your practice
2. Emerging trends in clinical pathways
3. Leveraging analytics to produce results
4. Moving towards highly reliable operations

Value Proposition

\[ V = \frac{Q}{\text{Quality}} + \frac{S}{\text{Cost}} \]

Value in healthcare is measured in terms of patient outcomes achieved per dollar expended

Reward for
- Best overall care
- Lowest cost
- Minimize complications

Disclosures

Travel & Expense support from the ASA, AQI, Omnicell
Indirect research support from Codonics and Omnicell
Presentation contains unpublished data from the AQI registries and data, slides used with permission

Triple Aim and Quality Improvement

To Error is Human

What’s wrong with this picture?

Humans make hundreds of mistakes every day
To Error is Human

Death every 5.5 minutes
100K a year in US
10X Significant harm
10X Minor harm
10X Near Miss

How Safe is Healthcare?

<table>
<thead>
<tr>
<th>Total lives lost per year</th>
<th>Number of encounters for each death</th>
</tr>
</thead>
<tbody>
<tr>
<td>Driving in US</td>
<td>10</td>
</tr>
<tr>
<td>Chartered Flights</td>
<td>100</td>
</tr>
<tr>
<td>Chemical Manufacturing</td>
<td>1,000</td>
</tr>
<tr>
<td>Mountaineering</td>
<td>10,000</td>
</tr>
<tr>
<td>Bungee Jumping</td>
<td>100,000</td>
</tr>
</tbody>
</table>

Risk of Harm

Checking a bag  Handing over a child

THE RISK IS THE SAME

Patient Harm in the OR

Four Million Cases – AQI Registries PACU and Operating Room

Minor: 10.21%
Major: 0.52%
MORTALITY 0.03%

Risk of Anesthesia - Perioperative

Perioperative Mortality
1.85% all cause
(0.07% hernia-5.97% major vascular)
**What is an Error?**

Circumstances in which planned actions fail to achieve the desired outcome

- Dr. James Reason

Adverse Event - Patient did not respond optimally to an appropriate treatment
- Side Effects, Patient Differences, Expected complications
- Undesirable & Unintentional

Error - an adverse event that could be prevented given the current state of medical knowledge.

---

**Basic Tenets of Human Error**

Everyone commits errors

Human error is generally the result of circumstances beyond the control of those committing the errors

Humans make more errors during routine activities, less when focused and thinking critically

---

**Types of Errors**

- Active Failures: Acts committed by those in direct contact with the patients: slips, lapses, fumbles, mistakes, procedural violations.
- Latent Conditions: Resident pathogens in the system: time pressure, inadequate equipment, fatigue, non-safe procedures, design and construction deficiencies.

---

**Near Misses**

On average, there are 8 errors that occur to result in patient harm

A Near Miss is an opportunity to improve safety, health, environmental and security aspects of an operation based on a condition or an incident with potential for more serious consequence

A Near Miss is an unplanned event that did not result in injury, illness, or damage - but had the potential to do so

A Near Miss is a window into the future

Analyzing near misses may represent opportunity

---

**Pyramid of Safety**

- 300 Incidents (near miss)
- 50 Near Misses (isolated)
- 1,000 Near Misses (investigated)
- 30,000,000 Actual Incidents (unreported)

---

**Direct Hits**

- 79 Major Incidents
- 100 Incidents (near miss)
Preventing Errors - Near Miss

Reducing Injury

Culture of Medical Error
Past: Individual is always responsible
Shame and blame culture
Hiding mistakes
Improvement difficult
Low morale - fear

Future: Culture of Safety
Recognize systems contribute
Speak openly about mistakes / errors
Concerns are valued and acted upon
Participants take ownership

The System
Humans make mistakes
The system stops human error from reaching the patient
Systems or processes that depend on perfect human performance are inherently flawed

Fix the System
Incredibly complex
Dependencies on everything and everyone
Highly variable
Can’t fix what we don’t know about

A history of Reporting in Aviation
1974 - TWA Flight 514
Pilots misunderstood Air Traffic Control instructions and the plane impacted Mt. Weather on final approach
Investigation yielded near misses from the exact same problem and one airline reported the issue to its pilots
The Aviation Safety Reporting System was formed to detect and collect near misses. This system is administered by NASA
A History of Reporting in Anesthesia

University of California, San Francisco & University of Colorado

Historically, UCSF

Slow

Time

Fear

Personal

Arduous,

Lack

Poor

Successful

Formed

Created

2006, new has a new electronic reporting system, the AQI system uses much of the same terminology / format

Incident

Reporting

System

in

2006, Switzerland, reporting system, the AQI system uses much of the same terminology / format

None

Discovery

Anesthesia

System

in

2006, Swiss and

Advisory

Committee

(CIRS)

Successful

system

in

Switzerland, may be expanded across Europe

A History of Reporting in Anesthesia

Disincentives for Reporting

Cognitive and behavioral reasons

Poor education about what constitutes an event

Concern over legal or credentialing consequences

Personal shame

Fear of implicating others

Systems reasons

Time consuming

Difficult to access

Lack of anonymity

Potentially discoverable

Lack of feedback and follow-up, no perceived value

Tenets of a successful system

Secure and non-discernible

- CIRS is part of AQI which is a registered PSO

Quick entry time and ease of use

Balance of data resolution against time

Accessibility

- Ideally, from any computer, anywhere in the world

Captures both near misses and incidents of patient harm

Option of anonymity

Searchable

Summary reports to departments, hospitals

Many events are locally influenced

Well Designed Systems Work

UCSF 750 / year reports

Historically, virtually none

CHCO 500 / year reports

Historically, about 10 / year

Benefits of Reporting

Advance the safety of perioperative care

Discover system issues you can fix

Gather quantitative data to influence organizations

Avoid repeating mistakes!
Getting what you need

Anecdotal evidence vs. quantifiable reports

How to start

Paper form – all cases or notable events

Collaborate with hospital / facility
Adapt an existing electronic system

Build your own system
Need IT infrastructure and support

Use the AQI’s system
Local vs. national reporting / reports

AQI Registries

NACOR

AIRS

PPAI

Closed Claims

AQI Incident Reporting System (AIRS)

Report

Adverse Events & Near Misses

www.aqiairs.org

AIRS data

Event Classification

1600 Cases

90 Institutions

Hundreds of reporters

Some are bulk submitted
**Case Discussion**  
80yo F for ERCP gallstone pancreatitis  
GETA (propofol, lidocaine, inhaled agent) stable vitals  
1 hour in – EtCO2 35 -S, Pulse ox perfusion 9-0.2  
No pulse or blood pressure  
Supine, CPR, Epi, Calcium, Bicarb, Vasopressin  
Complete recovery

**Conclusions – ERCP Air embolus**  
GI and Radiology  
ERCP – Airway, medications, 3 arrests  
Pressurized air used during the procedure  
Instrumentation used  
Numerous case reports (21)

**Trending**  
Hazards of Electronic medical records and AIMS  
Air embolus during ERCP  
Drug errors due to shortages  
Importance of teamwork  
Place for cognitive aids

**Case Discussion**  
26 yo F for cosmetic surgery  
Routine induction until patient started retching  
Reached for suction, no suction  
Copious vomiting  
Bronchoscopy noted vomit in airway  
Aspiration pneumonitis, 2 weeks in the ICU  
Preventable
Trending IT
Charting on the wrong patient
Sudden system failure
Failure to record vital signs
Failure of pharmacy dispensing systems
Incorrect calculations
Flawed/Incorrect decision support
Distraction from all these issues

Trending - Equipment
After induction, no blood pressure reading, weak pulses — checked O2 sat, didn’t work
No ECG cable in room noticed after case
No BP for an hour
No suction, needed suction
Monitor broken
No capnograph in room

AIRS Steering Committee
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University of Chicago
Peter Fleischut, MD
New York Presbyterian Hospital
David Gaba, MD
Stanford University
Patrick Guffey, MD
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Stephen Pratt, MD
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Avery Tung, MD
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Children’s Hospital of Chicago
Joyee Webb, MD
University of Michigan
Jim Caldwell, MD
Founding Chair, Emeritus Member

Integrating with the EMR
Good system design is integrated in workflow
What’s the denominator?
Moving towards 100% event capture
Local vs hosted?
Event Reporting from Epic

Data sent to AQI:

1. Institution ID (ID number given by AQI to provider group)
2. Anesthesia S2 CSN (NEF: This is the contact serial number for the anesthesia encounter)
3. HSB ID (NEF: This is a unique ID for the anesthesia record; the combo of the S2 and S3 encounters)
4. Service Date
5. ASA Score
6. Anesthesia Type
7. Case ID (EHR ID)
8. Service
9. Facility City
10. Facility State
11. Patient Age
Event Reporting from *Epic*

- Flowsheet row populated
- Close Encounter checks
- Hard stop vs. Soft stop
- Forcing function to create a denominator

**AIRS Options**

- Local AIRs system
- Integration with QM software
- Connection with NACOR
- Reports back to participating groups

**Discussion**

The Intersection of *Quality* and *Informatics* is:

*High Reliability*

**Conclusions**

- Medical errors are preventable
- System errors predominate
- Incident reporting detects system errors
- Strong system design leads to better reporting
- National databases allow aggregation and earlier detection
- Healthcare registries are everywhere - the goal is how do we maximize their potential
Mergers and Acquisitions

Peter Harkness, MD
Chairman USAP Colorado

Background

• Since Dec 2012, have helped take a 40 doc anesthesia group to over 210 anesthesiologists and 40+ mid-level providers
• While not an expert, understand the M&A landscape on a very high level, including pitfalls and advantages
• Hope to share my knowledge in a brief presentation and more extensive Q&A session

Current Landscape

• Mergers and Acquisitions have accelerated over the past 4 years to an unprecedented level
• Graph? All specialties or just anesthesia?
• Our future is to do more with less. This does not need to be smoke and mirrors. Showing extra effort is more than the current and is a step in the right direction.

Outside Factors

• There is a lot of consolidation happening across the healthcare landscape (hospital systems, insurance carriers, medical specialties) and the reason is multifactorial
• Overall healthcare costs are being shifted from traditional fee-for-service models to more bundled payments, “smarter” consumers, ACO’s, and shared exposure models that drive a demand for a greater “service” with less potential revenue

Internal/Group Drivers

• Groups are increasingly being asked to provide greater services (coverage, quality, esoteric demands) for diminishing stipend amounts
• National groups are looking to expand their “model” into new markets, so there is an increasingly organized and prepared outside threat to the current system
• The cost of new technology or service lines is often prohibitive for smaller practices

Disclosures

➢ Partner, US Anesthesia Partners
➢ Chairman of the CGB of USAP Colorado
➢ Participant in 3 major mergers, just a simple anesthesiologist
Why Consider a Merger or Acquisition?

- Need to stay competitive in your market
- Need help transitioning in the current landscape of medicine
- Leadership assistance
- Administrative assistance
- Off-set or share quality improvement, leadership, administrative costs
- Fill a gap that you cannot do on your own
- Deming/Toyota model that quality flows from having a solid system that cannot be achieved by individual efforts alone

What Exists in the National Landscape

- There are all flavors of National groups to help or hinder you
- Most/All? National groups will purchase future equity for a multiple
PERCUTANEOUS CRICOTHYROTOMY

Why?
- Can’t ventilate, can’t intubate
- Congenital deformities????
- Trauma to the head or neck which would preclude the use of ETT via nasal or oral passage
- Cervical spine fractures and tracheostomy is not fast enough?

Advantages
- Provides a definitive airway
- Can be performed quickly and has relatively few complications

Contraindications
- Patient < 40 kg and < 10 years old
- Suspected fractured larynx
- Inability to localize the cricothyroid membrane
Converting from Cricothyrotomy to Tracheostomy in trauma patients

- Controversy surrounds whether to expeditiously convert emergency cricothyrotomy to tracheostomy.
- Conversion advocated by many authors to decrease incidence of subglottic stenosis.
- Arch Surg 2010 (Review of literature from 1/1978 to 1/2008) – “Cricothyrotomy after trauma is safe for initial airway access among patients who require the establishment of an emergent airway. The prolonged use of a cricothyrotomy tube, however, remains controversial. Although no study to date has demonstrated any benefit of routine conversion to tracheostomy, considerable deficiencies in existing studies highlight the need for further investigations of this practice.”
Awake Fiberoptic Intubation

Indications for Awake Fiberoptic Intubation

- Known or anticipated difficult airway-mask or intubation
- Unable to move neck-c-spine injury, RA...
- Distorted anatomy

Awake Fiberoptic
NASAL or ORAL

"Fiberoptic intubation of the spontaneously breathing patent is the GOLD STANDARD and technique of choice for the management of a difficult airway"

Nasal

- Direct path
- Need smaller tube
- Not best idea if patient remains intubated
- Potential for nose bleed especially in patient we are already concerned about bleeding issues

Fiberoptic Awake Oral Intubation

ORAL with Berman, Ovassapian or Williams airway
### Sedation
- Have to make sure maintaining airway
- DON'T over sedate

### Medications
- 4% Lignocaine, Lidoine cream, 2% Lidocaine
- Glycopyrrolate-given early at least 20 minutes before
- Reglan? Bicarbonate?
- Varsad
- Fentanyl
- Precedex
- Ketamine
- Remifentanil

### Precedex
- Dexmedetomidine
- Alpha2-Adrenergic agonist
- Sedation without respiratory depression
- 200ug/50cc bag
- 0.2-1.4ug/Kg/hr
- Can load 1ug/Kg over 10 min- I don’t

### Ketamine
- NMDA receptor antagonist
- Dissociative
- Salivating
- Low dose to top sedation off-20-50 mg
- Antidepressant

### Innervation of the Airway
- Nasal cavities
- Oral cavities
- Pharynx-nasopharyngeal, oropharynx & hypopharynx
- Larynx
- Trachea

### Airway Reflexes
- Gag-glosso-pharyngeal and vagus branches
- Glottis Closure-superior and recurrent laryngeal nerves
- Cough-vagus

---

Juels, Alma, MD

Awake Fiberoptic Intubation
Oropharynx

- Viscous lidocaine
- Glossopharyngeal nerve block
- Nebulizer-3-5cc 4% Lidocaine
- 4% Lidocaine atomizer
- Lollipop-Lidocaine ointment
- Oral airway with Lidocaine ointment/cream

Glossopharyngeal nerve block

The glossopharyngeal nerve can be blocked by holding swabs soaked in local anesthetic at the point indicated by the white arrow. Or injecting local anesthetic at arrow.

Posterior pharynx

- Atomizer
- Nebulizer
- Superior Laryngeal Nerve-gag reflex, base of tongue to just above vocal cords.

Below vocal cords

- Transtracheal-4% Lidocaine 4-5 cc
- Recurrent Laryngeal Nerve-also part of gag reflex
- Patient coughs help spread
- Or-Direct visualization and injection through FO
- Nebulizer
Ways to numb airway

- Atomizer
- Nebulizer
- Direct injection
- Lollipop-lidocaine ointment on end of tongue blade with gauze-pat sucks it while advancing as tolerated
- Injection of lidocaine through Fiberoptic as advancing

Concerns numbing airway

- Biggest concern is numbing up the airway-above and below the vocal cords-TAKES AWAY PROTECTIVE AIRWAY REFLEXES!!!
- Is patient NPO, airway secretions, bloody airway...
- ASPIRATION!!!

Aspiration Risk

Concern is there, however, data has shown no increase in aspiration with FO after numbing the airway
Positioning

- NOT sniffing position
- Neutral position-chin lift and jaw thrust maneuvers move the soft tissues and lifts the epiglottis from the posterior pharyngeal wall improving the view through the fiberscope

Using Fiberoptic

- Keep bronchoscope taut between hands so the orientation of the tip is the same as the control lever
- Move right or left
- Move up or down

Flexion lever moves tip of the scope from 06:00 to 12:00 in one plane
Advancing ETT

- Lots of lubrication
- Consider smaller tube
- Parker tube
- Endotrol tube

Endotrol ETT

Has hook to maneuver end of tube

- If the fiberscope passes through the vocal cords, but the endotracheal tube does not pass, the tube may be getting caught on the arytenoid cartilages. Rotating the endotracheal tube ninety degrees counterclockwise directs the tip into the trachea.
Tuesday, March 1
**Perioperative Fluid Therapy For Major Elective Surgical Patient: Current Controversies and Concerns**

Girish P. Joshi, MBBS, MD, FFARCSI
Professor of Anesthesiology and Pain Management
Director of Perioperative Medicine and Ambulatory Anesthesia

**No Conflict of Interests**

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**Objectives**

- Understand the current controversies of periop fluid therapy for major elective surgery
- Discuss the consequences of perioperative hypo- and hypervolemia
- Explain the benefits and limitations of fluid minimization and goal-directed fluid therapy
- Recommendations for perioperative fluid therapy for major elective surgery

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**Perioperative Fluid Therapy**

- Fluid therapy for elective surgery ≠ Fluid therapy for emergent or trauma surgery
- Fluid therapy for major surgery ≠ Fluid therapy for mild-to-moderate surgery

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**Intravascular Volume Is Depleted in the Intraoperative Period?**

- Preoperative fasting
- Bowel preparation
- Intraoperative losses
  - Blood loss
  - Evaporation
  - Third spacing
- General and regional anesthesia
- Vasodilatation


---

**Current Perioperative Fluid Therapy**

- We have become desensitized to administration of high fluid volumes (5-6 liters for major surgical procedures)
- Patients typically gain 5 kg of body weight after major surgical procedure
Perioperative Crystalloid Administration and Postoperative Weight Gain


Perioperative Hypovolemia: Postoperative Morbidity and Mortality

- Perioperative hypovolemia increases postoperative morbidity and mortality
- Perioperative fluid overload is a contributory cause of postoperative complications and death
  - National Confidential Enquiry into Perioperative Death (http://www.ncepod.org.uk)

Postoperative Fluid Overload: Not a Benign Problem


Variation in Intraoperative Fluid Administration


Consider Fluids as Drugs, and Dose Them Appropriately!

“Poison is in everything, and no thing is without poison. The dosage makes it either a poison or a remedy.”

Paracelsus (Philipus Theophrastus Aureolus Bombastus von hohenhein), 16th century

Current Perioperative Fluid Therapy
### 4-2-1 Algorithm For Fluid Administration

<table>
<thead>
<tr>
<th>Time</th>
<th>Compensatory (ml)</th>
<th>Maintenance (ml)</th>
<th>Total (ml)</th>
<th>Third Space (ml)</th>
<th>Cumulative (ml)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Preinduction</td>
<td>-200</td>
<td>-220</td>
<td>0</td>
<td>0</td>
<td>420</td>
</tr>
<tr>
<td>Preincision</td>
<td>-200</td>
<td>-220</td>
<td>0</td>
<td>0</td>
<td>420</td>
</tr>
<tr>
<td>1st Hour</td>
<td>-200</td>
<td>-220</td>
<td>200</td>
<td>-250</td>
<td>1950</td>
</tr>
<tr>
<td>2nd Hour</td>
<td>-200</td>
<td>-220</td>
<td>200</td>
<td>-250</td>
<td>1970</td>
</tr>
<tr>
<td>3rd Hour</td>
<td>-200</td>
<td>-220</td>
<td>150</td>
<td>-350</td>
<td>830</td>
</tr>
<tr>
<td>4th Hour</td>
<td>-200</td>
<td>-220</td>
<td>110</td>
<td>-200</td>
<td>330</td>
</tr>
</tbody>
</table>

Kaye AD, Kucera AJ. In Miller RD Editor, Anesthesia, 6th Ed, 2005, pp 1763-98

---

### Algorithm-Based Fluid Administration

- Non-anatomical “third space” does not exist
  - Brandstrup et al: Surg 2006; 139: 419-32
- Fluid volume accumulated in traumatized tissue is very small
- Evaporative losses from abdominal cavity are small
  - Brandstrup B. Best Practice & Research Clinical Anaesthesiology 2006; 20: 265-83

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### Replacement of Blood Loss With Crystalloids

- Blood loss replaced with crystalloids in 1:3 ratio
- Increased survival of animals in hemorrhagic shock after resuscitation with 3X crystalloids
- Studies of goal-directed therapy suggest crystalloid-to-colloid volume ratios of 1.8-2
  - Perel P, Roberts I. Cochrane Database Syst Rev 2009:CD000567:
  - Hartog CS et al. Anesth Analg 2011; 112: 635-45
- SAFE study: crystalloid vs. colloid ratio 1:1.4

---

### Crystalloids Versus Colloids: Exploring Differences In Fluid Requirements by Systematic Review and Meta-Regression

- Greater fluid volumes are required to meet the same targets with crystalloids than colloids with estimated ratio of 1.5

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### Static Monitoring For Assessment of Intravascular Volume

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*What gets us into trouble, Is not what we don’t know. Its what we know for sure. That just ain’t so.*

Mark Twain
Unreliable Indicators of Plasma Volume Status

- Heart rate
- Mean arterial blood pressure
- Central venous pressure
  - CVP or PAOP
- Urine output


No Association Between CVP and Blood Volumes

1500 simultaneous measurements of blood volume and CVP (r = 0.27).


Intraoperative Urine Output and Postoperative Acute Renal Failure

- Origin of the recommendation of urine output of >0.5 ml/kg/h unknown
- Reduced intraoperative urine output is neither a trigger nor a predictor of acute renal failure
- No correlation between urine output and ARF

Urine Output Reduced During Inhalation Anesthesia

- Crystalloids infused during inhalation anesthesia lead to fluid accumulation
- Ratio of interstitial fluid volume to urine output increases 6-fold


Urine Output: An Indicator if Intravascular Volume Status?

- Urine flow rate reliable indicator of changes in BV after blood withdrawal (10ml/kg)
- No increase in urine flow after colloid administration (10 ml/kg)
  “...urine flow can act as an early sign of bleeding or hypovolemia, but not as a tool to define the end of resuscitation.”

Shamir MY et al: Anesth Analg 2011; 112: 593-6

Crystalloids: An Iatrogenic Source of Multiple Organ Failure?

- Administration of crystalloids to achieve adequate urine output may cause multiorgan failure
  “While renal failure is avoided, abdominal compartment syndrome resulting in multiple organ failure is increased”

Kudsk: Annu Surg 2003; 238: 649-50
Dynamic Monitoring For Assessment of Intravascular Volume

Goal Directed Fluid Therapy Using Dynamic Monitoring

- Static (HR, BP, CVP, PAOP) are single-point "snapshots"
- Dynamic indicators are predictors of fluid responsiveness
- Variation in PP, SBP, or SV, are 'virtual preload challenges occurring during each respiratory cycle in ventilated patients

Volume Responsiveness to Guide Fluid Therapy

Hemodynamic Monitors

Improving Quality

Enhanced recovery care pathway
A better journey for patients seven days a week and better deal for the NHS
Progress review (2012/13) and level of ambition (2014/15)

Oesophageal Doppler-guided fluid management during major surgery: reducing postoperative complications and bed days

Provided by: NHS Technology Adoption Centre

Publication type: National workstream example
Nexflin Noninvasive Continuous Cardiac Output Monitor

Non-invasive Monitoring For Respiratory Variations: Pulse Oximetry

Comparison between Respiratory Variations in Pulse Oximetry Plethysmographic Waveform Amplitude and Arterial Pulse Pressure during Major Abdominal Surgery

The Ability of Anesthesia Providers to Visually Estimate Systolic Pressure Variability Using the “Eyeball” Technique

Systolic Pressure Variation: “Eyeball” Technique

Visual Estimation

- Change the waveform speed to 12.5mm/s (default is 25mm/s)
- Use cursor to calculate the upper and lower SBP
- Calculate percentage variance
- If variance >14% administer fluid bolus

Physician decisions to administer fluid were incorrect in 4.4% occasions

Limitations of Dynamic Indicators

- Spontaneous breathing
- Open chest
- Low tidal volumes <8 ml/kg
- High PEEP
- High respiratory rate
- Sustained cardiac arrhythmias
- Right ventricular failure
- Laparoscopic procedures
Monitoring Truth

No monitoring device, no matter how accurate or insightful its data will improve outcome, Unless coupled to a treatment, which itself improves outcome

Pinsky & Payen: Functional Hemodynamic Monitoring, 2004

Fluid Minimization Therapy

Perioperative Fluid Therapy: Zero Balance Vs. Standard Practice

- Eliminate preloading
- Eliminate replacement of “third space”
- Eliminate replacement of urine output
- Use of colloids to replace blood loss
- Maintain postoperative weight gain < 1 kg
  - Body weight gain > 1 kg treated with furosemide


Goal-Directed Fluid Therapy

- Individualized fluid therapy that adapts to changing patient needs during the periop period
- Goal: maximize tissue O₂ delivery with minimal cardiac O₂ consumption
  - Optimal goal remains to be determined
  - Stroke volume most commonly used
- Prevents subtle hypovolemia and hypervolemia that might lead to organ dysfunction, increase perioperative complications, and delay recovery

Goal-directed Fluid Therapy

Standard, Restrictive, and Goal-Directed Fluid Therapy: Systematic Reviews

- Compared with traditional fluid therapy guided by static indicators, restrictive and goal-directed therapy
  - Early recovery of GI function
  - Reduced PONV
  - Decreased complications
  - Reduced critical care admission
  - Reduced ICU stay
  - Reduced hospital stay

Perioperative Goal-Directed Hemodynamic Therapy

- High-risk patients randomized to CO-guided hemodynamic therapy algorithm for IV fluid and inotrope (dopexamine) infusion during and 6h after surgery (n=368) or to usual care (n=366)
- No difference in composite outcome of complications and 30-day mortality

Cardiac Output-Guided Hemodynamic Therapy and Outcomes After Major GI Surgery

- Randomized controlled trial (n=730) comparing CO-guided hemodynamic therapy algorithm for fluid and inotrope (dopexamine) infusion vs standard of care
- No difference between groups in primary outcome of composite of 30-day moderate-to major complications
- No significant difference between groups for any secondary outcomes

Cumulative Incidence of 180-day Mortality: Cardiac Output–Guided Hemodynamic Therapy Algorithm Intervention Vs. Standard Care

Stroke Volume Optimization and Perioperative Outcome

- Elective bowel surgery
- Algorithm-driven SV optimization is of no benefit when superimposed on liberal baseline fluid regime
- NICE recommendation for intraop CO monitoring are not appropriate

Goal Directed Fluid Therapy: Meta-analysis

- Patients treated with GDT received a greater volume of colloids and smaller volume of crystalloids compared with patients not treated with GDT
- GDT is beneficial mainly when used outside ERAS programs and in patients undergoing colorectal surgery

Goal For Fluid Therapy: Stroke Volume vs. Zero Fluid Balance

- Double-blind, multi-center study (n=150) in patients undergoing elective colorectal surgery (lap and open)
  - Fluid therapy based on achieving max stroke volume
  - Zero balance (restricted approach)
- Postop weight increase similar (~1kg)
- Overall, major, minor cardiopulmonary, tissue healing complications, and LOS stay similar
Implementation of enhanced recovery protocols which include avoidance of preoperative mechanical bowel preparation, preoperative hydration/carbohydrate loading, aggressive ambulation may influence the need for minimally invasive (or non-invasive) CO monitors

Role of these monitors in laparoscopic procedures controversial

Crystalloids Vs. Colloids

High-risk patients undergoing colorectal surgery randomized to receive HES 6% (n=104) or crystalloid (n=98) for hemodynamic optimization using Lidco

Crystalloid group received more fluids (3175 ml vs. 1875 ml) and higher 24-h fluid balance (+4226 vs. +3610)

No difference in GI morbidity on POD 5

No difference in overall complication rate


Normal Saline: Hyperchloremic Acidosis

Hypochloremia After Noncardiac Surgery is Independently Associated with Increased Morbidity and Mortality: A Propensity-Matched Cohort Study

Background, several different crystalloid solutions are available for fluid administration but few, if any, have been studied in parallel for their effects on outcome compared to normal saline.

Methods: We performed a retrospective analysis of 2,563 patients undergoing non-cardiac surgery. Patients were matched for age, sex, and procedure using a propensity score and divided into normal saline or balanced crystalloid groups. In-hospital mortality and complications were assessed.

Results: The overall mortality rate was 0.5% in the normal saline group and 0.9% in the balanced crystalloid group. The incidence of complications such as sepsis, infection, acute renal failure, and respiratory failure was also lower in the normal saline group. The number of days spent in the ICU and the total length of hospital stay were also significantly shorter in the normal saline group.

Conclusions: This study suggests that normal saline is associated with improved outcomes compared to balanced crystalloids in non-cardiac surgery.
Approaches to Optimize Intravascular Volume and Avoid Fluid Overload

Effect of Volume Status on Morbidity After Different Surgical Procedures

Fluid Overload Avoided By Modifying Anesthetic Technique

- Avoid overdose of sedative-hypnotics, analgesics, which will mandate fluid administration to maintain blood pressure
- Avoid large tidal volumes and high peak pressures
  - Reduce venous return and cardiac output
  - Hypocapnia/alkalosis may reduce sympathetic output
  - Hypercapnia increases subcutaneous and colonic O₂ tension during abdominal surgery
- Fleischmann et al: Anesthesiology 2006;104:944-9

Summary

- Fluid therapy is often based on dogma and personal beliefs
- Patients commonly receive large amounts of crystalloids in the perioperative period
- Excessive fluids increase perioperative morbidity and mortality
- Avoid preop dehydration (encourage preop oral fluids and avoid bowel prep)
- Early optimization may be critical (proactive rather than reactive approach)

Fluid Minimization Approach

- Eliminate algorithm use (i.e., preloading and replacement of “third space”)
- Blood loss should be replaced with colloids or crystalloids based on volume responsiveness
- Avoid fluid administration based upon static indicators (HR, MAP, CVP)
- Role of CO monitors in modern practice remain questionable
- Need to follow postop, avoid weight gain > 1kg
"If you always do what you always did, you will always get what you always got."

Participants will be able to...

- Describe possible implications of the neurodevelopmental effects of anesthesia on young infants and children.
- Understand advances in pediatric pain management and regional anesthesia.
- Discuss growing use of dexmedetomidine in pediatric patients

Disclosures

- Strategies for Mitigating Anesthesia-Related neuroToxicity in Tots
- 2012 response to a 2009 FDA request
- Public-private partnership
  - International Anesthesia Research Society
  - FDA
  - Other stakeholders
- Coordinate and fund research
- Smarttots.org
Schwartz, Lawrence, MD

Update on Pediatric Anesthesia

**SmartTots**

- Consensus Statement, October 2015
- Animal Studies
  - Show brain injury, behavior/learning deficits
- Human Studies
  +/- on effects, confounding factors
- No definitive answers

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Anesthesia and the developing brain: a way forward for clinical research


- 2 day meeting in Genoa, Italy
- Pediatric Anesthesia and Neurotoxicity: From the GAS study to future collaborative trials.
- May 23 – 24, 2014
- Pediatric anesthesiologists, basic science & clinical researchers, project coord., neonatologists, neuropsychologists, surgeons, peds anesth society leadership
- Summarize current/ongoing research
- Develop key questions to drive future research

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**SmartTots**

- Healthcare Providers
  - Highlight difference between animal and human research findings
  - Most meds have been implicated in animal studies
  - Anesthesia is necessary for surgery, etc
  - Decisions regarding timing should be discussed with all team members & family
  - Elective procedures
    - Risk/Benefit of surgery vs delay
- Parents
  - Discuss timing of procedure with PMD, surgeon, anesthesiologist.
  - Weigh unknown risk of anesthesia vs potential harm of postponing surgery
  - Individualized decisions
  - Smarttots.org

---

**What we know**

- Animals studies
  - Many GAs have effects of developing brain: apoptotic cell death, impaired synaptogenesis, potential long term neurologic dysfunction.
- Effects greatest in very young animals
- Mixed evidence for association b/w anesthesia and poor neurodevelopment in animal models
- Some interventions mitigate changes observed
- Several plausible mechanisms implicated
- Mixed evidence for association between anesthesia and risk of poor ND outcome in children

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**What we do not know**

- Which children (age of exposure, dose) are at greatest risk for poor developmental outcome
- Which neurological domains are affected
- The mechanism involved
  - Hypotension, hypoxia inflammation, illness, surgery, direct toxicity, socio-economics?
- Possible neuroprotective effects
- Which interventions would reduce the risks

---

**3 Approaches to Research**

- Determine if clinically relevant toxicity exists
- Accept toxicity exists.
  - Find thresholds and mitigating mechanisms
- Make no assumption on association
  - Identify greatest risk population
  - Can we alter risk and change anesthetic techniques
2015 Basic Science

Dosing and Timing

Mechanisms - MicroRNA

- Small, endogenous, non-coding segments
- Negatively regulate target gene expression
- Implicated in disease processes, including (most recently) neurotoxicity

miRNA-124

What to do with the animal data?

- Does the animal data translate?
- NT is multifactorial
- Very young animal with high dosing

But there is a lot of alarming data
What about non-rodents

- Conflicting data
- Retrospective studies
- Power
- Learning & behavior is multifactorial
- Need better studies
  - Prospective
  - Large
  - Multi-institutional

Mayo Anesthesia Safety in Kids (MASK) Study

Gleich, Contemporary Clin Trials, 41:2015

Lancet, January 16, 2016

Neurodevelopmental outcome at 2 years of age after general anaesthesia and awake-regional anaesthesia in infancy (GAS): an international multicentre, randomised controlled trial

First randomized controlled trial assessing the effect of general anesthesia in infancy on neurodevelopmental outcome

GAS

- Subjects
  - < 60 weeks gestation, born >26 weeks
  - Inguinal herniorrhaphy
  - 28 hospitals: Australia, Italy, USA, UK, Canada, Netherlands, New Zealand
- Study
  - Feb 9, 2007 – Jan 31, 2013
  - Randomized to receive GA (359) or awake/spinal (363)
  - Primary outcome: Wechsler Preschool and Primary Scale of Intelligence III Full Scale Intelligence Quotient, at age 5 yrs
  - Secondary outcome: Bayley Scales of Infant and Toddler Development III, at age 2 years

GAS

- Outcome data available for 238 A/R and 298 GA
  - Median duration of GA 54 minutes
  - Cognitive composite score (mean [SD])
    - 98.6 [14.2] in the awake/regional group
    - 98.2 [14.7] in the general anesthesia group
- Found no evidence that less than 1 hour of sevoflurane anesthesia in infancy increases the risk of adverse ND outcomes at 2 years of age compared with awake-regional anesthesia
- Strongest clinical evidence to date, but still not definitive.
The surgeons are taking notice

**BRIEF COMMUNICATION**

Neonatal Anesthesia Neurotoxicity: A Review for Cleft and Craniofacial Surgeons

There is growing evidence that the commonly used anesthetic agents cause some degree of damage to the early developing brain. The animal evidence for anesthetic neurotoxicity is compelling. Scientific contributions in human research have grown rapidly from studies over the last two decades. The benefits of an early surgical intervention justify a potential but uncomplicated risk of neurotoxicity of anesthetic agents. The timing and number of surgeries to our treatment protocols may need to be reevaluated to account for these potential risks.

Surgical adaptation

- **TOPS Trial**
  - Timing of Primary Surgery for Cleft Palate
  - 6 months vs. 12 months
- **Orthopedics**
  - Club foot, digits, hips - wait?
  - Urgent trauma, infections - can’t wait, but can decrease # I&D procedures
- **General Surgery**
  - Hirschsprung Disease – early intervention improves outcomes
  - Non-surgical approach to abdominal wall defects

The New York Times

Researchers Warn on Anesthesia, Unsure of Risk to Children

F.D.A. to Study Whether Anesthesia Poses Cognitive Risks in Young Children

US News HEALTH

Should Surgery Wait? How Anesthesia Affects Kids

Learning about the potential risks on growing brains is important, experts say.

PALC survey results

- Most are getting some education
  - Journal Clubs, Grand Rounds, Conferences
- Providing parents with information
  - 91% discuss only if asked
  - 6% discuss NT routinely
  - 1 program is adding to their consent
  - 25% have a formalized mechanism to provide information

Consistency is the building block of trust

Figure 3: Of the 47 members of the PALC and PAPDA that mentioned an "age at risk," only 38 members cited a specific "safe age cutoff" for parents in which anesthesia given after that age were deemed safe. Nine individuals responded that although they made general statements about younger versus older children, they did not cite a specific age. The responses to the five zones of "no specific age" through "over 4 years" are displayed above for the question "Do you cite a specific "safe age cutoff" in your discussions of anesthesia-related neurotoxicity?"
Healthcare Providers
• Highlight difference between animal and human research findings
• Most meds have been implicated in animal studies
• Anesthesia is necessary for surgery, etc
• Decisions regarding timing should be discussed with all team members & family
• Elective procedures – Risk/Benefit of surgery vs delay

Parents
• Discuss timing of procedure with PMD, surgeon, anesthesiologist.
• Weigh unknown risk of anesthesia vs potential harm of postponing surgery
• Individualized decisions
• Smarttots.org

Regional Anesthesia in Children
• Benefits
  – Perioperative pain relief
  – Decrease opioids
  – Decreased general anesthesia*
  – Growing experience
  – PNB, NA
• Questions
  – Safety
  – Ultrasound
  – Awake vs. asleep

General Anesthesia compared to Spinal anesthesia study (GAS)
• Apnea post-anesthesia in infants
  – < 60 weeks gestation, born >26 weeks
  – Inguinal herniorrhaphy
  – Randomized to receive GA (359) or awake/spinal (363)

GAS – Apnea results
• Overall incidence of apnea, 0-12hrs
  – RA 3% vs GA 4%
• Early apnea, 0-30mins
  – RA 1% vs GA 3%, OR 0.2
• Late apnea, 30min-12hours
  – RA & GA 2%

Parents
• Discuss timing of procedure with PMD, surgeon, anesthesiologist.
• Weigh unknown risk of anesthesia vs potential harm of postponing surgery
• Individualized decisions
• Smarttots.org
GAS - Failure

- Failure of regional neuroaxial technique was 10%
- Bloody tap predicts failure, OR 2.46
- Heterogeneity of technique and experience limits ability to comment on preferred method

Frawley, ANES, (123) July 2015

Awake vs. GA/Sedation

- Turns out it’s not...
- 4 major large scale studies.
- No incidence of paralysis with neuroaxial anesth/anal
  – 95%CI 0(0% - 0.004%)

ESRA/ASRA Conclusion

- Performance of PRA under GA/DS is safe and should be viewed as standard of care
- Overall complication risk is 0.66% (95% CI, 0.6% - 0.7%)
  – Risk of paralysis is 0 (95% CI, 0% - 0.004%)
- Should maintain a high index of suspicion for serious complications/neurologic injury

4 large scale studies

- French Language Society of Paediatric Anaesthesiologists (ADARPEF), 1996
  – 38 centres, 24409 RA, 89% with GA
  – 0.6/1000 overall, 0 PN, 1.5/1000 NAB
- UK Prospective National pediatric Epidural Audit, 2007
  – 10633 RA
  – 96 complications; 5 serious, 9 major
- ADARPEF, 2010
  – 29870 blocks with GA
  – 41 complication, 0 long-term
- Pediatric Regional Anesthesia Network report, 2014
  – Internet database, 2007-2012
  – 53,564 PRAs
  – PRA under GA +/- NMB demonstrated no increase in complications
  – PRA with GA had less complication rate than awake or sedated

Test dosing in kids

- PRAN
- 26,949 blocks with a test dose
- 0.21% incidence of ±TD
  – All but 1 with caudal or epidural
- Careful dose calculation > test dose

Reg Anesth Pain Med (40) 2015
Problems with interpretation

- GA and dose at the time
- Higher resting heart rate
- Age-dependent CV reactivity to epinephrine
- Premedication received
- Type of local anesthetic received
- Type of general anesthetic received

Committee Recommendations

- Difficulty interpreting negative TD
  – False negative TD occur
  – LA solutions given slowly and small aliquots (0.1-0.2 ml/kg)
- Any T wave or heart rate changes within 30-90 second should be considered positive IV injection. No False Positives
- Imaging modalities may help.

Either is okay

**Air LOR**
- Nerve root compression, pneumocephalus, incomplete block, venous air embolism
- Associated with repeat, large bolus

**Saline LOR**
- Dural puncture detection, dilute dose, decrease CBF
- Volume dependent

- No evidence one is better than the other
- Consider combination
- Limit volume to 0.5 – 1 ml in neonate/infants

Compartment Syndrome

- Case reports
  – Root cause analyses reveal poor monitoring and poor positioning
- Diagnosis
  – 30mmHg
  – 4 hours to tissue loss
- Concern for masking
  – Breakthrough pain may be an early sign

Committee Advice

- No current evidence that RAs increase risk for Acute Compartment Syndrome or delay diagnosis in children
- Preop conversation with parents about risk

“Best Practice”
- Single shot 0.1 – 0.25% bupi, ropi
- Continuous infusion up to 0.1%
- Restrict volume and concentration in catheters for tibial compartment
- Cautions with additives
- Follow up/monitoring by APS
- Measure compartment pressures if suspected

PRAN

- Internet Database for PRA
- Prospective data
- Established 2006
- Data 2007-2012
- 2015 Publications
  – Caudal Safety
  – Peripheral Nerve Block Safety
PRAN - Caudal

- 18,650 children received a caudal block
- Complications
  - Overall rate 1.9% (1.7-2.1%)
  - Higher association with younger patients
    - Median 11 months vs. 14 months
  - Most common complications
    - Block failure (1%)
    - Blood aspiration (0.6%)
    - Injection (0.1%)
  - No temporary or permanent sequelae
  - 24.6% received potentially unsafe dose (>2mg/kg)

PRAN – Peripheral Nerve Catheters

- 2074 PNCs
- 251 adverse events & complications, 12.1%
  - Catheter malfunction
  - Block failure
  - Infection
  - Vascular puncture
- No persistent neuro injury, serious infection, or LAST

Evidence for the use of US in PRA

- Initial review 1994-2009
- Current review 2009-2014, 37 RCT and prospective observational studies.

Summary of findings

PNB
- ↓ Performance time
- ↑ Block success
- ↑ Block quality
- Excellent pain relief
- Lower post-op opioid requirement
- ↓ Volume need

NAB
- Improve needling time
- Predict depth
- Improve catheter visualization
- ↑ Block quality

Lam, Reg Anesth & Pain Med, 2015
Adjuncts to local anesthetics

- 212 children, ASA 1-2, 1-3 years, 8-18 kg
- Elective inguinal hernia/hydrocele repair
- Treat with caudal injection
  - 0.25% levobupivacaine
  - 0.2% levobupivacaine
  - 0.2% levobupivacaine + Dexmedetomidine 2mg/kg

Results

- No change in block onset time
- Increase mean block duration
  - 0.25% LB → 7.23 hours
  - 0.2% LB → 5.84 hours
  - 0.2% LB + DEX → 19.6 hours
DEX and nociception

- Dexmedetomidine depresses the release of C-fiber transmitters
  - Effect hyperpolarization of postsynaptic dorsal neurons
- Combination of dexmedetomidine and local anesthetics produces a synergism
  - Block Aδ and C fibers
  - Decreasing local anesthetic absorption
  - Activating cholinergic neuron.

Dexmedetomidine

- α₂-adrenergic receptor agonist
- α₂:α₁ selective binding 1600:1
- 7x more selective than clonidine

Cellular Mechanism of the α₂-Adrenergic Agonists

- Alpha-2 receptor provides negative feedback to inhibit NE release
- Decrease sympathetic response
- Clinical effectiveness tied to selectivity for alpha-2

Cellular Mechanism of the α₂-Adrenergic Agonists

- Alpha-2 agonist binds to receptor
- G-protein coupling
- Decrease cell membrane potential
  - Decrease Ca influx
  - Increase K efflux
- Hyperpolarized membrane less likely to fire
- Noradrenergic neuron does not release NE, inhibiting histamine release
- SLEEP
End organ effects of Dexmedetomidine

End Organ Effects - Neurologic

- Sedation via selective binding $\alpha_2$ receptors in the locus ceruleus
  - Decreased noradrenergic output $\rightarrow$ increased GABA firing
  - Natural, non-REM sleep
    - Animal studies
    - Pediatric EEG

Why the excitement

- Airway maintained
- Respiratory drive
- Cardiovascular stability
  - Heart rate, blood pressure
- "natural" sleep
- Possible organ protection
  - Ischemic/reperfusion, inflammation, CPB, sepsis
- Not implicated in neurotoxicity.
- May be neurologically protective

Areas of use

- Preoperative sedation
- Treatment of post-anesthesia shivering
- Procedural sedation
- MRI, radiology
- Anterior mediastinal mass
- Difficult airway
- Bronchoscopy
- Sedated echocardiography
- Sleep studies
- EEG
- Narcotic withdrawal
- Emergence delirium
- ICU sedation
- Cardiac anesthesia
- Regional anesthesia
- Spine surgery (evoked potentials)

Typical patient

- 6 month old infant with HLHS
- s/p Atrial balloon septostomy DOL 0
- s/p Norwood, Stage I repair, DOL 3
- Sedated ECHO @ 1 month, 3 months, 4 months,
  - CT angio @ 4 months
- Requires sedated preoperative ECHO today, in anticipation of modified bi-directional Glenn, tomorrow.

Intranasal use for transthoracic ECHO

- 115 kids, < 3 years old, acyanotic CHD
- 100 (87%) had satisfactory sedation
- Mean onset 16.7 +/- 7 minutes
- Wake up time 44.3 +/- 15 minutes
- Overall, no change in HR, BP, SpO$_2$
- 1 patient required NCO$_2$
- 4 patients with bradycardia < 90, no hypotension, no intervention

Li, Ped Anes (25), 2015
Emergence Delirium

Sleep: It is Worth the Fight

Summary

• Typical doses of dexmedetomidine (0.3-1 mcg/kg)
• Used as premed, part of the anesthetic, at the EOS
• Reduce the risk of PAED
  — Half to one third
• Reduce the severity of PAED
• Wake up time can be extended
• PACU time not significantly increased

2015 Papers

• Hauber, Anesth & Analg, Nov 2015
• Yao, Ped Anes, May 2015
• Liu, Int J Clin Exp Med, Sep 2015
• Hadi, Int J Ped Otolaryng, Feb 2015

Added benefits

• Decrease amount of opioids
• Decrease sevoflurane concentration


• 40 control, 40 DEX pts
• Mean age 6 years
• Treated at induction with Saline vs. DEX 0.5mcg/kg
• Sevoflurane to maintain BIS 45-55
DEX and Congenital Heart Disease

- Most complex patients are often the most young and require high dose, long, repetitive anesthetics
- Cardiopulmonary bypass + myocardial ischemia + hemodynamic instability + hypoxemia + anesthesia neurotoxicity risk factors = neurodevelopmental injury?

Benefits of Dexmedetomidine in CHD

- Shorter mechanical ventilation, earlier extubation
- Less opioid requirements
- Decreased stress response: cortisol, glucose
- Improved hemodynamic stability
- No significant difference in hospital or ICU LOS

Pan, Ped Anes, 2016

Potential Benefits

- Animal Studies
  - Attenuate ischemic-reperfusion injury
  - Decrease inflammatory molecules
  - Decrease neuroapoptosis, memory function

How this relates to clinical outcomes is unknown

- There is a growing body of scientific literature implicating most anesthetics in neurotoxic pathways
- The clinical impact of anesthetic toxicity is unknown
- Recommendations revolve around open and clear communication
- Pediatric Regional Anesthesia is growing strongly
- It’s safety and efficacy is now well established
- PRA may provide a avenue to avoid toxic anesthetics
- Dexmedetomidine use is growing in many arenas of pediatric anesthesia
- It’s appears to offer a growing number of clinical benefits to pediatric patients
- Preclinical research suggests it may attenuate cellular injury associated with inflammation, ischemia, and anesthesia-related neurotoxicity. However, the clinical data here is lacking.

Thank you
Intraoperative Monitoring, Resuscitation, and Transfusions
An Interactive Case-Based Pro/Con Debate

Learning Objectives for the Panel

1) Define goal directed fluid therapy and end-points for fluid resuscitation
2) Understand the arguments for and against the use of non-invasive cardiac output monitors to guide intraoperative fluid resuscitation
3) Discuss the use of vasopressors vs additional fluid resuscitation for the treatment of intraoperative hypotension
4) Examine the evidence for the rationale use of blood transfusions
5) Debate the real world justification for and against intraoperative blood transfusion
6) Outline and discuss the arguments for and against the use of Factor VII, prothrombin complex concentrates (PCCs) and anti-fibrinolytic therapy

Discussion Outline

A 65 year-old male with liver metastases is scheduled for an elective hepatectomy. The surgery is scheduled for 4 hours and the surgeon reports a planned EBL of approximately 500ml.

Should we utilize a non-invasive cardiac output monitor for the case?

Yes:

Please review

Rational fluid management in today's ICU practice.
Bartels K, Thiele RH, Gan TJ.
PMID: 23514431
Free PMC Article

No:

In the last few decades, an important paradigm shift has occurred in intensive and acute care medicine, including the operating room. During this time, a growing body of work has implicated over-resuscitation, particularly with crystalloid solutions, as a risk factor in many post-op complications, including several varieties of organ dysfunction. Although the specific endpoints of resuscitation are still a subject of intense debate, it does seem clear that both over- and under-resuscitation should be avoided. It has also been demonstrated quite convincingly that one of the old standbys for monitoring fluid status, the central venous pressure, has very little correlation with cardiac output, or more importantly, volume responsiveness. Some authors have rediscovered and re-validated older clinical exam techniques, such as the passive straight leg raise—but these are impractical in the operating room. The reigning gold-standard cardiac output monitor, the pulmonary artery catheter (PAC), has fallen out of favor in clinical settings after several studies found that they had an unacceptable complication rate,
and that even when placed successfully, they were often misinterpreted at the bedside and did not improve outcomes. Several relatively new monitoring devices have recently come into clinical use (having been heavily marketed) based on the promise of close correlation with the PAC, and simplified, real time assessment of both cardiac output and volume responsiveness—thereby helping the clinician to keep a challenging patient in the sweet-spot between over and under-resuscitation. Unfortunately, currently available minimally-invasive and non-invasive cardiac output monitors, while promising and extremely appealing, are plagued by important limitations that make their interpretation more challenging and less trustworthy than they might appear. In this section, several recent reviews and clinical studies will be analyzed, highlighting specific weaknesses of these technologies and critically appraising the data supporting their use. In some cases, the devices are more invasive than might be considered acceptable, some require expensive and non-standard catheters. Several require intermittent calibration. A key limitation of many of these techniques is that they lose validity in sicker patients—for example those with vasodilatory shock, poor distal perfusion, arrhythmias, poor lung compliance, or right heart dysfunction. Finally, although some small studies have suggested improved outcomes using protocolized care based on these monitors, others have found no difference, and in fact, that routine use of these monitors leads to increased administration of IV fluids. In any case, large, well-designed clinical trials are needed before we can confidently say that these monitors are truly ready for prime-time.

2 hours into the case, EBL is 500ml and the patient is hypotensive despite 3 Liters of volume resuscitation.

Should we treat the hypotension with continued fluid boluses?

Yes:

Please review

Rational fluid management in today’s ICU practice.
Bartels K, Thiele RH, Gan TJ.
PMID: 23514431
Free PMC Article

No:

Having just argued against the over-emphasis on non-invasive cardiac output monitoring, in this section, I will take the slightly contradictory position of warning against the dangers of empiric fluid over-resuscitation and in favor of judicious use of vasopressors. It could be argued that the answer to the question of fluid or pressor is a simple one once we “know the numbers.” In this line of thinking, we should use fluid resuscitation for hypovolemia, vasopressors for vasodilation, and inotropes for a so-called “pump problem” and the right answer lies in figuring out which of these problems is paramount in the patient in front of us. The challenge, unfortunately, is that we often have to make decisions in the absence of full information. Even when we have access to every number, pressure, and index in routine clinical use, the complex interactions between volume, perfusion, and vascular tone may preclude a
simple answer. This section will review the available data on the limitations of the “fluid first” mode of responding to hypotension, oliguria, and tachycardia. We will then turn our attention toward outlining some practical guidelines regarding when to start vasoactive infusions. Finally, we will conclude with a review of recent literature comparing the different vasoactive medications and highlighting current best-evidence regarding indication, drug choice, dose, and duration of pressor therapy.

4 hours into the case, the EBL is now 1000mL and the patient is hypotension. ABG reveals a HGB of 8.

Should we transfuse the patient with PRBCs?

Yes:

Data from clinical trials in the 1990’s suggests that blood transfusions do not improve outcomes of critically ill patients, and that the risks of transfusions may outweigh the benefits. However, recent data suggests that with leukocyte reduction that transfusion in critically ill patients actually improves outcomes. In the acute management of trauma patients in the postoperative management of cardiac surgery patients transfusing blood to hemoglobin goals improves outcomes. I will review recent clinical trials that suggest that anemia is a poor prognostic sign and that transfusion is not only but also improves patient outcomes.

No:

Since the 1980’s there has been a paradigm shift towards an era of blood conservation strategy. This has evolved from a number of different revelations related to anemia and transfusion. Large retrospective studies, primarily in Jehovah’s Witness patients and other patients that have refused blood transfusion have shown that the majority of patients can tolerate low levels of anemia. This is most likely due to a number of natural compensatory mechanisms such as increased HR, increased SV, peripheral and coronary vasodilation, increased extraction ratio, shift in the oxygen-hemoglobin dissociation curve, and shunting of blood to essential organs. There are inherent risks associated with transfusion that include but are not limited to infection, circulatory overload (TACO), acute lung injury (TRALI), and immune modulation, with little benefit coming from the transfusion of packed red blood cells. Other studies such as the TRICC trial have demonstrated that the majority of patients can tolerate hemoglobin levels in the 7-10 range without untoward side effects. More recent reviews, such as the ASA’s “Practice Guidelines for Perioperative Blood Management” do not provide convincing evidence that transfusion is warranted in these circumstances.

5 hours into the case, EBL is 4 liters. The patient was transfused 6U PRBCs, 6U FFP, and 1U PLTs. The surgeon tells you that the patient is oozing.

Should we transfuse Factor 7 or a Prothrombin Complex Concentrate or an Antifibrinolytic?

Yes:

The administration of recombinant Factor VII has only been shown to be an effective strategy in a few isolated circumstances, such as trauma, refractory GI bleeding, and possibly in the coagulopathy of liver
The over resuscitation of bleeding patients with blood products can lead to end organ damage, immune modulation, volume overload, and end organ dysfunction. Activated factors improve limit transfusion and in selected patients should be considered as part of a targeted resuscitation strategy.

No:

The administration of recombinant Factor VII has only been shown to be an effective strategy in a few isolated circumstances, such as trauma, refractory GI bleeding, and possibly in the coagulopathy of liver disease. However, studies do not support the routine use of Factor VII in “routine surgical oozing.” Rather, replacement of coagulation factors and transfusion of plasma and cryoprecipitate or platelets should be guided by lab data supporting coagulopathy or viscoelastic studies showing abnormalities in the clotting system. Recent studies looking at the off-label use of recombinant Factor VII have not shown a mortality difference. Other studies looking at anti-fibrinolytic agents such as aprotinin, TXA, or epsilon aminocaproic acid have not shown a difference in the amount of RBC’s transfused or mortality beyond a small subset of patients, for example, orthopedic total joint surgery patients. Other studies have noted a significant increase in the prothrombotic complications associated with these drugs.
Adductor Canal Block

**Objectives**
- Review anatomy of adductor canal
- Follow evolution of adductor canal block
- Understand anatomic and practical factors that lead to optimal blockade of the femoral/saphenous

**The Case for the Adductor Canal**
- Good Analgesia for TKA, ACL, medial malleolus
  - At UCH: has replaced inguinal crease for TKA, ACL and any distal saphenous blocks for Ankle/foot ORIF
- Vastly reduced Quad motor loss vs. inguinal crease
  - Fewer falls
  - Better participation in Physical Therapy POD0, POD1
  - Surgeons like them (relatively speaking)
- Reliable surgical block (w/pop-sciatic) for ORIF ankle
  - Likely prolonged local anesthetic exposure to the nerve, thanks to borders of adductor canal

**History**
- Saphenous nerve block has had a inconsistent success rate in the non ultrasound era
- Historical techniques include infiltration along tibial tuberosity in upper leg and adjacent to medial malleolus in distal leg
- Reported success rates for blind infiltration along anatomic path reported from 10-70%
- Improved success reported with nerve stimulation guided approaches despite being a pure sensory nerve

**Anatomy**
- Saphenous Nerve is a pure sensory branch from posterior division of the Femoral Nerve
  - Courses beneath the Sartorius muscle and passes through the Adductor Canal in its entirety
  - Exits in the distal portion of the adductor canal after piercing the Adductor membrane at the Adductor H hiatus
- After leaving the Adductor Canal passes between the Sartorius and Gracilis Muscles alongside the saphenous branch of the descending geniculate artery
- Travels along the Greater Saphenous Vein as it courses toward the lower leg and the area of the medial malleolus
Block approach

- **Position:** Supine, leg externally rotated
- **Probe placement:** Half way between inguinal ligament and patellar tendon, transverse to femoral artery. 2-5cm deep.
  - See femur? You are too lateral, scan medial!
- **Landmark:** Superficial femoral artery
- **Needle placement:**
  - Recommend echogenic needle >5cm length
  - In plane – lateral to medial

Approach/View


US Views

US views

Block approach, cont.

- **How do I know if the block will work?**
- Local anesthetic spread should push artery away and obscure contents of canal
- If sartorius is pushed up or vastus medialis is pushed away, you are still in the muscle plane!

Complications/Thoughts

- Cephalad spread is possible (weak quad!)
- Strong pressure on US probe may occlude veins ...don’t put your needle in there!
- Frequent aspiration is important!
  - Consider epinephrine “test-dose” (75mcg in 30mL)
- Consider adjuncts, due to shorter duration
  - Clonidine (preservative-free) 100mcg
  - Dexamethasone (preservative-free) 4mg
**Conclusion**

- Adductor Canal Block is still in evolution
- Motor sparing effects seem to exist despite use of large volumes and proximal approaches

**Three Pearls: Adductor Canal**

- Less Quad Weakness
- US Probe Halfway between inguinal ligament and patella
- Local anesthetic spread should push artery away
Anatomy of Brachial Plexus

The brachial plexus is divided into Roots, Trunks, Divisions, Cords, and Branches.

ANATOMY

- The Brachial Plexus is made up of anterior primary rami of C5, C6, C7, C8, and T1 with variable contributions from C4 and T2.
- After leaving their intervertebral foramina these nerves course between the anterior and middle scalene muscles.
- Between the scalene muscles the nerves unite to form three trunks. The superior (C5, C6), middle (C7), and inferior (C8 and T1).
**Interscalene Nerve Block**

- Principal indication for interscalene block is shoulder/proximal humerus surgery
- Also good for distal clavicle ORIF
- This block is typically not performed for forearm and hand surgery because the inferior trunk (C8—T1) is often incomplete

**Ultrasound guided Interscalene**

**Ultrasound Anatomy**

**Scan Medial to Lateral Or Inferior to Superior**

**Ultrasound Guided Interscalene**

**Ultrasound image of Interscalene**

- Yellow Arrows= Likely C5, C6a, C6b nerve roots
- Green Arrow= C7 nerve root
**Needle Placement**

- Find ideal Ultrasound view
  - depth 1-3cm
- In plane – Posterior to Anterior
- Go through Middle scalene muscle

**Medications for Interscalene**

- Typically 15-20 mL of 0.5% bupivacaine or 0.5% ropivacaine
  - Mass of drug is what matters
  - Many dose ranging studies have shown that only 5-10mL of local is required for maximal brachial plexus blockade
- Additives
  - Both alpha-2 agonists and steroids have shown to prolong this block when using Rop/Bup
  - 50-100mcg of clonidine
  - Data for dexamethasone may suggest that intravenous is comparable to perineural

**Complications of Interscalene**

- Ipsilateral phrenic nerve resulting in diaphragmatic paresis occurs in 100% of patients undergoing interscalene blockade
  - However, recent studies have shown decreased volumes may alleviate some of this blockade
  - This results in 25% reduction in pulmonary function
- b) The phrenic nerve is blocked because of its location overlying the anterior scalene muscle

**Complications, cont.**

- A cervical sympathetic block occurs frequently: (Horner’s syndrome)
  - a) miosis
  - b) anhydrosis
  - c) ptosis
  - d) vasodilation
  - Incidence is approximately 50% and always predictive of phrenic nerve blockade
- Recurrent laryngeal nerve block can occur resulting in hoarseness

**Three Pearls: Interscalene**

- Phrenic blockade: 100% (lower FRC)
- Find Trunks between scalene muscles
- See needle throughout! PTX is still a risk!
**Indications**
- lower leg, ankle, foot surgeries
- Analgesia following knee surgery - "posterior" pain

**Coverage**
- Sciatic nerve block results in anesthesia of the entire lower limb below the knee, both motor and sensory, with the exception of a variable strip of skin on the medial leg and foot, which is the territory of the saphenous nerve (femoral)

**Area of coverage**

**What is missed by the block?**
- Saphenous Nerve in Saphenous Neuralgia
The anatomy of the sciatic nerve as it approaches the popliteal fossa is quite variable, and the division into the tibial nerve (TN) and common peroneal nerve (CPN) occurs at a variable distance from the crease. Use of ultrasound allows for the reduction in the dose used since the injection can be halted once adequate spread is documented.

Patient Position - Can be done supine, prone or lateral
- I prefer supine with the leg elevated as it involves much less patient positioning.

In the popliteal crease with the probe oriented transversely, depth 3-4 cm. Should be superficial to popliteal artery.
- Note the image is 180° from "normal" orientation.

Slowly move the probe proximally until the TN and CPN merge to form the Sciatic Nerve.
Slowly slide the probe proximally and distally starting from the popliteal crease.
- Looking for two structures (TN & CPN) which merge as you move proximally and diverge as you move distally.

OK to inject around the CPN and TN as individual blocks.

I can see them distally, but lose them as I move proximally.

Start in the Popliteal crease, find popliteal artery.
- Tibial nerve sits superficial, scroll up until Common peroneal joins from lateral side.
- When you have found nerve, convince yourself that TN and CPN are coming together by scanning proximal and distal.

Three Pearls: Popliteal Sciatic

Looking for two structures (TN & CPN) which merge as you move proximally and diverge as you move distally.
**Supraclavicular Nerve Block**

**Anatomy**

- DO THIS WITH AN ULTRASOUND
- Blocks plexus at the divisions
- Hits arms more distally than interscalene
- Here, brachial plexus is LATERAL to the subclavian
- Bad Stuff: Big veins, and lung!

**Supraclavicular**

- Here, trunks and divisions of the nerve travel closely, and blocking here results in a quick, reliable block.
- Blockade results in anesthesia to the arm below the shoulder
- Does not hit intercostobrachial nerve (upper medial arm)

**Supraclavicular Nerve Block**

- **Position:** Supine, Head of bed 30 degrees
- **Probe placement:** above clavicle, almost looking behind it
  - Depth 2-3cm usually
  - Best view is with easily visible first rib
    - Hard white line below subclavian artery
- **Needle placement:** Lateral to medial
  - With good visualization ➔ advance
Supraventricular Nerve Block
Approach

Supraventricular Nerve Block
Images and Anatomy

Potential complications
- Pneumothorax
- If performed incorrectly: Ulnar sparing
- Picking the wrong block (not for shoulder surgery)
- Phrenic paralysis (around 50%)

Tips for Success
- Watch your plane- aim down, not across
- If you are lost, go back to interscalene
- Make the anatomy work for you
- You can sometimes abduct the arm to help
- Pleura is shiny and moves

US View

Where to hit it?
- Not in the lung
- Not in the nerve
- Around it
- No perfect spot
- Can spare ulnar nerve if injection is too superficial or lateral
Three Pearls: Supraclavicular

- Maintain needle view at all times, PTX still happens with Ultrasound!
- Too superficial or lateral block placement may spare ulnar nerve
- Phrenic blockade 50%

[Image: Pleura is easy to see...](http://med.dartmouth Hitchcock.org/images/supraclavic_fig4_full.jpg)
Ultrasound Vascular Access

- Brief overview
- Static and Dynamic technique
- ASA Guidelines for CVC placement
- Central Venous Catheterization:
  - Internal Jugular
  - Peripheral IV Placement
  - Arterial line placement

Complications:
- Pneumothorax
- Hemothorax
- Chylothorax – Thoracic duct injury (left only)
- Arterial cannulation/dilation

Other Patient-centered issues:
- Multiple previous lines, ESRD, Vascular disease, deep venous thrombosis, etc...

Guidelines:
- ASA Practice Guidelines for Central Venous Access (2012)

Why???

- Much like Regional Anesthesia:
  - In experienced hands, the most desirable technique may be the one in which the user has the highest comfort level
  - Maybe US won’t always be your first choice, but it can cut down on duration/frustration!
  - Guidelines may become more stout; some hospitals/systems already require US guided central access (IJ and Femoral)

Two Techniques

- Static
  - Used as mapping technique prior to procedure
  - “Take a look” ...then cannulate blind.
  - Patient should already be in final position
  - Gives an idea of depth/angle/anomalies/clots

- Dynamic – preferred technique at CU
  - Used “real-time” to watch needle enter vessel
  - Also can visualize wire in vessel
  - May require sterile U/S probe

Further Considerations

- Internal Jugular
  - Higher first insertion attempt success rate (A1)
  - Reduced access time (A1)
  - Higher successful cannulation rate (A2)
  - Decreased rate of arterial puncture (A1)
  - Fewer insertion attempts (A2)
Dynamic Ultrasound vs. Anatomic

- "The consultants agree and the ASA members are equivocal that, when available, real time ultrasound should be used for guidance during venous access when either the internal jugular or femoral veins are selected for cannulation."
- Subclavian – Both are equivocal

U/S Guided Vascular Access

- Central Venous Catheterization:
  - Internal Jugular
  - Subclavian
  - Femoral
  - Peripheral IV Placement
  - Arterial line placement

Internal Jugular

- Position – T’burg, head away
- prep/drape as per usual
- Ultrasound w/ sterile drape
- Identify Internal Jugular and Carotid
  - Jugular is superficial/lateral and COMPRESSIBLE
  - Carotid typically deep/medial and PULSATILE
  - Watch for External jugular
    - Going through the EJ is poor form, and a hematoma

Internal Jugular

- Needle placement:
  - Out of plane – 45 degree angle, to appropriate depth with constant aspiration, until flash with free-flow
  - Confirm venous access (Blood gas, Transduce, U/S)
  - Seldinger technique for placement
Hey, I can see it, how can I screw it up now?

**Plenty of ways! Complications will still exist**

- Through and through into carotid
- Dissect wall of Internal jugular
- No Man’s land (mediastinum, pleura, SubQ)

- Must always have free flow of VENOUS blood
- If you can’t aspirate and the patient still has blood, you’re most likely not in.
- Confirm VENOUS access prior to dilation!

**Peripheral IV access**

- Excellent for many situations:
  - Need for quick, large bore access
  - Patients with poor access (IVDA, Obesity, etc.)
  - Patients with good veins are good practice!
  - May be used in plane or out of plane
- Look for superficial compressible vessels
  - AC fossa and deep brachial veins are great
  - Don’t forget Saphenous, too!
- **USE LONG IV CATHETERS!**
  - Short catheters may go in and then pop out easily
  - Seldinger technique (over wire) may also help

**Arterial line**

- Excellent for easy or difficult access!
  - Radial, brachial, axillary
  - Dorsalis pedis, posterior tibial, femoral
- The more superficial, often easier
  - In high infection areas (Ax, Fem): aseptic
  - In plane or out of plane
  - Long catheters for proximal A-lines!!!
  - Seldinger technique (over wire) also helps
What do we practice at CU?

- Central Venous Catheterization
  - Internal Jugular – ALL placed under U/S guidance
  - Subclavian – Placed blindly
  - Femoral – Placed under U/S guidance
- Peripheral IV
  - For difficult IV access – known (will go straight to US), or unknown (after multiple attempts)
- Arterial line
  - Most placed blindly - U/S for difficult placement
  - U/S for most lines proximal to Radial or DP

Three Pearls: Vascular Access

- Position is still just as important!
- Ultrasound should be used for IJ placement
- Deep brachial veins are excellent access in difficult access patients
Wednesday, March 2
The Patient with Heart Failure

Determinants of Cardiac Function
- The physiologic milieu
  - acidosis, hypoxaemia, hypercarbia, K+
- Heart rate and rhythm
  - tachyarrhythmias, bradyarrhythmias
- Ventricular preload (filling)
  - inadequate or excessive
- Ventricular contractility (inotropy)
  - inadequate or excessive
- Ventricular afterload (resistance)
  - elevated or pathologically low

The Vicious Cycle of Left Ventricular Ischemia
- Acute ischemia / infarction
- Reperfusion injury
- Stunned myocardium
- Hibernating myocardium
- End-stage heart disease

54 yr-old man
Chronic ischemic cardiomyopathy
Grade III CHF, preoperative EF 35-40%
Undergoes AVR + CABG

Difficulty coming off CPB:
- HR 118/min
- BP 86 / 39
- CVP 8-10 mmHg
- PAOP 35 mmHg
- TEE: LVEF 15%
A Hemodynamic Algorithm for the LV
- Stabilize Milieu (ABG)
- Control Rate & Rhythm
- Optimize Preload
- Enhance Contractility
- Decrease Excessive SVR
- Increase Inadequate SVR

Pulmonary Artery Catheter: LV Indices
- Thermodilution CO / CI
- SVR = (MAP - RAP) / CO
- Mixed venous saturation (SvO₂)

Inotropic Agents
- Beta-adrenergic agonists
- Phosphodiesterase III inhibitors

Inotropic Agents
- Beta-adrenergic agonists
- Phosphodiesterase III inhibitors

Beta-Receptor Effects
- Inotropy
- Chronotropy
- Dromotropy
- Bathmotropy

Inoconstrictors
- Inotropy + α₁-adrenergic vasoconstriction

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Inodilators
- Inotropy + β₂-adrenergic vasodilation

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<td>Isoproterenol</td>
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Beta-Receptor Downregulation
- Normal
- CHF

PDE-III Inhibitors
- Milrinone

* G Sarclemma
- ATP → cAMP → PKa → AMP → PDE III inhibitor → Ca²⁺
**Inodilation**

![Graph showing inodilation with comparison to Dobutamine and Milrinone](image)

**Milrinone Pharmacokinetics**


- 50 μg/kg
- 0.5 μg/kg/min
- 60 min

**Milrinone in Renal Failure**

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<tr>
<td>30</td>
<td>0.33</td>
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<td>20</td>
<td>0.28</td>
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<td>10</td>
<td>0.23</td>
</tr>
<tr>
<td>5</td>
<td>0.2</td>
</tr>
</tbody>
</table>

**Combination Therapy**


- Milrinone 0.125 - 0.5 mcg/kg/min
- Dobutamine 1 - 5 mcg/kg/min
- Vasopressor!

**Combination Therapy**

- Milrinone 0.125 - 0.5 mcg/kg/min
- Epinephrine 1 - 5 mcg/min
- Less Vasopressor!

**RV Failure**

- TAPSE: tricuspid annular plane systolic excursion

**Pulmonary Artery Catheter: RV Indices**

- Transpulmonary Gradient (TPG) = mPAP - PAOP
- PVR = (mPAP - PAOP) / CO
- SVR = (MAP - RAP) / CO
- SVR / PVR

**Cardiac Fibre Orientation**

Buckberg G et al. *J Thorac Cardiovasc Surg* 2014; 148:3166-71

- RV free wall: transverse fibers, bellows action (20% of RV output)
- RV septum: oblique fibers, shared with LV, shortening (TAPSE) (80% of RV output)
LV and RV Interdependence

- Systolic ventricular interaction
  - LV septal contraction augments RV output
- Progressive LV failure
  - increasing PAOP, PAP and RV afterload
  - increasing RV septal dependence
  - impaired septal contraction
  - increasing impact of PVR on RVEF
- Progressive RV failure


The Vicious Cycle of RV and LV Interdependence

- RAP ⊖ RVEDP / D ⊖ PVR ⊖ LV Filling ⊗ Septal shift ⊗ RVF
- Cardiogenic Shock

Decrease Excessive PVR

- Remove exacerbating factors
  - hypoxemia, hypercarbia, acidosis
  - excess catecholamines
- Administer pulmonary vasodilators
  - dobutamine, milrinone
  - inhaled nitric oxide, prostacycline

Endothelium
- L-arginine → NO → cGMP → sGC
- L-citrulline
- NO Inactivation
- TNF-alpha, Interferon-gamma

Acute Elevation in PVR

- Hypoxaemia, hypercarbia, acidosis
- Catecholamines (endogenous or exogenous)
- Cardiopulmonary bypass (CPB)
  - inflammation, bronchial I/R injury
- Protamine infusion
- Blood transfusion
- Acute lung injury (ARDS, TRALI, TACO)

A Hemodynamic Algorithm for the RV

- Stabilize Milieu
- Control Rate & Rhythm
- Optimize Preload
- Enhance Contractility
- Decrease Excessive PVR

Benefits of Inhaled NO

- PVR ⊗ LV Filling ⊗
- CVP ⊗
- CPP =
- RVEF ⊗

NO Inactivation

- Affinity of NO for Hb is 1500 x > CO

Optimize Preload
Enhance Contractility
Decrease Excessive PVR
Stabilize Milieu
Control Rate & Rhythm
Optimize Preload
**Inhaled Prostacyclins**

- **PGI₂ - Epoprostenol**
  - 12.5 - 50 ng / kg / min
- **Iloprost**
  - 2.5 - 5 mcg q2-4hr

**Do not use inhaled pulmonary vasodilators in isolated LV failure!**

**Comprehensive Therapy**

<table>
<thead>
<tr>
<th>Drug</th>
<th>Dose</th>
</tr>
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<tbody>
<tr>
<td>Milrinone</td>
<td>0.125 - 0.5 mcg/kg/min</td>
</tr>
<tr>
<td>Dobutamine</td>
<td>1-5 mcg/kg/min</td>
</tr>
<tr>
<td>Norepinephrine</td>
<td>1 - 8 mcg/min</td>
</tr>
<tr>
<td>AVP</td>
<td>1 - 4 u/hr</td>
</tr>
<tr>
<td>Inhaled NO</td>
<td>1 - 20 ppm</td>
</tr>
<tr>
<td>Iloprost</td>
<td>2.5-5 mcg q2-4 hr</td>
</tr>
</tbody>
</table>

**Determinants of Cardiac Function**

- The physiologic milieu
- Heart rate and rhythm
- Ventricular preload (filling)
- Ventricular contractility (inotropy)
- Ventricular afterload (resistance)

**54-yr-old man**

Postoperative cardiogenic shock

- In OR: IABP then VA-ECMO
- ICU day 6: CentriMag BiVAD
  - VA-ECMO, IABP d/c
- ICU day 24: HeartMate II LVAD
  - CentriMag RVAD d/c
- ICU day 37: Discharged home with LVAD
- 6 months later: Heart transplant
- 1 year later: Doing well

rs543@cumc.columbia.edu
The Silver Tsunami: Are You Prepared?

Stacy L. Fairbanks, MD
Assistant Professor of Anesthesiology
University of Colorado Denver
CRASH 2016
3/2/2015

Disclosures: NONE

Objectives

• Better understand the “geriatric imperative.”
• Review basic physiology of the aging patient
• Review the current data for anesthesia in hip fracture patients and how we can impact outcomes.

What is the Silver Tsunami?

• 1950-2005: 8-12% increase in Seniors
• 2013: 13% of population (40 million)
• 2011-2030: Baby boomers!!!
• “Old” old is fastest growing:
  – 2010: 5 mil over 85
  – 2050: 21 million!

Geriatric Imperative’s Healthcare Impact

• ≥65 year olds made up 13% of the population in 2013, but
  – 25% of medications
  – 33% of hospital admissions
  – 44% of hospital bed days
  – Majority of nursing home beds

What will happen in 2030 when % of population doubles?!?!?

The Effects of Time . . .

Weight

The Effects of Time . . . Body Composition

<table>
<thead>
<tr>
<th>Age 25</th>
<th>Age 70</th>
</tr>
</thead>
<tbody>
<tr>
<td>Other</td>
<td>Other</td>
</tr>
<tr>
<td>Bone</td>
<td>Bone</td>
</tr>
<tr>
<td>Cell Mass</td>
<td>Cell Mass</td>
</tr>
<tr>
<td>Fat</td>
<td>Fat</td>
</tr>
</tbody>
</table>

Data from US Census Bureau
Physiologic Decline with Aging

CNS Changes

- Decrease in number of nerve cells in the CNS
- Accumulation of metabolic products that may play a role in increased sensitivity to sedatives
- Decreased dopamine and increased muscular rigidity
- Increased reaction time
- Increased risk for postoperative delirium
- Decrease in MAC (6% per decade after age 40)

Musculoskeletal System

- Osteoarthritis
- Osteopenia

Renal System

- GFR decreased 30-46%
- Not always manifested in creatinine (dependent on muscle mass and body weight)
- Decreased renal plasma flow by about 50%

Pulmonary System

- Loss of elastic recoil and collagen matrix (increased compliance)
- Prolonged expiratory phase, decreased maximal expiratory flow
- Decreased diffusion capacity
- Increased dead space
- Decreased FRC
- Increased alveolar-arterial gradient (A-a)
- Increased work of breathing

Cardiovascular System

- Maintenance of resting LV function
- Less cardiomyocytes \implies less myocardial contractility
- Decreased response to beta-receptor stimulation \implies lower max heart rate (requires compensatory increase in stroke volume to increase CO)
- Increased vessel stiffness \implies higher systolic pressure and increased LV afterload.
- Decreased VO2 Max

Summary of Physiologic Changes

Loss of functional reserve capacity

Loss of ability to compensate in the face of stress

Surgery=Stress

When Should We be Operating?

Predictors of Mortality in Elderly Patients With an Intertrochanteric or a Femoral Neck Fracture

The effect of early surgery after hip fracture on 1-year mortality

When Should We be Operating?

Meta-analysis of 16 observational studies

Delays >48 hours associated with increase in 30-day mortality and 1-year mortality

Hip Fractures in the Elderly

1-year mortality is estimated to be 14-58%

Most studies on morbidity/mortality done in Scandinavia

In US: White men most likely to die

Morbidity

Loss of independence

$$$$$$$

Jacobsen SJ et al. Race and sex differences in mortality following fracture of the hip.

Comparative Effectiveness of Regional versus General Anesthesia for Hip Fracture Surgery in Adults

2012 Retrospective cohort of 18,000 hip fracture surgery patients in NY state.

Lower odds of in-hospital mortality & pulmonary complications with regional anesthesia.

2014 AAOS: “Doesn’t Matter!”

2014 UK/Ireland Anesthesia Association: “Try to do neuraxial!”
Mode of Anesthesia in Hip Fracture: Does it Matter?

- Clinical/administrative databases lack specific info—type of block, amount of sedation, or meds used for GETA.
- Outcomes are also limited—no patient centered outcomes.

REGAIN

- Regional vs. General Anesthesia for Promoting Independence after Hip Fracture Surgery
- University Pennsylvania, Enrollment Spring ‘16
- 1600 patient multicenter randomized trial
- Primary outcome: Recovery of ambulation
- Secondary outcomes: Chronic pain, ability to return to prefracture residence, overall health, cognitive function

Hip Fractures in the Elderly

- Denmark 1977-2001
- >169,000 fracture cases compared with >500,000 controls followed for 20 years.
- Excess mortality of 19% within first year and then 1.8% per year for every additional year following the fracture.
- Major causes longitudinally were due to complications to the fracture event, not premorbid conditions

Hip Fractures in the Elderly

- Retrospective study; 2009-2013; patients with proximal femoral fracture
- follow-up for at least 1 year
- 115 patients after exclusions
- Things relating to mortality: type of surgery—THAs & hemiarthroplasty mortality >60% vs 24% in proximal femoral nail

Hip Fractures in the Elderly

- 114 patients age 65+ undergoing hip fracture repair with SAB and propofol.
- Excluded severe dementia and preop delirium
- BIS of ~50 for deep sedation group, BIS of 8+ for light sedation group. Standardized postop analgesia.
- Prevalence and mean days of delirium significantly greater in deep sedation group.

Controversies in anaesthesia for noncardiac surgery in older adults

- 2015 Review of most recent hip fracture data
- Reviews info and risk factors of postop delirium
- Discusses frailty & impact on outcome
Offsite Anesthesia for Cardiac Procedures
From EP to the Cath Lab

Dan Beck, M.D., M.S.
Assistant Professor
University of Colorado
VA Eastern Colorado Health Care

Objectives
- Understand history and future role procedures
- Overview of procedures
- Understand challenges in cardiac lab
- Identify our role in cardiac interventions
- Discuss anesthetic risks related to EP/Cath
- Case Discussions and Complications

What do they do up there?

Cath Lab
- Diagnostic Cath
- STEMI
- PCI
- Peripheral angio – stents
- IABP
- Percutaneous Assist Device
- PFO/ASD closure
- Perc Valve – TAVI, Mitraclip
- LAA occlusion

EP LAB
- EP studies – mapping
- Atrial and Ventricular ablation
- Pacemakers, ICD, BIV
- Generator Change
- Cardioversion
- Lead Extraction

History

<table>
<thead>
<tr>
<th>Year</th>
<th>Event</th>
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</thead>
<tbody>
<tr>
<td>1967</td>
<td>Intracardiac stimulation and mapping</td>
</tr>
<tr>
<td>1970s</td>
<td>Surgical approaches to arrhythmia control</td>
</tr>
<tr>
<td>1976</td>
<td>First Non-surgical ASD closure</td>
</tr>
<tr>
<td>1980</td>
<td>First Non-surgical AVR</td>
</tr>
<tr>
<td>1986</td>
<td>ICD</td>
</tr>
<tr>
<td>1991</td>
<td>First coronary stent</td>
</tr>
<tr>
<td>2002</td>
<td>First DES</td>
</tr>
<tr>
<td>2003</td>
<td>First Non-surgical AVR</td>
</tr>
</tbody>
</table>

Future Trends
- Over 5 million people have heart failure
- Expected to grow 5 fold in 20 years
- Increasing numbers using implanted devices
- CRT devices reduce hospitalization 50%
- Medical Care extending lifespan
- 25% increase in EP procedures last 10 yrs
- You will treat these patients somewhere

Technological advances
New Technology

Advanced Technology
- More Complex Procedures
- Often longer procedures
- New procedures = unknown complications

Too Sick for Surgery?
- Lower Risk in Cath lab???
- High risk for sedation!!

Welcome to the Cath Lab

Unique Environment

- Physical Limitations
- Cultural and political obstacles
- OR pressures and Cath lab pressures
- Communication between staff
- Fluoro - Mobile and unique imaging
  - ICE, IVUS, FFR

Physical Environment

- Set up for convenience of the proceduralist
- Limited Space
- Moving Equipment
- Poor access to Patient
- Remote Location
  - Transport to OR can be time consuming
  - Help can be very far away
  - Typical resources not available

Room Layout

- Window to control room
- Monitoring screen
- Defibrillator Ablation Unit
- Procedural table
- Anesthesia Machine
- Anesthesia Monitors and cart
- Card
- Patient

Practice models 2010s

- ~2/3 of centers use a mix of anesthesia providers (team MD or CRNA model) and RN sedation
- 1/3 exclusively anesthesia or RN sedation
- ¼ responded anesthesia was warranted >50% of time regardless of availability
- Frequent reasons for RN sedation alone
  - Unavailability of anesthesia services
  - Difficulty in scheduling
  - Prolonged OR turnover times
**Cultural differences vs the OR**

- Cardiologist is a medical director
  - Used to working with RN, techs who take orders
  - Not used to working with another MD
- May not know full skill set of anesthesiologist
  - May think sedation is our only role in their procedure
- Roles and responsibilities of care unclear
  - Hemodynamics, oxygenation, patient position
- Lack of communication leads to conflict and poor overall patient care

**Cultural Obstacles**

- Rationale for requesting anesthesia presence
  - High risk patient
  - High risk procedure
- May assume our presence allows them to do everything exactly as they normally would
  - Location - OR vs lab vs hybrid OR
  - Appropriate Anesthetic - sedation vs controlled airway
  - Drug of choice ("Just give some propofol")
- Not experts in high risk patient anesthesia
  - You are, that’s why they consulted you!

**Recognize the Home Team’s Skill**

- Cardiovascular knowledge
- Internal medicine background
- Procedural ability
  - Vascular access, echo, temp pacing wires, IABP
- Lab ancillary staff
  - ABGs, mixing gtt, getting supplies
  - Navigating the foreign environment
  - Calling for help

**OR pressure vs Cath/EP lab needs**

- Surgeons have block time, elective needs are fixed on a week to week basis
- Offsite locations create staffing challenges
  - Running 1 room all day remote offsite
  - 1-4 rooms in OR
  - Varies based on hospital layout
- Cath/EP lab are high volume, fast turnover
  - More daytime unscheduled cases
  - Unpredictable needs for anesthesia

**Who are these patients?**

- CAD and arrhythmia
- Dementia
- PTSD
- CVA
- Obesity; OSA; difficult airway
- Obstructive and restrictive lung disease
- Low EF with accompanying sequelae
- Renal Insufficiency
- Hepatic Insufficiency
- Diabetes and other metabolic syndromes

**What the patients and proceduralists bring to the table?**

- Histories and comorbidities
- Uncommon medications
  - Unique to EP patients
- Interventionalists are “surgeons of medicine”
  - Narrow focus, may not be aware of all history
  - Urgent or emergent procedures may prevent thorough H&P
Unique Procedures

Electrophysiology Studies
• Mapping studies using stimulation and response
• Multiple catheters in heart
• Induced and spontaneous arrhythmias
• Isolate arrhythmia circuit
• Endocardial - venous access
• Epicardial - pericardial sheath

Intra-procedural approach
• Pre-procedural TTE or TEE
• Access via groin
  – Venous only for right sided procedures
  – Trans-septal puncture for Left sided procedures
    • Anticoagulation, ACT, protamine reversal
  – Intraprocedural imaging
    • Fluro, ICE, TEE guided
• Mapping may take hours
  – Isolating arrhythmia focus or pathways

Electrophysiology studies
• Pre-procedural workups
  – H&P, TTE, Right/left heart cath
  – Anti-coagulation status
• Monitors – Standard ASA monitors
  – Defibrillator pads
  – Radiolucent 12 lead ECG
• Supine position on fluoro table with C-arm
• Intra-procedural anesthetic needs
  – MAC vs GETA

EP mapping studies
• Catheter placement
  – High right atrium
  – RV apex
  – Adjacent to His bundle – tricuspid annulus
  – Coronary sinus catheters
• Allows pacing-recording ability to map and detect abnormal conduction pathways
• Catecholamine infusions to help incite arrhythmia
• Confirms diagnosis prior to intervention

Anesthetic Drugs
• Commonly assumed anesthetic drugs influence cardiac conduction and myocardial refractoriness
  – Inhalational, IV agents, NMB, opioids, and anticholinergics may all have effects
• Volatile anesthetics
  – Isofuron/Sevoflurane
    • AV nodal conduction unchanged, His-purkinje slowed
• Rocuronium most free of CV side effects
• Opioids can have vagolytic effects
• Propofol may alter HR in either direction
• All agents may lower SVR and cause reflex tachycardia

RF Ablation
• Localized burn similar to electrocautery
• Power and length of burn determines depth
• Catheter size, irrigated and cooled catheters
  – Irrigated catheters add volume to circulation
• Risks: steam pops, clotting, deep burns
  – Monitor patient for 20-30 minutes during waiting period
• Post RF study – try to stimulate arrhythmia or test timing of pathway
ICD or PPM

- Vascular access
  - Usually Left subclavian
- Pocket formation under LA
- Wire placement
  - Can be lengthy – searching for ideal place
  - Wire burrowed/screwed into myocardium
- ICD Device Testing - Cardioversion
  - R on T induced VF
  - Device defibrillates ..... hopefully

EP Challenges

- Prolonged procedure
  - 4+ hours of MAC with little stimulation
  - Initial studies may request no sedation
- PPM or ICD placement may request no NMB
  - Detect phrenic nerve stimulation from pacing

Common Complications

- Vascular access issues
- Unstable arrhythmias
- Complete heart block requiring PPM
- Cardiac perforation and tamponade
- Left side procedures
  - Pulmonary vein stenosis
  - Atrio-esophageal fistulas
  - stroke

Lead Extractions

- ICD or PPM lead removal
  - Endocarditis
  - Lead failure/multiple lead replacements
- Traction removal vs laser or mechanical extraction
  - Adhesions to great veins
  - Intramyocardial adhesions
  - Myocardial injury-perforation

Lead Extraction Preparedness

- Pre-procedural
  - IV access
  - Arterial line
  - Blood bank
- Systems based planning
  - Surgical backup
  - Perfusionist backup
  - OR availability

Procedure and Disposition

- GETA
- TEE guidance
  - Anesthesia or cardiology
  - Lead position pre-extraction
  - Presence of effusions
- ICU Monitoring
- Post-op TTE if concerns
  - Pericardial effusions
Clear Communication is Key

- Discuss with the proceduralist
  - What exactly is he going to be doing?
  - Length of procedure
  - Points of potential instability
    - Plan for those events
  - Patient specific risk factors
  - Do we need/have surgical backup?
- Ongoing communication
  - Listen via headset and communicate often

Airway Emergencies

- ~40% of cases require airway adjuncts or interventions
- Physical access to airway limited

Case Discussion

- 68 yo M with SVT resulting in syncope, fall with facial fractures repaired in OR, jaw wired shut presents for EP mapping and ablation
  - MAC with remifentanil and propofol
- IV kink results in drug delivery backup
- Kink discovered and adjusted - patient received bolus of both agents
- Apnea ensued

Case continued

- Anesthesia team (CRNA/MD) unable to mask ventilate
- Wire cutters not immediately available
- Call for help
- Emergency cricothyrotomy to establish definitive airway

Too Sick for Surgery?

- New or unfamiliar procedures
- Need for unusual approaches and equipment
- Unanticipated course of procedure
- Excellent communication is obligatory

Anesthetic Plan

- Proceduralist doesn’t dictate your anesthetic
  - Understand physiologic needs of the procedure
- Assess your patient’s medical needs and ability to tolerate the procedures
- Tailor your plan to your environment
  - Access to airway mid procedure
  - Availability of surgical and OR backup
  - Communicate, communicate, communicate
Equipment

• If you even think about needing it, bring it
• Consider airway adjuvants
  — Multiple blades, video laryngoscope, FOB
• Special drugs, gtts, pumps, tubing
• Ultrasounds, TEE, central lines
• Plan for space limitations
• Understand what equipment your offsite location has — it is a cardiology suite

Anesthesia Personnel safety

• Moving equipment
  — Pay attention, keep your eyes open
• Radiation safety
  — Lead aprons, lead shield, eye protection
  — Radiation dosimeter
  — Radiation scatter and inverse square law
  — Time, barriers, and distance

Summary

• Understand the procedures, risks, pitfalls
• Communication and planning are key
• Clearly delineate patient care roles
• Understand your environment and plan for it
• Use your anesthetic knowledge to create the proper plan for your patient
• Be ready for everything
Non Operating Room Anesthesia: Perils, Pitfalls and Systems

Gina Whitney, MD
March 2016

Objectives
- Review regulatory requirements for anesthesia in a remote location
- What are the challenges of providing anesthesia in these locations?
  - Patient
  - Procedure
  - Systems
- Review systemic challenges to provision of high quality anesthesia in challenging environments
- Discuss common approaches to improving safety and quality of anesthesia care in remote locations.

ASA Closed Claims Database
- 8496 closed claim database cases 1990-2010
- Excluded OB, chronic pain and acute pain cases
- 87 remote anesthesia locations / 3287 OR cases
- Remote cases:
  - Patients were sicker, case more likely to be emergent
  - MAC 50% in remote locations vs. 6% in OR
  - Where do they occur?
    - 32% GI suite
    - 25% cardiac cath / EP
    - Other claims: INT, OR, radiology

Remote Location v. Operating Room

<table>
<thead>
<tr>
<th>Event</th>
<th>Remote Location</th>
<th>Operating Room</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mortality</td>
<td>54%</td>
<td>29%</td>
</tr>
<tr>
<td>Respiratory/ Airway Events</td>
<td>48%</td>
<td>20%</td>
</tr>
<tr>
<td>Inadequate Oxygenation/Ventilation</td>
<td>23%</td>
<td>3%</td>
</tr>
<tr>
<td>Care Determined to be “Substandard”</td>
<td>54%</td>
<td>17%</td>
</tr>
<tr>
<td>Event Preventable with Better Monitoring</td>
<td>32%</td>
<td>8%</td>
</tr>
<tr>
<td>Median claim</td>
<td>$330,000</td>
<td>$110,000</td>
</tr>
</tbody>
</table>

Respiratory Depression and Oversedation
- 30% respiratory depressions due to sedation
  - >50% of GI suite cases
  - 70% of radiology cases
- Only 15% of these cases used capnography
- 92% of cases resulted in death or severe hypoxic brain injury
- 75% of these claims results in payment to the plaintiff
- Median payment of $460,000

Metzner, J.L. Risks of Anesthesia in Remote Locations. ASA Newsletter. Volume 74, Number 2. February 2010
## Remote Anesthesia: What *doesn’t* change?

- Standards of anesthetic care
- Patient monitoring standards
- Equipment maintenance standards

_Easier said than done._

## ASA Recommendations

- Reliable oxygen source
- Available suction
- Gas scavenging system and anesthesia machine
- Hand resuscitation bag
- Monitoring equipment
- Electrical outlets for emergency power supply
- Proper illumination of patient and work areas
- Adequate work space
- Means of two way communication
- Emergency cart / defibrillator
- Compliance of facility with building and regulatory codes

## Operating Room Safety

- Enhanced by standardization and reliability built into that environment
  - Protocols
  - Procedures
  - Experience level of staff / team
  - Familiarity with processes
  - Standard equipment
  - Regular schedule, less prone to frenzied preparation.

_We rely on process RELIABILITY and RIGOR to conduct safe anesthetics._

## Anticipating the Risks of Remote Anesthesia

- Sicker patients
- Procedural areas usually not designed with anesthesia in mind
- Support personnel not familiar with needs / process of anesthesia
- Padding of pressure points, positioning issues
- Variability in equipment, monitoring, and environment
- Less efficient and effective scheduling.
- Inadequate monitoring of stock
- Team with which the anesthesiologist is unfamiliar
- Help is farther away

## Engineering Safety in Remote Locations

- How to obtain ideal outcomes
  - NOT ONCE, but repeatedly, reliably
- Evaluating process steps upstream of the desired outcome
  - Defects rates determine reliability

LOW DEFECT RATES  RELIABILITY  LIKELIHOOD OF DESIRED OUTCOME

## Achieving Reliability in Perioperative Settings

- Guidelines for anesthetic monitoring
- Interoperability of anesthesiologists
  - Promotes consistency of anesthetic approach
  - Flexibility
- Commitment to learning / teamwork
- Collaborative approach to care
- Organizational leaders engaged in reliability through use of data
- Learning, just culture
Ongoing Learning

- Multi-disciplinary groups of care givers
- Identification and evaluation of suboptimal outcomes
  - Reporting culture
  - Learning from near-miss events
- Anesthesia input is essential.

Improving Systems Safety

- Reasonable system for evaluating near-miss and patient harm events
  - System flaws are not mis-identified as individual flaws
  - Willingness to report
- Just Culture algorithm for evaluating choices made by frontline providers

"Just Culture"

<table>
<thead>
<tr>
<th>HUMAN ERROR</th>
<th>AT RISK BEHAVIOR</th>
<th>RECKLESS BEHAVIOR</th>
</tr>
</thead>
<tbody>
<tr>
<td>Intentional Action</td>
<td>A chosen: Risk not recognised or thought to be justified</td>
<td></td>
</tr>
<tr>
<td>&quot;It could have been me...&quot;</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Manage through process change, training, system design</td>
<td>Manage by removing incentives for at risk behaviour, mentoring, increasing situational awareness</td>
<td>Manage with remedial or punitive action</td>
</tr>
<tr>
<td>Take care of the person who made the error &quot;second victim&quot;</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

The Usual Scenario Plays Out....

- Anesthesia
- Delay
- Nursing
- Proceduralist

Systems Safety in Practice

At my institution, we have a formal team briefing prior to Out of OR cases:

A. Always  
B. Most of the time  
C. Occasionally  
D. Never

Who leads this briefing?

A. Anesthesiologist Care Team member  
B. Surgeon / Proceduralist  
C. Nursing Staff  
D. Other
Improving System Safety - Briefing

- Implementations more successful when these are NOT run by physicians
  - In Out of OR locations, anesthesiologist may be most familiar with (and committed to OR processes, however...)
- Leadership engagement
- Every case – not just during crisis, high risk, etc.

Debriefing

At my institution, we perform a case debriefing at the case conclusion:

A. Always
B. Most of the Time
C. Some of the Time
D. Never

Debriefing

When a case debriefing is performed, who usually initiates and leads the process?

A. Anesthesiologist
B. Surgeon / Proceduralist
C. Nursing Staff
D. Other
E. What debriefing?

Improving Systems Safety

- Debriefing
  - Teamwork
  - Systems improvement – continual learning

  What did we do well?
  What could we have done better?

  Is there anything that we should do differently with the next patient?

Debriefing

- Local, structured conversation
- Takes less than 2 minutes
- Requires leadership support and expectation....

Communication

- Closed loop communication
- Critical Language
  - “Stopping the Line”
  - Great Catch
- Concerns which turn out to be incorrect should be an opportunity for learning

Simple concepts, difficult to implement
Leadership Engagement

- Meet regularly
- Identified liaison within anesthesiology to manage process improvement and service line collaboration
- Lack of leadership engagement shows up in deterioration of processes over time....

Challenges in Out of OR Anesthesia

CASE 1:
75 year old male, 100kg scheduled for ERCP under MAC
Monitoring included pulse oximetry, BP cuff, and ECG.
Incremental doses of midazolam (4mg), fentanyl (200 mcg) were given without adequate effect
Propofol 20 mg then 50-70 mg/kg/min
Saturations from 92% on 4L NC to 70%, ensuing bradycardia
Difficult and delayed resuscitation resulted in hypoxic brain injury.

At my institution

Sedation for endoscopic (ERCP) procedures is directed by
A. Proceduralist
B. Anesthesiologist
C. Other
D. I'm not sure

At my institution

GI Proceduralists are able to administer propofol for endoscopic procedures
A. Yes
B. ASA 1-2 patients only
C. No, propofol administration requires an anesthesiologist to be present

CASE 2 (coordinate with Dan Beck)

CASE 3 (coordinate with Dan Beck)
Case Presentations

- Case presentations—all anesthesiologist at some point will be involved in these cases
- Review some database
- Closed claims
- More cases

Is this just an academic problem

Survey from the community shows otherwise

Case 1

- Radiologist placed a PEG in IR with sedation for woman with a huge laryngeal mass
- Patient went apneic
- Anesthesia called late—can’t ventilate/can’t intubate. Sux was wearing off
- To OR for awake trach
Case 2
- 400 lbs patient arrives by ambulance to ED
- Combitube in place
- ER doc gives 10 mg of vecuronium-pulls Combitube
- Unable to intubate or ventilate
- Patient had old trach scar
- Anesthesia finally called-blood everywhere, can't visualize anything
- Cut neck at old scar of trach and placed ETT

Case 3
- Called to ED for restrained prisoner with bilateral mandibular and orbital fractures.
- Uncooperative, combative, bloody mouth from unknown source, spitting blood.
- Given ketamine-no help
- Proposal/sux-can't see anything due to blood
- Some air getting in with masking
- Placed intubating LMA-able to ventilate
- Placed ETT thru LMA balloon, placed small ETT
- Switched to larger tube with tube exchanger

Case 4
- Anesthesiologist to radiology to help with patient that was desaturation during MRI
- 80 yo was given fentanyl, versed and phenergan
- Narcan and flumazenil given-still obtunded
- Large mass was noted on neck-no one else noticed
- Patient decompensating-DL done
- Friable large tumor eating through VC, epiglottis and tongue, can't pass ETT
- Masked to OR for emergent trach

Case 5
- Called to floor for patient in respiratory distress
- Patient with traumatic brain injury
- Propofol given difficult to ventilate with mask
- DL done-piece of hot dog stick occluding VC
- Removed with McGills-improved
- Similar situation with other foreign bodies

Case 6
- 12 mo old in ED after sibling gave him a dog biscuit-in respiratory distress, desaturating
- ED had multiple failed intubation attempts
- Sux and roca given-difficult to mask-low sats
- Baby vomiting
- Anesthesia called-belly size of a volleyball
- Passed OG-suctioned stomach
- Easy mask to high 90's, easy DL and tube placement

Case 7
- Anesthesia called to COR 0
- Walked in room-blood everywhere
- Placed yankauer for suction, no help
- Kept yankauer going-boogie with hockey stick placed until felt tracheal rings
- Advanced boogie, placed ETT over
Case 8

- Called to GI-patient became apneic during EGD
- GI unable to ventilate or intubate
- Patient cyanotic and bloody
- Anesthesia goes to head of bed and asks "can we use her trach?"

Case 9

- GI accidentally extubated a known difficult airway patient
- ICU doc and RT tried to reintubate unsuccessfully
- ICU doc tries to FO intubate - unsuccessful
- Anesthesiology finally called
- Grade 2 view with glidescope but bloody
- Yankauer used to suction and placed accidentally through VC
- Passed 9 Fr cook exchange catheter through yankauer
- ETT placed over cook catheter

Emergent Intubations Outside the OR is a Predictor of Airway Complications

Limited Literature On This Topic

Failed Intubations

- 1 in 2000 in elective cases
- 1 in 300 in OB RSI
- Up to 1 in 50 in ED/ICU

Can't intubate Can't Ventilate (CICV)

- Fewer than 1 in 5000 in elective GA
- Requiring emergency surgical airway (ESA) less than 1 in 50,000 in OR cases
- In ED-CICV requiring ESA 1 in 200
Majority led to death or permanent neurological injury
- ICU 61%
- ED 31%
- OR 14%
- Failure to use capnography contributed to 74% of deaths or permanent neurological injury

Reports 8-12% difficult intubation in the emergent setting versus 5.8% during elective intubations in the OR.
- A 7-fold higher complication rate when encountering difficult airways outside the OR

In two thirds of the claims where an airway emergency occurred a surgical airway was obtained but it was too late to avoid a bad outcome
- A surgical airway to be a successful option it must be instituted early
- Prompt action has been shown to save lives

Unique inherent challenges outside the OR
- Providers often must act quickly
- Providers are unfamiliar with the patient
- Limited time for assessment
- Lack of resources-equipment and training

Patients are usually hypoxic
- Hemodynamically unstable
- Full Stomachs
- Lacking optimal resuscitation equipment

Aspiration 2-4%
- Esophageal intubation 1.6-9%
- Oropharyngeal trauma 0.5-7%
- Higher complications in training centers
Anesthesiologist Calls for Emergent Airways

- ICU ~60%
- Floor ~39%
- ED ~1%, most manage airways themselves and ONLY call anesthesia when too late!!!

Reasons

- Respiratory distress alone ~52%
- Cardiac arrest ~45%
- Airway protection ~2%
- Other ~2%

Drugs

- Induction agents- Etomidate 57%, Propofol 18%
- Muscle relaxant used in 72% with succinylcholine 60%

Equipment Used

- DL
- LMA
- Light Wand
- Bougie
- Video assisted laryngoscope
- Fiberoptic-awake or asleep
- Retrograde wire
- Surgical airway

Self Extubation

- Hemodynamic instability
- Multiple attempts at reintubation due to difficulties
- Significant morbidity and mortality

Aspiration

- More frequent on floor than ICU
- NPO status-most full stomachs
- Equipment available-suction, resuscitation equipment and oxygen
- Training of staff-higher in ICU
- ICU recognizes earlier decompensation
Causes???

- Late identification of problems- awareness
- Lack of necessary equipment
- Lack of experienced personnel
- Poor planning
- Poor communication
- CAPNOGRAPHY

Awareness

- Human factors
- Reduce human error
- Improve human performance which enhances safety
- Anticipate problems and prevent them
- Situational awareness

Case 10-Example

- 5 am call for emergent intubation
- On route, changed to Cor zero
- Patient PEA, apneic-chest compressions, bag/mask ventilation, vomit
- Difficult DL due to vomit-get tube in. All we see with glidescope is green vomit flowing out of esophagus
- COR for 40 minutes about to call off
- ACLS protocol-consider narcan, "he did get a fair amount of Dilaudid..."
- Two doses of narcan-NSR, patient awake pointing to chest pain...

Case 11

- Called to Cor 0
- Patient can't be intubated due to inability to open mouth
- Push succinylcholine-still can't open mouth
- How long has the patient been like this??

Prevention???

- Fourth National Audit Project of the Royal College of Anaesthetists and the Difficult Airway Society-NAP4
- Recommendations for a checklist for all remote site emergency airway management
- Checklist has been shown to reduce complications rates
- Concept from success in the aviation industry

Rigor Mortis!!!

Lack of awareness
Intubation Checklist

- Emergency Rapid Induction Checklist
- Airway equipment with difficult airway cart
- Capnography-carbon dioxide detector filters
- Resuscitation drugs
- Place in all remote areas involved with critically ill patients

- Improves patient safety
- Reduces mortality
- Reduces complications
- Doesn't take any longer
- Less discrepancy with inexperience vs experienced

- Train all ICU and ED staff-assign someone per shift to be responsible and attend airway emergencies/cardiac arrests
- Check daily
- Keep stocked
- Keep photo of all equipment and drugs needed for restocking

Annex A: RSI Checklist

Annex B: Airway management / emergency drugs bags

Drugs Bag Inventory

1. Adrenaline 1:1000
2. Atropine 0.6mg
3. Flecainide 100mg
4. Lidocaine 100mg
5. Propofol 20mg
6. Succinylcholine 1mg
Difficult Intubation Kit: (main compartment)

- Stylet
- Gum-elastic bougie 15Ch
- Magill’s forceps (top-flap)
- Scissors (top-flap)
- Airtrac adult male + female (blue + green)
- Cook airway exchange catheter (side pouch)

Failed Intubation, “Plan C” Kit: (main compartment)

- OP Airways (green, orange, red)
- NP Airways (Size 6, 7, 8)
- i-gel (Size 3, 4, 5)

Remote Site Airway Emergencies

- Are among the most difficult and associated with the highest risks
- Delays or complications are very detrimental and potentially avoidable
- Mainly due to lack of available appropriate drugs, equipment or trained staff

Off Site Closed Claims

- A quarter involved tube changes
- Almost half were non-surgical patients
- Post-op patients need for reintubation were for neck swelling causing respiratory compromise-post: neck fusion, thyroidectomy, central line...

Claims for care off site were all associated with death/BD versus OR disasters have less morbidity and mortality

- Poor outcome due to the lack of operating room resources-standard airway management equipment and no immediate availability of healthcare providers skilled in airway management.
- There was no difference in the proportion of payments made, or the median payment between perioperative and outside location claims.
Difficult Airway Claims

- Perioperative Claims 87%
- Outside locations 13%
- Worst outcomes outside locations

<table>
<thead>
<tr>
<th>Table 3: Outcomes and Liability in Difficult Airway Claims (n = 179)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Perioperative</strong></td>
</tr>
<tr>
<td>-------------------</td>
</tr>
<tr>
<td>Death</td>
</tr>
<tr>
<td>Brain damage</td>
</tr>
<tr>
<td>Airway injury</td>
</tr>
<tr>
<td>Pneumothorax</td>
</tr>
<tr>
<td>Aspiration</td>
</tr>
<tr>
<td>Nerve injury</td>
</tr>
<tr>
<td>Emotional distress</td>
</tr>
<tr>
<td>Nerve injury</td>
</tr>
<tr>
<td>Emotional distress</td>
</tr>
<tr>
<td>Acute onset of surgery</td>
</tr>
<tr>
<td>Liability</td>
</tr>
<tr>
<td>Less than</td>
</tr>
<tr>
<td>appropriate</td>
</tr>
<tr>
<td>anesthetic care</td>
</tr>
<tr>
<td>Payment made</td>
</tr>
<tr>
<td>Payment in 1999</td>
</tr>
<tr>
<td>Payment in 1999</td>
</tr>
<tr>
<td>dollars, median</td>
</tr>
<tr>
<td>(range)</td>
</tr>
</tbody>
</table>

Case 12

- Emergent intubation in patient is severe respiratory distress
- Tachypneic
- Sat on 6l nasal cannula 74%
- Sitting straight up in bed

Quick History

- 63 yo AFF
- Obese-70”, 156 kg; BMI 50
- Severe pulmonary HTN
- CHF
- COPD
- CVA-?residual
- Gout

Home medications

- Advair 2 puffs BID
- HCTZ 12.5mg PO q day
- Lisinopril 5mg PO q day
- Magnesium Hydroxide 400mg PO BID
- Fentanyl patch 25mcg/hr transdermal

PRN Medications

- Acetaminophen
- Albuterol
- NTG
- Oxycodone
RV severely dilated with moderately reduced systolic function
- Dilated IVC with interatrial septum bowing, increase RAP
- PAP systolic-65mmHg
- LV cavity small with nl EF>55%

Sepsis of unknown origin
- CHF exacerbation
- Altered mental status

Labs
- K 5.9
- Cr 1.39
- WBC 28
- H/H 8.6/29.7

Difficult intubation-obesity, unable to do complete exam due to uncooperative
- Difficult bag/mask and quick desaturation-obesity, COPD, CHF, inability to lay flat-no reserve
- Can't pre-oxygenate-altered mental status refusing mask. Decreased FRC
- Can't use succinylcholine due to high K, history of CVA with unknown residual issues
- Non depolarizer-unknown NPO status, concern for ventilation/intubation

Patient somewhat breathing on her own
Large concern of taking away any respiratory drive

What was done
- Was able to get a non rebreather mask
- Precedex started 0.5ug/kg/hr increases to 1ug/kg/hr using assumed ideal body weight
- Layed patient down
- Awake DL a with Mac 4, quick view of closed VC, unable to pass ETT-coughing
- Felt a bit more comfortable added 2 mg Versed
- Another DL ETT placed as VC opened
- +ETCO2, BBSE
Conclusion

- Hospital needs a solid plan
- Train necessary personnel
- Have proper equipment
- Call anesthesia early
Acute Pain in the Ambulatory Setting

Tessa Mandler, M.D.
Assistant Professor

Disclosure

I do not have any financial or research affiliations with any product or pharmaceutical manufacturer displayed in this presentation.

Learning Objectives

• Understand consequences of poor pain control in the ambulatory setting
• Identify ways to improve pain control for outpatient surgeries
• Discuss the suitability of single shot peripheral nerve blocks versus continuous peripheral nerve catheters for ambulatory patients
• Discuss novel management strategies of outpatient peripheral nerve catheters in the setting of limited resources

Consequences of Poor Pain Control

- Cost
- Unplanned/Prolonged admission
- Post-operative pain
- PACU/Hospital LOS
- Satisfaction
- Respiratory Cx
- Sedation
- Opioids

Which Clinical Anesthesia Outcomes are Important to Avoid?
The Perspective of Patients

Alex Macario, M.D., M.B.Ch.B., Matthew Weinger, M.D., Stacie Carney, M.D., and Ahn Kim, M.D.

Table 4. Ranking and Relative Value of Anesthesia Outcomes

<table>
<thead>
<tr>
<th>Outcome</th>
<th>Rank</th>
<th>Relative Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Vomiting</td>
<td>2.95 ± 0.15</td>
<td>18.05 ± 1.09</td>
</tr>
<tr>
<td>Gagging on endotracheal tube</td>
<td>2.97 ± 1.43</td>
<td>17.96 ± 1.59</td>
</tr>
<tr>
<td>Pain</td>
<td>4.02 ± 0.17</td>
<td>11.82 ± 1.58</td>
</tr>
<tr>
<td>Nausea</td>
<td>4.85 ± 0.26</td>
<td>13.82 ± 1.58</td>
</tr>
<tr>
<td>Recall without pain</td>
<td>5.34 ± 0.17</td>
<td>7.90 ± 0.26</td>
</tr>
<tr>
<td>Headache</td>
<td>5.36 ± 0.20</td>
<td>7.60 ± 0.26</td>
</tr>
<tr>
<td>Sore throat</td>
<td>8.02 ± 0.11</td>
<td>3.04 ± 0.26</td>
</tr>
<tr>
<td>Numbness</td>
<td>8.28 ± 0.11</td>
<td>2.98 ± 0.26</td>
</tr>
<tr>
<td>Normal</td>
<td>10.00</td>
<td>0.00</td>
</tr>
</tbody>
</table>

Values are means ± SEM.

* This means that, for example, patients assigned 100% of their possible score avoid vomiting.


Which outcomes are frequent and important to avoid (from patient’s perspective) according to anesthesiologists?

-recall pain
- patient’s anxiety
- nausea
- vomiting
- back pain
- fatigue
- pain
Effects of Poorly Managed Post-operative Pain

| Cardiovascular | HR, IBP, cardiac work load |
| Pulmonary      | Splinting, IVC, atelectasis, hypoxia |
| Gastrointestinal | Post-operative ileus |
| Renal          | Risk oliguria and urinary retention |
| Glutagation    | Risk thromboembolism |
| Immunologic    | Immune function |
| Muscular       | Fatigue, immobility |
| Psychological  | Anxiety, fear, frustration, dissatisfaction |

Consequences of Rescue Opioids

- Sedation
- PONV

Post-operative Sedation

Differential diagnosis of post-operative sedation:
- Hypotension
- Hypoxia
- Hypercarbia
- Hypoglycemia
- Electrolyte abnormalities
- Anemia
- Cerebrovascular injury
- Persistent anesthetic effect

Post-operative Nausea & Vomiting

- Pulmonary aspiration
- Dehydration
- Electrolyte imbalance
- Fatigue
- Esophageal tear
- Wound dehiscence

Additional Sequelae of Poor Pain Control

- Delayed PACU discharge ➔ delay in OR turnover
- Unplanned hospital admission
- Decreased patient satisfaction
- Patient discomfort with development of late PONV

Ways to Improve Pain Control for Outpatient Surgeries

A 65 year old otherwise healthy male presents for total knee replacement due to severe osteoarthritis. How many days do you anticipate hospitalization?
A 65 year old otherwise healthy male presents for total knee arthroplasty. The surgeon requests he go home the same day you therefore elect the following for his anesthetic plan:

a. Combined spinal epidural, femoral nerve catheter, ketorolac, acetaminophen, diazepam, fentanyl
b. Spinal, ketorolac, fentanyl, acetaminophen, pregabalin, diazepam
c. Spinal, ketorolac, acetaminophen, pregabalin, celecoxib
d. Combined spinal epidural, intraarticular block, ketorolac, acetaminophen
e. General anesthesia, paralytic, fentanyl, ketorolac

Chronic Pain affects us all

- Quality of life
- Psychological
- Social
- Socioeconomic

"Divine is the task to relieve pain." -Hippocrates

Figure 1. Annual per-patient pre- and postindex direct medical costs among patients with chronic pain conditions. Index date was the first date of the ICD-9 code for the chronic pain condition during 2010. *p < 0.001 vs. pre-index.
How pain management impacts health care providers

- Bundled payments for care improvement initiative
- Hospital Consumer Assessment of Healthcare providers and systems (HCAHPS)
  - Comparable data on the patient's perspective on care
  - Public reporting → improve quality of care
  - Enhance public accountability

Quick Summary Non-Opioid MMA

- Non-selective NSAIDS:
  - ↓ Opioid use 25-45%, pain intensity, PONV, sedation
  - Limitations: COX1 inhibition, renal dysfunction, GI
- Acetaminophen:
  - Good tolerance and safety profile
  - Limitations: cost (IV) vs 1st pass effect; liver dysfunction
- NMDA antagonists (ketamine):
  - ↓ Opioid requirements and hyperalgesia
  - Limitations: neuropsychiatric disturbances, PONV
- Other: alpha-2-agonists, anticonvulsants, antidepressants
  - Limitations: sedation, dizziness

Quick Summary LA Adjuncts

- Epinephrine:
  - Intra-vascular test dose, ↓ absorption from tissues
  - Limitations: ↑ HR, ↓ perineural blood flow
- Dexamethasone:
  - Peripheral vs Systemic dosing
  - Limitations: not approved for peripheral administration
- Alpha-2-agonists:
  - Prolongs sensory and motor blockade
  - Limitations: ↓ HR, ↓ BP, sedation; variation with LA, block, dose
- Opioids:
  - Limitations: no clear benefit
Bupivacaine liposome injectable suspension (Exparel)

- DepoFoam® slowly delivers bupivacaine
  - ~72-96 hours analgesia
- Vial: 266 mg/20 ml
  - 3% “free” bupivacaine
  - $285/each
  - Vial = 300 mg Marcaine


Bupivacaine liposome injectable suspension

- Indications:
  - Wound infiltration to produce post-surgical anesthesia
- Safety: 21 clinical studies, >1300 patients
  - Additive toxic effects with other local anesthetics
  - Most common adverse reactions (~10%): nausea, vomiting, constipation
  - 1 ml Marcaine + 1 ml bupivacaine liposome injectable solution
  - Maximum dose recommended is 266 mg
  - Caution with liver and/or renal impairment

Bupivacaine liposome injectable suspension

- Plasma levels of bupivacaine can persist for 96 hours

Patient selection for ambulatory procedures/surgeries

- Anyone and everyone!

Contraindications to Regional Anesthesia

- Patient refusal
- Infection at the site of needle/catheter placement
- Coagulopathy
- Allergy to local anesthetic
- Pre-existing peripheral neuropathy
- Severe neurologic injury with precludes post-operative assessment for complications
Caution! Appropriate candidate for ambulatory surgery?

- Chronic pain disorders
- Cardiac history
- Chronic lung disease
- OSA
- Craniofacial disorders
- Neuromuscular disorders
- Failure to thrive
- Morbid obesity
- Other: sickle cell disease, central hypoventilation syndromes, genetic/metabolic/storage disease, Down’s syndrome, pre-maturity

Single Shot Nerve Block

Pros:
- 12-24 hour analgesia
- Decreased opioid use
- Faster PACU discharge
- Cost effective
- Decreases stress response to surgery
- Decreases post-operative immunosuppression

Cons:
- Neuropaxia
- Hematoma
- Local anesthetic toxicity
- Infection
- Secondary injury

Peripheral Nerve Catheters

Pros:
- Decrease opioid use
- Decrease in adjuvant pain medication use
- Prolonged blockade
- ↑ patient satisfaction

Cons:
- Catheter malfunction
- Catheter site infection or bacteremia
- Increased technical difficulty and increased time
- Post-op catheter management
- “Expensive”

Cost of materials

Catheter: $475-850
Single shot block: $10-20

Novel management strategies of outpatient PNC’s

- Potential barriers to PNC’s:
  - How are we going to teach the families about the PNC without on site APS?
  - Who is going to order the pump and manage the catheter?
  - How will follow up be done?

Children’s Hospital Colorado
IN CARE OF KIDS
Continuous Nerve Block with On-Q Pump

- General information about catheter and medicine inside it
- How the local anesthetic is not like other pain medicines
- Risks of complications
- Care of a child with a PNC:
  - Protect the limb
  - The pump is your friend
  - How to remove the catheter
  - Instructions when to call (i.e. infection, leakage, prolonged block effects, local anesthetic toxicity, etc.)
Patient/Family Education sans APS

- Face-to-face education
  - Review highlights in the handout
  - Use demo pain pump ball
  - Pen and paper exchange of contact information

Lessons learned in developing patient/family education materials

Management of PNC

- RN’s connect pump in PACU
- APS follow up via phone +/- provider phone call
- Surgical team (i.e. post-op visits)
- Patient and his/her family
- Product representative

Benefits Experienced

- Improved post-operative pain
- Decreased PACU length of stay
- Decreased number of unplanned admissions
- Decrease in unplanned hospital cost
Patients that received Combined Block spent less time in the PACU

Fine tuning for the future

- Introduce anesthesia plan to patients pre-operatively to establish expectations and begin education on PNC’s
- Identify patient candidates for pre-operative block to ensure efficacy
- Continue to trial various combinations of the MMA wheel

THANK YOU
The Perioperative Management of the Chronic Pain Patient

Dominique H. Schiffer, MD

Postoperative Pain Experience: Results from a National Survey Suggest Postoperative Pain Continues to Be Undermanaged

Apfelbaum, Jeffrey L. MD*; Chen, Connie PharmD†; Mehta, Shilpa S. PharmD‡; Gan, and Tong J. MD‡
Anesth Analg 2003

82% of pts experienced acute post op pain
Most had moderate, severe or extreme pain
Both inpts and outpts experienced acute post op pain
Ambulatory pts experienced more pain after discharge than before discharge
Some patients were so concerned about post op pain, they postponed surgery

Anesth Analg 2003

Consequences of Inadequate Postoperative Pain Relief

Cardiovascular
Increased heart rate, peripheral vascular resistance, arterial blood pressure, and myocardial contractility resulting in increased cardiac work, myocardial ischemia and infarction

Pulmonary
Respiratory and abdominal muscle spasm (splinting), diaphragmatic dysfunction, decreased vital capacity, impaired ventilation and ability to cough, atelectasis, increased ventilation/perfusion mismatch, hypoventilation, hypoxemia, hypercarbia, increased postoperative pulmonary infection

Gastrointestinal
Increased gastrointestinal secretions and smooth muscle sphincter tone, reduced intestinal motility, ileus, nausea, and vomiting
Immunologic
Impaired immune function, increased infection, tumor spread or recurrence

Muscular
Muscle weakness, limitation of movement, muscle atrophy, fatigue

Psychological
Anxiety, fear, anger, depression, reduced patient satisfaction

Overall recovery
Delayed recovery, increased need for hospitalization, delayed return to normal daily living, increased health care resource utilization, increased health care costs

• 1 in 8 surgery pts suffer from chronic pain (105,000 surveyed)
• Chronic pain patients (CPPs) have higher pre-op pain scores than non-chronic pain patients
• Psychiatric comorbidity in 25% CPPs vs. only 14% of non-CPPs
• BMI is higher in CPPs
• Regional anesthesia used less frequently in CPPs
• CPPs are more likely to have cardiovascular, pulmonary, hepatic and renal comorbidities


Postoperative Pain Patterns in Chronic Pain Patients: A Pilot Study

• 96 normal patients and 42 chronic pain patients
• Conclusion: “Surgical patients who have chronic pain and use opioid medications for that pain have more postoperative pain than normals and resolve that pain more slowly”


Today’s challenges
Opioid and non-opioid medications are used in the treatment of chronic pain. The number of chronic pain patients receiving large regular doses of opioids is ever-expanding.

The perioperative pain control of these patients is challenging.

“The perioperative management of opioid-dependent patients is not discussed in any major anesthesiology textbook”

Mitra & Sinatra, Anesthesiology 2004;101:212-227
Who is a typical chronic pain patient?

Patient “A”
Iraq War Veteran

- 34 year old female
- Hx of polytrauma
- Bilateral lower extremity amputations
- Mild TBI
- Phantom Pain
- SI joint Pain
- Failed Spinal Cord Stimulator Trial

- Medications:
  - Gabapentin 600mg TID
  - Quetiapine (Seroquel) 100mg qhs
  - Methadone 20 mg qAM, noon, 15mg qhs
  - Morphine 15mg q 6 hr prn

A Comprehensive Strategy To Manage Chronic Pain Patients Perioperatively

Key Concepts and Definitions

- Types of opioid dependency
- Substance abuse, dependence, tolerance
- Understand adjuvant medications used to treat chronic pain
- Pre-operative, intra-operative and post-operative planning and management

Clinical Differentiation of Opioid-dependent Patients

- Those with chronic pain, conditions who have been taking opioid analgesics for a prolonged period (months to years)
- Opioid abusers (addicts)
  - Additional concern is for cross-addiction or polydrug abuse
- Former addicts enrolled in long-term methadone maintenance programs.
- Long Term Tolerant Patients

A Comprehensive Strategy To Manage Chronic Pain Patients Perioperatively

Requires Knowledge of Key Concepts & Definitions

- Clinical differentiation of types of opioid dependency
  - Substance abuse, dependence, tolerance
  - Understand adjuvant medications used to treat chronic pain
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A Comprehensive Strategy To Manage Chronic Pain Patients Perioperatively

Requires an understanding of some key concepts and definitions

- Clinical differentiation of types of opioid dependency
- Substance abuse, dependence, tolerance
  - Understand adjuvant medications used to treat chronic pain
  - Pre-operative, intra-operative and post-operative planning and management
Addiction

aka: Substance Use Disorder

• Characterized by the four C’s
  • Craving for the substance
  • Compulsive use
  • Control—lack of, over substance use
  • Continued use despite harm
• Addict may be manipulative
  • Requesting more opioids pre-op, post-op
  • Refuses regional anesthesia, multimodal analgesia
• May be prone to opioid induced hyperalgesia

Dependence

• Psychological Dependence
  • Habituation, a continued desire for the drug, even after physical dependence is gone.
• Physical Dependence (example: opioid)
  • rapid dose reduction in opioid will cause withdrawal symptoms
  • Hypertension, tachycardia, diaphoresis, abdominal cramping
• These patients should not be labeled as drug seeking or addicts.

Tolerance

• Innate Tolerance: pre-existing insensitivity, genetically determined, present before drug exposure
  • Allelic variants in the genes dictating an individual’s complement of opioid receptors
  • Genetic variability in density of opioid receptors, receptor affinity, secondary messenger activation
• True Tolerance: acquired after multiple opioid exposures
  • Pharmacokinetic
  • Pharmacodynamic
  • Long Term

True Tolerance

• Pharmacokinetic Tolerance
  • Changes in the distribution or metabolism of the drug
  • There is a rightward shift in the dose-response curve, and patients require increasing amount of drug to maintain the same pharmacologic effects.
  • Think cytochrome P450
• Pharmacodynamic Tolerance
  • “What the opioid has done to the body”
    • Receptor desensitization
    • Cyclic AMP up regulation
• Long term tolerance
  • May represent a persistent neural adaptation.
  • This can be observed in patients who discontinued opioid (illicit or prescribed) use many months or years previously but continue to exhibit opioid insensitivity.
A Comprehensive Strategy To Manage Chronic Pain Patients Perioperatively

- Requires an understanding of some key concepts and definitions
- Clinical differentiation of types of opioid dependency
- Substance abuse, dependence, tolerance
- Understand adjuvant medications used to treat chronic pain
- Pre-operative, intra-operative and post-operative planning and management

Adjuvant Analgesics

- This is a diverse group of medications that were originally developed for a primary indication other than pain.
- Antidepressants
- Anticonvulsants
- Alpha-2-adrenergic agonists
- Corticosteroids
- Local Anesthetics
- NMDA antagonists
- Cannabinoids
- Bisphosphonates and Calcitonin
- GABA agonists
- Neuroimmunomodulatory agents

Antidepressants

- Tricyclics: (e.g., amitriptyline, nortriptyline)
  - Effective in neuropathic pain conditions.
  - Anesthetic implication: response to sympathomimetics remains complex and unpredictable.
- Serotonin and norepinephrine reuptake inhibitors (SNRIs: e.g., duloxetine, venlafaxine)
  - Modulate allodynia, effective for diabetic neuropathy and neuropathic pain in breast cancer.
  - Anesthetic implication: enhanced effects of sympathomimetics and CNS depressants, may impair platelet aggregation
- Selective serotonin reuptake inhibitors (SSRIs: e.g., citalopram, paroxetine)
  - Generally ineffective adjuvant analgesics
  - Used for depression

Anticonvulsants

- Gabapentin and Pregabalin:
  - First line therapy for neuropathic pain syndromes
- Carbamazepine and Oxcarbazepine:
  - Trigeminal neuralgia
  - Carbamazepine can sig decrease plasma level of Methadone (enzyme CYP3A4, aka CP4502B6)
- Lamotrigine:
  - Carbamazepine resistant trigeminal neuralgia
- Newer Anticonvulsants:
  - Levetiracetam, zonisamide, tiagabine, topiramate all may be helpful in headache syndromes

Alpha-2-adrenergic Agonists

- Clonidine
  - Binds to alpha-2-adrenergic receptors in the CNS and has a synergistic effect with opioids
  - Best intrathecally and epidurally
  - Can be used orally and transdermally for chronic pain
- Tizanidine
  - Manage spasticity
  - Some usefulness in some painful states (neuropathic pain)

Corticosteroids

- Inflammatory neuropathic pain from peripheral nerve injuries.
- Have been used successfully to treat bone pain, pain from bowel obstruction, lymphedema, and headache associated with increased intracranial pressure.
Topical Agents

- Capsaicin, natural substance in hot chili peppers, activates the vanilloid neuronal membrane receptor
- Diclofenac patch
- Novel formulations

Local Anesthetics

- Analgesic properties at sub anesthetic doses.
- Indications:
  - Neuropathic pain
- Examples:
  - IV Lidocaine
  - Mexilente (oral lidocaine)
  - Transdermal lidocaine (Lidocaine patch 5%)

Less Common Adjuvants

- NMDA Antagonists
  - Dextromethorphan, Ketamine
- Cannabinoids
  - Marinol
- Bisphosphonates
  - Pain reduction in bone metastases and Complex Regional Pain Syndrome
- Calcitonin
  - Pain reduction in bone metastases
- GABA agonists
  - Baclofen
- Neuroimmunomodulatory Agents
  - Thalidomide

Patient “A”
Iraq War Veteran

- 34 year old female
- Hx of polytrauma
  - Pelvic fracture
  - Bilateral lower extremity amputations
  - Mkt TBI
  - Phantom Pain
  - SI joint Pain
  - Failed Spinal Cord Stimulator Trial
- Medications:
  - Gabapentin 600mg TID
  - Quetiapine (Seroquel) 100mg qhs
  - Methadone 20 mg qAM, noon, 15mg qhs
  - Morphine 15mg q 6 hr prn
- Planned Operation:
  - Bilateral Stump Revisions

Management Challenges

- Opioid Tolerant and Dependent
- Quetiapine
  - likely that this patient has PTSD from polytrauma in Iraq
- Acknowledge potential for increased postoperative pain
Management Plan
Day of surgery

• Pre-op EKG (prolonged QT)
• Continue scheduled methadone
• Continue scheduled gabapentin
• Multimodal analgesia
  • Consider Celebrex (minimize inflammatory pain), or Acetaminophen
  • Regional Anesthesia (peripheral nerve block, epidural)
• Reassure patient regarding fears of adequate pain control

For those on methadone....

• Risk of prolonged QTc for those on high dose methadone (generally >100mg/day)
• This could lead to development of torsade de pointes
• Conversion of Methadone to other opioids...is a complex conversion
• No universally safe conversion ratio exists

Schiffer, Dominique, MD Outpatient Issues: The Perioperative Management of the Chronic Pain Patient

Management Plan
Intra-Op

• Consider regional technique (peripheral nerve block, epidural, spinal)
• Surgeon can infiltrate surgical site with long acting local anesthetic before and after operation
• Administration of opioid to meet the following requirements: chronic, intraoperative surgical, anticipated postoperative
• Ketamine
• Allow for spontaneous breathing at end of case (if GETA), titrating opioid to RR of 12-14 breaths per minute and slightly mitotic pupil

Now for a detour about Ketamine
Ketamine

- N-methyl-D-aspartate (NMDA) antagonist
- Used as an anesthetic – when given in high doses
- Produces a "dissociative" state
- Profound analgesia with sub anesthetic doses

Level 1 Evidence for Ketamine Analgesia

- Low-dose perioperative ketamine is "opioid sparing", "reduces PONV" and has "minimal" side effects.
- Ketamine is most effective as a "continuous low-dose" infusion for acute pain management.

IASP: Pain Clinical Updates, June 2007

Level II Evidence for Ketamine Analgesia

- Ketamine has "preventive" but not "pre-emptive" analgesic effects.
- Ketamine added to opioid PCA provides no additional analgesic benefit.

IASP: Pain Clinical Updates, June 2007

- Ketamine reduces acute wound hyperalgesia and allodynia.
- Ketamine may reduce the incidence of chronic post surgical pain following laparotomy, thoracotomy, and mastectomy.

IASP: Pain Clinical Updates, June 2007

- Ketamine reduces lower limb ischemic rest pain, peripheral neuropathic pain, and spinal cord injury pain.
- Ketamine does not improve analgesia when used alone or in combination with local anesthetic for peripheral nerve blocks, intra-articular injection, or wound infiltration.

IASP: Pain Clinical Updates, June 2007
Level III Evidence for Ketamine Analgesia

(evidence obtained from nonrandomized controlled trials)

- Ketamine may reduce severe chronic phantom limb pain.
- Level IV (evidence from case series)
- Ketamine improves analgesia in opioid-tolerant patients.

IASP: Pain Clinical Updates, June 2007

Ketamine for Perioperative Pain Management

- Major (more painful-visceral) procedure:
  - Before Incision: 0.5mg/kg IV bolus
  - During Surgery: 0.5mg/kg/hr IV infusion OR 0.25mg/kg IV bolus q 30 min
  - If procedure ≥ 2 hr, stop 60 minutes before end of surgery

- Minor (less painful-hip) procedure:
  - Before Incision: 0.25 mg/kg IV bolus
  - During Surgery: 0.25 mg/kg/hr IV infusion OR 0.125mg/kg IV bolus q 30 min

Himmelheber, et al; Anesthesiology 2005, 102:211-20

Management Plan Post Op-PACU

- Start IV PCA
- Continue applicable regional techniques
- Continue NSAIDs if possible (minimizing inflammatory pain) to augment opioid mediated analgesia
- Monitor for over sedation and withdrawal

PACU cont..

- Titrate opioids aggressively to achieve adequate pain control in PACU
- May continue Ketamine if started in OR, or institute Ketamine infusion if pain proves refractory to other measures
- Consider “rescue” regional technique for unrelieved pain

Post Op Transition Phase

- Resume maintenance doses of oral opioids and po adjuvants ASAP after surgery
- Transition from regional and parenteral techniques to oral opioids/adjuvants when possible

Chronic Pain Patient “B”

- 56 year old male
- Failed Back Surgery Syndrome
- Chronic Upper & Lower Back Pain, Left Leg Pain
- S/P Intrathecal Pump Placement
- Current Medications
  - Intrathecal: 1 mg/day morphine, 300mcg/day Baclofen
  - Duloxetine (Cymbalta) 60mg BID
  - Eszopiclone (Lunesta) 2mg qhs
  - Lorazepam 0.5mg prn
- Operation: Shoulder arthroplasty
Management Challenges

- Opioid Tolerant
- Implanted Intrathecal Pump
  - With opioid and baclofen
- Acknowledge potential for increased post operative pain

Management Plan Day of Surgery

- IDDS should be interrogated before surgery
- Continue intrathecal therapy
- Multimodal Analgesia
- Consider Regional Anesthesia
- Reassure patient regarding possible fears of pain control

Perioperative Management of Patients with an Intrathecal Drug Delivery System (IDDS) for Chronic Pain

- Major Pain Societies: No major consensus statements
- Current Literature:
  - Case Report, Pediatric Anesthesia 2006; 16:989-992
  - Letter to the Editor, Pain Physician 2007; 10:779-782
  - Case Series of 20 patients with IDDS for opioids for chronic pain
  - Case Report, Anesthesia and Analgesia 2008; 107:1393-1396
  - 3 patients in this series

Misconceptions:

- Patients with an IDDS are more susceptible to respiratory depression/sedation with parenteral opioids
- There is no evidence to support this statement!
Further Misconceptions...

The IDDS may provide adequate pain control for the postop period.

- IDDS is only providing the baseline narcotic requirement in these patients.
- It is reasonable to then continue this during the perioperative period for their baseline pain condition.

Therefore:
- Additional pain control will need to be provided via parenteral narcotics and potentially regional anesthesia.

Further Misconceptions...

- IDDS infusion may be modified to provide acute pain control
- Programming and exchange of pump reservoir contents is a complex task requiring experienced personnel.
- Not all IDDS have complex programming capabilities, eliminating the possibility of use as a titratable postoperative pain modality.
- We use if only for baseline pain condition

Intra-Op Management Plan

- Consider regional technique (interscalene block)
- Administration of opioid to meet chronic, intraoperative and anticipated postoperative requirement
- Consider intraoperative Ketamine
- Allow for spontaneous breathing at end of case (if GETA), titrating opioid to RR of 12-14 and slightly mictotic pupil

Management Plan PACU

- Start IV PCA
- Continue applicable regional techniques or offer rescue block if pain control inadequate
- Monitor for over sedation
- May continue Ketamine if started in OR, or institute Ketamine infusion if pain proves refractory to other measures

Pt with an intrathecal pump........

Can an epidural be placed perioperatively?
Emerging Analgesics and Analgesic Technologies

- Catheter-free PCA
- Liposomes or nanoparticles will be used as transdermal drug carriers
- Iontophoresis, where serum levels can rise more rapidly than in transdermal systems.
- Sufentanil Nano Tab PCA system, an oral PCA system
- IV Acetaminophen (Ofirmev) filed with FDA in May 2009 for approval (already available in 80 countries)

For the average patient “joe or jane”

- Go to: http://www.postoppain.org/
Postoperative Nausea and Vomiting: Update on Prevention, Rescue, and Novel Strategies

2 March 2016
Melissa Brooks Peterson, MD
Department of Anesthesiology/Pediatric Division

Overview

- Understand risk stratification for PONV
- Review Updated Guidelines that address PONV
- Controversies and Future Directions
- Discuss novel therapies for PONV
  - Pharmacologic and non-pharmacologic
- Understand PONV in the setting of postoperative pain control strategies
  - Multimodal analgesia

PONV: Does it matter?

- Incidence of PONV
  - General Incidence: 30%, Range 10-80%
  - Risk Factor Dependent
- Cost(s) of PONV
  - Prolonged PACU stay +/- unanticipated hospital admission
  - Increase overall healthcare costs
  - Poor Cost Effectiveness analysis in available literature
- Patient Satisfaction related to occurrence of PONV
  - Pain and PONV are the top two patient concerns
  - Patients are “willing to pay” for preventing PONV!

Assessing PONV Risk

<table>
<thead>
<tr>
<th>Risk Factors</th>
<th>Points</th>
</tr>
</thead>
<tbody>
<tr>
<td>Female Gender</td>
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<tr>
<td>Non-Smoker</td>
<td>1</td>
</tr>
<tr>
<td>History of PONV</td>
<td>1</td>
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<tr>
<td>Postoperative Opioids</td>
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<tr>
<td>Sum</td>
<td>5</td>
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</tbody>
</table>

POVN Risk

- No conflicts of interest to disclose (sadly)
### Table 1. Risk Factors for PONV in Adults

<table>
<thead>
<tr>
<th>Evidence</th>
<th>Risk factors</th>
</tr>
</thead>
<tbody>
<tr>
<td>Positive overall</td>
<td>Female sex (B1)</td>
</tr>
<tr>
<td>History of PONV or motion sickness (B1)</td>
<td></td>
</tr>
<tr>
<td>Nonsmoker (B1)</td>
<td></td>
</tr>
<tr>
<td>Younger age (B1)</td>
<td></td>
</tr>
<tr>
<td>General versus regional anesthesia (A1)</td>
<td></td>
</tr>
<tr>
<td>Use of volatile anesthetics and nitrous oxide (A1)</td>
<td></td>
</tr>
<tr>
<td>Postoperative opioids (A1)</td>
<td></td>
</tr>
<tr>
<td>Duration of anesthesia (B1)</td>
<td></td>
</tr>
<tr>
<td>Type of surgery (cholecystectomy, laparoscopic, gynecologic) (B1)</td>
<td></td>
</tr>
<tr>
<td>Level of anesthesiologist’s experience (B1)</td>
<td></td>
</tr>
<tr>
<td>Muscle relaxant antagonists (A2)</td>
<td></td>
</tr>
<tr>
<td>Conflicting</td>
<td>ASA physical status (B1)</td>
</tr>
<tr>
<td>Menstrual cycle (B1)</td>
<td></td>
</tr>
<tr>
<td>Disproven or of limited clinical relevance</td>
<td>BMI (B1)</td>
</tr>
<tr>
<td>Anxiety (B1)</td>
<td></td>
</tr>
<tr>
<td>Nonspecific tube (A1)</td>
<td></td>
</tr>
<tr>
<td>Supplemental oxygen (A1)</td>
<td></td>
</tr>
<tr>
<td>Perioperative fasting (A2)</td>
<td></td>
</tr>
<tr>
<td>Migraine (B1)</td>
<td></td>
</tr>
</tbody>
</table>

### Risk Factors Revisited
- Female (OR 2.57, CI 2.32-2.84)
- History of PONV (OR 2.09, 1.90-2.29)
- Nonsmoker (OR 1.82, 1.68-1.98)
- History of motion sickness (1.77, 1.55-2.04)
- Age (0.88 per decade, 0.84-0.92)
  - <50 increased risk
- Volatile anesthetics (1.82, 1.56-2.13)
- Longer Duration of Anesthesia (1.46 h⁻¹, 1.30-1.63)
- Postoperative Opioid Use (1.47, 1.31-1.65)
- Nitrous Oxide Use (1.45, 1.06-1.98)

### PONV and Pediatric Patients
- 2007 Guidelines
  - Surgery >30 minutes
  - Age >3
  - History of PONV in patient, parent, or sibling
  - Strabismus surgery
  - 0, 1, 2, 3, 4 Risk Factors ~ 9%, 10%, 30%, 55%, 70%
- 2012 Update: validated at a different institution in patients not undergoing strabismus surgery
  - 0, 1, 2, 3 Risk Factors ~ 3.4%, 11.6%, 28.2%, 42.3%
- SAMBA/ASA Guidelines support use of a simplified risk profile for pediatric patients

### Assessing PONV Risk
- "Low Risk" = 10-20% incidence of PONV
- Is this an acceptably "Low" Risk?
- With introduction of generic ondansetron, the conversation changes

### Ondansetron
- GSK 1980’s developed Zofran
- FDA Approved Jan 1991
- Generic approved by FDA in Dec 2006
- Wholesale Cost: $0.10 - $0.76 USD
- At CHCO: $0.17/vial, Pt charge $17.50
- At UCH:

### Mitigating Risk of PONV
- Recognizing Patient Factors
- Reducing Anesthesia Factors (IMPACT Trial, NEJM 2004)
  - 5199 high risk patients, 4123 randomized to 1 of 64 treatment combos
  - Ondansetron 4 mg, Dexamethasone 4 mg, Droperidol 4 mg, Propofol replacing volatile, omission of N2O, remi replacing fentanyl
  - Use of one antiemetic reduces PONV by 26% (IRR 26%, CI 23-29%)
  - Use of TIVA reduces PONV risk by 19%
  - Omission of N2O reduces PONV risk by 12%
  - Combination antiemetic therapy reduces incidence of PONV
  - 52% with none given → 37% with 1 → 28% with 2 → 22% with 3
Ondansetron
- A serotonin 5HT3 receptor antagonist
- Considered the “gold standard” of PONV prophylaxis
- Recommended dose of 4 mg IV = 8 mg ODT
- Administered at the end of surgery
- NNT 5-6 for prevention of vomiting
- NNT 7 for prevention of nausea
- Risks: of QTc prolongation with dose >16 mg
- NNH 32 for headache, 31 for elevated liver enzymes, 23 for constipation
- FDA pulled 32 mg IV from market due to QTc prolongation

Dexamethasone and PONV

Aprepitant/Fosaprepitant & PONV
- Emend™ (Merck 2003)
- IV formulation = fosaprepitant
- PO formulation = aprepitant, 40 mg PO or 80 mg PO
- t1/2 = 40 hours
- NK-1 receptor antagonist with high affinity and selectivity
  - Blocks action of substance P at neurokinin 1 receptors
  - Substance P also found in high concentrations at chemo trigger zone/vomiting center in the brain
- CHCO Cost:
- UCH Cost:

Aprepitant, cont’d
- 2 RCT (x year and x year) achieved similar 0-24 hour reduction in PONV when compared to ondansetron
- RCT in x craniotomy patients (A+A 2011) showed aprepitant 40 mg PO + dexamethasone was more effective than ondansetron + dexamethasone at reducing PONV
- Dose-finding study in laparotomy patients undergoing Gyn surgery found 40 mg PO less effective than 80 mg PO
- SAMBA/ASA Conclusions: clinical experience with aprepitant limited, role in routine use is unclear, more data needed

Neostigmine and PONV
- Early metaanalyses suggested that high dose neostigmine (>2.5 mg) and intrathecal neostigmine associated with PONV
- Updated data (A+A 2005) suggests that neostigmine in large or small doses does not increase PONV significantly
  - Overall vomiting (0-24 hrs postop): RR 0.91, CI 0.70-1.18
  - Overall nausea (0-24 hrs): RR 1.24, CI 0.98-1.59
  - Also not significantly higher in early (0-6 hr), delayed (6-24 hr)
- Current SAMBA/ASA guidelines show insignificant evidence to recommend avoidance of neostigmine

Supplemental Oxygen and PONV
- Systematic Review of 10 trials, 1729 patients
- “PONV” = any nausea, vomiting, retching in 0-24 hours
- 860 pts received 30-40% FIO2, 869 pts received 80% FIO2
- In patients to received 80% FIO2, relative risk for overall PONV was 0.91, CI 0.77-1.06:
  - Same results for early and delayed PONV
- SAMBA/ASA guidelines no longer recommend 80% supplemental O2 for reliable reduction of PONV
Intraoperative subhypnotic propofol infusion (~25 mcg/kg/min) reduced PONV in children when added to either dexamethasone or 5HT3 receptor blocker.

NSAID use in T+A population reduces emesis (OR 0.49, CI 0.29-0.83).

Adequate hydration (30 mL/kg vs. 10 mL/kg) resulted in less PONV in pediatric strabismus repair patients.
Infraclavicular Nerve Block

- Why is this “advanced???”
- Steep needle approach
- Holds a catheter well
- Most are not comfortable with this block, compared to ISB, SCV, Ax

Infraclavicular Anatomy

- Brachial plexus block at level of the Cords
- **Three cords:**
  - Medial: Musculocutaneous, ½ of Median
  - Lateral: ½ of Median, Ulnar
  - Posterior: Radial, Axillary
- Great block for any surgery distal to shoulder
Advantages

- Low incidence of phrenic block
  - ISB: 100%, SCV 50%, ICV 0%
  - Great for OSA, O2 dependents, Severe COPD
- Low incidence of pneumothorax
- Best location for placement of catheters
  - Anchored in Pec major and minor
  - Little movement compared to supraclavicular
- One injection point
  - Don’t have to chase Musculocutaneous

Approach

- Positioning
  - Patient Supine
  - Arm abducted (may keep elbow ext or flex)
- Probe placement
  - Parallel to spine, below Coracoid process
  - Axillary artery in center of screen, usually 3-4cm deep
- Landmarks
  - Axillary Artery – Cords surround

Approach, cont.

- Goal needle placement:
  - Cephalad to Caudal, below Coracoid process
  - Steep approach, may not see needle well
  - Tip behind Axillary artery at “6 o’clock”
- Injection:
  - Should see artery “lifted” by local
  - Classic U-shape infiltration will cover all cords
- Catheter:
  - Leave catheter posterior to artery, so that Medial cord is not spared.
  - Do not just blindly feed catheter; no sheath to keep local in

Source: Malin, Sean, MD; Marshall, Kyle, MD Infraclavicular Nerve Block

Image sources: The New York School of Regional Anesthesia

**Disadvantages**

- Technically difficult compared to ISB, SCV
  - Steep angle = poor needle visualization
  - Ulnar can be spared with poor needle placement
- Difficult vascular compression
  - Relative contraindication for coagulopathy, blood thinners, antiplatelet meds
- Misses the suprascapular nerve
  - This block not sufficient for shoulder surgery
    - Good for post-op analgesia in severe pulmonary disease

**Rate of complications**

- Vascular puncture 5.5%
- Transient neurological deficit 2.6%
- Horner’s Syndrome 2.2%
- LAST 0.2%
- Phrenic Nerve Blockade 0-3%
- Pneumothorax 0.2-0.7%
Systematic Approach to Ultrasound-guided Neuraxial Blockade of the Adult Lumbar Spine: 7 steps

1. Preparation for scanning
2. PS transverse process view
3. PS articular process view
4. PS oblique view
5. Identify and mark intervertebral levels
6. Transverse interlaminar view
7. Mark needle insertion point for a midline approach
Transverse Process – “Trident”

Articular Process “Camel”

Lamina – “Horse Head” / “Sawtooth”

Figure 2. Appropriate sagittal sonogram of the articular process from the (a) water-based spine phantom, (b) volunteers and (c) the Visible Human Project (cadaver) in the latter, the transverse processes of L2 and L3 have been shaded in green (c). Note how the acoustic shadow of the TP produces the “Trident sign” (b). ES, erector spinae muscle; PM, psoas muscle; TP, transverse processes;

Figure 3. Appropriate sagittal sonogram of the articular process from the (a) water-based spine phantom and (b) volunteers, and a representative anatomical slice from (c) the Visible Human Project (cadaver). A graphic overlay has been placed in (b) to illustrate the camel hump-like appearance of the articular processes (the camel hump sign). AP, articular process; ES, erector spinae muscle; ES, erector spinae; LF, lumbar fascia; PM, psoas muscle; VB, vertebral body.
Acoustic Window

Figure 6. Paramedian oblique sagittal sonogram of the lumbar spine at the L3/L4/L5 level. Note the acoustic shadow of the lamina and the acoustic window, which results from reflections of the ultrasonic signal from the neural structures within the spinal canal. ILS, interlaminar space.

Paramedian Sagittal Oblique

Figure 7. Paramedian oblique sagittal sonogram of the lumbar spine at the L3/L4/L5 level. The posterior epidural space is seen as a hypoechoic space by low reflections within the hyperechoic ligamentum flavum and the posterior dura. Note that the posterior dura appears brighter and is also better visualized than the ligamentum flavum in this sonogram. ESM, erector spinae muscle; ILS, interlaminar space; LF, ligamentum flavum.

Paramedian Sagittal Oblique View

"Sawtooth" appearance of the laminae
* Posterior complex (ligamentum flavum, epidural space and posterior dura)
* Anterior complex (anterior dura, posterior longitudinal ligament, vertebral body)

http://image.slidesharecdn.com/lumbarspinesonoanatomy-141204165614/9?cb=1506377537

Transverse View – Spinous Process

http://espine.com/normal-scapal-anatomy

Anesthesiology. 2011; 114:1459–85
FIGURE 3. Distribution of conclusive images at all interspinous levels in the right paramedian sagittal oblique plane (A) and in transverse median plane (B).
With the subjects seated in the standard flexed position with legs supported and cradling a pillow, they were asked to rotate their shoulders to a 45° angle (a).

References

- www.nysora.com
- www.usra.ca/vspine.php
- http://viewer.zmags.com/publication/70ed5a23#/70ed5a23/1
- Ultrasonography of the adult thoracic and lumbar spine for central neuraxial blockade
- Ultrasonography of the lumbar spine: sonoanatomy and practical applications
- Sonoanatomy relevant for ultrasound-guided central neuraxial blocks via the paramedian approach in the lumbar region

Three Pearls: Lumbar Neuraxial

- Goal is to visualize gaps between bones, if US can get through, so can your needle.
- In transverse view, spinal cord should be at depth of TP
- Do not do parasagittal oblique too close to midline, the side of SP will confound the view
Objective

- Discuss value and use of PECS I and II
- Overview of involved anatomy
- Briefly describe cytokine issues with general anesthesia
- Risks and benefits of adding a PEC block with ultrasound guidance

Pectoralis Blocks

- First described in 2012 at the ESRA Spain Congress by Blanco et al.
- Also known as PECS I, PECS II (Serratus-intercostal plane block (SIP))
- PECS I: median and lateral pectoral nerves
- PECS II: Long thoracic, Intercostal nn. (T2-T6) and thoracodorsal nerve
Lateral Pectoral N. (C5-C7) off lateral cord, innervates pec major

Medial Pectoral N. (C8-T2) off medial cord, innervates pec minor and major

Long Thoracic N. (C5-C7) off proximal brachial plexus, innervates Serratus Ante.

**PECS I**

- medial and lateral pectoral nerves (mid-clavicle)
  - **Medial Pectoral nerve (C8, T1):** immediately from Medial Cord (late anterior division).
    - Innervates Pec minor and Pec major(lower 1/3)
  - **Lateral Pectoral nerve (C5, C6, C7):** immediately from Lateral Cord
    - Innervates Pec Major
PECS I

- Infiltration technique under ultrasound guidance
- Head turned opposite side.
- Shoulder abducted and elbow flexed
- Similar probe position as Infraclavicular
- Linear probe
- Technique for muscle related pain
PECS I
- Target: fascial plane between Pec major and pec Minor. (L. and M. pectoral nn. branches)
- Vascular concern is branches from thoracoacromial artery and vein.
- Analgesic technique.
- Lower Concentration and Higher volume
  (0.25% LA, 20cc Volume)

PECS II
- Additive technique for PECS I and breast surgery
- Long thoracic, Intercostal nn. (T2-T6) and thoracodorsal nerve
- Analgesic benefit for WLE, mastectomies, and axillary dissection

PECS II
- Infiltration technique under ultrasound guidance
- Head turned opposite side.
- Shoulder abducted and elbow flexed
- Similar probe position as infraclavicular along breast toward latissimus dorsi m.
- Linear probe
- Technique for muscle and dermatomal analgesia

PECS I
- Infiltration technique under ultrasound guidance
- Head turned opposite side.
- Shoulder abducted and elbow flexed
- Similar probe position as infraclavicular along breast toward latissimus dorsi m.
- Linear probe
- Technique for muscle and dermatomal analgesia
Intercostal m.

Pleura injection rib4 rib3 anterior ľ lateral cephal ľ

PECs II SCAN

4th Rib pec maj pec min Serr Ant

Target: fascial plane between Pec minor and serratus ant. m. or superficial to serratus anterior m. (T3-T6)

Long Thoracic nerve is immediately superior-posterior along Latissimus dorsi and serratus

Analgesic technique.

Lower Concentration and Higher volume

(0.25% LA, 20cc Volume)

Three Pearls: PECS Blocks

Intravenous injection PECs II, then PECs I to preserve anatomy/view

Excellent alternative to paravertebral for breast surgery

Similar to TAP block, PECs are High Volume blocks!
Olivia Romano, MD University of Colorado Hospital CRASH 2016

Thoracic Paravertebral Block (TPVB)

Overview
- TPVB produces "ipsilateral, segmental, somatic, and sympathetic nerve blockade in contiguous thoracic dermatomes".
- Indications
  - Breast surgery (T3-5, unilateral or bilateral)
  - Thoracoscopic or open thoracic surgery (T5-7, unilateral)
  - Chest wall surgery (at dermatomal level, unilateral)
  - Upper abdominal surgery (T6-8, unilateral or bilateral)
  - Rib fractures (at fracture level, unilateral or bilateral)

Anatomy
- Boundaries
- Contents

Paravertebral block
- May be unilateral or bilateral
- May perform at single or multiple levels
  - Spread with a single injection 4 (±2) segments
- Amenable to single-shot or continuous (catheter) technique
- Choice of local anesthetic
  - Long acting agent
    - 15-20mL Ropivacaine 0.5-0.75% or Bupivacaine 0.5% ± epi
  - Smaller amounts if multiple injections
  - Consider that this space is highly vascularized (rapid absorption), reduce dose in frail/elderly
  - Duration of anesthesia 3-4h; duration of analgesia 6-8h
- Continuous infusion (catheter)
  - Ropivacaine 0.2% or Bupivacaine 0.125-0.25% at 0.5-2mL/h after initial bolus

Ultrasound technique
- Transverse approach
  - Place ultrasound lateral to spinous processes
  - Scanning cephalad or caudad finds acoustic window between the ribs and transverse processes (TPs)
- Sagittal approach
  - Place ultrasound sagittally 3-4cm from midline
  - Scanning mediolaterally, see 1-2 levels of TP (medially) or rib (laterally)
  - Tilt probe slightly laterally for better US visualization of the pleura and SCTL
Intravascular Pleural Needle

After Neuraxial block, pleural depression performed, local puncture/puncture/pneumothorax

Costotransverse spread/epidural will be seen in the injection into the intervertebral space. Likely catheter is punctured. To avoid catheter migration, use adjuncts including syringe dexamethasone may prolong anaesthesia.

Potential complications

- Epidural spread/epidural catheter migration
- Needle entry into intervertebral foramen
  - Neuraxial block, spinal cord injury
- Pleural puncture/pneumothorax
- Intravascular injection

Troubleshooting/Tips for Success

- The further laterally the block is performed, the thinner the PV space. Therefore, the smaller margin of error to pleural puncture.
- In-plane advancement of the needle requires visualization of the needle path at all times to reduce the risk of needle entry into unwanted locations (pleura, neuraxial space).
- Orient bevel of Touhy away from pleura to decrease risk of pleural puncture.
- May feel a "pop" or loss of resistance as needle penetrates internal intercostal membrane/costotransverse ligament.
- Always aspirate prior to injection of LA to reduce the risk of intravascular injection.
- Slowly inject 15 mL of LA in small increments to reduce the risk of epidural spread.
- If using continuous technique, advance catheter no more than 2 cm into space to avoid catheter migration.
- Adjuncts including spondylolysis may prolong analgesia.

Three Pearls: Thoracic Paravertebral

- Superior Costotransverse Ligament must be punctured.
- After puncturing SCTL, pleural depression will be seen with local anesthetic injection.
- The further lateral the block is performed, the more likely pleural puncture becomes.

References

What is a TAP block?

- It is NOT a peripheral nerve block
- It is a field block
- It provides analgesia to the anterior abdominal wall.

What is it good for?

- Cholecystectomy
- Appendectomy
- Hernia repair
- Renal transplant
- Colorectal procedures
- Flaps
- C section
- Abdominal hysterectomy
- Radical prostatectomy

TAP Block

- Good addition to multi-modal analgesia when thoracic epidural is contraindicated or not desired
- They provide analgesia to the abdominal wall, not viscera or skin.
  - There will be NO "level" or sensory dermatome
  - Put the ice pack away!
- Will need additional pain meds post-op and intra-op

TAP injection sites

- Initial studies T7 to L1 on Lateral approach
- Realistically...
- Above Umbilicus
  - T7-L1
  - Subcostal approach
- Below Umbilicus
  - T10-L1
  - Lateral Approach
- Anterior abdominal wall
  - muscles and parietal peritoneum
**Landmarks**

- Rafi (2001)
  - ‘double pop’
  - LOR
- Triangle of Petit
  - 4-8cm²
- Costal margin
- Iliac crest

**Lateral TAP**

- For below umbilicus incision
- Three layers
  - Ext oblique
  - Int oblique
  - Transversus abdominis

**Subcostal TAP**

- For incisions above umbilicus
- Two Layers
  - Rectus Abdominis
  - Transversus Abdominis

**Lateral Approach**

- Cranial
- Caudal
- Costal Margin
- Iliac Crest
**The block**

- US-high frequency probe 5-10 Hz
- Needle: 10cm short bevel
- LA-bupivacaine 2mg/kg (80kg= 160mgs=32mls of 0.5%)
  - 20 mls a side

**Complications**
- Failure
- LA toxicity
- Intraperitoneal, bowel, liver perforation.

**Subcostal Approach**

**Too shallow...**

**Too deep...**

**TAPtastic!**
### Three Pearls: TAP Block

- Subcostal – Above umbilicus, Lateral below
- Analgesia to anterior abdominal wall, not skin or viscera
- Volume block!
  - (Also, Bolus catheters)

### References:

Thursday, March 3
CRASH 2016:
Update in Cardiothoracic Anesthesia

The 2016-year promises to be another exciting and challenging one for practitioners in perioperative cardiac medicine. The objective of this lecture is to provide a snapshot of critical literature in the field of cardiothoracic anesthesia. As with last years presentation, I am taking a perioperative approach to this as I think it is critical that we as anesthesiology providers have an understanding of the issues our surgical, intensivist, and cardiology colleagues are focused on as well as our specific anesthesiology perspective in order to best plan for our patients.

It is clearly impossible to provide an in depth review of such a big topic – so I have tried to select a series of topics and will review the highlights of literature in each area. An overview of our topic choices is as follows:

- ECMO
- TAVR
- VAD
- Aortic Surgery
- Coagulation
  - Major Hemorrhage and appropriate transfusion
  - Red Cell storage
  - Point of Care Testing
  - Fibrinogen supplementation
- Patient Safety – FOCUS
- Cardiac revascularization

ECMO:
Extracorporeal membrane oxygenation (ECMO) has continued to increase in use and the number of programs reportedly implementing ECMO is rapidly expanding. Improvements in circuit design, oxygenator function, and cannulation strategies have opened up increasing clinical pathways to utilize ECMO. Increasing number of institutions have developed ECMO services or teams to use this modality to treat patients with severe respiratory failure, but also for cardiac failure, and to use in select CPR scenarios. Although a randomized controlled trial has not been performed to date, the updated 2015 AHA/ACC guidelines for CPR and ECC now state that E-CPR may be considered as an alternative to standard CPR in select patients with reversible causes of arrest^1. Evidence for E-CPR is growing^2,^3, with the CHEER trial publication this year
demonstrating reasonable survival benefits in a protocolized application of E-CPR along with hypothermia. Although this observational trial only included 26 patients, the authors reported a survival with full neurologic recovery of 54% of patients. Additional concepts from this year include use of ECMO in the setting of myocarditis as well as prediction of survival in settings of heart failure. Finally, there remains debate about the best method to deal with LV distension that occurs following institution of veno-arterial ECMO, and the concept of using an intra-aortic balloon pump to offload the LV was explored.

TAVR / VAD:

Following the theme of cardiac technology, both TAVR and Ventricular Assist device (VAD) therapy have seen some important updates for in 2015. In a recent review for Seminars in Cardiothoracic and Vascular Anesthesiology, Dr. Cleveland summarized critical updates for both of these areas. The Society of Thoracic Surgeons (STS) and American College of Cardiology (ACC) Transcatheter Valve Registry has become operational and it provides valuable insights into several aspects of TAVR. Most noteworthy is the data contained within this registry will be used for quality improvement and benchmarking of TAVR centers. Important trends in TAVR growth are evident in the latest report of the TVT registry. This latest TVT registry report demonstrates that the median age of patients in 2014 is 83 – compared to 84 in 2012. The risk factors remain similar – the typical TAVR patient is over 80, has several co-morbid conditions, and 80% have at least one frailty component present. Other interesting trends in this TVT report include a decrease in procedural mortality from 5.54% to 4.38%. 5 year data is now available from the Placement of Aortic Transcatheter Valves (PARTNER – I) - which is the only randomized trial comparing TAVR to surgically inoperable patients. This particular arm compared TAVR to patients who were treated medically with balloon aortic valvuloplasty (BAV). The resultant mortality in the medical arm was 93.6% - confirming the dismal 5-year survival of untreated symptomatic, severe aortic stenosis. While the mortality in the TAVR group at 5 years was 71.8%, many died of their co-morbid conditions. The second arm of the PARTNER 1 study randomized 699 patients who were at high risk for Surgical AVR (SAVR) to either TAVR or SAVR. The 5-year data from this arm showed no difference in risk of death, 62% in surgical group versus 67% in the TAVR group.

Major advances in VAD therapy include CE Mark approval for the Heartmate 3 pump, which is a fully magnetically levitated pump eliminating the need for mechanical
bearings. This has been a major design concern for longevity with previous pump systems as wear and tear on the bearings is thought to become a nidus for thrombosis. Increased blood flow within this pump reduces blood trauma, and there is now the ability for an artificial pulse. Approval was based on results of a 50 patient trial comparing outcomes with INTERMACs registry data. The Heartware HVAD is another device approved for bridge to transplant, and outcomes from the ADVANCE (Evaluation of the Heartware Left Ventricular Assist Device for the Treatment of Advanced Heart Failure) clinical trial became available with particular emphasis towards reducing the neurological events associated with this pump.

**Aortic Surgery:**

Aortic surgery remains a major surgical and anesthetic challenge, especially in cases involving the Thoracic Aorta and Aortic Arch. Optimal temperature management continues to be debated during arch surgery as techniques of antegrade cerebral perfusion continue to allow surgeons to improve cerebral protection. Angeloni et al completed a metaanalysis looking at bilateral vs unilateral antegrade cerebral perfusion during the circulatory arrest period for total arch reconstruction. The only difference that could be teased out between these groups was that longer circulatory arrest times affected mortality with unilateral cerebral perfusion but not bilateral. They concluded that unilateral was sufficient for constructions requiring<40 minutes, but that bilateral perfusion was optimal for longer cerebral perfusion times. These studies utilized surgeries with temperature at 24 C, however the question remains as to what temperature is acceptable. Two publications from Emory explore this topic looking at complex aortic repairs, as well as emergent dissection cases and they were able to demonstrate comparable outcomes using warmer temperatures (25-26 C).

**Bleeding and Coagulopathy:**

Cardiac surgery continues to represent one of the major perioperative areas of blood product use besides trauma and liver transplant. As such, review of recent updates in the area of coagulation management is critical and constantly changing. Hot topics from 2015 include appropriate ratio use of blood products in massive transfusion, use of point of care testing, transfusion thresholds, and factor concentrates. Holcomb et al published the long anticipated results of the Pragmatic Randomized Optimal Platelet and Plasma Ratios (PROPPR) Trial which incited a large number of editorial responses. This trial reported
that in patients with severe trauma and major bleeding, early administration of plasma, platelets, and red blood cells in a 1:1:1 ratio compared with a 1:1:2 ratio did not result in significant differences in mortality at 24 hours or at 30 days. However, more patients in the 1:1:1 group achieved hemostasis and fewer experienced death due to exsanguination by 24 hours. Two other major publications looked at the issue of transfusion triggers in the setting of cardiac disease and surgery. Murphy et al published results of the TITRe2 trial (2000 patients) and reported A restrictive transfusion threshold after cardiac surgery was not superior to a liberal threshold with respect to morbidity or health care costs.16 Carson et al reported on results from the FOCUS trial looking at over 2000 patients with cardiac disease, and having hip surgery for outcome related to liberal vs restrictive transfusion strategies. They reported Liberal blood transfusion did not affect mortality compared with a restrictive transfusion strategy in a high-risk group of elderly patients with underlying cardiovascular disease or risk factors. The underlying causes of death did not differ between the trial groups. These findings do not support hypotheses that blood transfusion leads to long-term immunosuppression that is severe enough to affect long-term mortality rate by more than 20-25% or cause of death.17 Finally – specific to RBC transfusions, debate has continued on age of PRBC and outcomes. Steiner et al published results of their trial looking at this question in NEJM and reported that the duration of red-cell storage was not associated with significant differences in the change in MODS. We did not find that the transfusion of red cells stored for 10 days or less was superior to the transfusion of red cells stored for 21 days or more among patients 12 years of age or older who were undergoing complex cardiac surgery.18

Point of Care testing is a frequent topic for coagulation management and cardiac surgery. Corredor et al published a review and meta-analysis looking at over 30 observational and 9 randomized studies examining the utility of POC testing in 4000+ patients.19 Overall conclusions support incorporation of point-of-care platelet function tests into transfusion management algorithms is associated with a reduction in blood loss and transfusion requirements in cardiac surgery patients. Karkouti et al published a similar trial this year in Anesthesiology with a similar conclusion regarding use of a ROTEM based algorithm.20 One of the interesting things we are learning about coagulation is the importance of various factors in the cascade and fibrinogen is gaining a lot of attention. With the availability of fibrinogen concentrate- there were two interesting publications
from 2015 worth looking at. Rannucci et al published a “Randomized, double-blinded, placebo-controlled trial of fibrinogen concentrate supplementation after complex cardiac surgery” which was a single-center, prospective, randomized, placebo-controlled, double-blinded study in one-hundred sixteen patients undergoing heart surgery with an expected cardiopulmonary bypass duration >90 minutes. They were able to demonstrate that fibrinogen concentrate limits postoperative bleeding after complex heart surgery, leading to a significant reduction in allogeneic blood products transfusions. The second trial by Jeppson et al, “Preoperative supplementation with fibrinogen concentrate in cardiac surgery: A randomized controlled study performed in 48 low-risk, coronary artery bypass grafting patients.” Findings in this study were that there was not an effect of Fibrinogen concentrate when given to this group of low risk patients with normal Fibrinogen, but the authors do suggest that further work should be done focused on patients with hypofibrinogenemia. Finally – regarding platelet activation and CPB, Kertai and colleagues published a study in over 4000 patients looking at the post-operative nadir platelet count with kidney injury. They demonstrated that for every 30 x 10^11 decrease in platelet counts, the risk for postoperative AKI increased by 14%.

In the past two years I have mentioned the issue of percutaneous cardiac interventions with coronary artery stenting and how it compares to CABG. This year brings a NEJM publication by Bangalore et al comparing registry outcomes between PCI using everolimus stents and CABG. They report the risk of death associated with PCI with everolimus-eluting stents was similar to that associated with CABG. PCI was associated with a higher risk of myocardial infarction (among patients with incomplete revascularization) and repeat revascularization but a lower risk of stroke. The concepts of revascularization and choice of conduit choice has also been debated for years. This year, Guadino et al published results of a nice meta-analysis that details the current state of the various options for arterial grafts, as well as proposing a patient choice algorithm. Critical for the anesthesiologist in this regard are positioning details, as well as pharmacologic therapy options if multiple arterial grafts are used.

The last section for this year is on patient safety initiatives. Beginning in 1999 the Institute of Medicine published a number of patient safety articles including their Seminal publication, “To Err Is Human” (1999) which reported 44,000 and 98,000 hospitalized people died each year from preventable medical errors. “Crossing the Quality Chasm” was
published in 2001 and highlighted deficiencies in quality in the American health care system and called for a complete system redesign. In response to this, the Society of Cardiovascular Anesthesiologists initiated a program named “FOCUS” (Flawless Operative Cardiovascular Unified Systems) to develop a funding mechanism for novel methodology in addressing patient safety issues in the cardiac OR. We are now seeing some of the fruits of this initiative with important publications coming out as a result of this funding. We will discuss two articles, one from Paulus et al, and the other from Thomson et al that are recent publications in this area and briefly explore the methodology that they have used to approach patient safety concerns in the OR. 27,28

References:


Analgesics and the Effects of Pharmacogenetics

Mindy Cohen, MD

Disclosures: none

Learning Objectives

2. Identify the most common polymorphisms in drug-metabolizing enzymes that influence analgesics.
3. Describe strategies for modifying analgesic regimens based on pharmacogenomics.

Before there was the need for analgesia, there was…

PAIN

Genetic influence on pain sensitivity

Genetic influence on analgesic medications
Genetic Influences on Pain
- Cases of Absent Pain
  - Some rare cases explained by genetics
  - Loss-of-function mutations
    - α-subunit of voltage-gated sodium channel
  - Other components that regulate functioning and homeostasis of nervous system

Genetic Influences on Pain
- Twin Studies
  - 2007: Thermal & chemical noxious stimuli
    - 98 pairs of twins
    - 22-55% of variability was genetic
  - 2008: Thermal noxious stimuli
    - 96 twins
    - Cold-pressor pain
      - 7% of variability was genetic
    - Heat pain
      - 3% of variability was genetic

Smith M et al. Clinical Genetics 2012

Genetic Influences on Pain
- Twin Studies
  - 2012: Thermal noxious stimuli, μ-agonists
    - 112 pairs of twins
    - Pain tolerance and opioid analgesia
    - 24-60% of the response was influenced by genetic makeup

Genetic variation affects Pharmacokinetics

Analgesics and Genetics:
Pharmacokinetics and Pharmacodynamics

Genetic variation affects Pharmacokinetics
Pharmacokinetics - Phase I Enzymes

- Cytochrome P450 superfamily
- Alter the chemical structure of drugs

Six most significant CYPs

- 3A4/5 37-60% of drugs
- 2D6 15-25% of drugs *CODEINE*
- 2C19 10%
- 1A2 9%
- 2E1 2%
- 2B6 4%

Zanger et al. Analytical and Bioanalytical Chem 2008

CYP 2D6

- 2D6 is highly polymorphic
- Alleles defined as
  - Normal, Reduced, Non-functional

<table>
<thead>
<tr>
<th>Metabolizer Phenotype</th>
<th>Activity Score</th>
<th>Active alleles</th>
<th>Reduced function</th>
<th>Non-functional alleles</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ultrarapid</td>
<td>&gt; 2</td>
<td>&gt; 2</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Extensive</td>
<td>1-2</td>
<td>1-2</td>
<td>0-1</td>
<td>0-1</td>
</tr>
<tr>
<td>Intermediate</td>
<td>0.5</td>
<td>1</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>Poor</td>
<td>0</td>
<td></td>
<td>2</td>
<td></td>
</tr>
</tbody>
</table>

Zanger et al. Analytical and Bioanalytical Chem 2008

CYP 2D6 - Ultrarapid Metabolizers (UMs)
CYP 2D6 - selected drug targets

- Oxycodone
- Hydrocodone
- Tramadol → pro-drug, requires activation
- Codeine → pro-drug, requires activation

Pharmacokinetics - Phase II Enzymes

- UGT enzymes
  - Glucuronidation of drugs
  - UGT2B7 has genetic polymorphism
- Many opioids have –OH (hydroxyl) group
  - Morphine, M3G, M6G
  - Codeine
  - Hydromorphone
  - Oxymorphone
  - Naloxone and Naltrexone

Case report: Codeine & Tonsillectomy

- 4 year-old boy (27.6 kg) with obstructive sleep apnea and recurrent tonsillitis
- Underwent adenotonsillectomy
- Discharged on POD #1
- Prescribed codeine 8 mg/dose q 4-6 hrs
  - Received a total of 4 doses

Drug/Metabolite Measured Blood Concentration

<table>
<thead>
<tr>
<th>Drug/Metabolite</th>
<th>Measured Blood Concentration</th>
</tr>
</thead>
<tbody>
<tr>
<td>Codeine</td>
<td>Within expected range</td>
</tr>
<tr>
<td>Morphine</td>
<td>17.6 ng/mL</td>
</tr>
</tbody>
</table>

Therapeutic morphine concentration is 4.5 +/- 2.1 ng/mL

Case report: Codeine & Tonsillectomy

- POD #2
  - Parents found him pulseless
  - Postmortem analysis suggested respiratory arrest
  - Codeine and Morphine blood levels were measured…
Case report: Codeine & Tonsillectomy

Genotyping revealed a gene duplication that led to an ultrarapid (UM) genotype


μ-Opioid Receptor

- OPRM1 encodes μ-Opioid Receptor
- G protein-coupled K+ channel
- 118A>G SNP influences binding of opioids and activation
  - G/G genotype has less benefit from opioids
  - However, less adverse effects as well

Oertel, B. et al. Pharmacogenet Genomics 2006
Chou, W. et al. Anesthesiology 2006

κ-Opioid Receptor

- MC1R encodes Melanocortin-1 receptor
- Improved analgesia of κ-opioid agonists in red-haired, fair-skinned women
  - 75% carry 2 or more inactive variants
- Consider incorporating κ-opioid analgesics in these patients (e.g. pentazocine)
- Non-gender specific μ-opioid agonist pain modulation
  - Potency of morphine increased in inactive variants

Mogil, J et al. Proc Natl Acad Sci USA 2003

ABC1/MDR1 transporter

- Removes drugs from intracellular compartment
- 3435 C>T SNP, T/T genotype has 4-fold less protein expression
  - Require less oral opioids for analgesia
  - Possibly due to increased drug absorption and concentration at site of action
- 2677 G>T/A SNP
  - A allele protective of central side effects

Genetic variation also affects Pharmacodynamics

Catechol-O-methyltransferase
- Metabolizes and inactivates catecholamines
- Regulator of Dopamine, Epinephrine, and Norepinephrine in the pain pathway
- 472 G>A SNP
  - Patients require less morphine
  - Perhaps low-function COMT leads to up-regulation of μ-opioid receptor

OPRM1 and COMT likely interact

ABCB1 & OPRM1 interaction
- Morphine analgesia
- ABCB1 transporter
  - T allele = less function
- OPRM1 mu-opioid receptor
  - G allele = less affinity of receptor for morphine

Non-Opioid Analgesics and Genetics
**NSAIDs**

- Example: Ibuprofen
- Major metabolic enzyme is CYP2C9
  - Some 2C9 polymorphisms decrease enzyme function

Mazakoukaya L et al. Pharmacogenet Genomics 2015

---

**CYP2C9 Genotype and NSAID clearance**

*3/*3 genotype has only 25% of the clearance as compared to *1/*1 (wild type) genotype

---

**Translational Potential of Genetics**

- More important than dose adaptations could be genetic guidance on the choice of analgesic
- Genetics-based dosing regimens?
- Chronic pain population...large potential for benefit

---

**CPIC Guidelines for Codeine Therapy in the Context of CYP2D6 Genotype**

<table>
<thead>
<tr>
<th>Phenotype</th>
<th>Implications for Codeine</th>
<th>Recommendations for codeine therapy</th>
<th>Classification of recommendation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ultrarapid metabolizer</td>
<td>Increased formation of morphine, risk of toxicity</td>
<td>Avoid codeine. Consider morphine or nonopioid. Consider avoiding tramadol</td>
<td>Strong</td>
</tr>
<tr>
<td>Extensive metabolizer</td>
<td>Normal morphine formation</td>
<td>15-60 mg q4 hrs</td>
<td>Strong</td>
</tr>
<tr>
<td>Intermediate metabolizer alternative</td>
<td>Reduced morphine formation</td>
<td>15-60 mg q4 hrs. If no response, consider alternative</td>
<td>Moderate</td>
</tr>
<tr>
<td>Poor metabolizer</td>
<td>Greatly reduced morphine formation, insufficient pain relief</td>
<td>Avoid codeine. Consider morphine or nonopioid. Consider avoiding tramadol</td>
<td>Strong</td>
</tr>
</tbody>
</table>


---

**FDA Black Box Warning**

CODEINE SULFATE: codeine sulfate solution
TAGI Pharma, Inc.

**INDICATIONS AND USAGE**

FDA Black Box Warning

Cohen, Mindy, MD

---

**What are graduating ENT residents planning to use in their practice?**

<table>
<thead>
<tr>
<th>Analgesic Regimen Post-tonsillectomy</th>
<th>Percent of ENT Residents</th>
</tr>
</thead>
<tbody>
<tr>
<td>Acetaminophen/Hydrocodone</td>
<td>25.5%</td>
</tr>
<tr>
<td>Acetaminophen</td>
<td>19%</td>
</tr>
<tr>
<td>Ibuprofen</td>
<td>17%</td>
</tr>
<tr>
<td>Acetaminophen/Oxycodone</td>
<td>14.9%</td>
</tr>
<tr>
<td><strong>Acetaminophen/Codeine</strong></td>
<td><strong>8.5%</strong></td>
</tr>
<tr>
<td>Hydrocodone</td>
<td>8.5%</td>
</tr>
<tr>
<td>Oxycodone</td>
<td>4.3%</td>
</tr>
</tbody>
</table>

Cheng et al. Otolaryngol Head Neck Surgery 2013
The Individual Patient...

- Better therapeutic outcome
- Successful management of “condition” in real world might increase from 60% to 90+% (9):
- Futile therapeutics would decrease
- Cost-benefit across drugs and conditions would improve

"Imagine if we could readily evaluate the opioid metabolism or receptor function of patients during their preoperative assessments and develop perioperative pain treatment plans targeted specifically to each one."
- Mark Warner, M.D. Rovenstine Lecture 2006

Resources

- Pharmacogenomics Knowledge Base
  - www.pharmgkb.org
- Pharmacogenomics Research Network (PGRN)
  - www.pgrn.org
- FDA genomics resource
  - http://www.fda.gov/drugs/scienceresearch/researchareas/pharmacogenetics/

References

References

Spine Surgery Panel: 
**Bleeding Is Not The Only Complication**

What Other Minefields are Out There?

Daniel Janik, MD  
Associate Professor  
University of Colorado School of Medicine

---

DISCLOSURE

I have no commercial or other conflicts of interest

---

Positioning is Important!

Where Are The Potential Risks?

---

Degenerative Disease of the Spine May Place Patients at Risk in Absence of Instability

---

Occult Risk of Perioperative Injury to The Cervical Spinal Cord

---

A Closed Claims Search

- All general anesthesia claims from 1970-2007  
- Cervical injury claims = 48 (1%)  
- 69% were permanent and disabling compared to 19% for other general anesthesia claims  
- 73% were male  
- Cord injuries (n=37) were most severe and resulted in quadriplegia  
- Cord injuries often occurred in absence of trauma (81%) or instability (76%)
Contributors to Cord Injury

• Anatomic abnormalities – 81%
• Direct surgical complications – 24%
• Preprocedure cord injury – 19%
• Intraoperative head/neck position – 19%
• Airway management – 11%  Now that is interesting!
• Another interesting finding – 24% occurred in patients in the sitting position!

What About Head Position?

• Of those claims where head position was judged to be contributory to injury, records showed the patient was:
  in marked extension, extension was possible, or in extreme hyperextension

Cervical Spondylosis

• 20-30% of patients age 40 have disc dessication, disc herniation, narrow intervertebral spaces
• 10-30% of patients age 60 have evidence of root or cord compression
• Advanced cervical spondylosis can lead to canal stenosis and cord compression with myelopathy
• Severe cervical stenosis can be asymptomatic with no clinical signs
• A chronically compressed cord has limited physiologic reserves and may be more prone to ischemia

Spondylotic Compression Can Increase With Neck Flexion or Especially Extension

A Wee Bit of Trouble?

Shedid D and Benzel EC, Neurosurgery 60:S7-13, 2007
Take-away Message From This Study

- Degenerative changes which may put cervical spinal cord at risk for injury are common and may be clinically silent
- These changes limit the physiologic reserve of the cervical spinal cord
- Events under our control (positioning of the head, blood pressure, airway management) can have significant impact on patient outcome
- Beach chair position merits close attention (both head position and blood pressure)

Another Take-Home Message

“We can take some comfort (though how much comfort is unclear) that contemporary anesthesiologists’ efforts to avoid injury during laryngoscopy and endotracheal tube placement are paying off. However, we should be disturbed that there are other groups of heretofore unrecognized patients who are becoming injured, and for reasons that are not readily apparent”


What About The Arms?

CERVICAL SPINE CASE
C3-T4 Scoliosis Correction

C3-T4 Scoliosis Correction
Left Median Nerve SSEP

C3-T4 Scoliosis Correction
Median Nerve SSEP Stacks Left & Right
C-T4 Scoliosis Correction

- What has happened?
- Is this an anatomic, physiologic, or technical problem?
- Where do you think the problem is?
- What would you do to investigate?
- Would you make any change in your management?

Lateral Decubitus

- Most common: Brachial, radial, median, ulnar
  - Radial nerve palsy of the upper arm
- Axillary Roll
  - supports the thorax, protect brachial plexus from compression
  - Should be placed caudal to the axilla, on the rib cage
- Arm holder, or pillow placed between the two arms

Prone

- Most common: ulnar, radial and median
  - Brachial plexus can be compressed against the second rib secondary to force on the clavicle
- Upper limb should maintain a small degree of anterior flexion, and then abducted and externally rotated to less than 90 degrees.
  - If arm is hyperabducted, the humeral head can compress the brachial plexus
- Ensure chest support does not impinge the axilla
- Forearm pronated and supports/pads should be placed to prevent the indirect compression of the ulnar nerve or axial pressure from the humerus.
- Head and neck neutral
What About The Eyes?

Post-operative Visual Loss
Roth S et al, Anesthesiology 1996; 85:1020-7

• Independent Risk Factors:
  Length of surgery
  Lateral positioning
  Operations on head or neck
  General anesthesia
  Surgery on Monday

Post-operative Visual Loss
Warner ME, Anesthesia & Analgesia 2001; 93: 1417-21

• Possible factors:
  Anemia
  Hypotension
  Surgical Duration
  Combination

Post-operative Visual Loss
Nuttall GA et al, Anesthesia and Analgesia 2001; 93:1410-6

• Study of 27,915 patients undergoing CPB
• 17 had ION; 0.06% (12 AION, 5 PION)
• Bivariate risk factors:
  Low Hgb conc (<8.5 g/dL)
  Atherosclerotic vascular disease
  Pre-operative angiogram
• Univariate risk factors
  RBC transfusions (OR 1.3)
  Any non-RBC product (OR 4.4)

Post-operative Visual Loss

• Highest incidence:
  Surgery for scoliosis – 0.28%
  Posterior-only approach – 0.29%
  Anterior-only approach – 0.17%
• Risk factors for non-ION, non-CRAO loss:
  Age<18 years: OR 5.8
  Age>84 years: OR 3.2
  Peripheral vascular disease: OR 2.0
  Pre-existing hypertension: OR 1.3
  Blood transfusion: OR 2.2
**Post-operative Visual Loss**  

- Risk factors for ION:  
  Hypotension: OR 10.1  
  Peripheral vascular disease: OR 6.3  
  Anemia: OR 5.9  

- Note – this study did not define hypotension or anemia  

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**Post-operative Visual Loss**  
Shen Y and Roth S, Anesthesiology 2008; 109: A1013  

- Retrospective study using National Inpatient Sample from 1996 to 2005  
- Rates of visual loss:  
  Spinal fusion – 1:3364 (0.029%)  
  Laminectomy – 1:11,453 (0.0087%)  
  Appendectomy – 1:78705 (0.0012%)  
- Spinal fusion with visual loss:  
  57% lumbar/lumbosacral  
  35% thoracic/thoracolumbar  
  8% cervical

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**Most Common Causes**  
- Ischemic Optic Neuropathy (ION)  
- Central Retinal Artery Occlusion (CRAO)  
- Cortical Blindness  
- Central Retinal Vein Occlusion

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**Cortical Blindness**  
- Caused by damage to the optic radiation or occipital cortex (resulting in infarction) from:  
  - Embolism (particulate or air)  
  - Sustained hypotension  
  - Cardiac arrest  
- Presentation:  
  - Painless loss of vision, pattern depends on area affected

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Non-hemorrhagic infarct in left occipital lobe
Central Retinal Artery Occlusion

- Usually caused by compression of the eye leading to increased intraocular pressure with resultant decrease or cessation of flow in the central retinal artery
- End result is retinal ischemia due to lack of oxygen delivery

Ischemic Optic Neuropathy

- Anterior ischemic optic neuropathy (AION)
  - Non-arteritic (more common perioperative type)
  - Arteritic
- Posterior ischemic optic neuropathy (PION)

Anterior Ischemic Optic Neuropathy

- Caused by transient decrease in perfusion pressure of the nutrient vessels of the anterior optic nerve below autoregulatory range
  - Decreased mean arterial pressure
  - Increased intraocular pressure
  - Both
- Injury depends on severity and duration of transient ischemia

Anterior Ischemic Optic Neuropathy – Etiology

Williams EL. Anesthesiology Clin N Am 2002; 20:367-384

- Predisposing factors
  - Variable blood supply (posterior ciliary arteries)
  - Small optic disk size
  - Aging
  - Hypertension
  - Smoking
  - Diabetes mellitus
  - Vascular disease
- Precipitating Factors
  - Acute systemic hypotension*
  - Venous obstruction*
  - Raised intraocular pressure
  - Lowered hematocrit*
  - Increased blood viscosity (sickle cell; polycythemia)

Posterior Ischemic Optic Neuropathy

- Caused by decreased oxygen delivery to posterior portion of optic nerve (between optic foramen and where central retinal artery enters nerve)
- Nerve only fed by pial vessels which are sensitive to compression
- Not usually associated with occlusive vascular disease
- More likely to be associated with emboli than AION

Posterior Ischemic Optic Neuropathy – Etiology

Williams EL. Anesthesiology Clin N Am 2002; 20:367-384

- Multifactorial:
  - Hypotension*
  - Low Hemoglobin*
  - Increased intraorbital venous pressure
  - Infection
  - Venous obstruction*
  - Congenital absence of central retinal artery
  - Internal carotid artery dissection
Post-operative Visual Loss

Anatomic Considerations

- Blood supply to optic nerve is vulnerable
- Known variability in blood supply
- Atypical anatomic patterns
- Poor watershed perfusion zones
- Abnormal autoregulation
- Optimal range of hematocrit and blood pressure for adequate O2 delivery to optic nerve unknown (particularly in presence of venous congestion in prone position)

Post-operative Visual Loss

Summary of Suggested Risk Factors

- Hypertension
- Diabetes
- Smoking
- Atherosclerosis
- Male gender
- Middle age
- Spine surgery
- Head and neck surgery
- Cardiac surgery
- Hyperlipidemia
- Intraoperative hypotension
- Intraoperative anemia
- Large blood loss
- Large fluid resuscitation
- Facial edema
- Prone position – head down
- Prolonged surgical time
- Eye trauma
- Vasopressors

Interesting Points:

- Most patients with CRAO had evidence of ocular trauma and unilateral vision loss which suggests positioning may be at fault
- Most patients with ION had bilateral visual loss indicating systemic or patient-specific factors may play role

Post-operative Visual Loss

Lee LA et al. Anesthesiology 2006; 105(4): 652-659

Hypotension and Post-operative Ischemic Optic Neuropathy

- 80 adults in POVL registry matched with 315 control patients for year of surgery
- Independent risk factors:
  - Anesthesia duration (OR/1 hr 1.39) Obesity (OR 2.83)
  - Wilson frame use (OR 4.3) Male Sex (OR 2.53)
  - Lower colloid use (OR/5% 0.67) EBL (OR/1L 1.34)
- No independent effect:
  - Any BP > 40% below baseline for 30 min
  - Anemia

POVL Study Group, Anesthesiology 2012, 116:15-24
Proposed Theories of Origin of Ischemic Optic Neuropathy

- Etiology of ION may be influenced more by intraoperative physiologic perturbations than pre-existing disease states
- Higher proportion of men to women (69%) suggests protective effect of estrogen
- Acute venous congestion of optic canal suggested by risk factors: Obesity, Wilson frame, long duration, EBL, % colloid (and cases of ION occurring in neck dissections and robotic prostatectomies)
- Role of systemic inflammatory response?

So, What Should I Do To Protect My Patient (and Myself)?

Post-operative Visual Loss: Strategies for Prevention

- Proper positioning:
  - Prone position with head down will cause increase in intraocular pressure and favor development of periorbital edema
  - Keep head above level of heart
  - Use padded headrest without pressure on eyes

Post-operative Visual Loss: Strategies for Prevention

Elevate the head of the bed to prevent edema formation

Properly pad and protect the eyes from compression

Proper positioning of ProneView™ Pillow
Post-operative Visual Loss: Strategies for Prevention

- Occlusive dressing over eyes to prevent entry of surgical prep solutions
- Stage long procedures into two or more short procedures?


**BUT**

Updated ASA Practice Advisory on POVL

Anesthesiology 2012; 116:274-85

- Use of deliberate hypotension not been shown to be associated with ION
- Colloids should be used along with crystalloids
- No documented hemoglobin level associated with development of ION
- Insufficient evidence to provide guidance on use of \( \alpha \)-adrenergic agents
- High-risk patients should be positioned so head is level with or above heart and head in neutral forward position
- Consider staging procedures in high risk patients

Is Staging Safer Than A Single Surgery?


- Nationwide Inpatient Sample
- 1998-2006
- 11265 circumferential spine surgeries
- Increased incidence (28.4% vs. 21.7%) of complications including:
  - DVT
  - ARDS
- Age > 65 years old also increased risk

Controversial Strategies

- Avoid the use of \( \text{N}_2\text{O} \):
  \( \text{N}_2\text{O} \) will ↑ plasma homocysteine by disrupting folate/B6/B12 metabolism; high homocysteine correlated with enhanced inflammation, diabetic neuropathy, and CRAO/CRVO

Kempen PM. *Anesthesiology* 2012; 117: 431-2

- Restrict crystalloid to 40 ml/kg total for spine case:
  - Based on findings that total volume of resuscitation, total non-blood replacement, and lower use of colloid were risk factors

Larson CP. *Anesthesiology* 2012; 117: 433-4

Can we prevent post-operative vision loss?

**MAYBE,**

But there is still a lot we do not know!

Would you lower a patient’s blood pressure to help control bleeding? And, if so, how low would you be willing to go?
Deliberate Hypotension

- Classic definition:
  A reduction in systolic blood pressure to 80-90 mmHg, or a decrease in MABP to 50 to 65 mmHg in normotensive patients.
- Almost all guidelines were developed for healthy, young patients

Potential Complications

- Delayed awakening
- Blurred vision
- Delayed hemorrhage
- Increased lung dead space
- Increased shunt fraction
- Decreased renal blood flow with oliguria or anuria
- Cerebral thrombosis
- Cerebral or cerebellar infarction
- Spinal cord infarction
- Retinal thrombosis
- Ischemic optic neuropathy

Potential Uses

- Prostate surgery
- Orthognathic surgery
- Spine surgery
- Total hip arthroplasty
- Shoulder surgery
- Head and neck surgery
- Intracranial procedures (aneurysm clipping)

Efficacy in Orthopedic Procedures

- Subgroup analysis showed reduction in blood loss for:
  - Total hip arthroplasty – 503 mL
  - Spine fusion – 318 mL
  - Orthognathic surgery – 147 mL
- Clinical significance depends on patient co-morbidities and surgical procedure

Review Article – Recommendations in Spine Surgery

- Contraindication: altered baseline autoregulatory mechanisms or vulnerability to ischemic complications
- Maintain SBP 20-30% below baseline values (80-90 mmHg) in normal patients
- Close monitoring of end-organ function
- Hypotension should be abandoned in presence of changes in nerve conduction studies (SSEP, MEP), EKG changes, decreased urine output, severe anemia (Hct < 20%), or tissue acidosis

Dutton RP, Eur Spine J (Supp) 13:S66-571, 2004
Does the ASA Provide Any Guidance?

“When appropriate, intraoperative or postoperative blood recovery and other means to decrease blood loss (e.g. deliberate hypotension) may be beneficial.”

Use of Deliberate Hypotension

- Selective use still advocated by some
- Proper patient selection
- Paired with procedures with proven efficacy
- Intense monitoring of end-organ perfusion
- Balance risks with benefits
- Maintain decreased MABP only as long as necessary
- Remember – the lower limit of cerebral autoregulation is higher than previously taught

In Conclusion

- Deliberate hypotension is considered an acceptable strategy to use to manage operative blood loss
- Careful patient selection is necessary to minimize risk
- It has been shown to significantly reduce blood loss and transfusion requirements in certain cases
- The lowest acceptable MABP must be individualized for each patient based on presence/absence of comorbidities and surgical position
- Close monitoring of end-organ perfusion is essential
- Maintain hypotension for as brief as necessary
How do I manage this coagulopathy?

Mindy Cohen, MD
CRASH 2016

All bleeding stops... eventually

Disclosures: none

Review of coagulation cascade

1. Injury. A blood vessel is severed. Blood and blood components (e.g., erythrocytes, white blood cells, etc.) are leaking out of the breaks.

2. Vascular spasm. The smooth muscle in the vessel wall contracts near the injury point, reducing blood loss.
Primary Hemostasis

- an initial platelet plug is formed when vascular tissue is damaged
- platelets activate and release chemical signals that induce aggregation
- adherence to the subendothelial matrix
- Activated surface receptors interact and protein bridges are created between the subendothelium and activated platelets

Coagulation Cascade

- **extrinsic pathway** begins when trauma to vasculature exposes tissue factor to blood
- activating coagulation factor VII (FVII)
- **active FVII complex** initiates and amplifies the coagulation cascade

- **intrinsic pathway** activates factor XII upon surface damage resulting in downstream
- proteolytic activation of other coagulation factors

- Converge into the common pathway
- activation of factor X cleaves prothrombin into thrombin
- activates fibrinogen into fibrin, reinforcing the platelet
Uncontrolled bleeding can lead to a combination of:
- hemodilution, hypothermia
- consumption of clotting factors
- acidosis

These exert their own negative influences over the clotting process to further exacerbate the problem in a vicious Bloody circle.

**Derangements in massive bleeding**

**Dilutional thrombocytopenia**

- the most common of the coagulation abnormalities in heavy bleeding
- particularly common with transfusion volumes in excess of 1.5 times their blood volume
- After replacement of one blood volume, only 35% to 40% of platelets remain in the circulation.

**Dilution of coagulation factors**

- dilution of procoagulant factors is seen with
  - fluid resuscitation
  - transfusion

**Hypothermia**

- hypothermia causes
  - platelet dysfunction
  - alteration of coagulation enzyme kinetics
  - disruption of fibrinolytic balance
  - Prolongation of clotting time

**Hypotension**

- Strong correlation between the development of coagulation abnormalities and duration of hypotension
- hypoperfusion is associated with
  - Consumptive coagulopathy
  - prolongation of aPTT
  - Decreased factor V activity
  - microvascular bleeding

**Hypothermia**

At a temperature of 33° C
- impairment in coagulation is equivalent to a factor IX deficiency of 33% of normal level
- Similar to Hemophilia B
- greater degree of clot lysis due to the impairment of intrinsic inhibitors of fibrinolysis
Laboratory analysis of coagulation status

Standard lab tests (SLTs)

- designed to test for coagulation factor deficiencies
  - not for predicting risk of bleeding or guiding hemostatic management.
- Slow turnaround times
- Typically performed with just plasma
- conducted outside the effect of *in vivo* physiology
- do not convey clot stability or fibrinolysis
- Delayed results may not reflect the current state of hemostatic physiology

Standard lab tests- aPTT

- integrity of intrinsic and common coagulation pathways
- invented to monitor heparinization in the treatment for thromboembolic disorders
- affected by
  - levels of fibrinogen & factors II, V, VIII, IX, XI, and XII
  - temperature
  - pH
- large variation in calibration, difficult standardization
- empiric cut-off value for therapeutic intervention
  - aPTT 1.5–1.8x above normal upper limit

Standard lab tests- PT/INR

- Integrity of extrinsic and common pathways
- created to monitor and adjust the doses of coumarins
- affected by levels of fibrinogen and coagulation factors II, V, VII and X
- standardized by conversion to an international normalized ratio (INR)
- empirical cut-off value for therapeutic intervention
  - PT less than 40 % of normal

aPTT and PT/INR

PT and aPTT assess only the speed of fibrin strand formation, not the mechanical or functional properties of the clot over time

Standard lab tests- fibrinogen

- Fibrinogen
  - essential for effective coagulation
  - the first factor to be depleted during massive bleeding and hemodilution
  - Excessive bleeding with fibrinogen levels below 50–100 mg/dl

Cohen, Mindy, MD  Spine Surgery Panel: How Do I Manage This Coagulopathy?
Standard lab tests—

- Platelet count

- Does not measure activity of the platelets
- Platelet function, more than number, is critical in the perioperative setting
- The empirical cut-off value for platelet transfusion is a platelet count of 50–100

Viscoelastic point-of-care monitoring

- Thromboelastogram (TEG)
  - Uses whole blood
  - More representative of in vivo coagulation

Thromboelastography measures viscoelastic properties

- Induction of clotting
- Pattern of changes in viscoelasticity
  - Thrombus formation
  - Clot stability and firmness
  - Fibrinolysis

Coagulation initiation

- R reaction time
- Amplitude of 2nm
- Partially dependent on thrombin generation

Figure 2: A depiction of a TEG device in which a pin suspended from a torsion wire is immersed in a cup of whole blood. The cup is held in a heating block and continually oscillates through 4°–45° every 5 sec. Changes in viscoelastic clot strength are directly transmitted to the torsion wire and detected by an electromechanical transducer.
Clot formation
- Alpha angle measures clot formation rate
- K time is the time for amplitude to increase from 2 to 20 mm

Clot strength
- Maximum amplitude MA
  - Combined effects
    - platelet aggregation and
    - fibrin polymerization

Clot stability
- Lysis index (LY30), % of clot strength remaining
- Can detect hyperfibrinolysis

Platelet function testing
- has been used successfully for screening of primary hemostasis abnormalities such as von Willebrand disease
- can detect disturbances in primary hemostasis by measuring deposition of platelets from whole blood on to an artificial surface
- preoperative platelet function testing can be used to identify decreased platelet function caused by medical conditions and antiplatelet medication

Transfusion product choices

Blood products- RBCs
- hemoglobin concentration might influence coagulation
- erythrocytes congregate in the inner lumen of blood vessels
  - resulting in localization of platelets at the vessel wall
  - erythrocytes stimulate thrombin generation
    - providing material for clot formation
  - no randomized controlled trials have proved that increasing hemoglobin concentration above 9 g/dL reduces bleeding or the number of blood transfusions
Blood products- FFP

- replace deficient clotting factors when a clotting factor concentrate is not available
- when multiple clotting factors are deficient (e.g., disseminated intravascular, coagulation, massive transfusion)
- when the cause of the coagulopathy is not known

- FFP for volume support is not an accepted indication

Blood products- cryoprecipitate

Indication is lack of available fibrinogen concentrate for bleeding in the setting of hypofibrinogenemia

Fibrinogen < 75-100 mg/dL.

Blood products- platelets

To treat or prevent bleeding secondary to
- critical thrombocytopenia or
- a qualitative platelet defect

Recombinant factor VIIa

Licensed for
- hemophilia and inhibitory antibodies or
- Glanzmann thrombasthesia

Recombinant factor VIIa

- rVIIa is increasingly used in off-label indications to control severe bleeding, such as in major trauma, surgical interventions, intracerebral hemorrhage
- locally activating hemostasis at sites of vascular injury
- thrombin burst leads to the formation of a fibrin clot if fibrinogen levels are adequate
Prior to use of FVIIa, all other components of coagulation should be optimized:

1. Fibrinogen
2. Platelets
3. Temperature less than 34 degrees inhibits thrombin generation, fibrinogen synthesis, platelet function, and accelerates fibrinolysis
4. Calcium enhances fibrin polymerization, coagulation factor activity, and platelet activity
5. Acidosis < 7.1 inhibits thrombin and platelet function, and accelerates fibrinolysis

Antifibrinolytics

- Tranexamic acid (TXA) or Aminocaproic acid (Amicar)
- Useful if evidence of hyperfibrinolysis

Desmopressin (DDAVP)

- Increases the levels of
  - factor VIII
  - plasminogen activator
  - von Willebrand Factor
- Beware of side effects, especially hyponatremia

Transfusion choices

Perioperative coagulation monitoring is beneficial only if the results contribute to clinically effective decisions.

Patients with similar conditions may receive different treatments if protocols and triggers for coagulation management are not in place.

What about massive transfusion ratios?
References:


Blood and Bones: What Makes This Case So Bloody?

C.J. Kleck, MD

Pre-operative planning
- Stopping all nutritional supplements
- Optimize their Physiology
- Weight loss
- Nutritional Considerations
- 25% of patients undergoing elective spine surgery are malnourished (Klein 1986)
- 42% over 60Y are malnourished
- Osteomyelitis and SCI have 75% malnourishment

Intra-operative management
- Pre-operative preparation
- Team approach
- Anticipate blood loss

Case examples

Pre-operative planning
- Optimize their Physiology
- Weight loss
- Nutritional Considerations
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Case 1
- 75 M with history of L3 compression fracture and previous laminectomies
- Medical history: ASA 3
- Stage IV Liver disease (NASH)
- BMI – 31
- CHF, T2DM

Surgical history:
- Decompression halted due to excessive bleeding
- Compressive epidural hematoma requiring second, more extensive decompressive laminectomy

Surgical Plan:
- Lateral L3 corpectomy followed by posterior fixation with cement augmentation
- Autologous blood
- Pre-op autologous blood donation (PABD)
- In elective spine surgery (Brookfield et al 2008)

45-55% of pre-donated units wasted
45-55% of pre-donated units wasted
45-55% of pre-donated units wasted
45-55% of pre-donated units wasted

Case 1

- Labs:
  - HH – 12.9/33.5
  - Platelet count 77
  - INR 1.3, PT 15.9, PTT 36.3
  - ALT 15, AST 23, Alk Phos 108

- PRBC – 2 units
- Platelets – 2 units
- FFP – 4 units
- Cell Saver – 1370 mL
- Crystalloid – 2000 mL
- Albumin – 1000 mL

- EBL – 3600
- UOP - 1300

Intra-operative care

- Patient Factors
  - BMI
  - Medical co-morbidities

- Surgical Factors
  - Elective versus Trauma
  - Complexity
  - Approaches

- Unexpected Factors
  - Vascular injuries
  - Neurologic issues

Case 1

- Considerations:
  - Liver disease – platelet number/function, factors and ability to clot
  - Previous surgery halted, compressive epidural
  - Surgery – corpectomy, use of cement

Intra-operative care

- Patient Factors
  - BMI
  - Medical co-morbidities

- Surgical Factors
  - Elective versus Trauma
  - Complexity
  - Approaches

- Unexpected Factors
  - Vascular injuries
  - Neurologic issues
Surgical Factors - Neck

- Anterior:
  - Recurrent laryngeal nerve injury
  - Exposure related bleeding
  - Esophageal injuries
    - Direct compression
    - Late rupture due to burn wounds and necrosis
  - Spinal cord injury
  - Vertebral artery injury

- Posterior:
  - Vertebral artery injuries
  - Exposure related bleeding
  - Nerve root injury
  - Spinal cord injury

Surgical Factors - Thoracic

- Anterior
  - Lung injury
  - Vascular injury
    - Segmental bleeding

- Posterior
  - Cord injury
  - Direct injury
  - Positioning
  - Pedicle screws
  - Most narrow part of the spinal canal
  - Sensitive to manipulation
  - Blood supply

Surgical Factors - Lumbar

- Anterior:
  - Vessel injury
  - Ureter injury
  - Bowel injury

- Posterior:
  - Epidural bleeding
  - Cauda equina injury
  - Nerve root injury
  - Dural tears
  - Fracture of the pedicles
  - Related to implants

Surgical Factors - Interbody Fusion Approaches

- ALIF: requires exposure surgeon, approach risks, avoids dural sac, no decompression option
- PLIF: decompression, exposes dural elements, retraction risks
- TLIF: avoids dural sac, decompression possible
- XLIF: L5-S1 not accessible
- AxiaLIF: percutaneous access to L5-S1. An anterior interbody fusion technique with a novel approach

Cases 2 and 3

- TLIF – 69 M T1DM
- ALIF – 28 M o/w healthy
- EBL – 200 mL
- UOP – 400 mL
- Crystalloids – 2000 mL
- No complications

Cases 2 and 3

- TLIF
  - EBL – 200 mL
  - UOP – 400 mL
  - Crystalloids – 1800 mL
  - No complications
Cases 2 and 3

Surgical Factors - Osteotomies

Intra-operative management
- Anticipated Blood loss in excess of 1500 – 5000 +ml
  - Central line
  - 2 peripheral lines
  - Arterial line
  - Urinary catheter

Intra-operative management
- EBL
  - Keep HB AROUND 10
  - Balance crystalloid and colloid replacement
    - >4 hours
    - 40% blood loss
    - Colloid
      - With increased blood loss
  - FFP and platelets
    - Scoliosis has abnormal bleeding times related to calmodulin and platelets
    - Tumors

Acute Blood Loss
- Intra-op
  - Cell saver
    - No platelets or coagulation factors
  - Cochrane review in 2010 – 40% reduction in transfusion
  - TXA
    - Meta-analysis 2015 – Reduces bleeding, no increased adverse outcomes
  - Body temperature at 37
  - Flo seal
  - Thrombin
  - Tisseele
  - Replace blood with blood or at least a colloid
  - Start transfusion of colloid after first 250 ml of loss
  - Platelets/FFP

Blood pressure
- Keep MAP between 70 -75 mmHg
  - Correlate for each patient if hypertensive, keep higher
- Keep the capillary osmotic pressure high
  - Perfusion of the spinal cord
  - Optic nerve infarction and blindness
  - Stroke
  - ATN
    - Oliguric and acidosis will further increase the bleeding
Case 4

- 66 F w/ L5-S1 pseudarthrosis and sagittal plane imbalance
- ASA 2
- PMHx:
  - GERD
  - HTN
  - BMI 31

Case 4

- Revision of L5-S1 anterior
- Avulsion of common iliac vein feeder
  - ~1800 mL blood loss with anterior approach

Case 4

- Posterior Osteotomy
- EBL (Total) – 3800 mL
- PRBC – 4 units
- FFP – 2 units
- Cell Saver – 1400 mL
- UOP – 1150 mL
- Crystalloid – 3300 mL
- Albumin – 1900 mL

Case 4

- Considerations:
  - Anterior approach vascular injury
  - Previous surgery (although posterior)
  - Osteotomy – high blood loss

Team surgery

- Neurological compromise
  - Base line SSEP, MEP and H-reflexes
  - Compare the values for upper and lower extremities as well as L and R
  - Nerve root compromise
    - Local
    - Unrelated to the surgical procedure
Signal loss

- ALWAYS RESPOND
- Raise the blood pressure (MAPS to 80-90)
- Remove all the distraction devices
- Do not manipulate the cord
- Reposition the neck of the patient
- Steroids may play a role

Case 5

- 35 F w/ T7 and T8 fractures and eventual infection treated non-operatively
- ASA 4
- PMHx:
  - Hypertension
  - Stroke
  - Asthma
  - Migraine
  - Ulcer
  - Arthritis
  - Surgical neuralgia
  - Pancreatitis
  - Kidney stones
  - Dislocation of mandible
  - Amenorrhea
  - PTSD (post-traumatic stress disorder)

Case 5

- Surgical plan:
  - T7 vertebral body resection
  - Posterior instrumented fusion T2 – L2
  - Maintain MAP > 90

Case 5

- EBL – 1500 mL
- PRBC – 3 units
- FFP – 1 unit
- Cell Saver – 540 mL
- UOP – 1425 mL
- Crystalloid – 3500 mL
- Colloid – 1500 mL

Complications related to surgery

- Inherent to the pathology
  - Vascular tumors
- Inherent to the level of technical difficulty
  - Anatomy
  - Implant related
  - Broken equipment
- Surgeon related
- Risks of anesthesia
- Positioning in the OR!!
Acute complications

- Hemorrhage
  - Reported to 10 liters for tumors
- Neurological disasters
  - Acute cord infarction
  - Accidental severance of the cord
- Fatal adverse events
  - MI
  - Pulmonary complications
    - Tension pneumothorax

GENERAL NOTES....

- LONG SPINE FUSIONS ARE EXTREMELY DEVASTATING OPERATIONS....
- ALL THE MUSCLES FROM THE SCALPULA TO THE SACRUM ARE STRIPPED....
- ANTERIOR SURGERY ADDS ANOTHER PAIN COMPONENT
- THE INABILITY TO MOVE DUE TO PAIN CAUSES ATELECTASIS...PNEUMONIA...DVT ...PE ...DEATH!

Acknowledgements

- My partners:
  - Dr. Evalina Burger
  - Dr. Vik Patel
  - Dr. Chris Cain

- Our Anesthesia Team!!!
Friday, March 4
WHAT’S NEW IN OBSTETRIC ANESTHESIA FROM 2015?

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

GOALS & OBJECTIVES

Participants will be able to:
1. Discuss how recent research is changing clinical practice in obstetric anesthesia via new guidelines and policies
2. Cite maternal and fetal effects of analgesic and anesthetic techniques and best practices.
3. Optimize and expedite management of obstetric and anesthetic complications.

GUIDELINES AND POLICIES

PRACTICE GUIDELINES

Updated ASA Practice Guidelines for Obstetric Anesthesia were published online 11/15. Recommendations are similar but references and survey responses are updated.

Anesthesiology 2016; 124: 270

See page 281 for Appendix 1 with the summary of recommendations.

EATING IN LABOR

Abstract from Canada reviewed the literature on aspiration during labor and found very few cases.
- ASA Press Release 10/24: “Most healthy women would benefit from light meal during labor.”
- Health Day: “…new Canadian research suggests that a light meal during labor could be a good idea for most healthy women.”
- ASA Press Release 11/06: “…on October 28, the Practice Guidelines were passed. On page 12 of the guidelines is the language: solid foods should be avoided in laboring patients.”

LEVELS OF MATERNAL CARE

Classification system for levels of maternal care (versus long-standing levels of neonatal care) developed by ACOG and SMFM.
- Unfortunately presented to ASA and SOAP leadership *after* already developed, so listed as “supportive” rather than “endorsed by”
- Goal: regionalize high risk maternal care in facilities with specialized resources.
LEVELS OF MATERNAL CARE

1. Birth Center: no anesthesiology needs except after transfer for unexpected events
2. Level I (Basic): OB and anesthesia services “available” for analgesia or cesarean, capability for massive transfusion - could include twins, VBAC, preeclampsia (not severe)
3. Level II (Specialty): OB and anesthesia services available at all times, MFM and Board-certified anesthesiologist available for consultation

LEVELS OF MATERNAL CARE

• Major goal is to collect accurate QI data at all sites because “Although specific supporting data are not currently available in maternal health, it is believed that concentrating the care of women with the most complex pregnancies at designated regional perinatal health care centers will ….achieve optimal outcomes.”
  Obstet Gynecol 2015; 125: 502
  Am J Obstet Gynecol 2015; 122: 259
  ASA Newsletter 2015; 79: 42

HOME BIRTHS - CANADA

Comparison of home vs. hospital births in Ontario, Canada (11,493 in each group):
• No difference in stillbirth, neonatal death or serious neonatal morbidity
• No difference for nulliparous vs. multips
• All intrapartum interventions were lower among planned home births.
  CMAJ 2015; DOI:10.1505/cmaj.150564

HOME BIRTHS - OREGON

Cohort study of births in Oregon 2012-3:
• ↑ perinatal death rate for planned out-of-hospital births (3.9 vs. 1.8 deaths per 1000 deliveries, p=0.003) vs. hospital births
• ↑ odds for neonatal seizures out-of-hospital
• ↓ NICU admission, ↑ unassisted vaginal delivery (94% vs. 72%) and ↓ odds of OB procedures in out-of-hospital births
  N Engl J Med 2015; 373:2642

HOME BIRTHS - U.S.

ACOG and AAP have requirements for planned home births. Are they followed?
• CDC data was used to compare midwife-attended home births to hospital deliveries by certified nurse midwives.
• 30% of home births were not low risk: 28% > 41 weeks, breech, twins, 4% TOLAC
• 66% were attended by non-certified midwives
  Am J Obstet Gynecol 2015; 212: 350
**HOME BIRTHS - RISKS**

What is the risk of medical complications or use of resources beyond routine among U.S. deliveries expected to be low risk?

- 4 million were low risk, 29% had at least 1 complication: 15% cesarean, 5% meconium, 4% assisted vaginal delivery, chorio
- With ≥ 1 risk factor, 57% had at least 1 unexpected complication.

Am J Obstet Gynecol 2015; 212: 809

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**CESAREAN RATES**

What is the optimal cesarean delivery rate? WHO states no more than 10-15%.

- Comparison of cesarean data in 194 WHO member states 2005-12 vs. health outcomes.
- Cesarean rates of 19% were associated with optimal levels of maternal / neonatal mortality.
- No one-size-fits-all rate for every country or institution; perform when appropriate.

JAMA 2015; 314: 2263, 2238

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**DECREASING CESAREANS**

What is the effect of having collaborative OB laborist and midwifery services on L&D?

- Community hospital changed from a private practice (clinic + L&D) to 24-hour coverage with a laborist-midwifery model.
- Primary cesarean rate ↓ 32% to 25%
- VBAC rate ↑ 13.3% to 22.4% (OR 2.03)

Obstet Gynecol 2015; 126: 716

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**CESAREAN RATES**

Community hospital with 2 distinct practice models: private practice or laborist-midwife.

- Cesarean rates were higher in the private practice model: 32% vs. 17% (OR 2.11)
- C/S rates also higher with a prior cesarean delivery: 71% vs. 42% (OR 3.2)
- Lowest risk G1, term, vertex singleton rates were 30% in private practice vs. 16%

Am J Obstet Gynecol 2015; 212: 491

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**DECREASING CESAREANS**

Are there safe strategies that can reduce cesarean delivery rates?

- 32 hospitals in Quebec, randomized trial of 1.5 years of audits of indications for CS, feedback to obstetricians, and use of “best practices”
- Reduction in CS in low risk pregnancies but not high risk, ↓ rate of major neonatal morbidity, no difference in maternal morbidity.


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**CESAREAN & INDUCTION**

What are the risk factors for cesarean delivery after induction of labor?

- Retrospective cohort study of 785 G1, term, vertex, inductions
- 29.4% had cesarean delivery, nomogram created
- Risk factors: older age, shorter height, ↑ BMI, ↑ weight gain in pregnancy, HTN, DM, ↑ gestational age, cervix < 3 cm initially.

Obstet Gynecol 2015; 126: 1059
CESAREAN & INDUCTION

Systematic review and meta-analysis of induction vs. expectant management of uncomplicated, term, singleton pregnancies.

- No difference in cesarean rates, operative vaginal delivery, chorioamnionitis
- Induction → less blood loss, less meconium stained amniotic fluid, lower birth weight

Am J Obstet Gynecol 2015; 212: 629

CESAREAN & CHILD HEALTH

Is there a relationship between planned cesarean delivery (vs. unplanned cesarean or vaginal delivery) and childhood health problems or death? Scottish registry data.

- No difference between planned/unplanned.
- Planned vs. vaginal delivery had ↑ risk of asthma requiring hospitalization, salbutamol prescription, and all-cause death by 21 years.

JAMA 2015; 12/3

DRUG LABELING

- Currently there is inadequate information for physicians and patients to make informed decisions about medications in pregnancy (e.g., ketorolac, propofol, bupivacaine).
- FDA final rule on pregnancy labeling for prescription medications requires removal of categories A-D, X
- New labeling will describe what is actually known and recommendations.

Am J Obstet Gynecol 2015; 212: 24

MARIJUANA

ACOG Committee Opinion: Marijuana Use During Pregnancy and Lactation

- Ask about use and discourage it.
- Because of concerns regarding impaired neurodevelopment (in animal studies), as well as maternal and fetal exposure to the adverse effects of smoking, women who are pregnant or contemplating pregnancy should be encouraged to discontinue use.

Obstet Gynecol 2015; 126: 234

FAMILY PLANNING

Costs of pregnancy and childbirth under ACA.

JAMA 2015; 313: 245
- Saving lives with contraceptive coverage.
  Am J Obstet Gynecol 2015; 212: 602
- Planned Parenthood at risk.
  N Engl J Med 2015; 373: 890, 963
  ACLU sues Catholic hospitals over abortions.
  Medscape Nov. 12, 2015

UK CEMD, 2009-2012

- 68% of women died from medical and mental health problems; only 32% from direct complications of pregnancy
- Almost ¼ died of sepsis → early diagnosis (MEOWS), rapid antibiotics, escalate care
- 1/11 died of flu → vaccinate
- Need multi-disciplinary review of all deaths

UK and Ireland Confidential Enquiries into Maternal Deaths and Morbidity, 2009-12
ANALGESIA FOR LABOR

PHYSIOLOGY OF LABOR
Pro-inflammatory cytokines ↑ at term and are associated with cervical ripening. Do they influence the pain of labor?
• Maternal inflammatory markers measured
• Pain scores recorded during labor
• Highest levels of IL-1β presented at greatest cervical dilation and had the fastest labors with less pain.
  Anesth Analg 2015; 121: 748

PHYSIOLOGY OF PREGNANCY
MRI exams of term unanesthetized parturients:
• IVC volume was much lower when supine.
• 15 degree tilt did not relieve compression, but 30 degree tilt significantly ↑ IVC volume.
• Aortic volume was never affected by position.
• Supine sleeping associated with ↑ risk for term stillbirth, esp. in compromised fetus with IUGR.
  Anesthesiology 2015; 122: 286
  Obstet Gynecol 2015; 125: 347

PHYSIOLOGY OF OXYGEN
Is oxygen in labor helpful or harmful to the fetus?
• Con oxygen: millions of babies are exposed, it’s uncomfortable and anxiety-provoking to the mother, no studies support its benefit, it could cause harm by ↑ free radical activity; why have routine exposure to an unproved intervention?
• Pro oxygen: may return fetal oxygen to normal if hypoxic and correct late decelerations
  Am J Obstet Gynecol 2015; 212: 459

NITROUS OXIDE FOR LABOR
• Few side effects for mother/ fetus, rapidly reversible unlike opioids
• Can be used if an alternative to neuraxial is needed (e.g., version, perineal repair)
• No relevant occupational exposure for nursing
• Satisfaction scores are similar for neuraxial, N2O, or transition from N2O to an epidural
• Meets CMS guidelines for conscious sedation
  SOAP Newsletter Summer 2015, page 22

An example of a mobile N2O delivery system with oxygen and scavenging connections.
**INHALED N₂O**

<table>
<thead>
<tr>
<th></th>
<th>UCSF</th>
<th>UCOLORADO</th>
</tr>
</thead>
<tbody>
<tr>
<td>% using N₂O</td>
<td>14%</td>
<td>20%</td>
</tr>
<tr>
<td>N₂O—epidural</td>
<td>42%</td>
<td>60%</td>
</tr>
<tr>
<td>Epidural only</td>
<td>76%</td>
<td>75%</td>
</tr>
<tr>
<td>Adverse events</td>
<td>0</td>
<td>0</td>
</tr>
</tbody>
</table>

UCSF found N₂O use did not affect admission to NICU, 5-minute Apgars, maternal bleeding.

**SAFETY OF NITROUS**

Pediatric patients exposed to nitrous for 8 hours during spine surgery did not show megaloblastic anemia (B12 inactivation).

Anesth Analg 2015; 120: 1325

ENIGMA-II Trial found no ↑ in adverse cardiac events 1 year after noncardiac surgery in at-risk patients exposed to 70% nitrous.

Anesthesiology 2015; 123: 1267

**REMIFENTANIL PCA**

Can the efficacy of a remifentanil PCA be improved by coordinating peak R levels with maximum contraction strength? No.

- Average duration of pain was 45 seconds
- Time between was highly variable
- No model improved matching remifentanil effect-site concentration with contraction peak
- Safe use requires continuous monitoring

Br J Anaesth 2015; 114: 281

**INTRA-NASAL FENTANYL**

Hand-held fixed-dose spray of 50 µg fentanyl was compared to IM meperidine for labor pain.

- Pain scores were similar with small reductions of 1-2/10.
- Women receiving fentanyl were more satisfied and had less sedation and nausea.
- Neonates exposed to fentanyl had fewer nursery admissions and better breast-feeding.
- No IV or painful injections needed.

BJOG 2015; 122: 983

**PATIENT PREFERENCES**

What factors are associated with 1) women avoiding epidural for labor, and 2) what factors are associated with a change in their plans?

1. Prefer no epidural: high parity, unfavorable social conditions, delivery in a public hospital; 52% delivered without an epidural
2. Change to epidural: nulliparity, oxytocin augmentation, presence of anesthesiologist, high midwife workload

Anesth Analg 2015; 121: 759

**PATIENT PREFERENCES**

Survey of women who had an epidural for labor and vaginal delivery:

- **Best**: effective pain relief
- **Adverse**: difficult placement, less effective than expected, physical effects (numbness, itching, shivering, ↓ BP)
- **Challenges**: waiting in pain, received too late or wore off too soon, inadequate info

Anesth Analg 2015; 121: 974
EPIDURAL ANATOMY
Cadaver study of 50 epidural catheters:
• 3 catheters curled in a circle, 2 entered intervertebral foramen, 5 caused venous damage
• Meningo-vertebral ligaments space connect to the venous plexus and the bony canal wall
• May result in epidural compartments and uneven distribution of anesthetic
  BMC Anesthesiol 2015; 15: 94

EPIDURAL MAINTENANCE
Does a background infusion confer any benefit?
A systematic review and meta-analysis found:
• No conclusions regarding risk/benefit.
• There was no difference in maternal or neonatal adverse events.
• Risk of instrumental delivery and length of 2nd stage were ↑ with infusion, but fewer patients required physician-administered boluses.
  Anesth Analg 2015; 121: 149

2ND STAGE MAINTENANCE
Does changing the infusion to fentanyl-only while pushing improve outcome?
• Women at 8-10 cm dilated, with a functional epidural, were randomized to continue their infusion or change to epidural fentanyl 100μg/hr
• No difference in duration of 2nd stage, degree of motor block, or instrumental delivery
• For similar analgesia, received 5x dose fentanyl
  Anesthesiology 2015; 122: 172

SCOLIOSIS & EPIDURALS
How successful is epidural labor analgesia in women with previous spinal instrumentation surgery for scoliosis?
• No difference in bupivacaine consumption per hour, number of boluses, or failure between post-surgery patients and controls
• ↑ time for placement in the surgery group, more re-directions and change in interspace, more need for an experienced provider to take over.
  Anesth Analg 2015; 121: 981

CSE AND DECELERATIONS
Would prophylactic IV ephedrine 10 mg prevent post-CSE fetal bradycardia?
• No difference in decelerations: 2.7% in the ephedrine group vs. 4.7% in controls
• Also no difference in urgent cesarean delivery, uterine hypertonus or tachysystole, and abnormal FHR patterns

CONTINUOUS SPINAL
• If a “wet tap” occurs, consider conversion to a continuous spinal (CSA) technique.
• Failure of the catheter is easier to diagnose because you can’t aspirate CSF if it dislodges – epidural catheters require dosing, then waiting to see an effect.
• The risk of PDPH is less in morbidly obese parturients versus non-obese.
  Anesth Analg 2015; 121: 451
CONTINUOUS SPINAL
Test of a 23 gauge spinal catheter (Wiley Spinal®) used for labor analgesia:
• 2.6% incidence PDPH, managed with EBP
• 23% had paresthesias, 9% had kinking that prevented aspiration or injection
• 36% required dose adjustments for breakthrough pain or weakness
• Steep learning curve for providers
  Anesth Analg 2015; 121: 1290

INTRATHECAL OXYTOCIN
Intrathecal oxytocin seems to prevent hypersensitivity after surgery, has treated cancer pain, and has receptors in the dorsal horn of the spinal cord.
• 5 healthy volunteers received 5-150 μg intrathecal oxytocin
• No adverse events or complications but no analgesic effects were apparent.
  Anesthesiology 2015; 122: 407

LABOR EPIDURAL BILLING
The ASA’s Anesthesia Quality Institute database was used to determine distribution of the mean durations of labor analgesia among US hospitals.
• Overall mean duration was 6 hours.
• 10% were below and 12% above the mean.
• The number of labor epidurals is not a valid measure to quantify productivity or payment to U.S. anesthesia groups. Base + time better.
  Anesth Analg 2015; 121: 1283

USE OF FORCEPS / VACUUM
• 3.3% of all deliveries with a low risk of complications
• Forceps more effective but more likely to result in a 3rd or 4th degree tear.
• Adequate anesthesia is necessary.
  ACOG Practice Bulletin #154: Operative Vaginal Delivery
  Obstet Gynecol 2015; 126: e56

AWHONN GUIDELINES
2015 Revision: After labor epidural placement and stabilization the labor RN may:
• Replace empty infusion syringes or bags
• Remove the catheter if ordered
• Stop the pump for safety concerns or after delivery.
The labor RN may not bolus the catheter, change pump settings, or obtain procedural consent.
  JOGNN 2015; 44:151

PATIENT EDUCATION
U.S. academic medical center websites were searched for English and Spanish language patient education materials on epidural analgesia.
• Readability was 9th-12th grade versus the 6th grade level recommended.
• All discussed benefits, only 14% discussed complications (PDPH and hypotension most common) or contraindications.
  Anesth Analg 2015; 121: 1295
**TRAINEE EDUCATION**

How many obstetric epidural placements are required to produce competence?
- Trainees new to L&D at a large public hospital in the UK were tracked.
- Used CUSUM (cumulative sum) analysis
- About 50 attempts required to achieve competence

Br J Anesth 2015; 114: 951

**CASE REPORTS**

Woman with an unstable cervical spine fracture in halo required induction for preeclampsia and passive 2nd stage.
- A&A Case Reports 2015; 4: 145

Woman with Harlequin Ichthysis required cesarean for failure to progress → failed epidural → general anesthesia.
- A&A Case Reports 2015; 4: 19

**ANESTHESIA FOR CESAREAN DELIVERY**

Gastric ultrasound

Pregnant women had gastric ultrasound after overnight fasting prior to their elective cesarean to determine “normal”.
- 53/103 had no antral fluid, 49/103 had fluid seen in RLD position only, 1/103 had fluid in supine and RLD positions
- Antral cross-sectional area = 95% CI, 8.6-10.3 in RLQ position = estimated gastric volume ≤ 117 ml.

Anesth Analg 2015; 121: 752

**GASTRIC EMPTYING**

Gastric emptying was compared among 5-500 ml beverages of increasing caloric content: water, OJ, milk, gum syrup.
- Healthy fasted volunteers (non-OB)
- Emptying depended mainly on caloric content rather than composition.
- Pulp-free OJ and milk no different.

Br J anaesth 2015; 114: 77

**ASPIRATION PROPHYLAXIS**

Which interventions given prior to cesarean section reduce the risk of aspiration pneumonitis? Poor quality evidence, but…..
- ↓ risk of intra gastric pH <2.5 with antacids (RR 0.17 versus placebo), H2-receptor antagonists (RR 0.09), and PPI (RR 0.26)
- Most effective: antacids + H2-antagonists but no study had adverse outcomes to compare

Cochrane Database Syst Rev 2014: CD004943
CEFAZOLIN DOSE IN OBESITY

Does 3 gm cefazolin produce better adipose tissue concentrations in obese women BMI > 30 than 2 gm for pre-cesarean prophylaxis?

- Tissue harvested before fascial incision and after closing fascia
- 3 gm cefazolin did not increase adipose tissue concentrations, so 2 gm is adequate

Obstet Gynecol 2015; 125: 1205

SKIN PREPARATION

Comparison of chlorhexidine with alcohol, povidone-iodine with alcohol, and both sequentially before cesarean to prevent surgical site infections:

- Overall rate of SSI: 4.3%
- No difference between the groups: PI-A 4.6%, C-A 4.5% and both 3.9%

Obstet Gynecol 2015; 126:1251

UTERINE EXTERIORIZATION

Systematic review and meta-analysis comparing uterine exteriorization at cesarean versus repair in situ:

- 16 studies, almost 20,000 patients
- No difference in EBL, intraoperative nausea and vomiting, or pain
- Faster return of bowel function by 3 hours with in situ repair

Can J Anesth 2015; 62: 1209

MUSIC THERAPY

A study of women having surgery for breast cancer compared preop patient-selected music and intraop therapist-selected music to usual preop care with ear plugs intraop.

- No difference in amount of propofol sedation, satisfaction, or recovery time
- Music group had lower preop anxiety scores

J Clin Oncol 2015; 33: 3162

“GENTLE” CESAREAN

- Featured on NPR, Today.com, many non-medical publications
- Elements: placing ECG leads on the back or sides, BP cuff and pulse ox on one arm to leave one free, immediate skin-to-skin contact if appropriate, lowering the curtain to a clear drape at delivery
- Not advocating for more cesareans

OB/Gyn news.com, 4/23/15

“GENTLE” CESAREAN

The opaque drape can be lowered to a clear plastic drape at delivery if desired.
“GENTLE” CESAREAN
Early skin-to-skin contact is typically encouraged as part of a gentle cesarean.

RSI AND OBESITY
What is the accuracy of finding the cricoid membrane by palpation versus ultrasound in obese vs. non-obese women?
• Digital exam was accurate in 71% of normal weight vs. only 39% of obese
• ↑ neck circumference → ↓ accuracy on palpation; consider pre-procedural US
   Anaesthesia 2015; 70: 1230

BIS DURING CESAREAN
Reasons why BIS may not be accurate:
• Using adequately high doses of induction agent should address the problem of awareness after RSI
• Lag time in speed of onset of BIS monitoring during and immediately after induction may not address real-time awareness
• May be useful during PPH when volatile agents are reduced or removed.
   Br J Anaesth 2015; 115: 530

DIFFICULT AIRWAY
The Obstetric Anaesthetists’ Association and Difficult Airway Guidelines
   Anaesthesia 2015; 70: 1286
These are the first national obstetric guidelines for safe management of difficult and failed tracheal intubation.

DIFFICULT AIRWAY
SOAP Patient Safety Committee Expert Opinion: Airway equipment and training
• Compared 4 institutions’ on what equipment they have on L&D and what training they do, eg. Simulations
• No real consistency
   SOAP Newsletter 2015; Summer: 17

GETA AND PREMATURITY
What is the incidence and risk factors for use of GETA during preterm cesarean?
• 11,539 women 24-36 weeks gestation
• 82% neuraxial, 18% general
• For every 1 week decrease in GA, odds of GETA increased by 13%
• Other risk factors: emergencies, hypertensive disease, non-Caucasian race
   Br J Anaesth 2015; 115: 267
RATE OF GETA
What is the appropriate rate of general anesthesia for cesarean? Should it be a quality indicator for anesthesiologists?
• In current practice, general has the same or fewer complications than regional
• Regional has other benefits that should be taken advantage of—bonding, pain control, less blood loss, ↓ thrombotic complications
  Anesth Analg 2015; 120: 1175

REGIONAL vs GETA
Both techniques have advantages and disadvantages; which is more efficacious?
• Patients receiving neuraxial for cesarean had ↓ EBL and ↑ postop Hgb.
• Higher satisfaction with general; more women said they would have the same technique after GETA—RR 0.8.
• No difference in neonatal outcomes.
  Cochrane Database Syst Rev CD 004350

EMERGENCY CESAREAN
Patient transfer for emergency cesarean delivery can lead to medication errors, venous access complications per reports to SOAP.
• Inadvertent magnesium and oxytocin boluses
• Lack of an IV at patient request, infiltration of the IV, lack of IV tubing ports or pump tubing that prevents flow are common
• Systems design, team training are key
  APSF Newsletter October 2015; 23

NITROUS OXIDE
• The ENIGMA trials compared 70% nitrous oxide versus no nitrous on outcomes for patients at risk of cardiac events having non-cardiac surgery.
• The ENIGMA-II trial found no difference in the primary outcome of death or cardiovascular events in either short-term or long-term (1 year) follow-up.
  Anesthesiology 2015; 123: 1267

BP MEASUREMENT
Shivering is common during cesarean. Would wrist BP trend accurately with upper arm BP measurements?
• Wrist BP overestimates by 13 mmHg
• The measurements trend together
• Wrist BP is probably not accurate enough to use versus upper arm BP
  Anesth Analg 2015; 121: 767

PREVENTING HYPOTENSION
• No fluid loading regimen reliably prevents ↓ BP, probably because ↓ SVR is an important component—not just ↓ preload.
• Phenylephrine rapidly corrects ↓ SVR, is faster than ephedrine and less likely to cross the placenta to cause fetal acidosis.
• Maternal response to SAB is ↑ HR and ↑ CO so giving a β-agonist isn’t physiologic.
• Phenylephrine infusion at 50 μg/min is optimal.
  Br J Anaesth 2015; 114: 183
**NOREPINEPHRINE?!!**

Would norepinephrine be a better pressor after spinal anesthesia than phenylephrine?

- Randomized, double-blind comparison: N 5 μg/min versus P 100 μg/min
- N → same BP control, less bradycardia, less decrease in cardiac output
- β-agonist activity may be preferable than α-agonist activity alone

*Anesthesiology* 2015; 122: 728, 736

**BUPIVACAINE BARICITY**

Systematic review of hyperbaric versus isobaric bupivacaine for spinal anesthesia for cesarean:

- Remarkably few studies and fewer outcomes
- No clear evidence to favor one over the other
- No data to determine which is more likely to fail → conversion to general anesthesia

*Anesth Analg* 2015; 120: 132

**INTRAOP WARMING**

Does active warming improve outcomes after neuraxial block for elective cesarean delivery?

- Meta-analysis of 13 studies, 789 patients who had forced air warming within 30 min
- Active warming → less shivering, better thermal comfort, less hypothermia, higher umbilical artery pH

*Br J Anaesth* 2015; 115: 500

**OXYTOCIN DOSE**

Comparison of women having elective cesarean to intrapartum laboring women exposed to exogenous oxytocin:

- ED₉₀ was higher in the exposed group, 44 versus 16 U/hour
- More laboring women required additional oxytocics (34 vs 8%) and thus had more side effects (69 vs 34%)

*Anesth Analg* 2015; 121: 159

**OXYTOCIC COMBINATIONS**

Would combining oxytocics be better than using oxytocin alone?

- Myometrial samples were exposed to saline, oxytocin, ergonovine, and/or carboprost
- If no pre-exposure to oxytocin (i.e. no labor), oxytocin works the best of all drugs
- If pre-exposed, oxytocin combined with ergonovine or carboprost is superior

*Anesth Analg* 2015; 120: 1074

**GABAPENTIN**

Would a perioperative course of gabapentin improve postop analgesia? No.

- Randomized, double-blind comparison of placebo with 600 mg preop gabapentin followed by 600 mg/day
- No clinically significant difference in pain but more sedation in G group

*Anesthesiology* 2015; 123: 320

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Hakins, Joy L., MD
What's New in Obstetric Anesthesia from 2015?
**TAP BLOCKS**

Surgical site infiltration was superior to TAP blocks after TAH with a Pfannenstiel incision.

*Anesth Analg* 2015; 121: 1383

Meta-analysis of efficacy of ultrasound-guided TAP blocks for abdominal surgery found marginal postoperative analgesic efficacy, and no additional effect if IT morphine is used.

*Anesth Analg* 2015; 121: 1640

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**PRURITUS**

Would methylnaltrexone 12 mg SQ prevent side effects after intrathecal morphine for cesarean delivery?

- No.
  - 80% in M and placebo groups had itching
  - Intraop vomiting was more common with M; no difference in postop vomiting
  - M only acts peripherally so it wouldn’t block any central opioid mechanisms.

*Br J Anaesth* 2015; 114: 469

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**PRURITUS**

Would ondansetron prevent pruritus by blocking 5-HT3 receptors if given before IT morphine for cesarean?

- Yes.
  - 4 mg ondansetron or placebo were given 30 minutes before spinal anesthesia
  - Pruritus was less after O: 16% versus 88%
  - PONV was less after O: 8% versus 56%

*BMC Anesthesiol* 2015; 15: 18

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**ANESTHETIC COMPLICATIONS**

U.S. NATIONAL DATA - CDC

Top 10 causes of maternal mortality after live birth:

1. Cardiomyopathy 15%
2. Cardiovascular conditions 14%
3. Infection 13%
4. Preclampsia / Eclampsia 11%
5. Non-cardiovascular medical 10%
6. Hemorrhage 9%
7. Thrombotic pulm. embolism 9%
8. Amniotic fluid embolism 7%
9. Cerebrovascular accident 6%
10. Anesthesia complications 0.7%

*Obstet Gynecol* 2015; 125: 5
UK TRIENNIAL REVIEW

“Lessons for Anaesthesia”:
• Subdural hemorrhage, cerebral venous sinus thrombosis should be in the PDPH differential
• Practice airway drills including bronchospasm
• Maintain postoperative standards in PACU
• Be ready to deal with LAST or high blocks
• Prompt action and good communication between teams during unexpected catastrophes

UK TRIENNIAL REVIEW

• Ambulance services must relieve aortocaval compression and document how achieved.
• Monitor all women; early warning systems should be followed and audited for actions.
• All investigations of serious untoward incidents must include an anaesthetist.
• Fewer direct deaths, more multi-factorial issues

STATE MMC REVIEW

California 2002-2005 had 207 pregnancy-related maternal deaths. Findings?
• 41% of deaths were deemed preventable.
• 70% of hemorrhage deaths and 60% of preeclampsia deaths were preventable.
• Other causes: cardiovascular #1, venous thromboembolism #4 and AFE #5.

Obstet Gynecol 2015; 125: 938

STATE MMC REVIEW

Cesarean deliveries in New York, 2003-12:
• Anesthesia-related complications ↓ 25%
• Similar ↓ for regional and general anesthesia
• Serious non-anesthetic complications ↑ 47%, including MI, stroke, sepsis, coagulopathy, thromboembolism, renal & respiratory failure
• Anesthesiologists should be in a multi-disciplinary team as peripartum physicians.

Anesthesiology 2015; 123: 1013

PDPH AND NIGHT FLOAT

Does a night-float call system influence unintentional dural puncture on L&D?
• Rate increased from 0.73% - 1.49%
• CA-1 residents’ rate increased from 5% of the wet taps to 28% - less supervision at night?
• Not all residents were on an OB rotation.

Anesth Analg 2015; 120: 1095

This is no longer the typical L&D patient who requires our care.
PDPH AND OBESITY
After wet tap, do obese parturients have a lower incidence of PDPH?
• Retrospective cohort study compared incidence of PDPH in low BMI <31.5 versus high >31.5
• OR 0.72 for PDPH in high BMI versus low
• OR 2.4 for PDPH if she pushed during labor
• No difference ± intrathecal catheter placement
Anesth Analg 2015; 121: 451

DURAL PUNCTURE AND CRANIAL NERVE PALSY
Hearing loss is improved with epidural blood patch, even without headache.
Canadian Anesthesiologists’ Society
Abstract #86119
When CN VI symptoms of diplopia occur, early blood patch may decrease morbidity of prevent progression of symptoms.
Anesth Analg 2015; 120: 644

PROPHYLACTIC EBP
Why does waiting 24 hours to perform a blood patch seem to give better results?
• Serial hemodilution of whole blood with CSF → TEG
• Dilution → ↓ R time, k time, alpha angle, MA
• Larger amounts of CSF near the EBP may lead to clot destabilization and failure
Anaesthesia 2015; 70: 135

MENINGITIS AFTER EBP
G1 in active labor, GBS +, requested epidural analgesia. Full ASRA/ASA sterile precautions used. First attempt wet tap, repeated at another interspace. Postural headache → EBP on day #1 → relief and discharge. PDPH recurred on day #4 and EBP repeated → relief. Day #5 returned with fever, ↑ WBC, neurologic symptoms with blood culture + for GBS, CSF culture and imaging negative. Related??
A&A Case Reports 2015; 4: 163

RESPIRATORY DEPRESSION
ASA Closed Claims database: 92/357 acute pain claims involved opioid-related resp. depression.
• 88% occurred in the first 24 hours
• 97% were judged preventable
• 42% had had a nursing check within 2 hours and 33% were on pulse oximetry
• 39% neuraxial: 47% morphine, 53% fentanyl
• 1/3 had more than one physician prescribing
Anesthesiology 2015; 122: 659

DIAGNOSING OSA
Can the usual OSA screening tools identify pregnant women with OSA?
• 248 patients had 6 screens + sleep monitoring
• 12% had OSA diagnosis: ↑ BMI, ↑ neck circumference; more HTN, DM, asthma, PEC
• None of the screening tools accurately detected OSA in the 3rd trimester – new tool?
Obstet Gynecol 2015; 126: 93
CARDIAC ARREST
Using cardiac MRI, is there upward displacement of the heart during pregnancy?
• CPR guidelines recommend hand placement higher in pregnancy
• 38 healthy women had MRI during 3rd trimester and again > 3 months postpartum
• There was no difference and thus no need to alter hand placement during CPR.
  Am J Obstet Gynecol 2015; 213: 401

CARDIAC ARREST
Shift in thinking from peri-mortem cesarean delivery (feto-centric) to resuscitative hysterotomy (maternal-centric) as soon as acute maternal cardio-pulmonary arrest is recognized.
• Don’t wait 4-5 minutes to deliver after arrest.
• Don’t delay to find fetal heart rate, locate optimal equipment, or transport to the OR
  Am J Obstet Gynecol 2015; 213: 653

CARDIAC ARREST
Is lipid emulsion’s rescue of bupivacaine cardiotoxicity (LAST) mediated through opioid receptors?
• Rat model of bupivacaine-induced asystole
• Prior administration of naloxone or highly selective opioid receptor antagonists
• Peripheral δ, κ opioid receptors are involved
  Anesth Analg 2015; 121: 340

CARDIAC ARREST
Case report: Perimortem cesarean in patient with goiter, preeclampsia and morbid obesity after arrest due to airway obstruction.
  A&A Case Reports 2015; 4: 41
Case report: Parturient with left ventricular non-compaction complicated by acute pulmonary hypertension after methylergonovine for PPH.
  A&A Case Reports 2015; 4: 166

EPIDURAL HEMATOMA
Non-obstetric retrospective analysis of 11,600 epidural catheters; 2.4% placed with abnormal coagulation and 3% removed.
• 2 epidural hematomas occurred: vascular procedures, abnormal postop coagulation parameters when catheters removed.
• Estimated 1:315 occurrence when coagulation status is abnormal – not 100%.
  Br J Anaesth 2015; 114: 808

NEUROPATHIES
Review of anatomy and etiology of postpartum thoraco-lumbar spinal cord, lumbar nerve roots, plexus and lower extremity peripheral nerve injuries. Cases used to illustrate diagnosis, management, and treatment.
  Anesth Analg 2015; 120: 141
ASRA GUIDELINES

Interventional Spine and Pain Procedures in Patients on Antiplatelet and Anticoagulant Medications

- New, separate guidelines from regional
- Similar, but more conservative
- Regional update in 2016?

NEURAXIAL DRUG ERRORS

Review of 29 published cases:

- 4 maternal deaths from intrathecal TXA
- Most common complication: block failure
- Human factors: drug storage, similar drug appearance → read labels carefully, label all syringes, check label with a 2nd person or bar code reader, use non-Luer lock connectors
  Anesth Analg 2015; 121: 1570

SURGERY IN PREGNANCY

Mayo Clinic review of 121 surgeries performed at ≥ 23 weeks gestation (viable):

- 73% general anesthesia, 12% used fetal monitoring, 1 fetal loss was unmonitored
- 41% delivered preterm (mean GA 37 weeks), but only 10% within a week of the surgery
- Risk of complications intra- or immediately postop were low – reassuring for patients.

SURGERY IN PREGNANCY

Using the NSQIP database, compared 2539 pregnant women who had surgery, and propensity matched them for complications.

- More emergencies in pregnancy (50 vs 12%)
- No difference in mortality rates (0.4 vs 0.3%)
- No difference in morbidity rates (6.6 vs 7.4%)
  JAMA Surgery 2015; 150: 637

BENZODIAZEPINES

Expert review of the literature on use of hypnotics and sedatives during pregnancy and association with adverse outcomes. Specific to use of benzodiazepines:

- No increased risk of congenital anomalies
- Possible association with preterm delivery, low birth weight or SGA babies
  Am J Obstet Gynecol 2015; 212: 428

SURGERY CASE REPORTS

Awake craniotomy at 20 weeks.
  Anesth Analg 2015; 120: 1099

Prone discectomy at 24 weeks.
  Int J Obstet Anesth 2016; 25: 95

Catheter ablation of SVT with 22 week twins.
  Obstet Gynecol 2015; 125: 1338
NEUROTOXICITY
Update from the FDA and Smart Tots: There is consensus that “surgical procedures performed under anesthesia be avoided in children under 3 years of age unless the situation is urgent or potentially harmful if not attended to”.
• Animal studies are consistent that all GABA agonists and NMDA antagonists have neurotoxic effects. Dexmedetomidine?

NEUROTOXICITY
Infants having inguinal herniorrhaphy were randomized to general or spinal anesthesia.
• 238 awake/regional, 294 general anesthesia
• Development was assessed at 2 years of age
• No difference in neurodevelopmental outcome between group.
• Primary outcome is testing at 5 years of age.
  Lancet 2016; 387: 239

NEUROTOXICITY IN ANIMAL STUDIES
↑ anxiety behaviors in monkeys exposed to multiple anesthetics as neonates.
  Anesthesiology 2015; 123: 1084
Neurotoxic exposure in rodents can be tracked using neuronal metabolites and magnetic resonance spectroscopy.
  Anesthesiology 2015; 123: 557

CESAREAN & AUTISM
Autism has been associated with cesarean birth. Study used data from a large Swedish registry:
• In the conventional cohort analysis, children born by elective CS were 21% more likely to be diagnosed as having ASD after controlling for known confounders.
• However, in the sibling control analysis, no association was found.
• Association is not causal and therefore is due to unknown genetic or environmental factors.
  JAMA Psychiatry 2015; 72: 935

SUBOXONE-DEPENDENCY
Buprenorphine is an alternative to methadone to treat dependence. Partial mu opioid antagonist.
• ↓ risk of overdose, fewer drug interactions, less severe neonatal abstinence syndrome
• ↑ pain med requirements after cesarean
• Need a multi-modal analgesic regimen: neuraxial, ketamine, TAP blocks, wound infiltration, acetaminophen, ketorolac
  SOAP Newsletter 2013; Summer: 13

UNUSUAL CASES
Loeys-Dietz Syndrome (autosomal dominant connective tissue syndrome) and cesarean delivery.
  A&A Case Reports 2015; 4: 47
Vaginal delivery with hyperekplexia – syndrome with exaggerated startle response.
  A&A Case Reports 2015; 4:103
Doctors can’t make you immortal…………
But with good luck they can prolong your suffering indefinitely.

UK TRIENNIAL REVIEW
• There has been an overall reduction in maternal mortality in the UK to 10 per 100K maternities
• All of that reduction has come from “direct” causes, e.g. preeclampsia, genital tract sepsis – #1 direct cause is venous thromboembolism
• No change in death rates from “indirect” causes, e.g. cardiac, epilepsy
• Recommendations support better training in obstetric medicine (an ABIM fellowship area)
Obstetric Medicine 2015; 8:3

STATE MMC REVIEW
Review of deaths in Illinois 2001-12 to describe potential preventability:
• #1 vascular causes (stroke), #2 cardiac causes, #3 hemorrhagic causes
• 1/3 of deaths related to pregnancy were deemed preventable including most hemorrhage and psychiatric causes
• Patient, provider and systems factors
Am J Obst Gynecol 2014; 211: 698

MANAGEMENT PROTOCOLS
• Use of comprehensive maternal protocols in a large health care system (> 60K annual births) reduced blood product use by 26% and hysterectomy by 15%.
Am J Obst Gynecol 2015; 212: 272
• A standardized multi-disciplinary approach to placenta accreta spectrum resulted in ↓ EBL, ↓ transfusions and fewer emergency deliveries.
Am J Obst Gynecol 2015; 212: 218
JW ALGORITHM
Comprehensive care of the Jehovah’s Witness parturient, including ethical/legal concerns and an algorithm for peripartum management.
Anesth Analg 2015; 121: 1564

POSTPARTUM HEMORRHAGE
Comprehensive management protocol including transfusion and testing.
Blood 2015; 125: 2759
Comparison of 4 national guidelines for management of PPH found substantial variation – US, UK, Canada, and Australia/New Zealand.
Am J Obstet Gynecol 2015; 213: 76

OXYTOCIN
Do parturients exposed to oxytocin during labor require more oxytocin after delivery to achieve satisfactory tone? YES.
- Oxytocin ED_{90} was 44 IU/hr after oxytocin in labor versus only 16 IU/hr without prior labor.
- 34% of laboring women but only 8% of non-laboring required other uterotonic agents.
Anesth Analg 2015; 121: 159

2ND LINE UTEROTONICS
Is methylergonovine (Methergine®) or carboprost (Hemabate®) preferable when a 2nd line uterotonic is necessary?
- 1335 women who required transfusion or operative intervention for PPH were reviewed
- 65% had Methergine®; 35% had Hemabate®
- Methergine was more effective and had less hemorrhage-related morbidity
Am J Obstet Gynecol 2015; 212: 642

ACCRETA / PERCRETA
Accreta Spectrum comprehensive management:
- Antenatal diagnosis by ultrasound
- Scheduled cesarean hysterectomy
- Multi-disciplinary preop care conference
- May need surgeons with experience in bowel or urological surgery for percreta
Obstet Gynecol 2015; 126: 654
Features of a center of excellence for accreta spectrum
Am Jobstet Gynecol 2015; 212: 561

ACCRETA / PERCRETA
Randomized trial of pre-cesarean balloon catheters for suspected placenta accreta:
- 13 in the intervention group, 14 controls
- 50% had cesarean hysterectomy in each group
- No difference in EBL, transfusion, EBL > 2500 ml, duration of surgery, peripartum complications, length of stay
- 15% had balloon-related complications
Obstet Gynecol 2015; 126: 1022
ACCRETA / PERCRETA
Review of conservative management:
• Procedures: leaving placenta in-situ, hysteroscopic resection, en bloc excision and repair, addition of arterial occlusion and methotrexate
• Risk of delayed hysterectomy for bleeding or infection, recurrence of accreta in subsequent pregnancy – cost analysis vs. immediate cesarean hysterectomy?

DIC SYNDROMES
• Associated with abruption, AFE, sepsis, acute fatty liver, preeclampsia / HELLP, and massive hemorrhage
• Initiated by tissue factor from trophoblastic or fetal tissue
• Treat the underlying disorder and provide blood and component therapy.
Obstet Gynecol 2015; 126: 999

RETAINED PLACENTA
Evaluation of risk factors in > 91,000 deliveries ≥ 24 weeks gestation:
• Occurred in 1.1%
• Stillbirth OR 5.7, age > 30 years, delivery < 34 weeks, ↑ labor duration
• Protective: non-Hispanic black race
• No association with BMI
Am J Obstet Gynecol 2015; 213: 864

TRANEXAMIC ACID
• Small studies have shown promising results but inadequate studies to recommend yet
• 10 RCT for cesarean → significant reduction in EBL, no adverse events (1 gm in 5-10 min)
• Concern for neonatal exposure if given prophylactically, maternal thrombosis PP
• WOMAN trial in Africa and Europe is recruiting 15,000 women; results pending
Br J Anaesth 2015; 114: 576

FIBRINOGEN
Does low plasma fibrinogen at admission to L&D predict severe postpartum hemorrhage?
• 1951 healthy women, average fibrinogen concentration = 530
• No correlation with median EBL at delivery or with EBL > 1000 ml
• Risk of hemorrhage ↑ with oxytocin during labor, cesarean delivery, uterine exploration
Br J Anaesth 2015; 115: 99

FIBRINOGEN
In early PPH, does pre-emptive treatment with fibrinogen reduce need for RBC transfusion?
• In early, severe PPH received 2 gm fibrinogen or saline regardless of labs
• No effect on transfusion; 20% with fibrinogen vs 22% received blood
• No thromboembolic events
Br J Anaesth 2015; 114: 623
CELL SALVAGE IN OBSTETRICS

- Change to a separate suction device after delivery.
- Use a leukocyte depletion filter to remove particulate and bacterial contaminants, reduce fetal cells, and remove AF-derived tissue factor.
- Consider cell salvage when patient will not consent to transfusion, cross-matched blood is unobtainable, or EBL is expected to be > 1 liter.
- “…no single serious complication leading to poor maternal outcome has been directly attributed to use of cell salvage”
- Supported by national bodies in U.S. and Britain.

Anesth Analg 2015; 121: 465

CELL SALVAGE IN OB

Which patients will lose enough blood during PPH to receive their cell salvage blood?

- Routine cesarean only 13%; 21% overall
- Cesarean hysterectomy 73%
- 69% with bleeding after cesarean
- 53% with bleeding after vaginal delivery

Obstet Gynecol 2015; 125: 919

PREECLAMPSIA: ETIOLOGY

Preeclampsia is a syndrome that:
1. Only occurs in pregnancy
2. Is characterized by maternal inflammation
3. Is associated with presence of a placenta

Does DNA shed from the placenta into the maternal circulation initiate the inflammatory response? Expert Review discusses evidence.

Am J Obstet Gynecol 2015; 213: 268

PREECLAMPSIA: ETIOLOGY

Expert Review: Why is placentation abnormal in preeclampsia? Recent evidence suggests that isolation and culture of cytotrophoblasts from the placentas of pregnancies complicated by preeclampsia enables normalization of their gene expression – some aspects may be reversible.

Am J Obstet Gynecol 2015; 213: S115

PREECLAMPSIA - DX

Survey of 140 pregnant women presenting to the ER with acute headache.
- 65% had primary HA diagnosis; 91% migraine
- Secondary HA due to another diagnosis in 35%
- Preeclampsia most common 2nd diagnosis in 51%
- Don’t miss other diagnoses: look for ↑ BP, seizures, fever, abnormal neuro exam.

Neurology 2015; 85: 1

EARLY VS LATE ONSET PREECLAMPSIA

Overall incidence of preeclampsia was 3%.

<table>
<thead>
<tr>
<th></th>
<th>Death per 100K</th>
<th>Morbidity (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Early-onset &lt; 34 weeks</td>
<td>42</td>
<td>12 (renal, CV, respiratory, CNS)</td>
</tr>
<tr>
<td>Late-onset</td>
<td>11</td>
<td>5.5</td>
</tr>
<tr>
<td>No PEC</td>
<td>4</td>
<td>3</td>
</tr>
</tbody>
</table>

Obstet Gynecol 2014; 124: 771
### EARLY vs. LATE ONSET PREECLAMPSIA

Data on 2 million infants in Quebec, 1989 – 2012

<table>
<thead>
<tr>
<th>Overall CHD</th>
<th>Non-Critical CHD</th>
<th>Critical CHD</th>
</tr>
</thead>
<tbody>
<tr>
<td>PEC vs None</td>
<td>Early vs Late PEC: P.R. = 1.57</td>
<td>Early vs Late PEC: P.R. = 5.55</td>
</tr>
<tr>
<td>P.R. = 1.57</td>
<td>P.R. = 2.78</td>
<td></td>
</tr>
</tbody>
</table>

CHD: congenital heart disease, PEC: preeclampsia

JAMA 2015; 314: 1588

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### #514: Emergent Therapy for Acute-Onset, Severe Hypertension During Pregnancy and the Postpartum Period.

“Acute-onset, persistent (>15 min) severe systolic (≥ 160 mmHg) or diastolic (≥ 110 mmHg) hypertension in the pregnant or postpartum patient with PEC/EC constitutes a hypertensive emergency. Severe systolic HTN may be the most important predictor of cerebral injury and infarction, and if not treated expeditiously can result in death…”

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### ACOG COMMITTEE OPINION

“…IV labetalol (20–40–80 mg), PO nifedipine (10–20–20 mg), and IV hydralazine (5–10 mg) are all considered first line drugs. In the rare circumstance that they fail to relieve acute severe HTN…emergent consultation with an anesthesiologist, maternal-fetal medicine subspecialist, or critical care subspecialist is recommended to discuss second-line intervention.”

Obstet Gynecol 2015; 125: 521

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### PREECLAMPSIA & STROKE

CVA in hypertensive disorders of pregnancy may be associated with impaired cerebral auto-regulation. Auto-regulatory index calculated:

- Normal in gestational hypertension (6.7)
- Reduced in preeclampsia and chronic hypertension (similar values of 5.5 and 5.6)
- Lowest in chronic HTN with superimposed preeclampsia (3.9)

Am J Obstet Gynecol 2015; 212: 513

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### PREECLAMPSIA & STROKE

Are complications higher in stroke during pregnancy when associated with HTN disorders?

- Women with HTN were 5.2 times more likely to have a stroke; especially with other risk factors such as atrial fib, congenital heart disease, sickle cell, thrombophilia
- Complications were more common with HTN.
- Stroke rates have ↑ since the 1990s.

Obstet Gynecol 2015; 125: 124

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### PREECLAMPSIA - RX

How tight should BP be controlled when treating chronic hypertension during pregnancy?

- Randomized trial of tight (diastolic target 85 mmHg) versus less-tight (diastolic 100 mmHg)
- No apparent benefit to the fetus (probably not powered to find differences in fetal death)
- Only moderate maternal benefit to tight control → less progression to severe hypertension, 28% versus 41%.

PREECLAMPSIA
Are health care providers aware that preeclampsia ↑ later risk of cardiovascular disease?
• Gynecologists more likely to ask about pregnancy history
• Internists more likely to get appropriate testing for CV disease
• Both groups need additional education.
  Obstet Gynecol 2015; 125: 1287

PREECLAMPSIA
HTN in pregnancy is associated with ↑ later risk of CV death before age 60.
• 2-3x risk after preeclampsia
• 6x risk after chronic HTN + preeclampsia
• 7x risk after chronic HTN + preterm delivery
• 5x risk after chronic HTN + low birthweight
• 5x risk after preeclampsia + preterm delivery
  Circulation on-line 2015; 9/21/15

OBESITY
CDC reports that among women who delivered a full-term, singleton infant:
• 32% gained an appropriate amount
• 20% gained too little
• 48% gained too much, leading to ↑ risk of macrosomia, postpartum weight retention, and child obesity
  MMWR 2015; 64: 1215

OBESITY PROTOCOLS
Assess the patient early and discuss the plan:
• Be frank about problems that might be encountered
• Perform an airway assessment
• Ensure reliable IV access – PICC?
• Consider an arterial line
• Use supplemental oxygen intrapartum
• Use continuous pulse oximetry
• Administer aspiration prophylaxis throughout labor
  Am J Obstet Gynecol 2015; 213: 318

OBESITY GUIDELINES (1)
ACOG Practice Bulletin #156:
• Calculate BMI at 1st prenatal visit to begin diet & exercise counseling
• Pre-conception and inter-pregnancy weight loss improve outcomes during pregnancy
• Consult Anesthesiology: obese women with OSA are at ↑ risk of hypoxia, ↑ CO₂ and death
• Ultrasound diagnosis of anomalies may be limited
• Screen early for diabetes
  Obstet Gynecol 2015; 126: e112

OBESITY GUIDELINES (2)
• Allow longer 1st stage of labor before C/S for labor arrest
• Use mechanical & weight-based pharmacologic thromboprophylaxis
• Subcutaneous drains ↑ post-cesarean cx and should not be routine
• Stillbirth rates are ↑ but role of antepartum surveillance is unclear.
BARIATRIC SURGERY
Pregnant women who had bariatric surgery were matched with pregnant controls of similar BMI.
• Gestational diabetes was less: 2 vs. 7%
• There were fewer LGA infants: 9 vs. 22%
• Higher risk of SGA infants: 16 vs. 8%
• Results not significant, but higher risk of stillbirth or neonatal death: 1.7 vs. 0.7%
• Bariatric surgery has strong benefits, but also risks.

CEFAZOLIN DOSE & OBESITY
Does 3 gm cefazolin produce better adipose tissue concentrations in obese women BMI > 30 than 2 gm for pre-cesarean prophylaxis?
• Tissue harvested before fascial incision and after closing fascia
• 3 gm cefazolin did not increase adipose tissue concentrations, so 2 gm is adequate
  Obstet Gynecol 2015; 125: 1205

ENOXAPARIN DOSE & OBESITY
This study compared the adequacy of thrombo-prophylaxis based on anti-Xa concentrations when enoxaparin was dosed by weight or BMI-stratification.
• Anti-Xa levels were higher with weight-based dosing (0.5 mg/kg enoxaparin every 12 hours)
• Only 26% were therapeutic using BMI
  Obstet Gynecol 2015; 125: 1371

SEPSIS
A review of maternal sepsis deaths in Michigan 1999-2006 found:
• 15% of all pregnancy-related deaths
• Review of hospital records found 73% had a delay in receiving antibiotics, 53% had delay in escalation of care
• Of the 22 deaths, 20 developed sepsis at home (before or after delivery), 2 while hospitalized
  Obstet Gynecol 2015; 126: 747

SEPSIS
Modified Obstetric Early Warning Scoring systems (MEOWS) are adapted for the physiologic changes of pregnancy. Attempt to validate 6 published MEOWS.
• Retrospective study of 364 women with chorio, 5 developed severe sepsis
• Multiple MEOWS with varying sensitivity and specificity but all poor & over-diagnosed
• None performed as well as standard MEWS
  Am J Obstet Gynecol 2015; 212: 536

Tdap VACCINATION
Tdap vaccination is recommended during each pregnancy regardless of prior immunization status. Is this safe in close intervals?
• Women receiving Tdap in current pregnancy stratified by time since last Tdap: < 2 years, 2-5 years, and > 5 years
• No ↑ risk of acute adverse events or adverse birth outcomes for intervals <2 or < 5 years.
  JAMA 2015; 314: 1581
**HIV TRANSMISSION**

ACOG Committee Opinion #635 recommends prenatal HIV screening for all women to:
1. prevent perinatal transmission,
2. get the mother the benefits of early therapy,
3. decrease the risk of transmission for HIV-uninfected sexual partners.
They recommend screening high-risk mothers again in 3rd trimester. On L&D, untested mothers should get rapid screens and antiretroviral prophylaxis started immediately if positive.

Obstet Gynecol 2015; 125: 1544

**HIV TRANSMISSION**

Multicenter cohort study of 8075 HIV-infected women on combination anti-retroviral therapy.
- Overall transmission rate only 0.7%.
- If started pre-conception and viral load was < 50, there was no transmission.
- If started in 3rd trimester, 2.2%
- Elimination of perinatal transmission may be possible!

Clin Infec Dis 2015; online

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**UNUSUAL INFECTIONS**

Embolic strokes caused by parasitic infection and eosinophilic syndrome.

N Engl J Med 2015; 373:1154

Fever and headache caused by tick-borne infection with *Borrelia*.

N Engl J Med 2015; 373: 468

**CARDIOVASCULAR DZ**

Describe the incidence and type of CV disease as a cause of maternal mortality in California, 2002-2006:
- 25% of deaths were from CV causes
- African-American race, illicit substance use and obesity were all risk factors
- Chronic disease prevention and treatment are needed to reduce maternal mortality


**CARDIOMYOPATHY**

Review on diagnosis and management of peripartum cardiomyopathy:
- Diagnosis of exclusion when EF ≤ 45
- Symptoms of heart failure; can be difficult to differentiate from normal pregnancy symptoms
- Stabilize before delivery with oxygenation, diuretics, vasodilators ± inotropes, then β-blockers; transplantation if no improvement

Anesth Analg 2015; 120: 638

**CORONARY DISEASE**

Review of subsequent pregnancy risks in women with pre-existing CAD or after acute coronary symptoms:
- CAD contributes to 20% of maternal cardiac deaths during pregnancy
- Requires specialist care with cardiology
- Treat modifiable risk factors (e.g., smoking)
- Complications † and outcomes are worse.

Heart 2015; 101: 502, 505
CARDIAC VALVULAR DZ
Review of 212 women with mechanical heart valves during pregnancy:
• Only 58% had an uncomplicated pregnancy
• 4.7% had valve thrombosis; half occurred in the first trimester when taken off warfarin
• Warfarin use ↑ miscarriage and late fetal death
• 23% had hemorrhagic complications vs 5% with a tissue valve
Circulation 2015; 132: 132

THROMBOSIS
Clinical management of DVT during pregnancy:
• Leading cause of maternal morbidity/mortality
• Gestational DVT is usually left leg and proximal → increased risk of embolism
• Ultrasound for DVT, V-Q for PE initially
• LMWH preferred treatment, continuing until 6 weeks postpartum; Coumadin contraindicated during pregnancy but safe for breastfeeding.

THROMBOSIS
Case report: G1 at 33 weeks presented with chest and shoulder pain, right leg edema, and upper thigh pain. US → femoral DVT. CT angiogram → large central saddle embolus. Worsening symptoms and RV dysfunction on TTE led to successful catheter-directed TPA thrombolysis under GETA in a hybrid OR with cardiac surgeons and bypass on standby. Induction for preeclampsia on POD11 with vaginal delivery.
A&A Case Reports 2015; 4: 91

RISKS FOR PP DEPRESSION
Women who strongly prefer vaginal delivery but require a cesarean.
Am J Obstet Gynecol 2015; 212: 229
Self-reported poor sleep during pregnancy and the postpartum period ↑ risk of PP depression. Sleep interventions should be studied.
J Affect Disord 2015; 176: 65

FETAL LOSS
A national survey on U.S. perceptions of miscarriages found many misconceptions.
• 55% believed miscarriage was rare (< 5%).
• Believed to be caused by a stressful event (76%), heavy lifting (64%), previous IUD use (28%) or oral contraceptive use (22%).
• Those who had a miscarriage felt guilty (47%), that they had done something wrong (41%), ashamed (28%) and isolated.
Obstet Gynecol 2015; 125: 1313

FETAL LOSS
This review of stillbirth or late termination for fatal fetal anomalies discusses:
• Psychological and emotional effects
• Obstetric management
• Ethical challenges
• Medical complications
Anesth Analg 2015; 121: 457
**BREECH DELIVERY**
What is the neonatal morbidity by mode of delivery for breech presentation at term?
- Canadian multi-center data from 2003-11
- Planned cesarean = 86%, lowest morbidity
- Vaginal delivery = 4%, OR 3.6 for composite neonatal morbidity or mortality
- Cesarean during labor = 10%, OR 2.8
- Outcomes worse when ≥ 40 weeks gestation.
  Obstet Gynecol 2015; 125: 1153

**BREECH DELIVERY**
Study of the association between intended mode of delivery and morbidity/mortality among preterm, breech fetuses.
- Netherlands registry, 26-37 weeks gestation
- Overall no difference in mortality, but morbidity was ↓ by cesarean: 8.7% vs 10.4%, OR 0.77
- For 28-32 weeks gestation CD ↓ mortality (1.7% vs 4.1%) and morbidity (6% vs 10%), OR 0.37
  Obstet Gynecol 2015; 126: 1223

**ANESTHESIA FOR VERSION**
Comparison of the success rate of ECV using spinal anesthesia or IV remifentanil:
- Spinal=hyperbaric bupivacaine 9 mg+fentanyl
- IV remifentanil at 0.1 μg/kg/min
- Spinal ↓ success rate: 83% vs 64% on first attempt and on second attempt for those versions that failed: 78% vs 0%
- No difference in fetal bradycardia requiring cesarean delivery (1.6% vs 3.2%)
  Br J Anaesth 2015; 114: 944

**INDUCTION FOR TOLAC**
Does induction of labor vs expectant management change outcomes in women attempting VBAC?
- ≥ 37 weeks, one prior cesarean, 6033 women
- Induction ↑ risk of failed TOLAC from 37-39 weeks but not at 40 weeks
- Induction ↑ maternal morbidity, OR 1.87
- No difference in neonatal morbidity
  Obstet Gynecol 2015; 126: 115

**CHOLESTASIS**
What are the pregnancy outcomes with severe intrahepatic cholestasis of pregnancy?
- Umbilical cord bile acid levels correlated with maternal bile levels
- ↑ risk of spontaneous preterm delivery, meconium-staining, postpartum hemorrhage and perinatal death
- IUFD 9.5% when bile acids ≥ 100 μmol/L → move to delivery
  Am J Obstet Gynecol 2015; 212: 100

**THE FETUS AND NEONATE**
**PREVENTING MISCARRIAGES**
For women with a history of recurrent miscarriages, does progesterone during the first trimester increase the rate of live births?
- 836 women received progesterone or placebo
- 66% live births in the progesterone group vs. 63% in the placebo group (CI 0.94-1.15)
- No difference in live births or adverse events
  
  *N Engl J Med 2015; 373: 2141*

**CELL-FREE DNA TESTING**
Can cell-free DNA testing perform as well in first trimester trisomy screening as the usual ultrasound and biochemical tests?
- 16,000 women tested at 12.5 weeks
- Cell-free DNA detected 100% of Trisomy 21 versus only 79% using usual testing.
- Cost?
  
  *N Engl J Med 2015; 372: 1589*

**FETAL MMC REPAIR**
CHOP reported fetal MMC repair outcomes for 100 cases following the MOMS trial:
- Average gestational age at surgery = 23 weeks
- Membrane separation 23%, PPROM 32%, PTL 38%, 2 IUFD, 4 neonatal deaths
- Average 34 weeks at delivery but over 50% delivered ≥ 35 weeks, 3.4% transfused
- 2 VP shunts, 71% no hind-brain herniation, 55% had better than expected functional level
  
  *Fetal Diagn Ther 2015; DOI:10.1159/000365353*

**ANTENATAL MAGNESIUM**
Antenatal magnesium may be used for preeclampsia, preterm labor, or fetal neuroprotection. Does it increase neonatal respiratory complications?
- 1500 infants < 29 weeks gestational age
- No ↑ in cardio-respiratory events in the Mg group and hypotension treatment and invasive ventilation occurred less often.
  
  *Am J Obstet Gynecol 2015; 212: 94*

**PRETERM LABOR**
Maternal microbiome may influence the risk of preterm labor.
- 40 women had their body-wide microbiota DNA sequenced weekly during pregnancy and for a year after they delivered.
- *Lactobacillus*-poor vaginal microbiota was inversely correlated with GA at delivery.
- Probiotic therapy? Environmental exposure?
  
  *Proc Natl Acad Sci USA 2015; 112: 11060*
FETAL MONITORING

Would use of fetal ECG ST-segment analysis assist in interpretation of conventional FHR monitoring and improve neonatal outcomes?

- 11,108 singleton fetuses > 36 weeks in labor
- Routine monitoring or addition of ST analysis
- No difference in cesarean rate, operative delivery, or any adverse neonatal outcome.
  
  N Engl J Med 2015; 373: 632

FETAL MONITORING

Can OB experts agree on interpretation of abnormal FHR tracings and appropriateness of obstetric management? No.

- “Experts” reviewed abnormal FHR tracings for court cases while either knowing neonatal outcomes or while blinded to outcome
- Both intra- and inter-observer agreement was poor → lack of objectivity of expertise
  
  Am J Obstet Gynecol 2015; 213: 856

DELAYED CORD CLAMPING

Delayed cord clamping by 1 minute prevents iron deficiency at 6 months of age. Are there neurodevelopmental effects at 4 years of age?

- Follow-up of 69% of children in a prior RCT
- Delayed cord clamping group had improved scores in fine-motor and social domains, especially in boys.
  
  JAMA Pediatrics online 5/26/2015

MODE OF DELIVERY

Does planned cesarean delivery lead to health problems in childhood?

- Scottish database using 321,287 term births
- Planned cesarean versus vaginal delivery had ↑ risk of asthma requiring admission and inhaler prescription, and all-cause death by 21.
- No differences in obesity, inflammatory bowel disease, type 1 diabetes, or cancer.
  
  JAMA 2015; 314: 2271

THE APGAR SCORE

ACOG Committee Opinion #644:

- Does not predict mortality or neurologic outcome and does not diagnosis asphyxia
- Apgar < 7 at 5 minutes → get cord gases
- Scores assigned during resuscitation are not equivalent to a score assigned to a spontaneously breathing infant.
  
  Obstet Gynecol 2015; 126: 914

CORD BLOOD GASES

Does base deficit add any further predictive value over pH < 7.0?

- Adverse outcomes (encephalopathy, death, NICU admission) increased as pH fell, but base deficit did not add predictive value
- Cord lactate level > 3.9 may be more sensitive / specific for neonatal morbidity
  
  Am J Obstet Gynecol 2015; 213: 373
NEWBORN RESUSCITATION
A literature review on evolving strategies.
Maternal Health, Neonatology, and Perinatology 2015; 1: 4
Multi-center safety audit to improve delivery room resuscitation management by including checklists, videotaping and debriefings.
Maternal Health, Neonatology, and Perinatology 2015; 1: 2

HYPER-BILIRUBINEMIA
Does the combination of antenatal phenobarbital and postnatal phototherapy decrease the need for blood exchange transfusions in newborns with hemolytic disease and hyperbilirubinemia?
• Yes – the differences in bilirubin levels and the need for transfusion were significantly reduced with combination therapy
• Phenobarbital ↑ hepatic enzymes and conjugation of bilirubin.

RISK OF CEREBRAL PALSY
Review of CP occurring in term infants.
• 80-90% of CP is due to prenatal causes; birth asphyxia has a minor role in < 10%.
• IUGR and major birth defects (especially involving the brain) occur more often with CP.
• Other associations include abnormal placentas, thrombotic states and genetic factors.
N Engl J Med 2015; 373: 946

EXTREME PREMATURENESS
• Survival and survival without major morbidity improved, especially 23-24 weeks gestation.
• More steroids, more cesareans, more CPAP and less intubation, less sepsis over time
JAMA 2015; 314: 1039

EXTREME PREMATURENESS
U.S. vital statistics were used to evaluate trends in mortality for infants born at 22-28 weeks gestation during 1990, 2000, and 2010.
• Infant mortality dropped by 50% from 1990-2000 with use of surfactant and steroids
• No change from 2000-2010 with changes in nutrition and ventilation strategy.
• Trend to ↑ effort to resuscitate at 22-24 weeks
J Perinatolgy 2015; 35: 885

EXTREME PREMATURENESS
NICHD Network examined in-hospital differences in outcomes for infants < 27 weeks without anomalies.
• Main difference was in local approach to active treatment of infants born at 22-24 wks
• There was large variation in initiating potentially life-saving treatment after birth
• After 24 weeks there was no difference.
EXTREME PREMATURITY
What are the ethical aspects of a prenatal consultation with neonatology when delivery is considered imminent? Less than ideal setting…
• Limits on accuracy of morbidity/mortality data
• Very emotional time for decision-making
• Variable amount of trust between parents and physicians in emergent setting
• Consider a trial of resuscitation with various decision-making points occurring over treatment in the NICU
  J Clin Ethics 2015; 26: 241

EXTREME PREMATURITY
Should preterm babies born < 29 weeks have screening for patent ductus?
• Ultrasound screening before day 3 of life was associated with ↓ mortality and pulmonary hemorrhage
• No difference in necrotizing enterocolitis, severe BPD or severe cerebral lesions
  JAMA 2015; 313: 2441

PREMATURITY
Should preterm babies have delayed cord-clamping vs. concerns about IVH and delay in resuscitation?
• Infants born ≤ 32 weeks
• Delay of 45 seconds to cord clamp was associated with ↓ intubation in the delivery room, less IVH and ↓ RBC transfusion
• No difference in death or major morbidity
  Am J Obstet Gynecol 2015; 213: 676

PREMATURITY
Premature newborns randomized to “kangaroo care” or skin-to-skin contact had a 36% lower death rate than those under standard care only.
• 50% lower risk of sepsis
• 78% lower risk of hypothermia
• 88% lower risk of hypoglycemia
  Pediatrics online: 12/22/15

ANTI-DEPRESSANTS
What is the fetal risk of exposure to anti-depressants during pregnancy?
• Large Canadian register cohort study
• Sertraline: 34% increased risk of ASD and VSD, twice the risk of craniosynostosis
• Non-Sertraline SSRIs: ↑ risk of craniosynostosis and musculoskeletal defects
  Am J Obstet Gynecol 2015; 212: 795

ANTI-DEPRESSANTS
What (if any) is the relationship between use of anti-depressants in pregnancy and autism spectrum disorder in the child?
• Large pregnancy database in Quebec
• 1054 children with autism disorder and mean follow-up of 3 years
• Using any anti-depressant during 2nd and 3rd trimester (but not 1st) was associated: hazard ratio 1.87; SSRI use in 2nd / 3rd trimester = 2.17
  JAMA Pediatr; online 12/14/15
**ABSTINENCE SYNDROME**
Recent studies have compared infants of opioid-addicted mothers who were treated with methadone or buprenorphine and naloxone.

- B-N exposed infants had fewer symptoms and shorter hospitalizations.
- But….mothers were less compliant with B-N
- Cost of infant treatment if abstinence syndrome occurred: $159K - 238K > a healthy neonate.
  Obstet Gynecol 2015; 125: 363

**MARIJUANA**
Is marijuana use independently associated with poor neonatal outcomes? No.

- 8.4% usage rate (at Wash U in St. Louis)
- ↑ if younger, AA race, inadequate prenatal care, used alcohol, tobacco and other drugs
- After risk adjusting, marijuana use did not increase markers of poor neonatal outcome (low birthweight, NICU, Apgar<7, acidosis)
  Am J Obstet Gynecol 2015; 213: 422

**REVIEWS**
Marijuana use in pregnancy and lactation: a review of the literature.
Am J Obstet Gynecol 2015; 213: 761

Fetal alcohol spectrum disorders.
Pediatrics 2015; 136: 3113

**MATERNAL CANCER**
Case-control study of mothers diagnosed with cancer during pregnancy.

- 129 children assessed at 18 months, 3 years
- 74% exposed to chemo, 8.5% to radiation, 10% to surgery alone, 10% to no treatment
- No differences in cognitive function, cardiac findings, or general development vs. controls
  N Engl J Med 2015; 373: 1824

**MATERNAL CANCER**
Does in-utero chemotherapy affect child outcome and development?

- Comparison of children whose mothers were diagnosed during pregnancy and did or did not have chemotherapy while pregnant
- Developmental testing at ≥ 18 months
- No differences in cognitive ability, school performance, or behavioral competence.
  Am J Obstet Gynecol 2015; 212: 658

**MATERNAL CANCER**
What is the long-term outcome of children who are exposed to maternal cancer, with or without treatment, during pregnancy?

- 129 children evaluated at 18 and 36 months
- 74% were exposed to chemotherapy, 8.5% to radiation, 10% to surgery, 11% no treatment
- No difference in birthweight, cognitive development or cardiology eval at 3 years
  N Engl J Med 2015; 373:1824
AND WE’LL SEE WHAT’S NEW IN 2016!

THE END
Assessment of Perioperative Cardiac Risk for Non-Cardiac Surgery

Your Cardiology Consult

Avoid hypoxemia and hypotension!

Levels of Evidence


<table>
<thead>
<tr>
<th>Class</th>
<th>I</th>
<th>2a</th>
<th>2b</th>
<th>3</th>
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</thead>
<tbody>
<tr>
<td>Benefit</td>
<td>&gt;&gt;&gt; risk</td>
<td>&gt;&gt; risk</td>
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<td>≤ risk</td>
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<tr>
<td>Recommend</td>
<td>&quot;should&quot;</td>
<td>&quot;useful&quot;</td>
<td>&quot;may consider&quot;</td>
<td>no benefit / harmful</td>
</tr>
</tbody>
</table>

The Goal:

to avoid a Major Adverse Cardiac Event (MACE)

Major Adverse Cardiac Events

ACC/AHA Guideline on Perioperative Cardiovascular Evaluation and Management of Patients Undergoing Noncardiac Surgery. JACC 2014; 64 (22)

- Myocardial infarction (MI)
- Pulmonary edema
- Complete heart block (CHB)
- Ventricular fibrillation (VF)
  - primary cardiac arrest

Active Cardiac Syndromes (1B)


- Unstable coronary syndromes, recent MI
- Acute decompensated heart failure (ADHF)
- Significant arrhythmias
  - symptomatic bradycardia, Mobitz II, CHB
  - SVT / AF > 100/min, ventricular arrhythmias
- Severe valvular disease
  - symptomatic aortic stenosis, mitral stenosis

Mobitz Type I and II (Second Degree Heart Block)

Is it ever obvious that I should just cancel the case?

Cardiac Preop CRASH 2-16 - January 24, 2016
OK, what if the patient does not meet these criteria?

Assessment of Cardiac Risk
(History, Examination, Resting ECG)

Revised Cardiac Risk Index (RCRI)
1. History of ischemic heart disease (IHD)
2. History of congestive heart failure (CHF)
3. History of cerebrovascular disease (CVA)
4. Insulin-dependent diabetes (IDDM)
5. Chronic kidney disease (CKD) (SCr >2 mg/dL)
6. Suprainguinal surgery - vascular, intraperitoneal or intrathoracic

Cardiac Risk of Non-Cardiac Surgery

Risk | Examples
---|---
High > 5% | Aortic, major, peripheral vascular surgery
Intermediate (1-5%) | Abdominal / thoracic surgery, carotid endarterectomy, head & neck, orthopedic, prostate surgery
Low < 1% | Endoscopic, cataract, breast, superficial, ambulatory surgery

Risk Factors and Perioperative Complications

• High risk surgery
• IHD
• CHF
• CVA
• IDDM
• CKD

Newer Risk Assessment Tools
ACC/AHA Guideline on Perioperative Cardiovascular Evaluation and Management of Patients Undergoing Noncardiac Surgery. JACC 2014; 64 (22)
American College of Surgeons (ACS)
NSQIP Database
www.riskcalculator.facs.org
www.surgicalriskcalculator.com

Defining Poor Exercise Tolerance
• Unable to walk four blocks
• Unable to climb two flights of stairs
• Serious complications after non-cardiac surgery: 20% vs. 10%
• Risk of serious complication inversely related to number of blocks able to be walked or stairs able to be climbed
Estimated Energy Requirements: Metabolic Equivalents (METS)


1 MET = Resting (basal) VO2 of a 70 kg, 40-yr old man
= 3.5 mL/kg/min
= 245 mL/min

Severity of Angina

Canadian Cardiovascular Society Website: www.ccs.ca

- Grade I: vigorous exercise (> 10 METS)
- Grade II: moderate exercise (4 -10 METS)
- Grade III: minimal exercise (1- 3 METS)
- Grade IV (unstable):
  - new onset, at rest or during sleep
  - increasing in intensity
- Subendocardial ischemia
  - new onset dyspnea with non-Q wave MI

A Caveat

- Myocardial ischemia can present as acute dyspnea:
  - left ventricular diastolic stiffness
  - elevated left atrial pressure
  - acute pulmonary congestion/edema

(remember the definition of subendocardial ischemia?)

Electrocardiogram (ECG)

- Resting ECG: variable risk assessment
  - bradycardia, heart block, arrhythmias
  - previous MI
- Induction of myocardial ischemia: stress
  - increased myocardial O2 demand (VO2) in the face of fixed supply
  - exercise ECG: 33% false negative
  - single vessel CAD: 50% false negative

Stress Testing

- Increased myocardial O2 demand
  - exercise ECG
  - dobutamine stress echo

- Decreased myocardial O2 supply (coronary steal)
  - dipyridamole-thallium scan
  - adenosine-thallium scan

Absence of Angina (“Silent Ischemia”)

- Subclinical disease
- Restricted activity (PVD)
- Autonomic neuropathy
  - diabetes, CKD
  - marker is peripheral neuropathy
- Transplanted (denervated) heart

Prediction of Diffuse or LM CAD


- Ischemia at low exercise intensity
  - (< 4 METS)
- Hypotension during exercise
- Diffuse ST changes during exercise
- Persistent angina after cessation
Limitations of Exercise ECG

- Left bundle branch block (LBBB)
- Ventricular pacing
- Pre-excitation syndromes (WPW)
- ST depression > 1 mm at rest
- Exercise restriction (e.g. PVD)

Dobutamine Stress Echo (DSE)

- Simple, reproducible, no radioactive tracer
  - High dose dobutamine + atropine + contrast
- Baseline ejection fraction (EF)
  - Decreased EF during DSE: diffuse disease
- New or worsened wall motion abnormality
  - Risk increases with low threshold, extent of WMA
- Assess ischemic heart rate threshold

Thallium-Dipyridamole Scan

- Risk increases with size of defect
- Strong negative predictive value

Risk Evaluation and Care Strategy

ACC/AHA Algorithm

Cardiac Risk of Non-Cardiac Surgery

Cardiac Evaluation and Care Algorithm

Cardiac Evaluation and Care Algorithm

Cardiac Evaluation and Care Algorithm
Step 5
≥ 4 METS without symptoms?
- Climb a flight of stairs
- Run a short distance
- Heavy housework, golf
- Swimming, singles tennis, skiing

If YES: Proceed to surgery
If no, or unknown, go to Step 6

Step 6
Will further testing impact decision-making or perioperative care?
If NO: Proceed to surgery or non-invasive treatment
If YES: Pharmacologic stress testing

Step 7
Pharmacologic Stress Test
If NORMAL: Proceed to surgery or non-invasive treatment
If ABNORMAL: Coronary revascularization

Can We Decrease Risk Preoperatively?
- Lifestyle modification
  - diet, exercise, weight loss
- Drug-based therapies
  - aspirin, statin, beta-blockade
- Device-based therapies
  - percutaneous coronary intervention (PCI)

Guideline-Directed Medical Therapy (GDMT)

POISE: PeriOperative ISchemia Evaluation Trial

Perioperative Beta Blockade
- Continue chronic beta blocker therapy
- RCRI ≥ 3: Initiate preoperative beta blockade
  - Do NOT start beta blockade ≤ 1 day prep
  - Ideal is 2-7 days before surgery
- RCRI < 3: Initiate postoperative beta blockade
- Utilize IV beta blockade as clinically indicated

Poise-2 Trial
Devereaux PJ et al, NEJM 2014; 370: 1494-1513
What Does the Evidence Tell Us?
One size does not fit all!

Preoperative Coronary Revascularization

Preoperative CABG or PCI*;
Level 1A Recommendations
- Left main disease
- Stable angina, 3-vessel disease
- Stable angina, 2-vessel disease, proximal LAD
- High-risk unstable angina, NSTEMI*
- Acute STEMI*

ACC/AHA Guideline on Perioperative Cardiovascular Evaluation and Management of Patients Undergoing Noncardiac Surgery. JACC 2014; 64 (22)

Percutaneous Coronary Intervention (PCI)
- Percutaneous transluminal coronary angioplasty (PTCA)
- Bare metal stent (BMS)
- Drug-eluting stent (DES)
  - sirolimus, paclitaxel, everolimus

PCI and Timing of Surgery
- PCI: dual antiplatelet therapy (DAPT)
  - clopidogrel
  - aspirin
- If continued within 3-5 days preop
  - increased risk of surgical bleeding
- If held more than 3-5 days preop
  - increased risk of stent thrombosis

Kaluza et al. J Amer Coll Cardiol 2000; 35: 1288-94

Summary (What You Should Know)
- MACE
- Active cardiac syndromes
- Revised Cardiac Risk Index
- Estimated energy requirements (METS)
- Non-invasive cardiac testing
- Cardiac risk of non-cardiac surgery
- ACC/AHA Cardiac Care Algorithm
- Implications of PCI
- POISE 1 and 2

Totsiens!

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