# CRASH 2020

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Sunday, March 1
4:00-5:00 pm  Update on OB Anesthesia – Joy Hawkins, MD
5:00-6:00 pm  ERAS for All Ages – Joy Hawkins, MD; Brenda Bucklin, MD; Megan Brockel, MD
– 1 Patient Safety Credit
6:00-6:30 pm  Q&A

Monday, March 2
7:00-8:00 am  Preoperative Management of the Geriatric Patient - Ruben Azocar, MD
8:00-9:00 am  Too Sick for the OR – Jason Brainard, MD
9:00-9:30 am  Q&A
4:00-6:00 pm  Resuscitation for Critically Ill Patients– Jason Brainard, MD; Brendan Sullivan, MD; Ruben Azocar, MD (moderator)
4:00-6:00 pm  You Asked, We Answer! Top questions in OB Anesthesia – Joy Hawkins, MD; Rachel Kacmar, MD; Brenda Bucklin, MD
4:00-7:00 pm  Comprehensive Airway Workshop - Beth Benish, MD; Marina Shindell, DO; Brian Somerset, DO; Dave Abts, MD; Nicole Arboleda, MD

Tuesday, March 3
7:00-8:00 am  What’s New in Cardiovascular Anesthesia - Breandan Sullivan, MD
8:00-9:00 am  Intraop & Postop Management in Elderly Patients - Ruben Azocar, MD
9:00-9:30 am  Q&A
4:00-6:00 pm  Using Conflict Competencies to Improve Care, Closed Claims and Career Satisfaction – Lisa Neale, BA, MSS; Scott Markowitz, MD; Karen Domino, MD
– 2 Patient Safety Credits
4:00-6:00 pm  What You Need to Know About Neuroanesthesia– Claudia Clavijo, MD; Scott Vogel, DO; Colby Simmons, DO
4:00-7:00 pm  POCUS – Tim Tran, MD; Breandan Sullivan, MD; Maung Hlaing, MD; Sarah Alber, MD; Brooke Calebrese, MD

Wednesday, March 4
7:00-8:00 am  Postanesthesia Cognitive Impairment in Older Patients – Ruben Azocar, MD
8:00-9:00 am  Liability in Anesthesiology: Lessons Learned from Closed Claims – Karen Domino, MD - 1 Patient Safety Credit
9:00-9:30 am  Q&A
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<td>4:00-6:00 pm</td>
<td>Novel Approaches to Pain Management: A Panel Discussion – Rachael Rzasa Lynn, MD; Justin Merkow, Narayana Varhabhatla, MD</td>
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<td>4:00-6:00 pm</td>
<td>Operational Challenges &amp; Solutions - Clark Lyda, PharmD; Patrick Guffey, MD; Brian Davidson, MD, MBA</td>
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<td>4:00-6:00 pm</td>
<td>Basic Regional Ultrasound Workshop - Kyle Marshall, MD; Marina Shindell, DO; Chris Ciarallo, MD; Roland Flores, MD; Olivia Romano, MD; Inge Tamm-Daniels, MD; Jillian Vitter, MD</td>
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<td>9:00-5:00 pm</td>
<td>Back to Basics in the Wilderness Workshop – Jay Lemery, MD, FACEP, FAWM; Todd Miner, Ed.D, FAWM</td>
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**Thursday, March 5**

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<td>8:00-9:00 am</td>
<td>Anesthesia for Minor &amp; Major Spine Surgery – Karen Domino, MD</td>
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<td>9:00-9:30 am</td>
<td>Q&amp;A</td>
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<td>4:00-6:00 pm</td>
<td>Anesthesia for Infants &amp; Children – Patrick Fernandez, MD; Larry Schwartz, MD; Monica Hoagland, MD</td>
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<td>4:00-6:00 pm</td>
<td>Now what? My Case is Scheduled Outside the Operating Room – Angela Selzer, MD; Debra Faulk, MD; Karen Domino, MD</td>
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<td>4:00-7:00 pm</td>
<td>Advanced Ultrasound Workshop - Kyle Marshall, MD; Marina Shindell, DO; Chris Ciarallo, MD; Roland Flores, MD; Olivia Romano, MD; Inge Tamm-Daniels, MD; Jillian Vitter, MD</td>
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**Friday, March 6**

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<td>7:00-8:00 am</td>
<td>Preventing Perioperative Neurological Injury During General Anesthesia – Karen Domino, MD - 1 Patient Safety Credit</td>
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<tr>
<td>8:00-9:00 am</td>
<td>Cancer Outcomes and Anesthetic Management – Roland Flores, MD</td>
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Disclosure of Relevant Financial Relationships

CRASH

Colorado Review of Anesthesia for Surgicenters and Hospitals

March 1-6, 2020 Vail, CO

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

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<tr>
<th>Name</th>
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<tr>
<td>Karen Domino, MD</td>
<td>Grants/Research Support: Edwards and Mathematica</td>
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<td>Olivia Romano, MD</td>
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All other faculty/contributors have reported no commercial affiliation associated with this conference or intent to reference off-label/unapproved uses of products or devices in their presentations.
Sunday, March 1st
WHAT’S NEW IN OBSTETRIC ANESTHESIA FROM 2019?
Joy L. Hawkins, M.D.
University of Colorado SOM
Disclosure: I have no financial relationships with commercial support to disclose.

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

NEW GUIDELINES AND POLICIES

RESEARCH DURING PREGNANCY
Pharmacologic Research in Pregnant Women — Time to Get It Right
70–80% of pregnant women take at least one prescription during the first trimester of pregnancy, and at least 90% take at least one medication at any point during pregnancy. Pregnant and postpartum women are often excluded from clinical drug trials, however, which leaves obstetrical care providers without adequate information regarding the safety, efficacy, and proper doses of many commonly used medications.

RESEARCH DURING PREGNANCY
“Is It Safe?” — The Many Unanswered Questions about Medications and Breast-Feeding
...up to 1.5 million lactating women who gave birth in the United States in 2017 and their infants were exposed to medications and their potential effects. But since few clinical studies have explored the effects of drugs on lactation or on lactating women and their children, health care providers often lack the evidence they need to counsel women on medication safety and breast-feeding.

RIGHTS DURING PREGNANCY
Statutory Restrictions on Advance Care Planning and Pregnancy
JAMA 2019; 321: 1574
...30 states restricted decisions to withdraw or withhold life support from women who are pregnant, either by invalidating their advance directives, restricting the decisions of their surrogate decision makers, or both... It is women who should decide — and their core values that should guide — whether and under what circumstances pregnancy would be a reason to delay their death, and when it would not.
**PUNITIVE POLICIES DURING PREGNANCY**

A study of 8 states with reporting policies for maternal substance use disorder and their 4.6 million births found that states with punitive policies – e.g., they classify SUD as child abuse or grounds for civil commitment – had higher rates of neonatal abstinence syndrome than did those states with only reporting policies (no criminalization).

**INSURANCE AND PREGNANCY**

ACA requires employer-based insurance plans to cover maternity costs, but plans can employ cost-sharing. What are trends in costs to the patient before and after ACA?  
- Large database from 2008 to 2015 found the costs of childbirth remained stable (~ $29,500).  
- But in 2008, women covered 12% of costs ($3069).  
- And in 2015, women covered 20% of costs ($4569).  
- Increasing out of pocket costs driven by high deductibles.  

Health Affairs 2020; 39: 18

**ELECTIVE INDUCTION vs WAITING**

Should low-risk nulliparous women have elective induction at 39 weeks or expectant management of labor?  
- Meta-analysis of 6 studies with 584,390 women  
- Benefits of induction for the mother include ↓ frequency of cesarean (RR 0.83) and ↓ peripartum infection (RR 0.53).  
- Rates of adverse perinatal outcomes are also ↓ including respiratory morbidity (RR 0.71), meconium aspiration syndrome (RR 0.49), NICU admission (RR 0.80), and perinatal mortality (RR 0.27).

Am J Obstet Gynecol 2019; 221: 304

**INSURANCE AND PREGNANCY**

Are women with Medicaid less likely than privately insured patients to receive a desired PPTL at time of cesarean? Yes.  
- 91% of women with private insurance received their requested TL versus 77% of women with Medicaid.  
- 66% who desired PPTL did not receive it because they did not have a valid signed Medicaid form 30 days in advance.  
- 17% who did not receive PPTL had another pregnancy.  

Obstet Gynecol 2019; 134: 1171

**ELECTIVE INDUCTION vs WAITING**

Is it cost-effective to induce low-risk nulliparous women at 39 weeks compared to expectant management?  
- Induction lowers cost by reducing cesarean delivery, hypertensive diseases, stillbirth and neonatal death.  
- Quality of care is increased but costs are as well.  
- Monte Carlo simulation estimated induction was cost-effective 65% of the time but would still involve $2 billion in additional healthcare costs.

Am J Obstet Gynecol 2019; 220: 590
PREOPERATIVE PREGNANCY TESTING
Mandatory pregnancy testing and the concept of patient autonomy: Discussion of a case where surgery was cancelled due to lack of a pregnancy test.

“...the discussion must adhere to the evidence about risks to the fetus and mother, and not be influenced by the provider’s concern about possible litigation. Cases that are simply cancelled without any patient or family participation in the decision go against all recognized ethical principles of health care.”

ASA Monitor 2019; 83: 44

MIDWIFERY vs OBSTETRIC CARE
A comparison of midwife and obstetrician labor practices and birth outcomes in women with low-risk pregnancies who delivered in 11 hospitals (23,100 births):

- Midwifery patients had 30% lower cesarean birth rate in nulliparous and 40% in multiparous women.
- Also ↓ operative vaginal births: RR 0.73 for nulliparous and RR 0.30 for multiparous women.

Obstet Gynecol 2019; 134: 1056

BREASTFEEDING AFTER ANESTHESIA
Statement on Resuming Breastfeeding after Anesthesia
ASA Committee on Obstetric Anesthesia (asahq.org, 2019)

- Patients should resume breastfeeding as soon as possible after surgery because anesthetic drugs appear in such low levels in breastmilk. It is not recommended that patients “pump and dump”.
- Because pain interferes with successful breastfeeding, women should not avoid pain medicines after surgery.
- Use multi-modal analgesia to lower narcotic requirements.

HOME BIRTH CHARACTERISTICS
Research Letter
Most Intended Home Births in the United States Are Not Low Risk: 2016–2018

Are home births restricted to low-risk patient? No.

- A large national database study found > 60% of intended home births were not low risk: 4% had a prior cesarean, 23% were to mothers > 35 years old and 5% > 40 years old, 22% were > 41 weeks gestation and 4% > 42 weeks gestation, 13% were obese.

CAUSE OF DEATH % OF TOTAL
Other Cardiovascular 15.4%
Other non-Cardiovascular 14.3%
Infection 12%
Hemorrhage 11%
Cardiomyopathy 10.3%
Thrombotic embolism 9.4%
Cerebrovascular accident 7.6%
Hypertensive disorders 7%
Amniotic fluid embolism 5.7%
Anesthesia causes 0.3%
Unknown 6.8%

LEVELES OF MATERNAL CARE
ACOG / SMFM Joint Statement on Levels of Maternal Care
(Supported by ASA House of Delegates, 2019)

- Updated from 2015 with more specific anesthesia language.
- Level 1: now defines types of anesthesia providers (MD, CRNA, AA)
- Level 2: now says “Anesthesiologist readily available at all times”
- Level 3: now says “Board-certified or board-eligible anesthesiologist is physically present at all times”
- Level 4: no changes for anesthesia but includes higher facility capabilities such as ICU, MFM, and surgical subspecialties.

Obstet Gynecol 2019; 134: e41-55

Leading causes of maternal mortality in the U.S., 2011-15
MMWR May 7, 2019
MATERNAL MORTALITY

- Timing of death differed by cause of death, but overall 31% occurred antepartum, 17% day of delivery, 19% first week postpartum, 21% in the first 6 weeks, and 12% from 6 weeks to one year.
- 60% of deaths were deemed preventable.
- The overall pregnancy-related maternal mortality rate was 17.2/100K live births, but varied by race: Black = 42.8 and Native American = 32.5 versus White = 13.0.

MMWR May 7, 2019

MORTALITY AT THE STATE LEVEL

1. Early 2019 Governor Polis of CO signed the Maternal Mortality Prevention Act to formalize and fund the Colorado Maternal Mortality Review Committee – finally since it had existed informally since 1993!
2. The U.S. Centers for Disease Control and Prevention awarded $375K per year for 5 years to fund the CO committee and its Maternal Mortality Prevention Program.
3. Top causes of maternal mortality in CO unrelated to pregnancy are mental health (e.g. suicide, substance abuse), MVAs and homicide.

RACIAL DISPARITIES

NYC hospital databases were used to examine severe maternal morbidity using race and insurance status:

- Overall, severe morbidity was higher among Black 4.2% > Latina 2.9% > White 1.5%.
- Risk for severe morbidity within the same hospital: Black aOR 1.52 > Latina aOR 1.44 > White.
- Severe morbidity was also higher among women insured by Medicaid 2.8% > all commercial insurances at 2.0%.
- However within the same hospital, risk was not associated with differences in types of insurance.

Obstet Gynecol 2020; PAP (Howell)

MORTALITY AT THE ACOG LEVEL

ACOG will focus on cardiovascular disease as the top cause of maternal mortality in the U.S. → Task Force and new Practice Bulletin. Multiple recommendations for care include:

1. Pre-pregnancy counseling for women with heart disease.
2. Creating a multi-disciplinary Pregnancy Heart Team for ongoing collaborative care peripartum.
3. Women with known or suspected cardiac disease should have an ECHO, as should their fetus.

Obstet Gynecol 2019; 133: e320

MEASURING OUTCOMES

Linked administrative and birth certificate data were used to calculate CA hospitals’ maternal complications, neonatal complications and composite scores that included both.

- Average composite scores which are publicly available were misleading: 10% of “average” hospitals were below average in maternal outcomes and 20% of “average” hospitals were below average in newborn outcomes.
- 13% of high performance hospital outliers based on their newborn outcomes were low-performance outliers for mothers.

Anesthesiology 2019; 131: 238, 223 (editorial)

MORTALITY AT THE ASA LEVEL

Several ASA efforts in 2019 showcased and explored how anesthesiologists are mitigating maternal morbidity and mortality:

- www.asahq.org / WhenSecondsCount shows examples of emergency care
- ASAhq.org/birth has information about all forms of pain management and a downloadable birth plan.
- McCallum (Cally) Hoyt, MD was interviewed several times as Chair of the ASA Committee on Obstetric Anesthesia.
- James Lozada, DO was on KevinMD.com speaking about maternal mortality.
ANALGESIA FOR LABOR

PHYSIOLOGY: GASTRIC VOLUME
What is the prevalence of high estimated gastric content at full cervical dilation in parturients with epidural analgesia who are allowed to drink clear fluids during labor?
- US exam of the antrum was done at complete dilation.
- 27% had gastric volume > 1.5 ml/kg or solid content.
- Predictive factors: maximal pain intensity during the last hour of labor and time interval since epidural insertion.
  Acta Anaesthesiol Scand 2019; 63: 27

SUPPORT PERSON’S PRESENCE
143 women were studied to assess the effect of having a support person present during epidural catheter placement.
- Healthy nulliparous parturients who had a companion with them were randomized to having them present or not in the LDR during epidural placement.
- Satisfaction scores were ↑ with companion present (OR 1.93) and anxiety scores were ↓.
- 89% of women randomized to having no companion present would have preferred them to stay.
  Int J Obstet Anesth 2019; 38: 66

PHYSIOLOGY: VITAL SIGNS
What are “normal” vital signs in term pregnant women pre-labor, intrapartum and postpartum?
- 32,161 women with singleton pregnancies, no co-morbidities
- Normal HR: 51-120
- Normal WBC: 6.1-23.9 and normal low-end platelets: 105-117K
- Reference ranges for “normal” parturients is wide.
  Anesth Analg 2019; 129: 1595

VIRTUAL REALITY ANALGESIA
Does virtual reality (VR) distraction decrease reported sensory pain in women experiencing unmedicated labor? Yes.
- Pilot study of 27 women observed + VR with the order of observation randomized during 1st stage of labor.
- During VR there were significant decreases in sensory pain, affective pain, cognitive pain and anxiety using numeric rating scale scores.
  Anesth Analg 2019; 128: e93-6
**INHALED N₂O**

Systematic review of its use in clinical practice, specifically OB:
- Currently used by at least 50% of women in the UK, Australia, Finland and Canada.
- Little effect on pain scores, but provides anxiolysis and a sense of control since self-administered.
- Can be used in very early or late labor, even while pushing.
- No adverse neonatal effects or effects on uterine contractility, but nausea and dizziness can occur.
- Fetal neurotoxicity? Environmental pollution?

Br J Anesth 2019; 122: 587

**NEURAXIAL ANALGESIA UTILIZATION**

Does the prevalence of neuraxial labor analgesia vary across the United States? Yes.
- Maine had the lowest prevalence at 36%. Vermont and Mississippi also low. Nevada had the highest at 80%.
- However U.S. state accounted for only 5.4% of variability. Other factors may be rural access to anesthesia care, especially in low-volume hospitals.

JAMA Network Open 2018; 1: e186567

**NITROUS OXIDE + KETAMINE**

Description of 2 parturients who were not candidates for neuraxial analgesia:
- They received usual nitrous oxide administration.
- Ketamine: 5 mg IV bolus + 0.3-0.4 mg/kg/hour infusion.
- Both patients described mild dizziness, light-headedness and dissociation. They were satisfied with pain control.
- No opioids were used and no adverse neonatal effects seen.

J Clin Anesth 2019; 57: 64

**NEURAXIAL ANALGESIA DISPARITIES**

Hispanic women choose epidural analgesia less commonly than non-Hispanic women for unknown reasons.
- Hispanic and non-Hispanic women randomized to usual care or routine care + video, pamphlet and in-person counseling in their preferred language (English or Spanish).
- The intervention group was 33% more likely to choose an epidural and they had fewer misconceptions about it.
- The non-Hispanic control group showed no difference.

Anesthesiology 2019; 131: 840

**LABOR EPIDURAL BILLING**

The Society for Obstetric Anesthesia and Perinatology (SOAP) has developed best practices for billing documentation for labor analgesia using epidurals or other means.

SOAP.org

Options for billing include base units + time, incremental time-based fees or a flat fee. Medicaid policies are usually the most specific, even though rates are usually lowest.

ASAhq.org
TEACHING CSE TO NEW LEARNERS
Can an on-line tool improve residents’ confidence during initial L&D rotations and shorten their procedure times?
- 2 weeks before their first OB Anesthesia rotation residents were randomized to control or given access to an on-line neuraxial learning module.
- A first day confidence scale showed no difference.
- The intervention group had shorter procedure times, higher scores on the performance checklist and higher scores on the medical knowledge test.
  Anest Analg 2019; 128: 999

DURAL PUNCTURE EPIDURAL (DPE)
Systematic review of 6 studies comparing DPE to conventional epidural for labor analgesia.
- The collective results are ambiguous.
- 25g spinal needles may provide better success than 26- or 27-gauge needles – more dural flux?
- DPE may provide better sacral spread and fewer unilateral blocks than conventional but results are not consistent.
- Provides additional confirmation of correct placement.
  J Clin Anesth 2019; 53: 5

EPIDURAL vs SPINAL DOSING
How do epidural vs spinal fentanyl vs sufentanil compare for early labor analgesia (4 groups)?
- 80 primiparous women received either sufentanil (5 μg IT or 20 μg epidural) or fentanyl (20 μg IT or 100 μg epidural)
- At 20 minutes, epidural sufentanil or fentanyl provided 63% and 60% of the analgesia effect of the spinal doses.
- Duration (time to epidural catheter activation) was longest with spinal fentanyl (177 minutes) and shortest with epidural fentanyl (112 minutes).
  Acta Anaesthesiol Scand 2019; 63: 1413

OPTIMAL PIEB DOSING
What is the optimal interval between 5 ml programmed intermittent boluses using bupivacaine 0.125% + fentanyl?
- Double-blind, up-and-down sequential allocation method used to study time intervals of 30, 40, 50 and 60 minutes.
- ED90 was approximately 35 minutes.
- Half had a sensory level above T6, most had no motor block, and none required treatment for hypotension.
  Can J Anesth 2019; 66: 1075

TREATING BREAKTHROUGH PAIN
RCT comparing epidural clonidine versus fentanyl added to bupivacaine for managing breakthrough labor pain:
- For pain ≥ 5/10, 98 term parturients received 10 ml 0.125% bupivacaine + clonidine 100 μg or fentanyl 100 μg.
- No difference in pain relief, hypotension or sedation after 15 minutes.
  Int J Obstet Anesth 2019; Lee et al. (PAP)

EARLY ANALGESIA PER ACOG
ACOG Practice Bulletin #209: Obstetric Analgesia and Anesthesia
“Randomized trials and systematic reviews including thousands of patients have shown that the initiation of epidural analgesia at any stage during labor does not increase the risk of cesarean delivery.....[Systemic] opioids are associated with adverse effects for the woman and the fetus and newborn, most significantly respiratory depression.”
  Obstet Gynecol 2019; 133: e208-25
ANESTHESIA FOR CESAREAN DELIVERY

The Push for Fewer Opioids for New Mothers

Top hospitals like Cleveland Clinic are turning to options beyond oxycodone for women who need painkillers after C-sections

ENHANCED RECOVERY FOR CESAREAN

Better late than never: why obstetricians must implement enhanced recovery after cesarean


CESAREAN DELIVERY: ERAS/C

All Those In Favor Of Faster C-sections, Raise Your Hand.

Goal of Enhanced Recovery after Cesarean (ERAC)

The goal of ERAC is to help provide all women with evidence-based, patient-centered care using a standardized, multidisciplinary approach that optimizes recovery from cesarean delivery and improves maternal and newborn outcomes. Central to this goal is a culture of critically examining and applying current knowledge through continual process improvements and collaborations.
ERAS: ELECTIVE CESAREAN

Antepartum preoperative education:
- Schedule a 1:1 meeting with an RN at 32-34 weeks.
- Provide a comprehensive education booklet that includes SSI prevention and breastfeeding education.
- Discuss NPO guidelines and encourage fluid intake (e.g. Gatorade™) up to 2 hours before surgery.
- Optimize hemoglobin if anemic using PO iron or infusions.
- Call her the day before surgery to review the checklist.

Intraoperative management:
- Administer appropriate antibiotic prophylaxis.
- Use spinal anesthesia including fentanyl and morphine.
- Add fluid co-load, phenylephrine infusion at spinal injection.
- After delivery, delay cord-clamping for 30 - 60 seconds.
- Limit fluids to < 3 liters; use vasopressors in preference.
- Administer oxytocin and PONV prophylaxis.
- Skin-to-skin + breastfeeding in OR; room temp > 72 degrees.

Postoperative Care:
- Ice chips in PACU → food when on postpartum unit.
- Begin scheduled multi-modal non-opioid analgesia.
- Oxycodone 5 mg is available for breakthrough pain.
- Encourage early mobilization after block wears off.
- Remove the urinary catheter at 12 hours postop.
- Remove the IV 24 hours post-surgery (after morphine).
- VTE prophylaxis. Lactation consult. Peds visit.

PHYSIOLOGY: LEFT vs RIGHT TILT

Women with singleton pregnancies in the third trimester had MRI supine, 15 and 30 degrees right tilt, and 15 and 30 degrees left tilt. The aorta and IVC were measured at L1-L4.
- Aortic volume did not differ in any position.
- IVC volume was greatest in 30° left tilt but no different between supine or the other positions.
- A small subset of 23% had their greatest IVC volume in 30° right tilt, so right lateral may occasionally be beneficial.

Anesth Analg 2019; 128: 1217

PHYSIOLOGY: GASTRIC VOLUME

Ultrasound-determined gastric volume was measured in non-laboring term pregnant patients and compared to non-pregnant females.
- Curvilinear low-frequency transducer with gastric antrum measurements in the supine and right lateral positions
- The two groups were not significantly different.
- Suggests that risk of aspiration in pregnant patients is low.

Br J Anaesth 2019; 122: 79

PHYSIOLOGY: PREOXYGENATION

Could high-flow humidified nasal oxygen be used to achieve adequate pre-oxygenation (etO₂ > 90%) prior to GETA?
- 3-minute high flow protocol of 30 L/min for 30 seconds and then 50 L/min for 150 seconds.
- No difference in comfort scores between the cannula and mask, however 56% preferred the cannula.
- End-tidal oxygen was > 80% after the first breath in 84% but > 90% in only 60% - not adequate for pre-oxygenation.

Br J Anaesth 2019; 122: 86
**IS GENERAL ANESTHESIA SAFE?**

Cochrane Database 004350: There is no evidence from this review to show that regional anesthesia is superior to general in terms of major maternal or neonatal outcomes.

- **However,** GETA may ↑ risk of hemorrhage, SSI and VTE. Neonates may have lower initial Apgar scores and risk of respiratory complications. Mothers have amnesia for the delivery, worse postoperative pain, delayed mobilization, impaired breast-feeding success, and cannot do skin-to-skin time immediately after delivery.

**SUPRAGLOTTIC AIRWAY vs ETT**

Meta-analysis of 14 studies with 2236 patients comparing SGA to endotracheal intubation for elective cesarean delivery.

- No difference in first-attempt success rates.
- No difference in time to insertion.
- No difference in any adverse event except sore throat which was less using SGA.
- Results are still underpowered but reassuring.
  Anesth Analg 2020; PAP (White et al.)

**IS GENERAL ANESTHESIA SAFE?**

7% of all cesareans in NY were done using general anesthesia. What is the risk of adverse maternal events for potentially avoidable (i.e. low risk) GETA compared to neuraxial anesthesia?

- **Findings:** Avoidable general anesthetics were associated with ↑ risk of anesthesia complications (aOR 1.6), severe complications (aOR 2.9), surgical site infection (aOR 1.7), and venous thromboembolism (aOR 1.9), but not of death or cardiac arrest.
- Neuraxial anesthesia remains the gold standard for cesarean.
  Anesthesiology 2019; 130: 864, 912

**Israeli study links autism to general anesthesia in C-sections**

Ben-Gurion University research says other types of sedation for the surgery, such as epidural, still relatively safe

Editorial: After reviewing the paper, we identified a number of critical design flaws. These likely resulted in biased estimates of the autism risk associated with general anesthesia reported in the study....This is not the first time, and is unlikely to be the last, that media have highlighted misleading findings from studies of obstetric anesthesia practices and interventions.

**IS GENERAL ANESTHESIA SAFE?**

Is general anesthesia associated with ↑ odds of severe postpartum depression (PPD) requiring hospitalization?

- 3% of all women required hospitalization for severe PPD.
- Compared to neuraxial, GETA was associated with a 54% ↑ odds of depression and 91% ↑ odds of suicidal thoughts or self-injuring injury. Yet another reason to avoid GETA if possible.
- Possible reasons: delays mother-infant skin-to-skin interaction and breast-feeding, ↑ severe acute pain and persistent pain.
  Anesth Analg PAP 2020 (Guglielminotti)

**POSTPARTUM SALPINGECTOMY**

Ovarian cancer often arises from the fallopian tubes so salpingectomy is now routine during hysterectomy or interval tubal ligation. What are the benefits of performing a bilateral salpingectomy rather than PPTL in obstetric cases?

- Estimated ovarian cancer risk reduction of 64% after salpingectomy.
- After PP salpingectomy, estimate over 10 years is 422 fewer ovarian cancer diagnoses and 252 fewer ovarian cancer deaths.
- Estimated about 1% higher operative complication rate for salpingectomy over tubal ligation.
  Am J Obstet Gynecol 2019; 220: 8, 106
**NEURAXIAL FLUID-LOADING**
Which is better – 500 ml colloid preload + 500 ml crystalloid co-load or 1000 ml crystalloid co-load before spinal for cesarean delivery?
- No difference: pressor dose and maternal hemodynamics were similar in both groups.
- Neonatal Apgar scores did not differ.
- IVC diameters increased after spinal and after delivery, and collapsibility index was higher with crystalloid co-load.
  
  Anesth Analg 2019; 128: 304

**POST-SPINAL PRESSORS**
The EDS0 and ED90 for fixed-rate infusion of prophylactic phenylephrine were 0.31 and 0.54 μg/kg/min respectively.
  
  Anesth Analg 2020; 130: 187
Comparing bolus, fixed-rate and variable-rate infusions of phenylephrine for prevention of hypotension, infusions were better than boluses and fixed-rate was favored because it required fewer physician interventions.
  
  BMC Anesthesiol 2019; 19: 197

**SPINAL TO DELIVERY TIMES**
Do time intervals between spinal anesthesia and delivery affect umbilical arterial pH, i.e. undetected hypo-perfusion?
- 527 scheduled term cesarean deliveries using spinal
- A longer spinal-to-delivery time was associated with decreasing umbilical arterial pH.
- A spinal to delivery time > 27 minutes was associated with umbilical arterial pH < 7.1.
- Efforts should be made to minimize pre-delivery time after spinal placement.
  

**POST-SPINAL PRESSORS**
Ondansetron 4 mg reduces hypotension and vasopressor use after spinal anesthesia when given before spinal anesthesia for cesarean. What is the magnitude of effect on the phenylephrine infusion dose needed?
- Compared to saline control, 4 mg ondansetron pre-procedure decreased the ED50 of phenylephrine infusion by 26% from 0.32 to 0.24.  
  
  Anesth Analg 2019; PAP (Xiao et al.)

**SHIVERING DURING CESAREAN DELIVERY**
There are no maternal variables that predict post-spinal shivering.
  
  Acta Anaesth Scand 2020; 64: 112
Prophylactic pre-spinal granisetron 1 mg ↓ incidence and severity.
  
  Acta Anaesth Scand 2019; 63: 381
Dexmedetomidine 30 μg post-delivery stopped shivering in 90% of women by 15 minutes after administration (versus 23% in the control group) without bradycardia or sedation.
  

**POST-SPINAL PRESSORS**
Would norepinephrine cause less bradycardia than phenylephrine when used in equipotent bolus doses during cesarean delivery to treat hypotension? Yes.
- Double-blind randomized comparison of phenylephrine 100 μg to norepinephrine 6 μg for systolic BP < baseline.
- Bradycardia (HR < 50) occurred in 11% of NE and 38% of PE.
- 20% of PE group had multiple episodes of bradycardia vs 4% of NE group and need for rescue ephedrine was less.
  
  Anesth Analg 2019; 129: 1312
**POST-SPINAL PRESSORS**

Norepinephrine may have a better hemodynamic profile than phenylephrine: less bradycardia and ↑ cardiac output. What is the best infusion rate after spinal for cesarean?

- Double-blind RCT of 3 infusion rates: 0.025 , 0.050 or 0.075 μg/kg/min begun after spinal injection.
- Both higher doses reduced hypotension better than 0.025.
- There were comparable rates of hypertension, bradycardia and similar neonatal outcomes in all 3 groups.

Anesthesiology 2019; 130: 55

**OXYTOCIN AND POSTPARTUM PAIN**

Oxytocin has anti-hyperalgesic effects. Are higher plasma oxytocin levels associated with less post-cesarean pain?

- Pilot study of 18 women at term having scheduled cesarean deliveries. Oxytocin levels were drawn before and after their spinal anesthetic and their surgery.
- Those with higher oxytocin levels at 1 and 24 hours postpartum had lower acute pain scores post-cesarean.

Anesth Analg 2019; 129: e118

**INTRATHECAL FENTANYL**

Is fentanyl a valuable addition to spinal bupivacaine + morphine for cesarean delivery? Yes.

- Meta analysis of 17 RCT with 1064 patients.
- ↓ need for supplemental analgesia by 82%
- ↓ incidence of nausea and vomiting by 59%
- ↑ time to first request for postop analgesia: 91 m difference
- There was more pruritus, RR 5.89

Anesth Analg 2020; 130: 111

**CHOOSING A PAIN PROTOCOL**

Women were randomized to choose their spinal morphine dose for cesarean or be assigned to routine care.

- All received scheduled ibuprofen and acetaminophen.
- Choices: Low (18%) = 50 μg IT morphine, Medium (64%)/Routine care = 150 μg, and High (14%) = 300 μg + 600 mg gabapentin.
- No difference in pain scores or oxycodone use but women who were offered a choice were more satisfied with their care.
- Patients have insight → those who chose a high dose required more oxycodone and those choosing low dose needed less.

Reg Anesth Pain Med 2019; 44: 578

**DISPARITIES IN PAIN MANAGEMENT**

Two large institutions found significant disparities in postpartum pain management for Hispanic and non-Hispanic black women.

1. Non-white women had greater odds of reporting a pain score > 5 but received fewer inpatient pain medications. Also less likely to receive an opioid prescription at discharge.
2. Severe pain scores > 7 were more common and fewer pain assessments were done in the first 24 hours after cesarean. Non-white women received less opioids at 0-28 hours postop.

Obstet Gynecol 2019; 134: 1147 (1) and 1155 (2)

**SOAP CONSENSUS DOCUMENT**

Monitoring Requirements for Prevention & Detection of Respiratory Depression (SOAP.org)

Purpose of the document:

1. Encourage the use of neuraxial morphine as best practice.
2. Reduce the burden of excessive respiratory monitoring in healthy mothers after cesarean delivery.
3. Focus vigilance and monitoring on those women at high risk for respiratory depression.

Anesth Analg 2019; 129: 458
MONITORING AFTER NEURAXIAL MORPHINE

1. Risk of respiratory depression = 1.08 per 10,000 women.
2. Neuraxial morphine is superior to systemically administered opioids and should be used preferentially.
3. Neuraxial opioids do not increase risk of respiratory depression compared to systemic opioids.
4. Suggested monitoring for usual dosing: respiratory rate and sedation every 2 hours for 12 hours postoperatively.
5. For higher doses or high risk women, use ASA/ASRA guidelines (q hour x 12 hours, then q 2 hours x 12 hours).
6. Pulse oximetry and capnography are not recommended.

PERIPARTUM CANNABIS USE

Does preoperative cannabis use impact postoperative pain after major orthopedic surgery? Yes.

- Compared to non-users, those using cannabinoids for recreational or medical indications had higher pain scores at rest and with movement.
- Also had a higher incidence of sleep disturbances in the early postoperative period.

Anesth Analg 2019; 129: 874

MONITORING AFTER NEURAXIAL MORPHINE

Is capnography useful to determine respiratory depression after spinal morphine for cesarean delivery? No.

- 53% had apneic events with mean duration of 57 seconds, although there were no clinically relevant adverse events.
- These were not confirmed by hourly nursing assessments.
- 82% of women complained about capnography: itchy nose, nausea, interference with nursing, overall inconvenience.

Anesth Analg 2019; 128: 513

ANESTHETIC MORBIDITY

L&D MEDICOLEGAL ISSUES

The Harvard Medical Institutions’ insurer was queried for closed malpractice cases related to obstetric anesthesia from 2005-2015 (106 cases).

- 55% involved nerve injury and 78% did not receive payment.
- Only 15% involved maternal death or brain injury but these received large payments. Most common diagnoses: high block, embolic events and failed intubation.
- Compared to dismissed or denied claims, settled claims had more general anesthetics and delays in care.

Anesth Analg 2019; 128: 1199
A. Causes of maternal death and brain injury.
High neuraxial #1 at 31%, Embolic #2 at 25% and Failed airway #3 at 19%.

B. Cause of nerve injury.

C. Location of nerve injury.

D. Severity.

INCIDENCE OF PDPH AND EBP

Large cohort of 1.7 million privately insured deliveries:
- Incidence of PDPH after neuraxial labor analgesia: 0.58%
- Incidence of PDPH after neuraxial for cesarean: 0.64%
- Incidence after cesarean with pre-existing neuraxial for labor analgesia: 0.47% (was the cesarean protective?!)
- EBP was performed for PDPH after vaginal delivery in 68% and in 60% after cesarean delivery. 8.3% had a repeat EBP

Anesth Analg 2019: PAP (Delgado)

ANESTHESIOLOGY & MATERNAL MORTALITY

Ways you can improve maternal care at your institution:
1. Speak up with your obstetricians to improve consultation.
2. Take charge: care conferences, simulations, introduce MEWS.
3. Use free resources like safety bundles, MEWS protocols, debriefs.
4. Seek peer support from SOAP, ASA, AIM, etc.
5. Be familiar with Levels of Maternal Care, and transfer if needed.
7. Listen to patients – if she doesn’t feel right, it isn’t right.

Anesthesiology News Special Edition 2019: 78

PDPH: LONGTERM OUTCOMES

Question: Is post-dural puncture headache in obstetrics associated with an increased risk of maternal complications?

Findings: In women who received neuraxial anesthesia for childbirth in New York State hospitals, post-dural puncture headache was associated with significantly ↑ risks of cerebral venous thrombosis or subdural hematoma (OR 19), bacterial meningitis (OR 40), depression (OR 2), persistent headache (OR 8), and persistent low back pain (OR 4.6).

Conclusions: Early recognition and treatment is important.

Anesth Analg 2019; 129: 1328

TEAM TRAINING & DRILLS

Multidisciplinary Disaster Planning for Obstetrics
- This is an obstetric-specific triage tool for any disaster to enable safe and rapid evacuation from L&D.

APSF Newsletter; February 2019: 99

Obstetric Anesthesia: Leading the Way in Patient Safety
- Team training is a major advance in patient safety on L&D

1. Position her supine in the sniffing position.
2. Place a 2% or 4% lidocaine-soaked cotton-tipped applicator in the posterior naso-pharynx bilaterally.
3. Leave for 10 minutes.
4. Repeat for an additional 20 minutes.

SOAP Newsletter, Winter 2019, page 10

**REVIEW: TREATMENT OF PDPH**

**Conservative & pharmacological therapies:**
- Not bedrest: may increase risk of thromboembolism.
- Usual fluids only: no evidence of benefit from additional intake.
- Not abdominal binders: no evidence to recommend use.
- Oral analgesia should be offered.
- Opioid analgesia may be offered but not long term.
- No IV caffeine and oral caffeine is problematic: limited evidence to support. Breast-feeding women should have < 200 mg in 24 hours.
- ACTH analogues, steroids, triptans, gabapentinoids, neostigmine: ?

Int J Obstet Gynecol 2019; 38: 93 and 104

**SHOULD WE TEST DOSE IN LABOR?**
1. Catheter malposition in parturients is comparable to non-OB cases.
2. Undetected intrathecal or intravascular insertions after negative aspiration are rare.
3. Using contemporary low-concentration infusions, accidental venous cannulation will present as a failed block.
4. Epinephrine test dose 15 μg IF given intravascular in labor can have severe or even fatal effects (e.g. severe preeclampsia).
5. Test dose is not recommended → may cause more harm than the consequences of the situation it aims to prevent.

Curr Opin Anesthesiol 2019; 32: 263

**REVIEW: TREATMENT OF PDPH**

**Invasive procedures:**
- Acupuncture: case reports only; insufficient evidence.
- Greater occipital nerve blocks: insufficient evidence.
- Sphenopalatine ganglion blocks: no RCT but case series are +.
- Epidural morphine: minimal evidence, but consider prophylaxis?
- Epidural fluids: no benefit to crystalloids; insufficient evidence and no safety data for dextran, HES, gelatin, or fibrin glue.
- Epidural blood patch: gold standard but many questions remain.

Int J Obstet Anesth 2019; 38: 104

**MATERNAL CARDIAC ARREST: REVIEWS**

- Maternal cardiac arrest should be managed similarly to other adult arrests, but consider early airway and unique reversible causes such as LAST, high block, AFE, magnesium.
  Curr Opin Anesthesiol 2019; 32: 298
- Consider unique maternal physiology (e.g. uterine displacement, aspiration risk and ↓ FRC) and presence of 2 patients (i.e. delivery within 5 minutes). All L&D providers should know the most recent AHA guidelines for pregnancy.
  Sem Perinatol 2018; 42: 33

**NEURAXIAL DRUG ERRORS**

Case series of drug errors during spinal anesthesia:
- 4 received TXA due to ampule confusion: presented with refractory seizures and pulmonary edema → 3 died, 1 had a prolonged 3-week complex recovery.
- 3 received atropine due to syringe confusion with morphine: presented with HA, agitation and confusion but recovered.
- 1 received norepinephrine due to ampule confusion: presented with HA, chest pain, agitation, ↑ BP but recovered.
- 1 had a morphine overdose due to concentration error.

J Clin Anesth 2019; 58: 48
**LMWH AND EPIDURAL HEMATOMA**

**Case report:** Woman received one dose of prophylactic LMWH 14 hours before cesarean. Had spinal anesthesia with 26g needle and one pass. LMWH resumed 9 hours after surgery. POD #3 complained of back and thigh pain but no deficits → discharged. POD #10 returned with severe backache, low grade fever and normal neurologic exam. MRI → 10x14x30 mm epidural hematoma compressing at L4. Neurosurgery recommended conservative therapy, observation in the hospital, and her symptoms gradually resolved.  

Int J Obstet Anesth 2019; 37: 118

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**ACOG PRACTICE BULLETIN #207**

*Thrombocytopenia in Pregnancy*

- Platelet counts between 100-149K in asymptomatic pregnant women is usually due to gestational thrombocytopenia.  
- Consensus guidelines recommend platelet transfusions to increase the maternal platelet count to > 50K before surgery.  
- Epidural or spinal anesthesia is considered acceptable and the risk of epidural hematoma is exceptionally low in patients with platelet counts > 70K provided the count is stable, there is no other coagulopathy, the platelet function is normal, and she is not on any anti-platelet or anti-coagulant therapy.  

Obstet Gynecol 2019; 133: e181

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**ARNOLD CHIARI MANAGEMENT**

Multicenter retrospective review of 185 deliveries:  
- 80% diagnosed pre-delivery; 36% had Neurosurg consult  
- 48% had pre-existing symptoms  
- 43% had vaginal delivery with 78% receiving neuraxial  
- 57% had cesarean with 67% receiving neuraxial  
- PDPH in 2% after neuraxial and 12% who had syringomyelia  
- One case (3%) of aspiration pneumonia with GETA  
- No cases of worsening neurologic symptoms – reassuring!  

Int J Obstet Anesth 2019; 37: 52

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**LMWH AND EPIDURAL HEMATOMA**

Editorial points out several potential risk factors:  
1. LMWH was started at 9 hours postop; ACOG says 12.  
2. This particular LMWH (nadroparine / Fraxiparine®) is usually given once a day for prophylaxis – she had BID.  
3. Scheduled NSAIDs were also being given.  
4. She had pre-existing lumbar disk disease at this level by MRI and EMG. More vulnerable?  
5. Be vigilant for any unusual symptoms postpartum.  


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**BREAST-FEEDING & EPIDURALS**

1204 women intending to breastfeed delivered with or without an epidural and were assessed at 3 days and at 6 weeks.  
- Overall rate at 6 weeks was 77%, but lower among women who had an epidural (74%) than those who didn’t (85%).  
- If women had breastfed previously, their odds of breastfeeding at 6 weeks was OR 3.17 versus Q1.  
- The rate was no different between women with or without an epidural if they had prior breast-feeding experience.  
- Offer tailored interventions such as lactation support.  

Anesth Analg 2019; 129: 784
FEVER & EPIDURALS

Maternal non-infectious fever in pregnant rats increases neuronal and glial cell proliferation in the neonatal hippocampus. These changes might disrupt neurodevelopment.
Anesth Analg 2019; 128: 1190

Epidural-related fever occurs in ~26% of laboring women but mechanism is unclear. In a combined clinical and lab study, fever occurred only in women with an epidural. Bupivacaine impaired release of anti-pyrogenic cytokines.
Br J Anaesth 2019; 122: 92

NON-OBSTETRIC SURGERY OUTCOMES

Single-center retrospective review of 171 patients who had surgery during pregnancy from 2001-16 (Belgium):

- Incidence was 0.48% with 44% in 2nd trimester and 81% GETA.
- 44% were intra-abdominal with 79% laparoscopic. There was no difference in outcomes using laparoscopy vs open procedures.
- ↑ preterm births (25% vs 17%), lower birth weight (3.16 vs 3.27 kg), and preterm birth rate was higher for 3rd trimester surgeries.
- GETA was associated with low birth weight – but was it the surgery, the anesthetic, or the underlying condition?
Int J Obstet Anesth 2019; 39: 74

IMAGING CONCERNS

Joint Obstetric and Radiology recommendations for the evaluation of abdominal pain in pregnancy:
1. Ultrasonography should be the initial imaging test since obstetric causes are most common, but US has poor specificity for appy.
2. MRI is only available in 66% of EDs, but avoids radiation.
3. CT is most accurate and exposure is well below any fetal risk.
JAMA 2019; 322: 455

IN UTERO NEUROTOXICITY

What are the consequences of anesthesia during pregnancy on fetal development?

- RCT using rabbits at end of 2nd trimester of pregnancy
- 2-hour general anesthetic with propofol and sevoflurane (1 MAC), vitals and pH monitored.
- Brain morphology changed and motor function was delayed, but effect was undetectable at 7 weeks.
Am J Obstet Gynecol 2019; 221: 355
SUGAMMADEX
Is sugammadex safe to administer to pregnant women?
- Does it cross the placenta? Unknown.
- What are its fetal effects? Unknown.
- What are its effects on maintaining the pregnancy? Unknown but its interaction with progesterone is concerning and there is no human data on safety.
- Amounts in breast milk should be very low and infant enteral absorption is unlikely, but unknown.

SOAP Newsletter (soap.org), Winter 2019

JOINT STATEMENT (cont)
5. Pre and post-op Doppler FHR are adequate if pre-viable.
6. Continuous FHR monitoring may assist with positioning and cardio-respiratory status, but if used a qualified person (usually an L&D nurse) should be readily available for interpretation.
7. Monitor FHR and contractions in PACU and beyond.
8. A pregnant woman should never be denied indicated surgery, but postpone her elective surgery until after delivery, and her non-urgent surgery until 2nd trimester if possible.

Obstet Gynecol 2019;133: 285

SUGAMMADEX
Recommendations from the SOAP Statement on Sugammadex during pregnancy and lactation:
- Avoid in early pregnancy.
- Avoid or use with caution at or near term.
- Safe to use with established lactation.
- Safe to use in patients of reproductive age IF they receive counseling to use additional non-hormonal contraception (e.g. condoms) for 7 days.

SOAP.org

OBSTETRIC & MEDICAL COMPLICATIONS

ASA & ACOG JOINT STATEMENT ON NON-OBSTETRIC SURGERY IN PREGNANCY: KEY POINTS
1. Consult the Obstetric service preoperatively. They should be readily available during the surgery. Consider steroids for the fetus. If viable, discuss and consent for emergency cesarean.
2. No anesthetic or sedative agents are teratogenic or neurotoxic.
3. Perform surgery where there are obstetric and pediatric services to handle delivery of a viable pregnancy.
4. FHR monitoring may assist in positioning, cardiorespiratory management, and delivery options.

REVIEWS OF OB CRITICAL CARE
1. ACOG Practice Bulletin #211: Critical Care in Pregnancy
   Obstet Gynecol 2019; 133: 303-19
2. What’s New in Obstetric Anesthesia: Focus on Maternal M&M
3. The Last Person You’d Expect to Die in Childbirth
   ProPublica May 12, 2017 (Martin & Montagne)
MATERNAL EARLY WARNING CRITERIA

Are the maternal early warning criteria (MEWC) useful? No.
• Review of 400 deliveries in 2016.
• 70% triggered MEWC at least once; 25% had actual morbidity – most commonly hemorrhage, infection, ↑ BP.
• Sensitivity was 0.97 but specificity was only 0.39.
• Conclusions: patients who do not trigger are at low risk for morbidity, but in current form MEWC do not identify patients who experience morbidity.

Anesth Analg 2019; 129: 1621

AMNIOTIC FLUID EMBOLISM

Case report: G4P1 at 36 weeks had scheduled repeat cesarean for complete placenta previa under CSE. 3 minutes after delivery she became unresponsive, apneic and pulseless. CPR was begun with intubation and mechanical ventilation. With generalized bleeding, labs showed: platelets 64K, INR 1.5, PTT > 150 and fibrinogen 81. TEE during resuscitation → acute RV failure and PH → inotropes and inhaled nitric oxide → improvement. She received TXA, 15 PRBC, 15 FFP and 18 platelets to normalize labs. Hysterectomy was performed. Femoral catheters were placed for ECMO cannulation if needed. To ICU → recovery and discharge POD #5.
• Great discussion of multi-disciplinary management of AFE.

Hypothesis for the Pathophysiological Process of Amniotic Fluid Syndrome. NEJM 2019; 381: 1664

ACCRETA SPECTRUM: OB MANAGEMENT

Accreta / Percreta Guidelines
• Schedule her cesarean hysterectomy at 34 weeks.
• Have a multi-disciplinary preoperative care conference including anesthesiology, nursing and other surgical subspecialties that might be involved.
• Prophylactic ureteral stents and balloon catheters should not routinely be placed.
• Uterotonics and TXA should be given if bleeding occurs.

Am J Obstet Gynecol 2019; 220: 511

HEMORRHAGE: VASA PREVIA

Vasa previa is a condition in which unprotected fetal blood vessels run through the membranes over the cervix or close to the cervical os (Figure B). These unprotected vessels are at high risk of rupture during labor or SROM, leading to fetal death. Cesarean delivery before labor and rupture of membranes is indicated.
AMNIOTIC FLUID EMBOLISM MGT

Principles of early management target evolving pathophysiologic phases to the maternal response to introduction of foreign antigenic material of fetal origin:
1. High quality CPR in response to cardiac arrest (87% of cases).
2. Manage pulmonary hypertension and cardiac failure using TEE or TTE, pressors and inotropes, pulm vasodilators.
3. Manage coagulopathy with products, POC testing.
4. Consider preparing for ECMO.

Am J Obstet Gynecol 2020; 222: 48

THROMBOELASTOGRAPHY (TEG)

Surgical Innovation: Thromboelastography-guided resuscitation of the trauma patient
JAMA Surgery 2019 online (Subramanian)

Use of earlier-reported rotational thromboelastometry parameters to evaluate clotting status, fibrinogen, and platelet activities in PPH compared to surgery and ICU patients
Anesth Analg 2019; 128: 414

Assessment of coagulation by TEG during ongoing postpartum hemorrhage: a retrospective cohort analysis
Anesth Analg 2020; 130: 416

TRANEXAMIC ACID (TXA)

In the U.S., is routine administration of TXA in the treatment of postpartum hemorrhage cost effective, given that hemorrhage-related mortality is lower than the WOMAN Trial?
• Decision tree analysis: no TXA, TXA given any time, TXA given within 3 hours of delivery/hemorrhage.
• Despite some initial cost (est. $37.80/vial), annual net cost savings is $11.3 million with 9 maternal deaths averted.
• Giving TXA within 3 hours triples savings and improves outcomes even further.

Am J Obstet Gynecol 2019; 221: 275

AMNIOTIC FLUID EMBOLISM: ECMO

Case report and series of 19 additional cases of AFE using ECMO as part of the resuscitation.
- 11 used venoarterial (preferred), 3 used venovenous, 3 used CPB; consider an anticoagulation-free ECMO strategy.
- Hemorrhage and coagulopathy were common.
- ECMO was started after delivery for median of 48 hours.
- Maternal survival 85%, with length of ICU stay 7-59 days.

Obstet Gynecol 2019; 134: 989

QUANTITATIVE BLOOD LOSS

ACOG Committee Opinion #794 Summary: “Imprecise health care provider estimation of actual blood loss during birth and the immediate postpartum period is a leading cause of delayed response to hemorrhage…… quantification of blood loss, such as using graduated drapes or weighing provides a more accurate assessment of actual blood loss than visual estimation. Successful obstetric hemorrhage bundle implementation is associated with improved outcome measures related to obstetric hemorrhage.

Obstet Gynecol 2019; 134: 1368
HEMORRHAGE: REBOA IN PPH

- The Resuscitative Endovascular Balloon Occlusion of the Aorta (REBOA) device has been used in traumatic hemorrhagic shock. It provides the equivalent of an aortic cross-clamp.
- Recently it has been described for patients with morbidly adherent placenta, severe refractory uterine atony, during cesarean hysterectomy, and when there is bleeding from coagulopathy.

SOAP Newsletter, Winter 2019, p. 12

REBOA OUTCOMES IN TRAUMA

Case-control analysis of REBOA use in civilian trauma from a national surgery database 2015-16:
- No difference in 4 or 24 hour transfusion requirements.
- No difference in median hospital or ICU length of stay.
- Mortality rate was higher in the REBOA group.
- REBOA group was more likely to develop acute kidney failure and to undergo lower extremity amputation.

JAMA Surg 2019 online (Joseph)

COSTS RELATED TO PREECLAMPSIA

Data from a large regional health care system in PA identified mother-infant pairs from 2010-2015. Three cohorts: preeclampsia, HTN, or uncomplicated.
- Costs: preeclampsia = $41,790 > HTN = $24,182 > uncomplicated = $13,187.
- Differences largely due to infant costs from early delivery.
- More women with preeclampsia and their infants also had adverse events: 14% of mothers and 14.6% of infants.

Obstet Gynecol 2019; 134: 1227

PREECLAMPSIA: PREVENTION WITH ASPIRIN

ACOG and USPSTF recommend starting low-dose aspirin by 16 weeks gestation if the woman is high risk. Did she have....?
- Prior preeclampsia < 34 weeks requiring preterm delivery
- Preeclampsia in more than one prior pregnancy
- The Task Force found no maternal or newborn risks.
- It is cost-effective - even if given to all pregnant women - based on savings for ↓ preterm birth, PEC complications.

Obstet Gynecol 2019; 133: 725
This defines the severe features that indicate a need for delivery by 34 weeks in women with preeclampsia. These features increase the risk of maternal morbidity and mortality.

PREECLAMPSIA: ACOG’s ANESTHESIA RECCS

- With improved techniques over the past decades, regional anesthesia has become the preferred technique for women with preeclampsia with severe features and eclampsia.
- Epidural or spinal anesthesia is considered acceptable, and the risk of epidural hematoma is exceptionally low in patients with platelet counts > 79K or more provided that the platelet level is stable, there is no other acquired or congenital coagulopathy, the platelet function is normal, and she is not on any anti-platelet or anti-coagulant therapy.

PREECLAMPSIA & TRANSFUSION RXN

Pregnancy has modulating effects on the immune system, and 3% of postpartum women receive blood transfusions. Is there an increased risk of transfusion reactions (TR)?

- Postpartum risk of TR: 79 per 10K (0.7%) compared to 40 per 10K (0.4%) among nonpregnant women, OR 2.0.
- Preeclampsia was the most important risk factor for TR, OR 2.1; preterm delivery 2nd highest, OR 1.7

Blood Advances 2019; 3: 2298

ACOG: 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...”
ACOG EMERGENCY HTN GUIDELINES

“...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 2019; 133: e174-80

PREECLAMPSIA: FUTURE IMPLICATIONS

UK population-based EHR investigation from 1997-2016 determined associations between 1.3 million women with hypertension in pregnancy and 12 cardiovascular disorders:

- Stroke Hazard Ratio 1.9
- CAD HR 1.67
- Heart failure HR 2.13
- Atrial fibrillation HR 1.73
- Cardiovascular deaths HR 2.12 Circulation 2019; 140: 1050

PREECLAMPSIA & STROKE

California database used to identify stroke in preeclampsia:
- Systolic blood pressure > 160 mmHg in 96% of cases.
- Diastolic BP > 110 mmHg in 65%, HELLP in 38%.
- Headache was the most common symptom in 87% and ↑ LFT the most common lab abnormality.
- Only 48% of women received an anti-hypertensive. There was a chance to improve outcomes in 66% of cases.
Obstet Gynecol 2019; 133: 1151

THROMBOEMBOLISM

ACOG Practice Bulletin #196: Thromboembolism in Pregnancy
- Initial diagnostic test for DVT is compression US of veins.
- Anti-coagulate with LMWH based on reliability and ease of use.
- Resume anti-coagulation 4-6 hours after vaginal delivery or 6-12 hours after cesarean delivery.
- OK to breastfeed using warfarin, LMWH or UF heparin.
- Have a protocol for when pregnant / postpartum women should have anti-coagulants held to be eligible for neuraxial anesthesia.
- Place compression stockings on all women for C/S.
Obstet Gynecol 2018; 132: e1-17

PREECLAMPSIA & NSAIDS

Does use of NSAIDs worsen postpartum BP in women with hypertensive disorders of pregnancy?
- Double-blind RCT of postpartum women with HTN who received either acetaminophen or ibuprofen for pain.
- There was no difference in postpartum average BP, need for breakthrough opioid pain meds, length of stay, or postpartum diuresis.
Obstet Gynecol 2019; 134: 1219

THROMBOEMBOLISM: PE

Case Report: 27-year old G3P2 at 9 weeks gestation with history of DVT and PE presented with chest pain, dyspnea and hypotension in 70s. CT angiogram showed saddle embolism and bedside TTE → RV dysfunction. IR procedure → catheter-directed tPA (pregnancy is considered a contraindication to systemic tPA) and IVC filter. Restarted on LMWH, discharged on day 5, and delivered vaginally at 39 weeks.
Obstet Gynecol 2019; 134: 1002
THROMBOEMBOLISM: STROKE
Acute stroke management in pregnancy:
• Head CT without contrast to rule out hemorrhagic stroke.
• Can receive tPA if within 4-6 hours of onset.
• BP control is paramount 140-160/90-110 mmHg.
• Pregnancy is not a contraindication to mechanical thrombectomy in selected cases.
• Supportive therapy includes treating fever, avoiding hypotonic fluids, maintaining normal Na and glucose.
 Obstet Gynecol 2019; 133: 933

CARDIAC DISEASE: ANESTHESIA MGT
Excellent review focused on anesthetic management and written by obstetric anesthesiologists. Sections include:
• Risk stratification and high risk cardiac conditions
• Delivery planning: analgesia for vaginal delivery and anesthesia for cesarean delivery
• When to use cardiac monitoring
• Postpartum monitoring for decompensation
• Emergency preparedness for cesarean, PPH, cardiac arrest

CARDIAC DISEASE MANAGEMENT
ACOG Practice Bulletin No. 212: Pregnancy and Heart Disease
Cardiovascular disease affects 1-4% of the nearly 4 million pregnancies in the U.S. each year. The U.S. experienced a linear increase in maternal congenital heart disease, and maternal deaths due to acquired heart disease remain high... ~ 22% of all deaths.
 Obstet Gynecol 2019; 133: 1067

CARDIAC DISEASE: ACOG RECOMMENDATIONS
1. Refer to a hospital setting with appropriate level of care.
2. Obtain a baseline BNP in women with known disease.
3. Chest pain requires troponin measurement and ECG.
4. Avoid pregnancy or terminate if EF < 30%, Class III/IV heart failure, severe valvular stenosis, Marfan syndrome with aortic root > 45 mm, or pulmonary hypertension.
5. Early and ongoing Cardiology involvement is key, as well as a Pregnancy Heart Team (including anesthesiologists for III, IV).
6. Be aware of obstetric medications with cardiac implications.
7. Vaginal delivery is preferred with stable disease.
 Obstet Gynecol 2019; 134: 974

Pulmonary Hypertension and Pregnancy
Multi-factorial group of conditions diagnosed by ↑ PAP > 20 mmHg on right heart cath. High rates of maternal morbidity and mortality even with best care. Therapies include anti-coagulation, calcium channel blockers and pulmonary vasodilators. Few studies on timing and mode of delivery or anesthetic considerations. An experienced multi-disciplinary team is mandatory.
 Obstet Gynecol 2019; 134: 974
OBESITY S/P GASTRIC BYPASS

Case report: G2P1 at 36 weeks with history of gastric bypass 4 years prior → lost 70 kg. Presented to the ED with 10/10 abdominal pain but no fever, chills, ROM, bleeding. Diagnosed with preterm labor, epidural placed and baby delivered. Abdominal pain persisted 36 hours later. CT scan with contrast showed mesenteric vascular compromise → internal hernia with gangrenous bowel. At exploratory laparotomy required pressor support, resection of necrotic bowel and abdomen left open with closure 36 hours later.

JAMA 2019; 321: 998

Obstet Gynecol 2019;133:e110

Recommendations: Most women with 1 prior cesarean and a low-transverse incision are candidates for and should be counseled about and offered TOLAC. Misoprostol should not be used for induction. Epidural analgesia may be used during TOLAC. Other candidates for TOLAC include 2 prior cesareans, twins, unknown scar, and induction of labor. Version for breech is not contraindicated. Home birth is contraindicated. Shared decision-making is key.

OBESITY S/P GASTRIC BYPASS

Case report: 26-year old at 27 weeks gestation with history of gastric bypass 4 years earlier. Presented with abdominal pain and vomiting but normal ultrasound. Abdominal MRI without contrast → jejunojejunal intussusception. Exploratory laparotomy confirmed the diagnosis and manual reduction was successful. No recurrence postop and no obstetric complications.


OPIOID USE DISORDER

Can naltrexone be used for medication assisted treatment for opioid use disorder in pregnancy?

- 121 pregnant patients chose detox + naltrexone treatment while 109 patients chose methadone or buprenorphine.
- NAS was ↓ in naltrexone group: 8.4% vs 75.2%.
- No difference in obstetric outcomes, use of illicit opioids.
- 7-10 day period of abstinence required before naltrexone but none relapsed – compared to 72% in nonpregnant.

Am J Obstet Gynecol 2020; 222: 83
**CANNABIS USE IN PREGNANCY**

Is self-reported cannabis use in pregnancy associated with adverse maternal or perinatal outcomes?
- Ontario database of > 661K women; 1.4% used cannabis.
- Preterm birth was 12% in cannabis users vs 6% non-users.
- Also ↑ frequency of SGA babies RR 1.53, abruptio RR1.72, transfer to NICU RR 1.40, and 5-minute Apgar <4 RR 1.28.
- However, significant problems with confounding and (especially) self-reporting.
  JAMA 2019; 322: 145 and 121 (editorial)

**PERIPARTUM HOMICIDE**

Homicide has been mentioned as a cause of peripartum death, but there are no rigorous comparisons to non-pregnant women.
- Louisiana Dept of Health mortality data during pregnancy and up to 1 year after delivery for 2 years (2016, 2017).
- 13.4% of deaths were homicide → 12.9 deaths per 100K births.
- Exceeded mortality from any single obstetric cause of death including HTN, embolism, etc.
- This was 2.38 times higher than homicide mortality for women and girls who were not pregnant/postpartum.
  JAMA Pediatrics online 2020 (Wallace)

**POSTPARTUM DEPRESSION**

The FDA approved the GABA<sub>2</sub> receptor modulator brexanolone (Zulresso<sup>®</sup>) for IV treatment of postpartum depression – the first drug approved for this indication.
- Chemically identical to the major metabolite of progesterone.
- 2 double-blind RCT of women < 6 months postpartum with new onset of major depression showed improvement at 60 hours and 30 days compared to placebo. Main side effect was sedation.
- Requires a 60-hour inpatient infusion; cost is $34K just for the drug; unknown how it compares with other anti-depressants.
  JAMA 2019; 322: 73

**THE FETUS AND NEONATE**

**SELF-HARM DEATHS IN PREGNANCY**

Drug-related deaths and suicide are #1 cause of maternal death in Colorado. New data from California hospitals 2010-12:
- Drug-related deaths were 2<sup>nd</sup> leading cause of death.
- Suicide was 7<sup>th</sup> leading cause of death.
- 74% of those dying by drugs / suicide made ≥ 1 trip to the hospital or ED between their delivery and death.
- These are major public health concerns but not well documented compared to hemorrhage, preeclampsia, etc.
  Am J Obstet Gynecol 2019; 221: 295 and 489

**TERATOGENICITY: ANTIEPILEPTICS**

10 different drugs were evaluated for teratogenicity when used in the first 2 months of pregnancy:
- 1.9 million pregnancies in French healthcare database.
- Valproic acid (Depakote<sup>®</sup>) → spina bifida OR 19.4
- Topiramate (Topamax<sup>®</sup>) → cleft lip OR 6.8
- No other significant associations.
  Neurology 2019; 93: e167
MEDICATION EXPOSURES

• Benzodiazepine exposure from 6-19 weeks gestation ↑ miscarriage rate, aOR 1.85.
  JAMA Psychiatry online 2019 (Sheehy)
• COX-2 exposure (not non-selective NSAIDs) in 3rd trimester ↑ preterm birth, OR 2.46.
  Pain 2018; 159: 948
• IV ondansetron in 1st trimester was not associated with cardiac malformations, oral clefts, or congenital malformations overall.
  JAMA online 2019 (Huybrechts)

TTN AND SPINAL ANESTHESIA

Transient tachypnea of the newborn (TTN) is 2-6 fold higher after elective cesarean than vaginal delivery.
• Review of 30 newborns with TTN after elective cesarean under spinal anesthesia versus 151 healthy neonates.
• The degree and duration of maternal systolic blood pressure < 90 mmHg was higher in mothers of infants with TTN versus control mothers.
• Prevention of spinal hypotension could help ↓ TTN.
  Anesth Analg 2019; 129: 162

MEDICATION EXPOSURES

• Cord biomarkers of acetylsalicylic acid were associated with ↑ risk of childhood ADHD and autism spectrum disorder.
  JAMA Psychiatry online 2019 (Yuelong)
• No increased risk of congenital malformations following 1st trimester exposure to 10 commonly prescribed antibiotics.
  Am J Obstet Gynecol 2019; 221: 648
• SSRI use in pregnancy is associated with autism, but there is strong evidence of confounding by the severity of the mental illness being treated with the SSRI.
  JAMA Psychiatry online 2019 (Flores)

DELAYED CORD CLAMPING

Is delayed cord clamping safe for the mother, and is cord milking equivalent to delayed cord clamping for infants < 32 weeks gestation? Yes and no.
• During scheduled term cesarean, delayed vs immediate cord clamping does not affect maternal Hgb on POD #1.
• In preterm infants < 32 weeks, cord milking at delivery significantly ↑ risk of severe IVH - leading to early termination of the study.
  JAMA 2019; 322: 1877 and 1869

RISKS OF MATERNAL ANEMIA

Iron plays a role in neurodevelopment; is iron-deficiency anemia in mothers associated with risks in their children?
• Swedish registry of > 500K individuals age 6-29; controlled for socioeconomic, maternal and pregnancy factors.
• Maternal anemia diagnosed during the first 30 weeks of pregnancy (but not later) was associated with autism spectrum disorder (OR 1.44), ADHD (OR 1.37), and intellectual disability (OR 2.59).
  JAMA Psychiatry online 2019 (Wiegersma)

PRETERM VENTILATION AT DELIVERY

What is the best ventilation strategy for extremely preterm infants 23-26 weeks GA during resuscitation at birth?
• 460 infants were randomized to sustained inflations or standard intermittent positive pressure ventilation.
• Sustained inflation did not ↓ risk of BPD or death at 36 weeks post-conceptional age.
• Death at < 48 hours was higher in the sustained inflation group leading to early termination of the trial.
  JAMA 2019; 321: 1165
EXTREME PREMATURITY
Infants with birthweights < 400 gm had 26% survival but 74% had moderate or severe neurodevelopmental impairment.
JAMA Pediatr online 2019 (Brumbaugh)
Editorial: Should we try to save such infants? Consider the harms of pain from invasive procedures, the fact that 74% will have severe neurodevelopmental impairments, parental preferences at birth but also over time, and cost - which is important but requires defining value of life with disability.
JAMA Pediatr online 2019 (Lantos)

NEONATAL ABSTINENCE SYNDROME
What is the best pharmacologic treatment for NAS?
• Meta-analysis of 1072 studies that included buprenorphine, clonidine, opium + clonidine, opium, morphine, methadone and phenobarbital.
• Buprenorphine is the optimal treatment based on length of stay, length of treatment, need for adjuvant therapy and adverse events.
• Morphine was lowest-ranked though often standard of care.
JAMA Pediatr 2019; 173: 234

FETAL SURGERY FOR MMC
The Management of Myelomeningocele Study (MOMS), a randomized trial of prenatal versus postnatal repair of myelomeningocele, found that prenatal surgery resulted in ↓ hindbrain herniation and ↓ need for shunting at 12 months of age and better motor function at 30 months.
• At 6-10 years of age the fetal surgery group showed improved mobility and independent functioning and fewer surgeries for shunt placement and revision, but no strong evidence of improved cognitive functioning.
Pediatrics 2020; PAP (Houtrow)

BREAST-FEEDING AND NAS
1. Mothers in treatment (e.g. methadone, suboxone) – YES
2. Using opioids but not in treatment – NO
3. Polysubstance use including opioids, no treatment – NO
4. Substance use but not opioids (e.g. marijuana unless < 2 times per week) – NO
5. Medical conditions requiring prescribed opioid therapy → care consultation with Pediatrics and obstetric providers, then depending on medication and dose either YES or NO
(Suggested protocol, University of Colorado Hospital)

NEONATAL ABSTINENCE SYNDROME
What is the national incidence and cost estimates for NAS?
• 2016 data from national all-payer pediatric discharges
• Rate of in-hospital births with NAS was 6.7 per 1000.
• Total costs were $572.2 million.
• Medicaid was responsible for 83% of charges for in-hospital births with a NAS diagnosis. State and federal budgets may continue to bear disproportionate costs.
JAMA Pediatrics online 2019 (Strahan)

AND WE’LL SEE WHAT’S NEW IN 2018!
Thank you.
ERAS for All Ages
Joy Hawkins, MD
Brenda Bucklin, MD
Megan Brocket, MD

Goals

Maintain normal physiology in the perioperative period by using a comprehensive perioperative management program to decrease surgical stress.

Learning Objectives

1. Describe the science and evidence supporting best practices in ERAS to optimize patient outcomes.
2. Integrate the basic principles of ERAS guidelines and steps for implementation to improve patient care during the perioperative period.
3. Describe how intraoperative interventions regarding fluids, PONV prophylaxis, pain management, etc., can improve perioperative period.

Adult ERAS Outcomes

• Shorter length of hospital stay (30-50%)
• Similar reductions in complications
• Reductions in readmissions
• Reductions in costs

Has your hospital developed and implemented ERAS in your hospitals?

☐ Yes
☐ No

Preoperative

• Preoperative information, education and counseling
• Preoperative optimization
• Preoperative bowel preparation
• Preoperative fasting and carbohydrate treatment
• Preamnestic medication

Intraoperative

• Prophylaxis against thromboembolism
• Antimicrobial prophylaxis and skin preparation
• Standard anesthetic protocol
• PONV
• Laparoscopy and modifications of surgical access
• Nasogastric intubation
• Preventing hypothermia
• Perioperative fluid management
• Drainage of peritoneal cavity after colonic anastomosis

Postoperative

• Urinary drainage
• Prevention of postoperative ileus
• Postoperative analgesia
• Perioperative nutritional care
• Postoperative glucose control
• Early mobilization
### ERAS Society

<table>
<thead>
<tr>
<th>Procedure</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cardiac surgery</td>
</tr>
<tr>
<td>Bariatric surgery</td>
</tr>
<tr>
<td>Gynecologic/oncology</td>
</tr>
<tr>
<td>Rectal/pelvic surgery</td>
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<tr>
<td>Colorectal</td>
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<tr>
<td>Colonic surgery</td>
</tr>
<tr>
<td>Lung surgery</td>
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<tr>
<td>Pancreaticoduodenectomy</td>
</tr>
<tr>
<td>Esophagectomy</td>
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<tr>
<td>Radical cystectomy</td>
</tr>
<tr>
<td>Breast reconstruction</td>
</tr>
<tr>
<td>Gastrectomy</td>
</tr>
<tr>
<td>Major head and neck cancer surgery</td>
</tr>
<tr>
<td>Gastrointestinal surgery</td>
</tr>
<tr>
<td>Liver surgery</td>
</tr>
</tbody>
</table>

### Preoperative
- Counsel about ERAS protocol
- Avoidance of bowel preparation
- Clear liquid carbohydrate load
- Antibiotic prophylaxis

### Intraoperative
- Regional anesthesia
- Avoidance of excess drains
- Euvolemia
- Minimization of opioids
- Minimally invasive technique (laparoscopy)

### Postoperative
- No NG tube
- PONV prevention
- Early feeding
- Early mobilization
- Adjunctive analgesics
- Early discontinuation of IVF
- Minimization of opioids

---


**Prospective study of enhanced recovery after surgery protocol in children undergoing reconstructive operations**


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Standard anesthetic protocol

---


**Prospective study of enhanced recovery after surgery protocol in children undergoing reconstructive operations**

Anesthesia Protocol

• Intraoperative guidelines
  • General anesthesia
  • Regional anesthesia
  • TAP blocks
  • Wound soakers
  • Minimization of opioids
  • Dexmedetomidine infusion
  • Acetaminophen and ketorolac
  • Euvolemia
  • Standard monitors
  • Pleth Variability Index
  • PONV prevention
    - Dexamethasone and ondansetron

Anesthesia Protocol

• Postoperative guidelines
  • Patients managed by Acute Pain Service
  • Regional analgesia
  • Wound soakers infuse ropivacaine for up to five days
  • Adjunctive analgesics
    - Acetaminophen and NSAIDS scheduled and staggered
  • Minimization of opioids
    - Hydromorphone or oxycodone as needed for breakthrough pain
  • PONV prevention
    - Ondansetron

Outcomes

<table>
<thead>
<tr>
<th></th>
<th>Historical controls</th>
<th>ERAS patients</th>
<th>p value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mean length of stay, # midnights</td>
<td>8</td>
<td>5.7</td>
<td>0.52</td>
</tr>
<tr>
<td>Total complications within 90 days</td>
<td>56 (2.1 per patient)</td>
<td>17 (1.3 per patient)</td>
<td><strong>0.035</strong></td>
</tr>
</tbody>
</table>
### Historical controls vs. ERAS patients

<table>
<thead>
<tr>
<th>Received opioids in PACU</th>
<th>ERAS patients</th>
<th>p value</th>
</tr>
</thead>
<tbody>
<tr>
<td>14 (54%)</td>
<td>2 (15%)</td>
<td>0.057</td>
</tr>
</tbody>
</table>

### ERAS expansion at CHCO

- Urology
- Bladder reconstruction
- Pyeloplasty
- Ureteral reimplantation
- Urologic oncologic surgery (nephrectomy)
- Bariatric surgery
- Plastic surgery
- Colorectal surgery
- Adolescent gynecologic surgery

### Study Plan Do Act

- Dexmedetomidine
- Ketamine
- TAP blocks/wound soakers
- QL and ES blocks
- Pleth variability index
- Written guidelines with clinical judgment

### Colorectal/Gloaca

**Implementation of an enhanced recovery protocol in pediatric colorectal surgery**

Heather L. Short, Kurt F. Heiss, Katelyn Burch, Curtis Travers, John Edney, Claudia Venable, Mehul V. Ravai

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<table>
<thead>
<tr>
<th></th>
<th>Pre-ERP Period (43 Patients)</th>
<th>Post-ERP Period (36 Patients)</th>
<th>p value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of ERP interventions</td>
<td>5</td>
<td>11</td>
<td></td>
</tr>
<tr>
<td>Mean dose of intraoperative narcotics (morphine eq., mg/kg)</td>
<td>0.52</td>
<td>0.07</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Mean dose of postoperative narcotics (morphine eq., mg/kg)</td>
<td>1.15</td>
<td>0.20</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Mean intraoperative fluid volume (mL/kg/hr)</td>
<td>9.2</td>
<td>5.4</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Median time to regular diet (days)</td>
<td>2</td>
<td>1</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Median length of stay (days)</td>
<td>4</td>
<td>3</td>
<td>P=0.01</td>
</tr>
<tr>
<td>Mean complication rate</td>
<td>21%</td>
<td>17%</td>
<td>P=0.85</td>
</tr>
<tr>
<td>30-day readmission rate</td>
<td>23%</td>
<td>11%</td>
<td>P=0.63</td>
</tr>
</tbody>
</table>

**Value of protocolized care**

- Decreasing unwanted variability improves outcomes
- Bridges the gap between what we **know** (evidence) and what we **do** (practice)

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**What we think we do**

The German "Practice Prevalence" Study of intensivists

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**What we actually do**

The German "Practice Prevalence" Study of intensivists
ERAS Saves Money

An economic evaluation of the Enhanced Recovery After Surgery (ERAS) multimodal implementation program for colorectal surgery in Alberta

Nguyen K. Trinh, MD, MSc
Anderson W. Goujard, PhD, MHA
Tony Wan, MD
Jonathan Tanner, MD, MSc
Olha Lepage, MD, MSc
Diana Neufeld, MD, MSc
Linda M. Scarchilli, MD

Background: In February 2013, a Multi-disciplinary Enhanced Recovery After Surgery (ERAS) group was established at the CALM Centre, Foothills Medical Centre, in Calgary, Alberta. This group was established to improve the recovery of colorectal surgery patients by implementing an ERAS program based on the published guidelines from the Enhanced Recovery After Surgery (ERAS) Society.

Methods: We measured the impact of ERAS on patients' health services utilization after colorectal surgery, including pre-operative, in-hospital, and post-discharge care. We used a retrospective cohort study design to compare patients who underwent colorectal surgery during the pre- and post-implementation period. The primary outcome was the length of stay, measured in days.

Results: Patients in the post-implementation period had a significantly shorter length of stay compared to the pre-implementation period. The odds ratio for a longer length of stay in the post-implementation period was 0.45 (95% CI: 0.37-0.55; p < 0.001).

Conclusion: The adoption of ERAS implementation for colorectal surgery at Foothills Medical Centre resulted in a significant reduction in length of stay, leading to improved patient outcomes and potential cost savings.
Association Between Use of ERAS and Postop Complications in Colorectal Surgery

- 2084 patients
- **Primary outcome**: complications within 30d
- **Secondary outcomes**: ERAS adherence, mortality, readmissions, reoperation, LOS
- Best adherence: 77%; worst 55%
- Outcomes improved with adherence
- Severe infections ↓ one-third
- Other improved complications: ileus; anastomotic leak; 30d mortality

Take home...

- Low adherence overall
- Having a protocol is not enough!
- Control over complete pathway
- **Hospitals**: need up-to-date and sustainable care
- **Outcome audits**: improve processes to secure good practice
- **CQI**: continuous auditing of adherence and postop outcomes

Case 1:

68 year-old cattle rancher
Dx: adenocarcinoma of the colon
Medical history: Hypertension, non-insulin dependent Diabetes
Plan: Partial colectomy

What’s the Evidence for Enhanced Recovery After Surgery
Guidelines for Perioperative Care in Elective Colorectal Surgery: Enhanced Recovery After Surgery (ERAS®) Society Recommendations: 2018

Intraop

- **Quality of Evidence and Recommendations**
  - 12. Standard anaesthetic protocol
  - 13. Fluid normovolaemia
  - 14. Normothermia
  - 15. Minimal invasive surgery
  - 16. No drainage

Preadmission

- **Quality of Evidence and Recommendations**
  - 1. Information
  - 2. Optimisation
  - 3. Prehabilitation
  - 4. Nutrition
  - 5. Anaemia screening

Postop

- **Quality of Evidence and Recommendations**
  - 17. No gastric drainage
  - 18. Multimodal analgesia
  - 19. Thromboprophylaxis
  - 20. Fluid normovolaemia
  - 21. Urinary catheter
  - 22. Prevent hyperglycaemia
  - 23. Postoperative nutrition
  - 24. Early mobilisation

Preop

- **Quality of Evidence and Recommendations**
  - 6. Prevention of nausea and vomiting
  - 7. Selective premedication
  - 8. Prophylactic antibiotics
  - 9. No bowel preparation
  - 10. Maintaining normovolaemia
  - 11. No fasting and carbohydrate drink

Strong evidence but.... Perioperative care rather than the actual operation, dictates outcomes.

So, the challenge becomes implementation.
Teamwork involving ERAS...

Eras Flowchart

Case 2:
40 year-old pharmacist
Dx: spinal stenosis
Medical history: Otherwise healthy
Plan: Spinal fusion

Case 3:
65 year-old retired teacher
Dx: DJD of left knee
Medical history: Hypertension
Plan: Total knee replacement

Roadmap of a patient’s journey through ERAs vs. traditional surgery...

Evidence: ERAS and Total Joint Replacement
“substantial reduction in death rate, reduced length of stay, and reduced transfusion requirements.”

“... reduction in mortality rate at 2 years following elective lower-limb hip and knee arthroplasty.”

Key points for implementation...

Barriers...

For more information...

Take home points...

- Implementation and application of ERAS principles changes outcome
- Change is difficult but rationale for change can help
- Having a protocol is not enough!
- CQI: continuous auditing of adherence and postop outcomes

https://erassociety.org/guidelines/
The Push for Fewer Opioids for New Mothers

Top hospitals like Cleveland Clinic are turning to options beyond oxycodone for women who need painkillers after C-sections

OPIOID USE AFTER CESAREAN

Initial exposure to opioids may occur during routine medical care; about 1.3 million U.S. women have cesareans yearly.

- An insurance database was used to identify women with no prior opioid prescriptions → cesarean delivery → 1:300 had an opioid prescription a year later.
- Implications: 4333 women/year become chronic opioid users
- Patients more likely to become persistent users had chronic pain conditions, pre-existing psychiatric comorbidity (e.g. depression) and substance use/abuse (including smoking).


ERAS: ELECTIVE CESAREAN

Antepartum preoperative education:
- Schedule a 1:1 meeting with an RN at 32-34 weeks.
- Provide a comprehensive education booklet that includes SSI prevention and breastfeeding education.
- Encourage continued exercise during pregnancy.
- Discuss NPO guidelines and encourage fluid intake (e.g. Gatorade™) up to 2 hours before surgery.
- Optimize hemoglobin if anemic using PO iron or infusions.
- Call her the day before surgery to review the checklist.

Am J Obstet Gynecol 2019; 221: 117


ERAS: ELECTIVE CESAREAN

Intraoperative management:
- Administer appropriate antibiotic prophylaxis.
- Use spinal anesthesia including fentanyl and morphine.
- Begin fluid co-load, phenylephrine infusion at spinal injection.
- After delivery, delay cord-clamping for 30 - 60 seconds.
- Administer oxytocin and multi-modal PONV prophylaxis.
- Skin-to-skin + breastfeeding in OR; room temp > 72 degrees.
- Limit fluids to < 3 liters; use vasopressors in preference.

Am J Obstet Gynecol 2019; 221: 247
**PREVENTING INFECTION**

Does the addition of IV azithromycin to standard antibiotic prophylaxis ↓ postoperative infection after non-elective (laboring or ROM) cesarean delivery?
- RCT of 2013 women undergoing cesarean during labor or after rupture of membranes
- Infection (endometritis, SSI or other infection) occurred in 6% receiving A vs 12% receiving placebo (RR 0.51)
- No difference in neonatal outcomes (14.3 vs 13.6%)


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**CHOOSING AN IT MORPHINE DOSE**

Women were randomized to choose their own spinal morphine dose for cesarean or be assigned to routine care.
- All received scheduled ibuprofen and acetaminophen.
- Choices: Low (18%) = 50 µg IT morphine, Medium (64%)/Routine care = 150 µg, and High (14%) = 300 µg + 600 mg gabapentin.
- No difference in pain scores but women who were offered a choice were more satisfied with their care.
- Patients have insight → those who chose a high dose required more oxycodone and those choosing low dose needed less.

Reg Anesth Pain Med 2019; 44: 578

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**INTRATHECAL FENTANYL**

Is fentanyl a valuable addition to spinal bupivacaine + morphine for cesarean delivery? Yes.
- Meta analysis of 17 RCT with 1064 patients.
- There was more pruritus, RR 5.89 with fentanyl, BUT......
- ↓ need for supplemental analgesia by 82%  
- ↓ incidence of nausea and vomiting by 59%
- ↑ time to first request for postop analgesia: 91 m difference

Anest Analg 2020; 130: 111

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**DELAYED CORD CLAMPING**

**ACOG Opinion: Delayed umbilical cord clamping after birth**
- ACOG recommends a delay of at least 30-60 seconds after birth for all vigorous infants.
- Benefits for term infants: ↑ Hgb levels, improves iron stores, and may have developmental benefits.
- Preterm infants → improves transitional circulation, better red blood cell volume, ↓ need for transfusion, ↓ risk of NEC, IVH.
- No ↑ risk of postpartum hemorrhage for the mother.

Obstet Gynecol 2017; 129: e5

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**INTRATHECAL MORPHINE**

The SOAP ERAS protocol recommends ≤ 150 µg of IT morphine. Comparison of low-dose (50-100 µg) versus higher dose (≥ 100-250 µg) IT morphine for cesarean:
- Meta-analysis of 11 studies with 488 patients.
- Pain scores at 12 hours and morphine consumption at 24 hours were no different, but time to first analgesic request was 4.49 hours longer in the higher dose group.
- There was less N/V and pruritus in the low-dose group.

Anest Analg 2016; 123: 154

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**DELAYED CORD CLAMPING**

The opaque drape can be lowered to a clear plastic drape at delivery if desired.
SKIN-TO-SKIN CONTACT

Early skin-to-skin contact is typically encouraged as part of an elective cesarean. Benefits include ↑ maternal satisfaction, longer and more effective breast feeding, newborn heart rate, breathing, and oxygen levels are more likely to remain stable, less crying, and less newborn hypoglycemia.

ERAS: ELECTIVE CESAREAN

Postoperative Care:
• Ice chips, gum in PACU → food when on postpartum unit.
• Begin scheduled multi-modal non-opioid analgesia.
• Oxycodone 5 mg is available for breakthrough pain.
• Encourage early mobilization after block wears off.
• Remove the urinary catheter at 12 hours postop.
• Remove the IV 24 hours post-surgery (after morphine).
• VTE prophylaxis. Lactation consult. Peds visit.

CHEWING GUM IN PACU

Does chewing gum after cesarean hasten the return of GI function? Yes! Systematic review and meta-analysis:
• 17 trials of 3041 women randomized to gum or control
• ↓ time to first flatus (-6.5 hours), bowel sounds (-8.5 hr), feelings of hunger (-2.9 hr) and bowel movement (-9.6 hr)
• ↓ nausea and vomiting (RR 0.33), less ileus (RR 0.39)
• Significantly ↑ maternal satisfaction
J Matern Fetal Neonatal Med 2018; 31: 1924

SOAP CONSENSUS DOCUMENT

Monitoring Requirements for Prevention & Detection of Respiratory Depression (SOAP.org)

Purpose of the document:
1. Encourage the use of neuraxial morphine as best practice.
2. Reduce the burden of excessive respiratory monitoring in healthy mothers after cesarean delivery.
3. Focus vigilance and monitoring on those women at higher risk for respiratory depression.

Anesth Analg 2019; 129: 458

MONITORING AFTER NEURAXIAL MORPHINE

1. Neuraxial morphine is superior to systemically administered opioids and should be used preferentially.
2. Neuraxial opioids do not increase risk of respiratory depression compared to systemic opioids.
3. Risk of respiratory depression = 1.08 per 10,000 women.
4. Suggested monitoring for usual dosing: respiratory rate and sedation every 2 hours for 12 hours postoperatively.
5. For higher doses or high-risk women, use ASA/ASRA guidelines: every hour for 12 hours, then q 2 hours x 12 hours.
6. Pulse oximetry and capnography are not recommended.

MONITORING AFTER NEURAXIAL MORPHINE

Is capnography useful to determine respiratory depression after spinal morphine for cesarean delivery? No.
• 53% had apneic events with mean duration of 57 seconds, but there were no clinically relevant adverse events.
• The events weren’t confirmed by hourly nursing assessments.
• 82% of women complained about capnography: itchy nose, nausea, interference with nursing, overall inconvenience.

Anesth Analg 2019; 128: 513
MONITORING AFTER NEURAXIAL MORPHINE

The ASA / ASRA guidelines do not specifically address the unique obstetric population. Changes in the SOAP document:
1. Healthy women receiving ≤ 150 μg IT morphine or ≤ 3 mg epidural morphine can be monitored q 2 hours for 12 hours with respiratory and sedation documentation.
2. With ultra-low doses (≤ 50 μg IT or ≤ 1 mg epidural), no additional respiratory monitoring is needed which may encourage its use in low resource settings.

SOAP Newsletter 2019; Summer: 3

MULTI-MODAL ANALGESICS

- Scheduled non-steroidal anti-inflammatory drugs (NSAID): ibuprofen 600 mg q 6 hrs after IV Ketorolac 30 mg
- Scheduled acetaminophen 650-1000 mg q 6 hrs starting preop
- Oxycodone 2.5 -5 mg PO q 4 hrs only PRN for breakthrough
- Gabapentinoids are sedating and have limited benefit but may be appropriate in select patients
- Pre-emptive/rescue regional blocks as indicated: TAP, QL, On-Q™
  Enhanced Recovery After Cesarean (ERAC) Consensus Statement
  SOAP.org 5/2019

QL vs. TAP BLOCKS

A randomized trial compared quadratus lumorum (QL) to transversus abdominus plane (TAP) blocks after cesarean.
- QL block was more effective than TAP blocks in ↓ morphine requests and consumption after cesarean.
- This effect was observed up to 48 hours postoperatively.
- The QL block may facilitate spread of LA into the paravertebral space, achieving visceral pain relief.

Reg Anesth Pain Med 2016; 41: 757
Anesth Analg 2018; 126: 559
Monday, March 2nd
Preoperative Care of the Geriatric Patient
Ruben J. Azocar, MD, MCCM, FASA, FCCM
Professor and Chair
Department of Anesthesiology and Perioperative Medicine
Tufts University School of Medicine & Tufts Medical Center

Disclosures
Financial: None
SAGA Immediate Past President
http://www.sagahq.org
razocar@tuftsmedicalcenter.org

Objectives
At the conclusion of this activity, participants should be able to:
- Review the impact of the growing geriatric population on healthcare
- Discuss the drivers of perioperative outcomes in the older adult
- Review the data surrounding frailty and pre-habilitation

The elderly as a [%] of the US population

![The Grey Tsunami Image](image-url)
Procedures in the older adult

From 1994–2005 the average number of inpatient procedures per year in patients >65 years old increased from 6,500,000 to 7,353,000

Currently 35% of all surgical procedures are performed in elderly patients

More than half of the elderly population will have at least one procedure done before they die

Ambulatory cases

About 32% of all ambulatory procedures were performed in those >65 y.o. which is a higher rate per 1000 than any other group
The baby boomer’s “vanguard” is getting older

| "Young-old" (65-74) | "Old-old" (75-84) | "Oldest-old" (85+)
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<td>Hospitalizations per 1,000 women</td>
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</table>

Surgical treatment of AS (4 LV, remote)

34.1% 25.9% 15.8%

Physiological changes include:

1. Major hip and knee joint replacement
2. Septicemia
3. Heart failure
4. COPD
5. Pulmonary edema and respiratory failure

Physiological Changes with Aging

- Functional and structural changes occur in most organ systems
- The basal function may remain stable in various organs’ systems
  - Older adults compensate on a daily basis for physiological declines in every organ system
  - However, the functional reserve and the ability to compensate under physiological stress are greatly reduced
  - Periods of extreme stress, such as surgery and anesthesia, can decompensate the older adult
- Chronological age becomes somehow irrelevant
CNS: Physiological Changes

- Loss of neural tissue
- 10-20% Reduction in cerebral blood flow
- Decreased number of serotonin, acetylcholine, and dopamine receptors
- Decline in memory, reasoning, perception
- Disturbed sleep/wake cycle
- Prone to delirium and cognitive dysfunction

Renal: Physiological Changes

- Loss of renal tubular mass and decreased perfusion
  - Decrease renal blood flow by 50%
  - Susceptible to AKI
- Decreased GFR
  - By age 80 GFR decreases 45%
- Reduced ability to dilute and concentrate urine and conserve sodium
- Decreased drug clearance

CV: Physiological Changes

- Frequent comorbidity
  - > 65 y.o.: 40% of deaths
- Diastolic dysfunction and stiff arteries
  - Sensitive to intravascular volume changes
- Poor response to catecholamines
- Autonomic tissue replacement with fat and connective tissue
  - With loss of cholinergic
- Medications blunt sympathetic response

Pharmacological Changes

- Protein binding
  - ↓ level of proteins
  - Multiple medications that interfere with drug binding sites
  - ↑ level of free unbound drug in plasma → prolonged effect
- ↓ Lean and ↑ Fat body mass
  - ↑ storage of lipid-soluble drugs → prolonged effect and longer time for elimination
- ↓ Circulating blood volume
  - ↑ initial plasma drug concentration

Pulmonary: Physiological changes

- Loss of pharyngeal reflexes
- Decrease in chest wall compliance
- Decline in lung elasticity
- Alteration in control of ventilation

Physiological impact of aging

Physiological changes with age, showing a decline in lung function.
Effect of age and disease on risk of perioperative complications

Number of Comorbidities


Physiological impact of aging

Frailty: Lack of physiological reserve across multiple organ systems

Preoperative Evaluation

OPTIMAL PERIOPERATIVE MANAGEMENT OF THE GEROiatric PATIENT: Best Practices Guidelines from ACS NSQIP/American Geriatrics Society

Frailty is losing the ability rebound

No one over 65 looks the same
Intermediately frail Frail
Postoperative complications OR = 2.06 OR = 2.54
Increased length of stay Incidence RR 1.49 Incidence RR 1.69
Discharge to a skilled or assisted-living facility after previously living at home OR = 3.16 OR = 20.48

Observational Study Examining the Association of Baseline Frailty and Postcardiac Surgery Delirium and Cognitive Change

- 133 patients with baseline frailty assessments
- Fried frailty scale evaluates 5 domains (shrinking, weakness, exhaustion, low physical activity, and slowed walking speed) and classifies patients as non-frail, pre-frail, and frail
- Non-frail patients: 13% delirium incidence
- Pre-frail and frail patients: 48% delirium incidence
- Frail patients were also at higher risk for the secondary outcome of greater decline in cognition from baseline to 1 month, but not baseline to 1 year, after surgery

J Am Coll Surg. 2010;210:901-908

Results: All the tested frailty indexes, as well as PSA and PSV, were good predictors of 12-month all-cause mortality after TAVI with the highest area under the curve value for normalized PSA and PSV

Lin et al. BMC Geriatrics (2016) 16:157
Having surgery might not be that much different than running a race: It is better if you are fit. Is the patient fit for surgery?

Interaction of the NEW Pre-habilitation Components

Nutrition and Surgery
- Catabolism → High prevalence of low body weight and protein energy malnutrition
- Hypoalbuminemia → postoperative complications
Results The whey group experienced a mean improvement in functional walking capacity before surgery of +20.8 m, with a standard deviation of 42.6 m, and the placebo group improved by +1.2 m (P=0.27).

Nutrition: Preoperative Assessment

Step 1 BMI
BMI < 18.5
(<20 if age >65)

Step 2
Unplanned weight loss > 10% in past 6 months

Step 3
Preoperative nutrition score

(PONS) assessment tool

Any Yes

Answers

A/N

Albumin < 3.0

PONS Score

Pre-Op Nutrition

Anemia or Diabetic Intervention

Nutritional Prehabilitation alone or combined with an exercise program significantly decreased length of hospital stay by 2 days in patients undergoing colorectal surgery.”


Effects of Nutritional Prehabilitation: With and Without Exercise, on Outcomes of Patients Who Undergo Colorectal Surgery: A Systematic Review and Meta-analysis

Gastroenterology

Perioperative Immunonutrition supplementation group had less complications, primarily infections but no difference in LOS.
RCT in patients undergoing elective liver resection for colorectal liver metastases

4-week (12 sessions) high-intensity cycle, interval training program.

Primary endpoint: Oxygen uptake at the anaerobic threshold.

Secondary endpoints: quality of life (QoL)


Table 2: Changes in cardiopulmonary exercise testing values and quality of life indices following prehabilitation or standard care

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Pre-surgery, functional capacity ≥20 m in a higher proportion in the pre-habilitation group. The difference between baseline and 8-week 6-min walking test was significantly ↑ in the pre-habilitation compared with the rehabilitation. A higher proportion of the pre-habilitation group recovered to or above baseline exercise capacity at 8 weeks. Complication rates and duration of hospital stay were similar. Compared 41 frail patients undergoing oncologic surgery for malignant tumors of the upper GI tract with comparable historical controls. Pts. underwent a multidisciplinary preoperative management plan, composed of nutritional intervention, physical/respiratory enhancement, and optimization of ongoing therapy. 30-days and 3-months mortality, overall and severe complication rates were found to be significantly lower (p < 0.05) in intervention group. No significant differences were recorded for the following outcomes: LOS, referral to post-discharge institutionalization and hospital readmission.

In addition, 86% of patients on the prehabilitation group recovered their baseline functional capacity 4 weeks post-operatively as compared with only 40% in the control group (p<0.01).

Cognitive Reserve Threshold Theory for Cognitive Decline
A: Protective factor (greater brain Reserve Capacity) no impairment
B: Vulnerability factor (less brain reserve capacity), impairment

Prospective observational, orthopedic patients
- Proxies for cognitive reserve included early life and late life (reading, knitting, email, computer games)
- CAA and MDAS at 22 hrs and 32 hrs
- Late life cognitive reserve decreased incidence and severity of POD
- The more the better, each activity lowered POD risk by 8%
Frailty and cognitive impairment in predicting mortality among oldest-old people.

Out of 705 participants, prevalence of frailty was 63.7%, Cognitive impairment was 74.2%, and the Frailty Prevalence + Cognitive impairment = 50.3%.

Combined frailty and cognitive impairment was associated with increased risk of death (age, gender, education level, and other potential confounders adjusted; Hazard ratio was 2.13 (95% confidence interval 1.39, 3.24).

Frailty and cognitive screening protocols are feasible and provide information for perioperative care planning.

Challenges to clinical adaptation include staff training, missing data, and additional administration time.

These challenges appear minimal relative to the benefits of identifying frailty and cognitive impairment in a group at risk for negative postoperative cognitive outcome.

Feasibility and rationale for incorporating frailty and cognitive screening protocols in a preoperative anesthesiology clinic

Researchers at Kings College in London 7000 People 10 minutes on-line games Cognitive tests/daily task testing at start, 6 weeks, 3 months, and 6 months.

At 6 months participants were doing better.

Best if playing >5 times week.

No effect in those <50.

Overall, preoperative staff administered the frailty-cognitive vital sign protocol to 714 of 870 patients attending the preoperative clinic.

CONCLUSIONS: Preoperative frailty-cognitive vital sign protocols can be implemented in a large hospital setting. Challenges to clinical translation of this preoperative frailty-cognitive vital sign protocol included effort training staff, missing data, and time for administration (approximately 5 minutes per protocol).

The incidence of POCD in the intervention group (15.9%) was significantly lower than in the control (36.1%) (P<0.05).
Pts > 70 years underwent elective surgery for colorectal carcinoma or AAA between January 2013 and October 2015 (control group, n=360) and between November 2015 and June 2018 (prehabilitation group, n=267).

The preoperative interventions were aimed to improve patients' physical health, nutritional status, factors of frailty and preoperative anemia.

The prehabilitation group had a higher burden of comorbidities, and was more physically and visually impaired at baseline.

The adjusted logistic regression analysis indicated a decrease on the incidence of delirium from 11.7 to 8.2% (OR 0.56; 95% CI 0.32-0.98; P = 0.043).

No statistically significant effects were seen on complications, LOS, unplanned ICU admission, length of ICU stay, readmission rates, institutionalization, and in-hospital or 30-day mortality.

107 Patients >65 years (Randomized) Control vs. EA
Spine Surgery <180 min - ASA I/II - Blood Loss < 800 ml.

Intervention: EA (3 points) - 30 min pre-anesthesia
Standardized anesthesia protocol
Data: IL-6, IL-10, and S100B - (Before EA, 1h IntraOp, End)
MMSE - Pre-Op 1, POD7, POD30

Primary Outcome: % of Delirious patients (vs non interventional group)
Secondary Outcomes: Cognitive Function (Attention, focus, memory, brain processing speed), Hospital LOS, Length of ICU stay, Physical Therapy

Home-based Cognitive Prehabilitation in Older Surgical Patients: A Feasibility Study.

POD incidence was 6 of 23 (26%) in the pre-habilitation group compared with 5 of 29 (17%) in the control group (P=0.507).

No significant differences between groups in NIH Toolbox cognitive function scoring, hospital LOS, or physical therapy participation rates.

Feasibility data:
- Most common reasons for declining enrollment were lack of computer access (n=19), time commitment (n=9), and feeling overwhelmed (n=9).
- In the training group, only 5 of 29 (17%) included patients were able to complete the prescribed 7 days of training, and 14 of 29 (48%) opted out of training once home.
- Most common reasons were feeling overwhelmed (n=4) and computer difficulties (n=3).

Prevention of Early Postoperative Decline (PEaPoD).

Objective: to determine whether using a brain training program in the time leading up to as well as after heart surgery will reduce confusion and cognitive loss that can occur after surgery.

Intervention: use of a neurocognitive training program (Lumosity) for 10 days preoperatively, and then for four weeks postoperatively.
Prevention of Early Postoperative Decline: A Randomized, Controlled Feasibility Trial of Perioperative Cognitive Training.

- 45 pts, age 60-90 undergoing cardiac surgery at least 10 days from enrollment
- Feasibility was evaluated by enrollment patterns and adherence to protocol
- Sixty-five percent of eligible patients were enrolled
- Declining pts most commonly cited: time commitment (21%), lack of interest in the research study (21%), or no desire to use an iPad (17%)
- Median interquartile range adherence (as % of prescribed minutes played) was: Preoperatively 39% (20%-68%), Immediately postop, 6% (0%-37%), and 19% post-discharge (0%-56%)
- POD and POCD were assessed using the CAM and the Montreal Cognitive Assessment
- POD incidence: CT group 5/20 [25%] versus control 3/20 [15%]; P = .69
- POCD incidence: CT group 53% versus control 37%; P = .33

Anesth Analg. 2019 Sep 22... [Epub ahead of print]
Geriatric Surgical Home

- The elderly is the perfect population to benefit from the Quadruple Aim
- Requires an older adult centered approach, no a type of surgery centered one
- Use of patient reported outcome tools like PROSPER
- Create Geriatric syndromes pathways of care: Prevention of Delirium
- Including preoperative optimization and pre-habilitation

Conclusions

- The Gray Tsunami is here
- Surgical Outcomes in the elderly are not good
- Multifactorial - but Frailty is an excellent predictor of outcomes
- Pre-habilitation improves outcomes with more gain for the frail
- Geriatric Surgical Home should include pre-habilitation

National Initiatives

Local Initiatives

Strong for Surgery Program Washington State

- Glucose control
- Smoking cessation
- Optimize nutrition
- Medication review

www.becertain.org/strong_for_surgery
Anesthesia for Patients Too Sick For Anesthesia

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Goals and Objectives

- Discuss Successful Intraoperative Management of
  1) Acute Respiratory Failure
  2) Acute Renal Failure
  3) Septic Shock (Quick Updates)
  4) Cardiogenic Shock

Disclosures

- None
- But, Open to Offers 😊

Goldilocks Paradigm

Goals

1) Keep the Patient Alive
2) Avoid VILI

Acute Respiratory Failure

- prag·mat·ic
  /praɡˈmadik/
  - adjective
  - dealing with things sensibly and realistically in a way that is based on practical rather than theoretical considerations.
Ventilator Induced Lung Injury (VILI)
- Secondary to Volutrauma and Atelectrauma (prev Barotrauma)
- Mostly related to non-physiologic stretch or shearing
- Plateau Pressure (Pplat) and Driving Pressure (ΔP) most useful/available pressure measurements
  - Pplat = Pressure at End-Inspiration
  - ΔP = Pplat - PEEP
- Transpulmonary Pressure (PtP = Palv – Pip) requires esophageal balloon

Hypercarbic ARF
- Titrate Ventilation to pH > 7.15-7.25 (not PCO2)
- Can increase TV or RR (MV = TV x RR)
- Maintain TV < 6-8ml/kg PBW and Pplat < 30cmH2O
- Watch for Auto-PEEP
  - Risk with obstructive pulmonary disease
  - Treat with ↓ TV, RR, or I:E ratio

Acute Respiratory Failure
- Hypercarbic
  - Rarely life threatening and usually manageable
- Hypoxic
  - Can be treated the same regardless of etiology (ARDS vs multifocal PNA vs pulmonary edema)

Auto-PEEP - Diagnosis
- Expiratory Flow does not return to Ø prior to initiation of next breath
- Measured with end-expiratory pause (measured PEEP > set PEEP)
- VCV → Progressive increase in Pip
- PCV → Progressive decreased in TV
- Hypotension (↑ intrathoracic pressure and ↓ IVC return)

Auto-PEEP
Hypoxic ARF

- Maintain organ perfusion and avoid VILI
- Goal (or minimal tolerated) SpO2 and PaO2 not well studied
  - Multiple other variables in tissue delivery
  - SpO2 > 85-88% or PaO2 > 55-60mmHg

- P/F Ratio (PaO2/FiO2) is criteria for ARDS, but not clinically useful except for identification of sick lungs
- OI (Oxygen Index = FiO2 x Mpaaw / PaO2) more clinically meaningful, but requires ventilator calculation of Mpaaw

Hypoxic ARF - Treatment

- Classic Variables - FiO2 and PEEP
  - PEEP needs to improve V/Q matching
  - ↑↑ PEEP → over-distended alveoli → dead space
- 3rd Variable - Mean Airway Pressure (mPaw)
  - Area under pressure/time curve
  - Increased by ↑ PEEP, I/E ratio, Inspiratory Pressure, Inspiratory Flow, Decelerating Inspiratory Flow Pattern
  - Same treatment regardless of etiology (ARDS vs pulm edema)

Hypoxic ARF - Optimal PEEP

- Goal to improve oxygenation by increasing lung recruitability and avoiding VILI
- No single method of PEEP titration has been shown to improve morbidity or mortality
  - Too ↑ PEEP = overdistention, dead space, VILI, ↓ cardiac output
  - Too ↓ PEEP = hypoxemia, alveoli collapse, VILI
- Open lung strategy (↑↑ PEEP) has no clear clinical benefit

Optimal PEEP

Hypoxic ARF - Treatment

- PEEP
- I/E Ratio
- Decelerating Inspiratory Flow Pattern
My “expert” advice
1) Utilize ICU titrated PEEP
2) Utilize ARDSnet PEEP table - Low PEEP scale
3) Titrate by Driving Pressure (ΔP = Pplat - PEEP)

Optimal PEEP - Reduction in Driving Pressure (ΔP = Pplat - PEEP)

1) Stepwise increase in PEEP until Pplat (or ΔP) increases 1:1 with PEEP
   Examples → Increasing PEEP from 10 → 14
   #1 - PEEP 10, Pplat 20 → PEEP 14, Pplat 20 = recruitment (ΔP)
   #2 - PEEP 10, Pplat 20 → PEEP 14, Pplat 22 = recruitment (ΔP)
   #3 - PEEP 10, Pplat 20 → PEEP 14, Pplat 24 = overstretch (ΔP)

Optimal PEEP - ARDSnet

Recruitment Maneuver

Table 1: PEEP Table Adapted from ARDSNet NIH R118K ARDS Clinical Network Mechanical Ventilation Protocols Summary http://www.arndnet.org/files/ventilator_protocols_2015-03.pdf
I:E Ratio
- Improved oxygenation via increased mPaw
- Adjust from 1:2 → 1:1 → 2:1
- Watch for Auto-PEEP

Decelerating Inspiratory Flow Pattern
PCV > VCV
- Improved oxygenation via increased mPaw
- Improved V/Q matching
  - More uniform distribution of ventilation
- PCV-VG, APV, PRVC, VC+ are all modes of PCV

Advanced Mechanical Ventilation Modes
- BILEVEL, Biphasic Positive Airway Pressure, APRV
  - Extensions of PCV with Severe Inverse Ratio Ventilation (>8:1)
  - Instead of ΔP set by Phigh and Plow (+/- Thigh and Tlow)
  - Active Inspiratory Valve → Allows Spont Breath During Any Point in Insp Cycle
  - Ventilation Dependent on Spont Breathing
- NOT IN OR

General Considerations
- Transport to OR on ICU Ventilator for PEEP > 10, FiO2 ≥ 70
  - Ambubag is 1.5-2L and ??? Pip with ventilation
- Consider maintaining on ICU Ventilator for:
  - PEEP > 14-16
  - Inverse Ratio Ventilation > 2:1 (strict criteria)
  - OI > 12-15
  - PaO2:FiO2 ratio ≤ 100 (Severe ARDS)
  - TIVA on ICU Patients is Very Easy
  - Talk to the Intensivist
Acute Kidney Failure

- Primary Concerns
  1) Hyperkalemia → Arrhythmias
  2) Acidosis

- Secondary Concerns
  1) Other Electrolytes
  2) Pharmacokinetics/Dynamics
  3) Everything Else

AKF → Hyperkalemia → Arrhythmias

- EKG Changes
- Progression to Vfib or Asystole
- Also include other tachy/bradycardias

AKF → Hyperkalemia → Arrhythmias

- Usually Associated w/ Serum K⁺ ≥ 7
- Lower threshold for AKI vs. CKD and baseline cardiac conduction diseases (LBBB)
- K⁺ will ↑ intraop with
  - Worsening Acidosis (cellular shift)
  - Blood Transfusions
  - Ischemia / Reperfusion

AKF → Hyperkalemia → Arrhythmias

- Treatment
  #1 - Calcium
  - Membrane stabilization (No effect on K⁺ Levels)
  - Onset 5 minutes, Duration 30-60 minutes
  - Re-dose until supratherapeutic (>1.3)

  #2 - Insulin (and Dextrose)
  - Moves K⁺ intracellularly
  - Onset 10-20 minutes, Duration 4-6 hours
  - 10 Units Regular Insulin and ~ 1 amp (25g) Dextrose
  - K⁺ ↓ 0.5-1.2 mEq/L

  #3 - B2 Agonists (Albuterol)
  - Moves K⁺ intracellularly
  - Large doses OK and preferred (10-20mg or “lots of puffs”) (?? additive effect w/ insulin)
  - Onset 30 minutes, Duration 2-6 hours
  - K⁺ ↓ 0.5-1.5 mEq/L

  #4 - Loop Diuretics / Lasix (if some renal function)
  - Most have impaired K⁺ secretion

  #5 - Sodium Bicarbonate
  - Moves K⁺ intracellularly
  - ? Clinical benefit, best as infusion
  - 150mEq (3 amps) in 1L D5W at rate ~250cc/hr
  - Watch for ↑ Na

  - Potassium Binders (Sodium Polystyrene Sulfonate (Kayexalate))
  - Do NOT Use
  - Slow (>1hr), No data in hyperkalemic emergency
  - Can cause bowel necrosis

AKF → Hyperkalemia → Arrhythmias

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**AKF → Acidosis**

- Retained H+, Hyperchloremic, and/or Lactic Acidosis
- Can Determine Anion-Gap, Delta Gap, Winter’s formula
- Clinical Impact
  - Myocardial Depression
  - ↓ Catecholamine Response (endogenous/exogenous)
  - Arrhythmias
- Sodium Bicarbonate → ↑ CO2, ↑ lactate, ↑ Na, ↑ fluid extravasation
  - Worsen intracellular pH even with increased blood pH

**Septic Shock**

- Definition
  - “Life-threatening organ dysfunction caused by a dysregulated host response to infection”
- 2017 Global Data (NIH / Gates Foundation)
  - 48.9 Million Cases of Sepsis
  - 11.0 Million Sepsis Related Deaths
  - 19.7% of all Deaths
  - 1990-2017 Incidence ↓ 37% and Mortality ↓ 53%

**AKF → Acidosis**

- Maintain pH ≥ 7.15-7.2
  - Consider higher if symptomatic
- Sodium Bicarbonate
  - Monitor for ↑ Na
  - Careful if associated Respiratory Acidosis (↑ PCO2)
- THAM (Tromethamine)
  - Ø CO2 generation
  - No data
  - Reverse the Underlying Process (if possible...)

**Sepsis Incidence per 100,000 Persons**

**AKF → Intraoperative Dialysis**

- IHD or CRRT
- No data to guide guidelines
- Inefficient and Expensive (FTE)
- Risk > Benefit secondary to operative delay
- Consider only for symptomatic hyperkalemia or acidosis with hypernatremia and planned OR duration > 6 hours

**Septic Shock (Quick Updates)**

- Fluid Resuscitation
- Vaspressors
- Steroids
- Antibiotics
Septic Shock – Fluid Resuscitation

- ProCESS, ARISE, ProMISeE (2014, 2015)
- “EGDT did not result in better outcomes than usual care”
- CVP Not Useful, PAC Probably Not Useful
- PPV / SPV (and TEE) Probably Best

Septic Shock - Vasopressors

- Norepinephrine (1st Line)
- Vasopressin (2nd Line)
- No Difference in Peripheral Extravasation or Injury Risk Compared to Phenylephrine
- Early Vasopressors and Less Fluids is Probably Better

Septic Shock – Antibiotics

- Antibiotic timing (Early Antibiotics) most directly related to mortality
- Broad Spectrum
- Zosyn, Cefepime/Flagyl, Meropenem
- Confirm ED / ICU Dosing
- Broad Spectrum 1st, Vancomycin last

Septic Shock - Steroids

- Possible Mortality Improvement
- More Definite Earlier Shock Reversal
- New Expert Panel Recommendation
  - “Weak/Conditional Recommendation to give steroids to patients will all severities of sepsis”
  - “As we are not certain they are beneficial, OK not to prescribe”
- Hydrocortisone 50mg IV q6h - Dexamethasone 2mg

Summary

- Hypercarbic ARF - titrate to pH > 7.15-7.25, careful of AutoPeep
- Hypoxic ARF - SpO2 > 85-88%, PEEP titration, PCV > VCV
- Maintain TV < 6-8ml/kg PBW and Pplat < 30cmH2O
- Transport to OR on ICU Ventilator for PEEP > 10, FIO2 ≥ 70
- Consider Maintaining on ICU Ventilator with TIVA
- Hyperkalemia - Calcium, Insulin (Dextose), Albuterol
- Acidosis - Maintain pH ≥ 7.15-7.2
- Fluids - PPV/SPV if available (no CVP or PAC)
- Vasopressors - Norepi (1st), Vasopressin (2nd)
- Steroids - Covering with Decadron
- Antibiotics - Confirm Dosing

Septic Shock – Antibiotics

- Antibiotic timing (Early Antibiotics) most directly related to mortality
- Broad Spectrum
- Zosyn, Cefepime/Flagyl, Meropenem
- Confirm ED / ICU Dosing
- Broad Spectrum 1st, Vancomycin last
A 30 y/o G2P1 is undergoing an emergency CD for placental abruption and abnormal FHR. There is brisk bleeding following delivery with an EBL of 1700 and ongoing bleeding. You decide to give 1 gm tranexamic acid (TXA). What is TRUE regarding the use of TXA in PPH Protocols?

A. NO increased risk of a thromboembolic event
B. Decreased risk of death due to bleeding in low-middle resource countries
C. Cost - effective in routine use in the US
D. Should be included in all PPH Protocols
E. All of the above

Which of the following is TRUE regarding peripartum hemorrhage?

A. The most common cause is uterine atony
B. PPH is the #1 cause of maternal morbidity and mortality worldwide
C. A significant percentage of PPH-related deaths are preventable
D. The Joint Commission now recommends implementation of the NPMS Obstetric Hemorrhage Bundle on all obstetric units.
E. All of the above are TRUE
**Physical resources - “Hemorrhage Cart”**

- Provides organized and immediate access to resuscitation and hemorrhage treatment supplies
- Should be easily accessible from ALL areas of Labor & Delivery
- Contents determined by OB, Anesthesia and Nursing teams

**Physical resources - “Hemorrhage Kit”**

- Easy and rapid access to medications is crucial

**Quantitative blood loss**

- Measure blood loss
- Suction cannisters
- Calibrated drapes
- Weighed laps/ sheets/ chux (gravimetric method)

**Goal IS:**
- Improve prompt recognition and response
- Decrease denial of blood loss

**Goal is NOT a precise, perfect number**

**Even partial or individual component implementation is helpful**

**Early recognition and timely intervention are key points**

**Implementation can decrease PPH-related morbidity and mortality**
Which of the following can be given as a first-line agent to treat acute hypertension in a pregnant patient?

A. Intravenous labetalol (20 mg)
B. Intravenous hydralazine (10 mg)
C. PO nifedipine (10-20 mg)
D. All of the above

Raise your hand if your L&D unit has or is currently implementing the “Hypertension Bundle”

A 28 y/o G1P0 woman at 39 weeks EGA in triage complains of chest pain and then suffers a witnessed cardiac arrest. Which of the following is NOT part of the maternal ACLS algorithm?

A. Same ratios of chest compressions and breaths as ACLS for a non-pregnant person
B. Manual left uterine displacement (in supine position)
C. Transfer to OR for perimortem cesarean delivery
D. Consider starting perimortem CD at 4 minutes of non-resuscitative ACLS efforts

Which of the following are symptoms of uterine rupture?

A. Change of fetal station
B. Breakthrough pain despite “adequate” epidural analgesia
C. Shoulder pain
D. Fetal bradycardia

Every facility should have a protocol for rapid escalation of anti-hypertensive therapy. This should include provision for use of IV infusions and anesthesiology service involvement.

A Mag & Mafe

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D. Consider starting perimortem CD at 4 minutes of non-resuscitative ACLS efforts

Maternal Cardiac Arrest

Incidence: Approximately 1 : 12,500 deliveries

Perimortem cesarean by 4 min if no ROSC
*In patient’s room*

Which of the following are symptoms of uterine rupture?

A. Change of fetal station
B. Breakthrough pain despite “adequate” epidural analgesia
C. Shoulder pain
D. Fetal bradycardia

Every facility should have a protocol for rapid escalation of anti-hypertensive therapy. This should include provision for use of IV infusions and anesthesiology service involvement.
• -0.5 - 1.0% risk for rupture during TOLAC
• Most sensitive sign is FHR abnormality
• When rupture does occur, HIGH risk of maternal and neonatal morbidity

Epidural analgesia will NOT mask the pain associated with uterine rupture. We may be able to help with the diagnosis if you have suspicion, ask the OB team to evaluate!

A G2P0 with von Willebrand disease at 39.5 wks EGA presents for elective IOL. Prior to epidural placement, which of the following is necessary?

A. vWF serum level
B. DDAVP administration
C. vWF concentrate administration
D. All of the above
E. Depends on Type of VWD

VWD and Pregnancy

Type of VWD | % Patients
--- | ---
Type 1 | 70-80
Type 2 | > 20
Type 3 | < 10

Type I VWD

VWF levels usually normal/ supra-normal by term

Likely OK to perform neuraxial procedure

Type II VWD

VWF levels may show NO improvement during pregnancy

May NOT be candidates for neuraxial procedure

Type III VWD

VWF levels vary based on subtype

- Type IIIA/ IIB → Typically normal vWF levels

Neuraxial has been described → individual risk-benefit analysis on case by case basis

Type IIA/M/N VWD

- “Normal” vWF level plus thrombocytopenia

May NOT be candidates for neuraxial procedure

NO DDAVP → Can WORSEN thrombocytopenia
A 35 y/o G1P0 is at 6 cm cervical dilation and is having pain during contractions. You placed her epidural about 8 hours ago when she was 3 cm (easy placement). What is your initial plan to treat her pain?

A. Nothing - tough it out
B. Volume! (10-15 mL 0.125% bupivacaine)
C. Density (0.25% bupivacaine +/- opioid)
D. Replace epidural

Maternal Risk Factors
Obesity
Structural back abnormalities
Chronic low back pain
Opioid tolerance
Increasing age

Obstetric Risk Factors
Nulliparity
Increased fetal weight
Abnormal fetal position
Induction/augmentation of labor
Epidural request at cervical dilation > 7 cm
Prolonged/rapid labor progression

Breakthrough Pain

Stepwise Approach to Breakthrough Pain

Determine pain characteristics (Nature, location, labor progress)
Is there adequate sensory blockade and block density??
REPLACE THE EPIDURAL
Determine extent of analgesia
Catheter and pump evaluation

What is the most effective way to prevent hypotension following spinal for cesarean delivery?

A. 2L crystalloid preload
B. 30-degree LUD
C. Ephedrine boluses
D. Phenylephrine boluses
E. Phenylephrine infusion
F. Norepinephrine infusion

Who routinely uses a phenylephrine infusion following spinal for cesarean delivery

What’s the goal?

Maintaining maternal baseline BP
Maintains uteroplacental perfusion

Old doctrine ➔ New recommended practice ➔

→ Easier titration
→ Less maternal nausea/vomiting
→ Less placental transfer
Embrace phenylephrine infusions!

- Either weight-based or non-weight based
- Titrate rate prn for relative hypo- or hypertension
  - 50 mcg/min
  - 0.54 mcg/kg/hr

Still OK to add ephedrine boluses for hypotension + bradycardia

Norepinephrine...the new phenylephrine?

- Potency is 13-16:1 compared to phenylephrine
  - E.g. 100 mcg phenylephrine = 6-8 mcg norepinephrine
- Versus phenylephrine:
  - Higher average heart rate
  - Significantly higher cardiac output
  - Lower systemic vascular resistance
  - Less placental transfer

- Concerns re: peripheral administration?

Take home point → PROMISING, but we need additional studies.

Management of suspected amniotic fluid embolism includes which of the following strategies?

A. Begin immediate hemodynamic support
B. Administer high-quality CPR if necessary
C. Prepare for treatment of disseminated coagulation and massive hemorrhage
D. Consider atropine, ondansetron, ketorolac therapy

In which of the following circumstances should magnesium be discontinued?

A. Preeclamptic patient going to the OR for a cesarean delivery
B. Healthy G2P0 at 30 wks EGA following delivery of the preterm baby
C. Preeclamptic patient s/p delivery 12 hours ago
D. Preeclamptic patient with serum magnesium level of 6 mg/dL

Principles of early management target evolving pathophysiologic phases to the maternal response to introduction of foreign antigenic material of fetal origin

1. Consider in any sudden cardiopulmonary collapse on L&D
2. High quality CPR in response to cardiac arrest (87% of cases).
3. Manage pulmonary hypertension and cardiac failure using TEE or TTE, pressors and inotropes, pulm vasodilators.
4. Manage coagulopathy
5. Consider preparing for ECMO.
AMNIOTIC FLUID EMBOLISM: ECMO

Case report and series of 19 additional cases of AFE using ECMO as part of the resuscitation.

- 11 used venoarterial (preferred), 3 used venovenous, 3 used CPB; consider an anticoagulation-free ECMO strategy
- Hemorrhage and coagulopathy were common
- ECMO was started after delivery for median of 48 hours
- Maternal survival 85%, with length of ICU stay 7-59 days

- 0.2 mg atropine
- 4 mg ondansetron
- 30 mg ketorolac

Join us in May for more OB Anesthesia CME!

#SOAPAM2020
Tuesday, March 3rd
CRASH 2020
Cardiac Anesthesiology
A year in review

Breandan L Sullivan MD
Associate Professor
Department of Anesthesiology
Co-Medical Director Cardiothoracic Intensive Care Unit

Financial Disclosures
- None

Outline
- Data on Transcatheter valves
- Pulmonary Hypertension Outcomes in noncardiac surgery

MASSIVE TOPIC
- Highlights from 2019
- The Year in Cardiothoracic and Vascular Anesthesia: Selected Highlights for 2019 (J of Cardiothoracic and Vascular Anesthesia 34 (2020) 1-11
- Identify major clinical advances
  - Procedures
  - Intraoperative care
  - Perioperative care

Audience Survey
- old fashion way vs fancy pants transcatheter valve
Data Piling up

Partner 1
- 358 Non-surgical candidates
- Randomized
  - Transcatheter Aortic valve replacement
  - Standard Treatment

Partner 2
- Intermediate Surgical Risk patients
  - STS predicted mortality 4-8%
- Primary outcome
  - Composite outcome
  - Any cause death/Disabling stroke at 2 years

One trip around the sun...
- One year mortality after randomization
  - 50% SAHR
  - 50% Standard management
  - 40%
  - (11,000 died/28,000 infected)
- Liver Transplant
  - 11% mortality
- Mortality of SARS 2002
  - Mortality 9.5%
  - (174 died/8,098 infected)
- Mortality of Wuhan Corona Virus
  - Mortality in Wuhan 4.9%

Partner 2
- Randomized
- SAVR (1021 pt’s)
  - Surgical Aortic Valve Replacement
- TAVR (1011 pt’s)
  - Transfemoral
  - Transthoracic
  - Transapical
  - Transaortic

Partner 2
- Results
- 18 pt’s died (0.9%)
- No difference in primary endpoint at 2 and recently published 5 years
- HOWEVER...
- If you take out
  - Transthoracic
  - Transapical
- TAVR WINS
- But long term follow up will be very important to pay attention to
Partner 3

- Low surgical risk
  - Clinical/Anatomical assessment
  - Predicted Mortality less than 4%
- TAVR 503 pt's
  - SAPIEN 3 system
- SAVR 497 pt's
- Primary Outcome
  - Composite
    - Any cause death
    - CVA
    - Rehospitalization at 1 year

University of Colorado

- Default is sedation
  - Dexmedetomidine 0.5 mg/kg bolus over 15 min
- Monitoring
  - Attending Anesthesiologist 1:1 with a resident
  - Radial arterial line
  - Femoral venous sheath placed in the field
  - Transthoracic echo by sonographer
- Scrubbed into the case
  - 2 attending CT surgeons
  - 2-3 attending interventional cardiologists
  - 1 imaging cardiologist plus a sonographer
  - OR nursing team (2-3 nurses)
  - Cath lab nursing team (2-3 nurses)
  - Advanced interventional cardiology fellow
  - C T Surgery Fellow

PARTNER 3

- Low risk pt’s w/severe AS
  - Composite outcome
  - TAVR 8.5%
  - SAVR 15.1%
- Lower rates TAVR GROUP
  - DEATH or Stroke at 30 days (1 vs 3.3%)
  - STROKE (0.6 vs 2.4%)
  - DISCHARGED HOME WITH SELF CARE
    - TAVR 95%
    - SAVR 73%

Outline

- Data on Transcatheter valves
- Pulmonary Hypertension Outcomes in noncardiac surgery
- Volatile anesthetics vs IV anesthetics
- Prevention of Post operative pneumonia

Sedation vs. General

- Partner 1
  - General Anesthesia 100%
  - PA Catheter 100%
  - TEE 100%
- Partner 3
  - 65% Sedation

Pulmonary Hypertension

- FREAKS US OUT!!!
- RAISE HANDS
- Would you rather....
  - Aortic Stenosis medical management vs Pulmonary Hypertension?
- After diagnosis
  - 15% of people are dead within 1 year
  - Eur Respir J 2007;30(6):1133-1137
Pulmonary Arterial Hypertension

- **Definition**
- Mean pulmonary artery pressure greater than 25mmHg at rest or 30mmHg with exercise
- In the setting of normal to reduced cardiac output
- PVR Greater than 3 Woods units
- Normal capillary wedge pressure
  - PCWP, Left atrial pressure, LVEDP
  - Less than 15mmHg

References

- J Am Coll Cardiol 2004;43:405-475

Pulmonary Hypertension

- Data Base Demographics
- Patients Undergoing Surgery with Pulmonary Hypertension
- Older and sicker
- Higher rates
  - Smoking, COPD, OSA, DM, CAD, CKD

Pulmonary Hypertension

- Evaluate the incidence of perioperative adverse cardiac events
- "Cardiovascular outcomes of patients with pulmonary hypertension undergoing noncardiac surgery" American Journal of Cardiology 2019;123:1532-1537
- Health Care and Utilization Project's National Inpatient Sample Data
- 2004-2014
- >18 y/o
- Undergoing noncardiac surgery

References

- Cardiovascular Outcomes of Patients with Pulmonary Hypertension Undergoing Noncardiac Surgery (Am J Cardiol 2019;123:1532-1537)
- Transcatheter Aortic-Valve Replacement with a Balloon-Expandable Valve in Low-Risk Patients (NEJM 2019:380:1695-705)
- Five-Year Outcomes of Transcatheter or Surgical Aortic-Valve Replacement (NEJM 2020 Jan 29, 382(8))
- Transcatheter or Surgical Aortic-Valve Replacement in Intermediate-Risk Patients (NEJM 2016 April 28, 374(17))

Pulmonary Hypertension

- Identified Patients with Pulmonary hypertension
  - 143,846/17,853,194 Hospitalizations
  - ICD-9 Codes
    - Primary PH
    - All of non-primary PH
  - Major Adverse Cardiac and Cerebrovascular Events (MACCE)
    - Ischemic stroke, TIA, NSTEMI, PE, Cardiogenic Shock, Cardiac Arrest
- Excluded
  - Heart transplant
  - Bone marrow transplant
  - Minimally invasive cardiac procedures
  - Dental Surgery
  - Radiation Therapy
  - Non-operating room procedures

References

- Five-Year Outcomes of Transcatheter or Surgical Aortic-Valve Replacement in Intermediate-Risk Patients (NEJM 2020 Jan 29, 382(8))
- Transcatheter or Surgical Aortic-Valve Replacement in Intermediate-Risk Patients (NEJM 2016 April 28, 374(17))
Intraoperative and Postoperative Management in Elderly Adults

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Disclosures

SAGA
SOCIETY FOR THE ADVANCEMENT OF GERIATRIC ANESTHESIA
http://www.sagahq.org

Objectives

- Correlate the physiological changes of aging with intraoperative issues
- Discuss intraoperative strategies to minimize complications
- Review post-operative issues impacting the geriatric patient

Effect of complications

- 30-day mortality for 60-year-olds vs. patients ≥80
  - 1.1% vs. 3.7% if no complications
  - 15.1% vs. 26.1% if ≥1 complications
- 3-month mortality in patients ≥70 vs. nonsurgical controls
  - 2.9 hazard ratio if no complications
  - 7.3 hazard ratio if ≥1 complications
- If survive 3 months, complications minimally increase subsequent mortality
- Diminished functional status/dependency compared to patients with no complications

Which complications are most severe?

- Heart failure: incidence of 5% in some studies, with mortality as high as 63%¹
- Pulmonary: 2.4 hazard ratio for death²
- Renal: 6.1 hazard ratio for death²
- Infection: UTI just as likely to lead to death as deep surgical wound infection is³
- CNS: stroke, delirium, post-op cognitive dysfunction


“A man is as old as his arteries.”

-Thomas Sydenham

Age and postoperative complications

<table>
<thead>
<tr>
<th>Complication</th>
<th>Complication Rate (%)</th>
<th>Mortality from the Complication (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Age &lt;80</td>
<td>Age ≥80</td>
</tr>
<tr>
<td>Myocardial infarction</td>
<td>0.4</td>
<td>1.0</td>
</tr>
<tr>
<td>Cardiac arrest</td>
<td>0.9</td>
<td>2.1</td>
</tr>
<tr>
<td>Pneumonia</td>
<td>2.3</td>
<td>5.4</td>
</tr>
<tr>
<td>&gt;48 hours on ventilator</td>
<td>2.1</td>
<td>3.5</td>
</tr>
<tr>
<td>Cerebrovascular accident</td>
<td>0.3</td>
<td>0.7</td>
</tr>
<tr>
<td>Prolonged ileus</td>
<td>1.2</td>
<td>1.7</td>
</tr>
</tbody>
</table>


Effect of Aging on Blood Pressure

Decreased Beta-Receptor Response

Fed Proc 1979;38:13

Am J Cardiol 1985;55:1575

Where Aging Affects Intra-op Management

- Cardiovascular instability
- Decreased respiratory reserve
- Higher risk of renal failure
- Increased risk of residual neuromuscular blockade
- Increased drug sensitivity, decreased metabolism
- Thermal regulation
**Cardiovascular Aging**
- Slowed LV contraction, but preserved EF
- Diminished response to inotropes
- Stiffening of heart and vasculature
- Enhanced sympathetic tone at rest and in response to stimuli (more basal vasoconstriction, and larger swings in vascular resistance with changes in surgical stimulation)

**Cardiovascular Stiffening**
- Greater dependence on filling volume due to decreased response to catecholamines
- Stiff ventricle (diastolic dysfunction) narrows acceptable range of LV filling pressure
  - Too high and pulmonary pressures go up
  - Too low and end-diastolic volume is too low
- Stiff veins poorly buffer changes in blood volume (bigger swings in filling pressure with volume shifts)

**Increased Blood Pressure Lability during General Anesthesia**
- Changes in sympathetic tone from waxing and waning surgical stimulus
- Changes in sympathetic tone cause changes in systemic vascular resistance
- Changes in distribution of blood volume causing changes in cardiac filling and performance

**Diminished Cardiovascular Reserve**
- 25 - 35 y/o vs. 65 - 80 y/o subjects
- 60° upright tilt test performed
  - at baseline
  - after two days of diuresis caused subjects in each group to lose 2 kg in water and 170 mEq Na+

**Should Hypotension be Treated Differently in the Elderly?**
- Beware fluid overload
  - Crystalloid may restore stroke volume, but not blood pressure if SVR way down
  - plus risk of volume overload 2° stiff CV system
- Alpha-agonists restore vascular resistance and shift blood from the periphery to the heart
- Consider invasive or non-invasive monitoring
**Pulmonary Aging**
- Decreased lung stiffness
- Increased chest wall stiffness
- Flattened diaphragm
- Decreased muscle coordination
- Decreased muscle mass
- Impaired immune system
- Pathogenic colonization

**Risk of Ventilatory Failure**
- Increased work of breathing
  - Barrel-shaped chest (flatter diaphragm flattens, less mechanical advantage)
  - Chest wall stiffens
- Increased ventilatory requirements postop
  - From oxygen demand and dead space
  - Poor airway tethering increases airway resistance, esp. with forced exhalation
- Sarcopenia

**Risk of Hypoxia**
- Shallow breathing and increased closing volume promote atelectasis and shunt
- Increased V/Q mismatch increases A-a O2 gradient
- General anesthesia in the elderly:
  - Reduces the hypoxic and hypercarbic drives
  - Impairs hypoxic pulmonary vasoconstriction
- 75% of elderly may have sleep apnea
- Opioids

**Risk of Pneumonia**
- Decreased cough efficacy
- Loss of muscle mass
- Pharyngeal muscle hypotonia
- Decreased immune function?
- Decreased mucociliary clearance
- Increased aspiration

**Aspiration Pneumonia**
- CNS aging impairs the gag reflex
- Muscle dysfunction impairs swallowing
- Esophageal dysfunction worsens reflux
- Decreased saliva enhances mouth pathogenic colonization
- Decreased stomach acid enhances pathogenic colonization
Preoperative Preventative Strategy

- Assess current pulmonary status
- Try to optimize
  - Smoking cessation
  - Treat bronchospasm (steroid taper?)
  - Treat URI, (antibiotics, delay surgery?)
  - Start incentive spirometry
- Consider less invasive surgery

Intraoperative Preventative Strategy

- Bronchospasm prophylaxis
  - Albuterol and/or anticholinergic inhaler preop
  - Propofol, sevoflurane better than pentothal, desflurane
- Use supplemental O₂ but avoid 100% O₂ to minimize resorption atelectasis
- Use low V_t (6-8 ml/kg ideal wt.), plus PEEP and recruitment maneuvers to prevent atelectasis
  Anesth 2015;123:66

Postoperative Preventative Strategy

- Avoid excessive opioid use
- Supplemental oxygen prevents hypoxia from V/Q mismatch and hypoventilation, but not atelectasis
  - May need on ward as well
- Deep breathing, upright posture, coughing up secretions, incentive spirometer, early ambulation, avoid dehydration
- CPAP? Proton pump inhibitors?

Renal Aging

- Decreased parenchymal mass and blood flow (~25% by age 80)
- Loss of glomeruli (50% by age 80) with concomitant decrease in GFR
  - Cockcroft-Gault formula for GFR:
    (140-Age) x BW x [.85 if female] ÷ (72 x Cr)
- Decrease drug metabolism

Renal System

- Decreased ability to concentrate or dilute urine
- Decreased ability to retain or eliminate sodium
- Impaired ability to eliminate excess fluid
- Decreased thirst sensation
- Hypovolemia common, esp. in hospital
- Hypo- or hypematremia common

Perioperative Risks for ARF

- Pre-existing renal dysfunction
- Hypertension
- Poor LV function (EF<35%)
- Peripheral vascular disease
- Diabetes mellitus
- Surgical procedure (cardiac, aortic)
- Age
Perioperative Acute Kidney Injury

- Rarely occurs absent other complications
- Associated with high mortality
  - Non-cardiac surgery: poor data, but <1% incidence (10% needed dialysis), ~16% mortality, much higher in elderly (~50%)
  - Cardiac surgery: declining incidence (16% → 9%) and mortality (40% → 18%)

Increased Drug Effects

- Smaller initial volume of distribution: higher blood levels for a given dose
- Slower redistribution of drugs: higher blood levels over time, allows more drug to get to brain
- Increased CNS drug sensitivity: same brain level has bigger effect
- Slower liver and kidney drug metabolism: prolonged drug effects

Prevention of Renal Injury

- Functional hemodynamic monitoring to assess fluid status
  - Consider A-line (SPV/PPV), PA catheter, TEE
  - Maintain fluid and electrolyte balance
  - Avoid normal saline, large mol. wt. starch
- Avoid/minimize use of nephrotoxic drugs
- No known successful protective agents

Can J Anesth 2010;57:985

Pentothal Dose for Burst Suppression

Age and Midazolam Sedation Requirements

"I don’t do drugs anymore – I get the same effect from standing up fast.”

- author unknown
Effect of Age on Drug Metabolism

Diazepam Half-life (hours)

Age (years)

0 20 40 60 80 100

J Clin Inv 1975;55:347

And...

<table>
<thead>
<tr>
<th>Drug Class</th>
<th>Medications</th>
<th>Concerns</th>
<th>Precautions</th>
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<tbody>
<tr>
<td>First generation barbiturates</td>
<td>Phenytoin</td>
<td>General anaesthetic effects</td>
<td>Benzodiazepines, second generation</td>
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<tr>
<td>Phenobarbital</td>
<td>Propofol</td>
<td>General anaesthetic effects</td>
<td>Benzodiazepines, second generation</td>
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<tr>
<td>Antipsychotics (first generation)</td>
<td>Haloperidol</td>
<td>Risk of cardiomyopathy, delirium, neurotoxicity</td>
<td>Haloperidol, risperidone</td>
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<tr>
<td>Benzodiazepines</td>
<td>Midazolam, diazepam</td>
<td>Risk of respiratory depression, delirium</td>
<td>Midazolam, diazepam</td>
</tr>
<tr>
<td>Opioids</td>
<td>Fentanyl, hydromorphone</td>
<td>Risk of respiratory depression, delirium</td>
<td>Fentanyl, hydromorphone</td>
</tr>
<tr>
<td>Volatiles</td>
<td>Enflurane, isoflurane</td>
<td>Risk of cardiomyopathy, delirium, neurotoxicity</td>
<td>Enflurane, isoflurane</td>
</tr>
<tr>
<td>Neurolytics</td>
<td>Cytotoxic drugs</td>
<td>Neurotoxic effects</td>
<td>Cytotoxic drugs</td>
</tr>
</tbody>
</table>

Basically...

Quick and Dirty Drug Adjustment

- Induction agents: Dose on lean body mass and reduce dose by 20%-60%.
- Benzodiazepines: Rapid reduction in dose beyond age 60 with 75% reduction by age 90. Use only midazolam.
- Narcotics: 50% reduction. Avoid meperidine except for shivering.
- Muscle relaxants: Pretty much no change.
- Volatiles: MAC ↓6% per decade after 40

Residual Neuromuscular Blockade

- Can occur with both long- and short-acting NMBs
- Occurs more often in elderly patients
- Is associated with pulmonary complications: hypoxia, obstruction, pulmonary edema, respiratory failure, pneumonia, reintubation
- Risk of residual NMB increases with:
  - Larger doses of intermediate acting NMBs
  - Excessive doses of neostigmine reversal

Prevention of Residual NMB

- Monitor reversal at the adductor pollicis
- Do not administer neostigmine until the TOF shows all four twitches (fade is OK)
- Reduce neostigmine dose to 15-25 ucg/kg if no fade on qualitative TOF
- Do not extubate until at least 10 minutes after neostigmine administration
- Quantitative TOF monitoring is better
Heat Redistributes with Anesthesia

- Elderly prone to hypothermia
- Vasodilation less
- Shiver less
- Lower metabolism (less heat production)

Consequences of Hypothermia

- Shivering (increased strain on heart)
- Although elderly can only increase body VO2 about half as much as young adults
- Coagulopathy, increased blood loss
- Impaired drug metabolism
- Increased infections (NEJM 1996;334:1209)
- Increased myocardial ischemia (JAMA 1997;277:1127-1134)

Prevention of Hypothermia

- Warm patient in holding
  - Ambient temperature warm
  - Warm blankets at a minimum, air blanket better
  - Air blanket in OR
- May need to increase OR temperature
- Air blanket in PACU

Neuraxial Anesthesia and the Elderly

- Longer duration of block
- May get higher block (especially epidural)
- Epidural or continuous spinal reduces doses
- Epinephrine test dose → hypertension, not tachycardia, especially if beta-blocked
- Don’t be heavy handed with sedation

General Anesthesia and the Elderly

- Use smaller doses of drugs, show patience
- Avoid meperidine, anticholinergics (glyco OK)
- Use low tidal volumes plus PEEP during mechanical ventilation
- Meticulous reversal of NMB
- Consider short-acting, potent opioids and possibly beta-blockers to reduce volatile anesthetic use

Postoperative concerns

- Complications form major organ systems
  - CNS, CV, Pulmonary, Renal
- Falls
- Quality of life
- End of life issues
Interventions for a favorable post op period

- **Pre-op**: Optimization and pre-habilitation
- **Intra-op**: Adjust to geriatric physiology
- **Post-op**: Prevention of complications, Pain Management, nutrition, avoidance of falls and pressure ulcers, avoidance, long term outcomes

Cardiovascular and Pulmonary Complications

- The burden of cardiovascular and pulmonary disease increases as the body ages. In fact, cardiac pathology is the most common cause of death in the elderly surgical patient.
- Postoperative management should focus on maintaining stable hemodynamics, oxygenation, and electrolytes, as well as restarting pre-operative medications early for pre-existing co-morbidities.
- The care should include vigilant management of fluids (especially avoiding fluid overload), prevention of atelectasis and pneumonia (incentive spirometer, upright position, pulmonary toilet, respiratory therapy), early mobilization, and oral intake of fluids and food.

Dehydration/AKI in the Postoperative Period

- Higher risk for electrolyte and acid-base abnormalities, fluid disorders and acute postoperative renal impairment
- Early return to PO intake, balanced approach to fluid management, maintaining appropriate blood pressure.
- Avoid nephrotoxic drugs, especially in the context of the highly prevalent polypharmacy are essential.
- Consider measuring electrolytes after surgery, remembering that normal plasma level of creatinine might be due to the decreased skeletal muscle mass.

Pain Management

- Effective pain control is probably the key to prevent reduce postoperative complications in the elderly, as pain can negatively affect vital aspects of recovery, including ambulation, DVT, respiratory, GI function and cognition.
- Given the age-related changes effective pain control can be challenging in the aged.
- The two principles of pain control in the elderly include:
  - Individualization of the medications for the elderly patient to account for the less predictable onset, delayed or protracted effect.
  - Multimodal approach using different analgesics to minimize the side effects of opioids.

Multimodal Analgesia

- Acetaminophen (PO or IV) is one of the safest analgesics in the elderly, typically needing no dose adjustments.
- Peripheral nerve blocks using local anesthetics represent an excellent way to reduce post-operative pain and narcotic use.
  - Adding a glucocorticoid steroid, clonidine, or NSAIDs can augment the block and increase its duration.
- NSAIDs, while effective, should be used with caution as they may increase the risk of GI-bleed or renal failure.
  - In cyclooxygenase-2 (COX-II) inhibitors may represent a short-term alternative (long-term use is associated with cardiovascular complications).
- Nontraditional drugs that have been found to reduce postoperative pain and deserve consideration on individualized basis, include gabapentin, ketamine, clonidine, and dexmedetomidine.

Immobility, Fall Risk

- Early ambulation, daily physical activity, and avoidance of falls are the key steps to prevent functional decline as well as prevent respiratory, thromboembolic, and cognitive complications after surgery.
- Many elderly patients have preexisting conditions that place them at higher risk of immobility or falls, including baseline functional deconditioning, malnutrition, sarcopenia, arthritis, poor sensory input (vision, hearing, etc), arthritis.
- In addition, surgery and anesthesia may add surgical pain, sedatives, and analgesics that may make mobilization more challenging while increasing the risk of falls. The latter is a real problem, with reported 1.5% of surgical inpatients suffering a fall after surgery.
Fall Prevention/Early Ambulation

- Obviously, early ambulation with a low risk of a fall is more likely in a patient with normal cognition who is not in pain - so effective pain control and prevention of delirium are a must.
- Multicomponent interventions are recommended:
  - Early assessment
  - Early involvement of physical therapy
  - Supervised and assisted exercises
  - Maintaining call light within reach
  - Placing handrails in relevant areas
  - Using nonslip footwear
  - Geriatric-focused training of staff

Wound healing and Pressure Ulcers

- The prevalent co-morbid conditions, such as poor nutritional state, sarcopenia, diabetes, circulatory and oxygenation problems, impair wound healing in the elderly.
- Avoid fluid overload, hypotension, hypoxia, hypothermia, ileus, or hyperglycemia.
- Similarly, the elderly are at higher risk to develop postoperative pressure ulcers:
  - Early involvement of physical therapy, turning patients regularly, oral/tube feeding, nutritional supplementation, optimization of co-morbidities.

Nutrition and Ileus

- Postoperative problems with nutrition are common in the elderly.
  - 40% of hospitalized patients are malnourished.
  - Chronic constipation, poor appetite, or social isolation are additional factors in the elderly that increases the risk for malnutrition.
  - Surgery/anesthesia further compounds this problem with its attendant risk of ileus, nausea/vomiting, and loss of appetite.
  - Early return to oral intake (daily evaluations of PO intake), enteral feeding if PO intake is not possible, and nutritional supplementation in undernourished patients.
  - In addition, consider early ambulation, opioid-sparing pain management, and normal fluid intake to prevent ileus.

How Does One Manage an Anesthetic for an Elderly Patient?

- Understand and manage chronic disease
- Be comfortable with advanced monitoring
- Be meticulous - do not cut corners
- “Go Low, Go Slow” with drugs

Other Issues

- Alpha-agonists likely better than fluids for hypotension in the absence of hypovolemia
- Supplemental oxygen postoperatively
- Pulmonary complications cause as much morbidity and mortality as cardiovascular
- Maintain normothermia
Post op Care

- Prevention of complications
  - CNS, CV, Pulmonary, Renal, Falls, wound healing/pressure ulcers, ileus
  - Delirium prevention, pain control, euvolemia, early mobilization are key interventions

Questions?
Learning Objectives

- Review closed claims data and examples in which conflict played a key role.
- Identify benefits of building emotional intelligence, including patient outcomes, and culture/climate.
- Consider natural tendencies in conflict and how to effectively re-engage in important conversations.
- Understand the role of coaching in the development of emotional intelligence and leadership skills.

Agenda

- Introductions
- Lessons from Closed Claims
- Competence in Conflict: The Case for “Soft” Skills
- Evidence-Based Coaching in Healthcare, Burnout, Happiness
- Case Studies

Poll:

TO: 37607
Message: lisaneale831

What are the main contributors to conflict in the anesthesia sphere? (Choose all that apply)

A. Communication skills
B. Attitude
C. Burnout
D. Leadership
E. Lack of civility
F. Clinical competence
Lessons From Closed Claims

Karen B. Domino, MD, MPH
Professor & Vice Chair for Clinical Research
Anesthesiology & Pain Medicine
University of Washington
Seattle, WA  98199
kdomino@uw.edu

Communication Failure Contributing to Patient Injury

- 43% Communication Failures
  - Root Causes of Communication Failures
    - Content 60%
    - Audience 13%
    - Occasion 12%
    - Agreement (k=0.83)

Characteristics of Cases with Communication Failures Resulting in Injury

- 43% Communication Failures
- 30% No Failures

- Emergency: 20% Failures, 10% No Failures
- Outpatient: 25% Failures, 20% No Failures
- Death: 30% Failures, 20% No Failures

Liability with Failures Contributing to Injury

- Substandard Care: 50% Failures, 25% No Failures
- Payment Made: $281,250 Failures, $313,542 No Failures

Douglas et al.: Anesthesiology 2016; A3208

n=914
n=446 failures
Type of Purpose Failure

- Inappropriate resolution: 40%
- Can't agree: 30%
- Rude: 10%
- Other: 5%

N=67

Team Composition of Purpose Failures

- Anesthesia & Surgery: 60%
- Anesthesia: 20%
- Surgery: 20%
- Other: 0%

N=67

Surgeon-Anesthesia Disagreements Contributing to Patients Injury: Preop

- Optimization prior to surgery
- Medical consultation
- Postponement of elective surgery
- Urgency of surgery
- Anesthetic choice and plan
- Case delays

Surgeon-Anesthesia Disagreements Leading to Patient Injury: Intraoperative

- Placement of extra IVs/invasive monitoring
- Surgical airway in CICO emergency
- Seriousness of deteriorating hemodynamics
- Seriousness of hypoxemia
- Continuation of surgery with severe instability
- Refusal to turn prone patient quickly after PEA
- Post-op airway management

Surgeon-Anesthesia Disagreements Contributing to Patients Injury: Postop

- Dx, Rx of deteriorating hemodynamics
- Dx and Rx of hypoxemia
- Resuscitation management
- Pt placement: ICU vs. floor
- Postop monitoring requirements
- Management of postop pain

Critical Role of the Surgeon–Anesthesiologist Relationship for Patient Safety

Jeffrey B Cooper, MD

Teamwork is key recognized as important for safe, high-quality perioperative care. The relationship in surgery–anesthesiology teams is perhaps the single critical element of overall care performance. A well-functioning relationship is conducive to safe, effective care. A dysfunctional relationship can paralyze team members and contribute to adverse outcomes. Yet, there is little research about this relationship, about what works well or not well, what can be done to

- Anesthesiologists’ negative perceptions of surgeons
- Surgeons’ negative perceptions of anesthesiologists
- Differing values of healthcare “tribes”
- Lack of emotional and social IQ

Cooper JB. Anesthesiology 2018;128:402-5
Lessons from Closed Claims

• Communication failures are common in claims
• Failures contribute to poor patient outcomes
• Conflict occurs in 1 out of 6 failures
• Anesthesia/surgeon interaction very important
• Providers not trained in conflict management
• Communication skill training is essential

Costs of Institutional Silence

• Why do we keep quiet when adverse outcomes are a real possibility?
• NASA’s Columbia disaster
• United Flight 173
• “The Silent Treatment Study” (2010) by AACN, AORN and Vital Smarts

Competence in Conflict; The Case for “Soft Skills”

Materials adapted from Crucial Conversations

Lisa Neale, M.S.S.
Ombuds Office, Associate Director
Certified Organizational Ombudsman Practitioner CO-OP
University of Colorado Denver / Anschutz
lisa.neale@cuanschutz.edu

Relationship & Communication Issues Brought to the Ombuds Office in 2019

0 5 10 15 20 25 30 35 40

0 5 10 15 20 25 30 35 40

n = 35 faculty
Anschutz & Denver
The big idea: when people either shut down or force their opinion, they don’t feel safe.

Motives when in conflict...
- Be Right
- Look Good/Save Face
- Win
- Punish/Blame
- Avoid Conflict
- Keep the Peace

- Learn
- Find the Truth(s)
- Produce Results
- Strengthen Relationships

ASk: What do I really want... long term?

“I can fake it ‘til I make it…”
- We “leak” (Argyris, 1974)
- Attribution Theory – Psychology
- What is the cost of an unhelpful story?

The power of a positive story – being emotionally regulated
You can either control your emotions or be controlled by them
Telling Positive Stories

- How do you humanize others?
- Does a positive story have to be true?
- Back to your challenging person...
- What is a positive story you could regularly tell yourself about this person to remain emotionally agile?

Evidence-Based Coaching in Healthcare, Burnout, Happiness

Scott Markowitz, M.D.
Associate Vice Chair of Anesthesiology for Faculty Affairs
University of Colorado Anschutz Medical Campus

“After eight years, I've performed more than two thousand operations...

...I compared my results against national data, and I began beating the averages...

...And then, a couple of years ago, they didn’t....”

-Atul Gawande

What is Coaching?

An evidence-based, relationship-focused approach to sustained, desired change and growth.
- build leadership skills and improve organizational impact.
- successfully manage a big transition-promotion, career change, etc.
- improve wellbeing and work-life balance.
- enhance performance.
Effect of a Professional Coaching Intervention on the Well-being and Distress of Physicians
A Pilot Randomized Clinical Trial

Liakeotta H, Dyches, MD, WHMPE, Tal O. Sharan, MD, MPH, Slavin R, Gill D, Gied D, Daniel V. Samek, BA, Colff F. West, MD, PhD

Outcome Measures
- Burnout
- Quality of Life
- Resilience
- Job Satisfaction
- Engagement
- Meaning at Work

Coaching Model: Intentional Change

Key Elements for Successful Coaching
1. Desire for change.
2. Willingness to work.
3. Selection of your coach.
4. Relationship quality.

EMOTIONAL EXHAUSTION

Control
Intervention

Turning Doctors into Leaders
by Thomas H. Lee
What Can Coaches Do for You?

by Diane Coutu and Carol Kauffman

Top 3 reasons coaches are engaged
Coaches are no longer most often hired to usher toxic leaders out the door.

1. Develop high potentials or facilitate transition ................. 48%
2. Act as a sounding board .......... 26%
3. Address derailing behavior .......... 12%

Our Coaching Program
Providers and Their Teams


Table 3. Examples of MD and RN Improvement: Training Pre- and Postcoaching Results.

<table>
<thead>
<tr>
<th>Question</th>
<th>Precoaching Mean FY 2015</th>
<th>All PO DB Percentile Rank</th>
<th>Question</th>
<th>Postcoaching Mean FY 2016</th>
<th>All PO DB Percentile Rank</th>
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</thead>
<tbody>
<tr>
<td>Overall</td>
<td>87.5%</td>
<td>2</td>
<td>Overall</td>
<td>86.4%</td>
<td>99</td>
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<tr>
<td>Nurse assistant</td>
<td>73.5%</td>
<td>1</td>
<td>Nurse assistant</td>
<td>89.4%</td>
<td>92</td>
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<tr>
<td>Care provider</td>
<td>73.5%</td>
<td>1</td>
<td>Care provider</td>
<td>86.4%</td>
<td>99</td>
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<tr>
<td>Overall</td>
<td>87.5%</td>
<td>6</td>
<td>Overall</td>
<td>94%</td>
<td>67</td>
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<tr>
<td>Nurse assistant</td>
<td>91.9%</td>
<td>11</td>
<td>Nurse assistant</td>
<td>96.3%</td>
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<td>91.9%</td>
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<td>95</td>
</tr>
</tbody>
</table>

Abbreviations: FY: fiscal year; PO DB, Press Ganey database.
Case Studies & Discussion

Time Pressure and Stress from Communication Failure

- 38 y.o. ASA 2 man
- 5-level thoracolumbar spine fusion-scoliosis
- Difficult IV access
- Surgeon threatened to Cx if not ready in 15 min.
- Patient and wife overheard
- Filed claim for surgical complication
Bullying in the OR

- 40 y.o. man with GBM for craniotomy
- 20 min case delay for preop MRI
- GA induced, lines being placed
- MRI not checked
- Surgeon bullies resident in front of team
- MRI-tumor now inoperable
- Offer to wake up patient
- Surgeon proceeds anyway
- Entire OR upset, multiple errors
- Everyone unhappy

Airway Emergency During Crani for Placement of Deep Brain Stimulator

- 72 y.o. woman Parkinson’s disease
- Leksell frame, semi-sitting position
- MAC with dexmedetomidine
- Laryngospasm, hypoxia
- Unable to ventilate patient
- Anesthesia team unable to get surgeons to stop surgery
- RN calls for help
- AIC physically grabs surgical gowns to get attention

How realistic was this response?

Is this a new idea/method you could employ?
Communication Failure in PACU

- 65 y.o. ASA 3 man HTN, CAD
- Acute appendicitis
- Laparoscopic appy
- Pt hypotensive, tachycardic in PACU
- Anesth concerned re intra-abdominal bleeding
- Surgeon disagreed; refused to return to evaluate patient
- Cardiac work-up ordered
- Pt coded in PACU, died

How realistic was this response?

Is this a new idea/method you could employ?
Stroke Update
Scott Vogel, DO
Assistant Professor, Department of Anesthesiology
University of Colorado School of Medicine

Objectives
- Review etiology and pathophysiology of acute ischemic stroke
- Examine rational for t-PA and endovascular therapy
- Introduce novel therapies for late presenting and posterior circulation strokes
- Review data on blood pressure management and anesthetic technique during endovascular treatment

Background Incidence
- Hemorrhagic vs ischemic strokes
  - 795,000 cases per year
  - 140,000 deaths
  - $34 billion per year
- Mortality can be assessed in terms of modified Rankin Score (mRS)
  - 0-2 is independent
  - 3-4 moderate disability
  - 5-6 severe disability
cdc.gov, 2019 statistics

t-PA
- NIH, 1995
- Within 3 hours
- Improved 3-month outcomes
- Exclusion criteria
  - Many
  - Controversy with baseline pt characteristics

Marler, JR et al., Tissue Plasminogen Activator For Acute Ischemic Stroke, NEJM 1995


Marler, JR et al., Tissue Plasminogen Activator For Acute Ischemic Stroke, NEJM 1995

NIH, 1995
- NNT 0-3h: 10
- NNT 3-4.5h: 19
- NNT 4.5-6.0: 50
- NNH 0-3h: 40
- NNH 3-4.5h: 50
- NNH 4.5-6.0: 40

t-PA

- Recanalization rates improved
- 24 hours, 2-fold greater with tPA (46% vs 24%)
- Worse with large clot burden (38% with distal MCA vs 4% for ICA)

Rha JH, Saver JL, The impact of recanalization on ischemic stroke outcome: a meta-analysis. Stroke, 2018

Endovascular therapy (EVT)

- 2013, 3 RCTS, no benefit
  - SYNTHESIS, MR RESCUE, IMS III
  - 1st and 2nd gen devices
- 2015, 5 RCTS, benefit
  - MR CLEAN, EXTEND-IA, ESCAPE, SWIFT PRIME and REVASCAT
  - 3rd gen devices

Saver et al; Time to treatment with endovascular thrombectomy and outcomes from ischemic stroke: a meta-analysis. JAMA 2016

EVT device evolution

Meta-Analysis 2016

EVT time efficacy

EVT device evolution

EVT time efficacy
EVT past 6 hours?

- 2018
- 2 studies showed benefit 6-24 hours LKW
- DAHIN and DEFUSE 3
- Inclusion criteria
  - Small core
  - Large penumbra
  - Slow progressors

EVT for posterior AIS

- 20% of AIS are posterior
- ENDOSTROKE showed that recanalization does not improve outcomes
  - 79% basilar artery recanalization rate but no association to mRS 0-2
- Small retrospective study from AUS
  - Improved recanalization rates associated with decreased inpatient mortality
  - 16-28
  - Pending
    - BASICS (IVT vs IVT plus IAT), closed Dec 2019
    - BEST (medical vs medical plus EVT), open

AIS standards of care

- Diagnostic imaging <30 min
- Diagnostic imaging to arterial puncture <60 min
- Arterial puncture to first thrombectomy attempt <30 min

Stroke Alert: How do I prep?

- Time to arrival
- What artery(s) are occluded
- How many occlusions
- Patient mental status
- GA and MAC setup
  - Who is in the room, where are they
  - Proceduralist's opinion
  - Vasovactive agents

EVT process in the room

- GA vs MAC - quickly
- Likely neo or nonopi
- Arterial access by IR
- Digital Subtraction Angiogram (DSA) "road maps"

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EVT process in the room

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What influences EVT outcomes?

- Age
- NIHSS
- Time
- Location
- Collaterals
- TICI classification
- BP on presentation and continued management
- Anesthesia technique

BP management

- Presenting too high is bad
- Presenting too low is bad
- Lowering too much is bad
- Raising too much is probably bad

Great…

Presentation SBP

- Lowering too much is bad
- Raising too much is probably bad

BP management

- Presenting too high is bad
- Presenting too low is bad
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Great…

Presentation SBP and Recanalization

<table>
<thead>
<tr>
<th>Variable</th>
<th>OR (95% CI)</th>
<th>P Value</th>
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<tbody>
<tr>
<td>SBP (mmHg)</td>
<td>[0.01-0.2]</td>
<td>0.0007</td>
</tr>
<tr>
<td>IVT</td>
<td>[1.01-1.07]</td>
<td>0.4000</td>
</tr>
</tbody>
</table>

Presentation SBP

- Lowering too much is bad
- Raising too much is probably bad

BP management

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- Presenting too low is bad
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- Raising too much is probably bad

BP management

- Presenting too high is bad
- Presenting too low is bad
- Lowering too much is bad
- Raising too much is probably bad

Great…
Presentation SBP

- Higher SBP on presentation
  - Increased infarct size
  - Lower 3-month mRS
  - 145 vs 131 mmHg


Pneumbra blood flow

- Pneumbra blood flow increases with increasing MAP to a greater extent than surrounding healthy brain tissue
- Pneumbra areas have differing amounts of collaterals
- Good collaterals typically are reflected in a lower NIHSS
- It may be possible to test this theory by looking at outcomes at different blood pressures broken down by NIHSS and mRS outcomes


Lowering SBP is dangerous

- Lowering SBP is dangerous


Pneumbra blood flow

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Should I raise BP?

- SNACC recommends 140-180
- AHA recommends <180 with t-PA, higher without
- Scarcity data on iatrogenic HTN
- Animal models say yes
- Small human trials say yes
- SETIN-HYPERTENSION is open and enrolling
- Phenylephrine induced SBP plus 20% up to improved NIHSS or SBP 200
- Samsung Medical Center
- Estimated completion date Dec 2017
- Emails sent

What about anesthesia technique?

- Significant bias
  - Intubated patients included in GA
  - Patients on GA doses in MAC
  - No hemodynamic data
  - Mostly done pre-2014 SNACC recommendations
  - Worse NIHSS, ICA, posterior circulation, converts to GA, patients risk factors and comorbidities all in GA group

3 RCTs GA vs MAC

- Sedation vs Intubation for Endovascular Stroke Treatment (SIESTA), 2016
  - Prop and remi ANH vs prop and remi GA
  - Norepi, SBP 140-140
- Anesthesia during Stroke (deSTROKE), 2017
  - Remi ANH vs sens and remi GA
  - Norepi, SBP 140-140
- General or Local Anesthesia in Intra Artery Therapy (GOLIATH), 2018
  - Prop and fent ANH vs prop and remi GA
  - SBP >140

SIESTA vs AnSTROKE vs GOLIATH


SIESTA vs AnSTROKE vs GOLIATH


Where does that leave us?

- More cases coming to the Neuro IR suite nearest you
- Free to do MAC vs GA based on best data to date
- Proceduralist may even request GA
- SBP 140-180 prior to thrombectomy seems safest
- Maybe we should raise SBP to that range
- Awaiting results from Korea
- Probably not wise to drop SBP at all before thrombectomy
- Unless SBP >180 with t-PA or >210 without t-PA
- Maybe safer to drop SBP following thrombectomy to lower hemorrhagic conversion rate
- Time is brain

SIESTA vs AnSTROKE vs GOLIATH


Introduction

Prior to 1987, treatments for Parkinson’s disease (PD), dystonia, essential tremor and Tourette’s syndrome were medication and ablative neurosurgery, thalidomide and pallidotomy.

Deep Brain Stimulation (DBS), a reversible, adjustable and safe technique, has revolutionized the treatment of movement disorders.

DBS electrodes in the subthalamic nucleus (STN), globus pallidus internus (GPI) and ventralis intermedius (Vim) drastically reduce motor symptoms.

Objectives

- Relate the historical aspects that have led to modern practice.
- Understand the implication of anesthesia on microelectrode recordings (MER) and macrostimulation.
- Discuss relevant anesthetic management in regard to pre-operative planning, intraoperative management and postoperative care.
- Review current literature related to anesthetic practice in DBS surgery.
- Discuss future potential for DBS expansion.

Neuroanatomy and Physiology

Targeting DBS electrode insertion requires accurate neurological evaluation, knowledge of the association between symptoms and likely therapeutic locations.

Location of the anatomical target requires an MRI with previously placed stereotactic head frame as well as microelectrode recording (MER).

Lesions within the putamen, globus pallidus internus and the subthalamic nucleus (STN) are most commonly associated with parkinsonian signs, dystonia and hemiballismus.
Neuroanatomy and Physiology

Primary neuronal control of movement lies within subcortical nuclei: basal ganglia, striatum, caudate-putamen and globus pallidus. The basal ganglia maintains three basic functions: input, output, intrinsic modulation.

Input nuclei: caudate nucleus (CN), the putamen (Put), and the thalamus.

Output nuclei: globus pallidus internus (Gpi) and the substantia nigra pars reticulata (SNr).

Intrinsic: external segment of the globus pallidus (Gpe), the STN and the substantia nigra pars compacta (SNc).

Surgical Technique

Successful DES surgery begins with a qualified team that includes: neurosurgeon, neurophysiologist, neurologist, neuroradiologist and Neuroanesthesia provider.

The procedure takes place in two steps:

1) Electrode placement

2) Internalization of cables and implementation of the programmable pulse generator.
Macrostimulation

Identifies the electrode contacts that best control the patient’s symptoms with the least unpleasant side effects.

Neuro exam that takes place after electrode positioning and determines:

- Assists in determining pattern, energy, and site of the electrode that maximizes reduction of symptoms with minimal negative side effects
- Evaluates the patient’s ability to report changes in:
  - sensation, motor function or speech fluency
  - observe the benefits versus the adverse effects created by DBS

Microelectrode Recordings (MER)

MERs improve accuracy of electrode placement with characteristic sound and recognition of neuronal discharge patterns.

Between 1 to 5 electrodes are advanced to approximately 10-15 mm above the target.

Proprietary software analyzes the data obtained from the electrodes and suggests an electrode depth.

Neurosurgeon and neurophysiologist will simultaneously evaluate MER to identify different noises of neuronal activity indicating that the associated area has the expected neurological activity.

Microelectrode Recordings (MER) of the Subthalamic Nucleus (STN)

Anesthetic role in DBS Surgery

Anesthetic management, during DBS procedures, has two predominant components:

1) avoid GABAergic drugs for the interpretation of microelectrode recordings (MER) and
2) cautious airway management

DBS technique has expanded to other treatment-resistant neurological disorders, obsessive-compulsive disorder (OCD), depression, seizures, schizophrenia and chronic pain.

Anesthetic effects

the role of the anesthesiologist in DBS surgery to treat movement disorders is complicated by the effects that anesthetic agents have on MER and macrostimulation.

Many anesthetic drugs unpredictably alter consistent trigger patterns at target nuclei and do not allow the surgeon to accurately recognize and place the electrode.

GABA-ergic anesthetic drugs evenly alter THE MERs in GABA neurons.

Therefore, the practice of anesthetic favors the use of an anesthetic technique or “wake up” or “asleep” for the treatment of movement disorders that does not change neural activity.
Preoperative Evaluation

Consideration of co-morbid conditions is

- Assess the severity of the disease in the "off-drug" state
- Severe stiffness, difficulty swallowing, anxiety, breathing problems etc.
- You may not be a candidate for "wake up" surgery

Consideration of the need for General Anesthesia

Comprehensive advice on intraoperative management and airway rescue plan

Intraoperative management:

- Awake vs. Asleep
- Lines and monitors
- Airway rescue maneuvers

Propofol Effects

- Propofol effects on STN spiking activity in the PD patients
- Motor suppression observed
- No change in inhibition
- STN firing decreased by ~23% in 18/24 patients
- Return to baseline in 9.3 min after discontinuation

Dexmedetomidine Effects

- No difference in LFP in Dex vs. Control
- Loading dose of 1mcg/kg over 10 min then maintenance of 0.2 to 1.4mcg/kg/hr.
- Improved patient satisfaction and hemodynamics compared to awake.No depression of MERs observed

Ketamine, Remifentanil Effects

- 5 patients requiring re-implantation of electrodes underwent GETA with ketamine/remifentanil infusion.
- No statistically significant differences in MER from awake vs asleep placement.
- EAR placement with MER is reliable with a ketamine-based anesthetic.
Awake vs. Asleep: Current Literature

- Review of 145 studies (inclusion criteria >15 patients)
- 16 studies of patients under general anesthesia
- There is no significant difference in clinical motor results.
- General anesthesia should be considered in experienced centers.

Fluchere et al. Controlled general anesthesia for stimulation of the subthalamic nucleus in PD.
- 213 patients under general anesthesia
- Similar short- and long-term reductions in motor symptoms were observed in general versus awakening techniques.

Awake vs. Asleep

Tsai et al. Sevoflurane and Parkinson’s Disease: Subthalamic Nucleus Neuronal Activity and Clinical Outcome of Deep Brain Stimulation
- Sevoflurane-induced changes in electrical activity patterns did not reduce electrode placement accuracy and clinical effect.
- These observations suggest that microelectrode-guided deep brain stimulation under sevoflurane anesthesia is a feasible clinical option.

Airway rescue

The incidence of respiratory complications reported is 1.6%
- Patients often suffer from respiratory dysfunction and have an increased risk of respiratory suppression.
- Excessive sedation can lead to upper airway obstruction by decreased muscle tone in patients at increased risk of airway compromise.
- There must be a detailed plan for airway rescue.
- Due to the patient’s position and the location of the header, oral endotracheal intubation is not possible.
- Similarly, ventilation of the bag mask is difficult for many practitioners to do due to the small space between the header and the patient’s face.
- **At the author’s institution, we routinely have Igel® supraglottic airways.**

Anesthetic Plan for DBS patients presenting for non-DBS surgery:

It is increasingly common to have patients with DBS pulse generators present for non-DBS cases (in the USA 50,000 people).

Considerations should be made for interactions between ASA monitors, interference between the DBS pulse generator and pacemakers or AICDs, and procedure-specific considerations.

Electrocautery can damage stimulator cables and should be used with caution.
- If coagulation is mandatory, bipolar cautery is preferred; the stimulator should be turned off and the grounding pad placed as far away as possible from the generator site.
- Patients with an unknown DBS brand or inability to describe the DBS brand must have a preoperative x-ray to verify the placement of potential customers and the location of the generator.

The Future

Current pathologies (FDA approved)
- Parkinson’s disease, Dystonia, Essential tremor, Obsessive Compulsive Disorder (OCD)

Future potential
- Major depression, chronic pain, schizophrenia, epilepsy, Alzheimer’s

Concerns:
- Are basic functions such as memory, control, and intelligence modifiable?
- Other worst-case scenarios

Population of patients with disease statuses with potential for DBS benefit exceeds 1.00 million

Thank you!
Intraoperative Neurophysiologic Monitoring
Claudia Clavijo, MD
Associate Professor, Anesthesiology
University of Colorado School of Medicine

No conflict of interest to disclose

Outline
- Purpose and general aspects of IONM
- Types of IONM recordings
- Common surgical applications
- Examples of alerts
- Anesthetic effect on IONM responses
- Strategies to manage alerts
- Summary

Purpose of IONM
- Reduce the risk of postoperative neurological deficits
- Real-time detection of:
  - Ischemia
  - Mechanical insult
  - Malposition of patient
  - Malposition of hardware
- Identification of:
  - Nerves
  - Nerve roots
  - Eloquent cortex
  - Spinal cord structures

Goals and Objectives
- Learn common uses of IONM
- Review recent evidence for use of IONM in common cases
- Review anesthetic effect on IONM responses
- Learn management strategies when IONM signals change or disappear

Types of Recordings
- Spontaneous activity
  - Electroencephalography (EEG)
  - Electromyography (EMG)
- Evoked responses
  - Somatosensory (SSEP)
  - Motor (MEP)
  - Auditory (ABR)
  - EMG

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  - EMG
Common Surgical Applications

- Spine surgery
  - Most fusions
  - Spinal cord tumors
- Intracranial surgery
  - Posterior fossa tumors
  - Microvascular decompression
  - Cerebral mass in or near eloquent cortex
- Vascular surgery
  - Carotid endarterectomy
  - Aortic aneurysm repair
- Cardiac surgery
  - Aortic arch repair or replacement
- Head and neck surgery
  - Parotidectomy
  - Thyroidectomy
  - Parathyroidectomy
  - Neck dissection

MEPs

- Controversial
- All-or-nothing
- Amplitude decrease
- Threshold increase
- Morphology change

SSEP Alert Criteria

- 50% decrease in signal amplitude
- 10% increase in signal latency
- International Society of Intraoperative Neurophysiology released new recommendations

MEP Alert Criteria

- Controversial
- All-or-nothing
- Amplitude decrease
- Threshold increase
- Morphology change

SSEPs

EMG
EMG

- Spontaneous
- Stimulated

ABR

EEG

Reasons For Alerts

- Patient factors
  - Age, preexisting neurologic status
- Surgical factors
  - Compression, retraction, trauma, vibration
- Anesthesia factors
  - Anesthetic agents used, depth of anesthesia, hypotension, temperature, anemia, hypoxia
- Patient positioning for surgery
- Miscellaneous

Who is your patient?
Effect of Anesthetics on IONM responses

<table>
<thead>
<tr>
<th>AGENT</th>
<th>EFFECT</th>
</tr>
</thead>
<tbody>
<tr>
<td>Inhalational agent/N2O</td>
<td>Affects SSEP, MEP</td>
</tr>
<tr>
<td>Propofol</td>
<td>Helps preserve responses</td>
</tr>
<tr>
<td>Sufentanil/remifentanil</td>
<td>No effect</td>
</tr>
<tr>
<td>Neuromuscular blockers</td>
<td>Affect MEP, EMG</td>
</tr>
<tr>
<td>Ketamine</td>
<td>Enhances responses</td>
</tr>
<tr>
<td>Dexmedetomidine</td>
<td>Conflicting</td>
</tr>
<tr>
<td>Lidocaine</td>
<td>Inconclusive</td>
</tr>
</tbody>
</table>
Spine Surgery

- IONM applications
  - Identification of inadequate spinal cord perfusion
  - Identification of spinal cord or spinal nerve injury
  - Guide surgical decision making
  - Prognosticate postoperative neural function
  - Evidence in spine surgery
  - Most data of any type of surgery using IONM

Table 1
Summary of IONM results.

<table>
<thead>
<tr>
<th></th>
<th>Total</th>
<th>PCO</th>
<th>3CO</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of patients, n (%)</td>
<td>275 (100)</td>
<td>162 (58.9)</td>
<td>113 (41.1)</td>
</tr>
<tr>
<td>Tc-MEP alert, n (%)</td>
<td>32 (11.6)</td>
<td>17 (10.4)</td>
<td>15 (13.2)</td>
</tr>
<tr>
<td>Neurologic deficit, n (%)</td>
<td>15 (5.5)</td>
<td>8 (4.9)</td>
<td>7 (6.2)</td>
</tr>
<tr>
<td>True positive</td>
<td>15</td>
<td>8</td>
<td>7</td>
</tr>
<tr>
<td>True negative</td>
<td>235</td>
<td>139</td>
<td>96</td>
</tr>
<tr>
<td>False positive</td>
<td>8</td>
<td>3</td>
<td>5</td>
</tr>
<tr>
<td>False negative</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Rescue cases</td>
<td>17</td>
<td>9</td>
<td>8</td>
</tr>
</tbody>
</table>

3CO, three-column osteotomy; IONM, intraoperative neuro-monitoring; MEP, motor-evoked potential; PCO, posterior column osteotomy.

Table 2
Demographics and clinical characteristics between cases with PNMD and true-negative cases.

<table>
<thead>
<tr>
<th>Variable</th>
<th>Cases with PNMD (n=15)</th>
<th>True negative cases (n=235)</th>
<th>p value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Patients demographics</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mean age</td>
<td>66.2 ± 8.2</td>
<td>60.8 ± 18.7</td>
<td>.115</td>
</tr>
<tr>
<td>Male sex, n (%)</td>
<td>4 (26.6)</td>
<td>46 (19.6)</td>
<td>.506</td>
</tr>
<tr>
<td>Mean BMI</td>
<td>25.2 ± 3.8</td>
<td>23.5 ± 5.8</td>
<td>.011</td>
</tr>
<tr>
<td>ASA-PS</td>
<td>2.13 ± 0.5</td>
<td>1.85 ± 0.5</td>
<td>.033</td>
</tr>
<tr>
<td>Surgical factors</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Operative time (min)</td>
<td>462 ± 84.2</td>
<td>361 ± 93.6</td>
<td>&lt;.001</td>
</tr>
<tr>
<td>Estimated Blood loss (mL)</td>
<td>2373 ± 1344</td>
<td>1415 ± 1058</td>
<td>&lt;.001</td>
</tr>
<tr>
<td>3CO (%)</td>
<td>7 (46.7)</td>
<td>96 (40.9)</td>
<td>.657</td>
</tr>
</tbody>
</table>

MEP Alert Evidence

Intraoperative Neuro-monitoring During Adult Spinal Deformity Surgery: Alert-Positive Cases for Various Surgical Procedures

Go Yoshida, MD, PhD, Hiroki Ushirozako, MD, Sho Kobayashi, MD, PhD, Tomohiko Hasegawa, MD, PhD, Yu Yamato, MD, PhD, Tomohiro Hanada, MD, PhD, Shun Oe, MD, Hideki Aritu, MD, PhD, Yuki Mihara, MD, Tatsuya Yasuda, MD, Daisuke Togawa, MD, PhD, Yuukiro Matsuyama, MD, PhD.
Objectives

- To determine if patterns of injury could be detected through IONM changes
- To identify if perfusion based or direct trauma causes of IONM changes could be distinguished
- To observe the effect of interventions performed in response to events
- To attempt to identify different treatment algorithms for the different causes

Results

- A total of 97 pediatric patients
- Incidence of alerts 27.8% (39 in 27 patients)
- Bilateral changes responded to transfusion, ↑ BP and rod removal
- Unilateral changes responded to removal of the causative agent
- All cases were completed after corrective actions
- Signals returned to baseline in 20/27 patients
- No permanent neurological deficits

Intracranial Surgery

- IONM applications
  - Identification of cranial nerves or eloquent cortex
  - Aid in dissection on or near cranial nerves, brainstem, or eloquent cortex
  - Prognosticate postoperative neural function
- Eloquent cortex at risk
- CN 5-12

Vascular Surgery

- IONM applications
  - Identification of inadequate cerebral, spinal cord and/or tissue perfusion
  - Guide interventions
  - Prognosticate postoperative cognitive and/or neural function

Cardiac Surgery

- IONM applications
  - Identification of inadequate cerebral perfusion
  - EEG and SSEP
  - Prognosticate postoperative cognitive function
- Evidence
  - Little to no studies examining effect of EEG on outcomes in surgery of the ascending aorta and aortic arch
Head and Neck Surgery

- IONM applications
  - Identification of cranial nerves
  - Aid in dissection on or near cranial nerves
  - Prognosticate postoperative neural function
- Cranial nerves at risk
  - Facial nerve
  - Vagus nerve
  - Spinal accessory nerve

Strategies to Manage Alerts

- All team members need to search their respective areas for possible contributing factors
- Rule out technical problems
- Recent surgical event? (reversible or not reversible)
- Increase perfusion MAP >10-20%
- Pharmacology (change in regimen, bolus or NMB)
- Physiology (BP, temperature, oxygenation)
- Position, compression, vascular obstruction

Summary

- IOM provides important real-time information
- Communication between anesthesia team, IOM staff and the surgeon is critical when alerts arise
- Know that the anesthesia team plays a crucial role in alert prevention and intervention
- Adequate management of alerts decreases postoperative neurologic deficits
Objectives

- Learn the core images in cardiac point of care ultrasound
- Learn the core images in lung point of care ultrasound
- Identify normal vs abnormal pathology
- Have fun!

Overall Flow

- 5 Stations
  - Parasternal Long/Short Axis
  - Apical
  - Subxiphoid Cardiac and IVC
  - Systolic Function/Pathology
  - Lung Ultrasound - “lung sliding” and “pleural effusions”

- At Each Station, 10 minute presentation on the view, relevant structures
- Hands-on time for each learner to obtain the view

Where to go from here?

- American Society of Anesthesiologists is developing some certification process
- POCUS ACGME requirements now in place
- PRACTICE PRACTICE PRACTICE!
- DON’T MAKE SIGNIFICANT CLINICAL DECISIONS YET!
Question and Answer Session

Contact Info

- Tim Tran
  - timothy.t.tran@cuanschutz.edu
  - Twitter: @thinkpocus
  - Website: thinkpocus.com
Subxiphoid Views: Cardiac and Great Vessels

Learner Objectives
- Obtain the Subxiphoid Cardiac View
- Obtain the Inferior Vena Cava View
- Obtain the Aortic View
- Learn how to measure the Inferior Vena Cava

Subxiphoid Great Vessels
- IVC View
- Aorta View

Subxiphoid Long-Axis

Subxiphoid Great Vessels
- The Aorta and the IVC are next to each other, so it’s critical to differentiate them. A “non-collapsible IVC” may actually be the aorta and lead you down a wrong treatment path.
Subxiphoid: IVC

- Hepatic veins feed into IVC
- IVC feeds into the Right Atrium

Subxiphoid: Aorta

- Medial to IVC
- Pulsatile

Aorta does NOT feed into the heart

IVC Diameter

- Why MIGHT IVC Diameter be predictive of fluid responsiveness?

| Table 1: Correlation of RA pressures on the basis of IVC diameter and collapsibility |
|--------------------------------------|-----------------|-----------------|-----------------|
| IV diameter | High RA pressure | Low RA pressure | Both pressures |
| IVC diameter | Normal (20-40 mmHg) | Normal (20-40 mmHg) | Both pressures |
| Hepatic veins | Feeds into IVC | Feeds into IVC | Both feeds into |
| Subxiphoid: | Aorta | Medial to IVC | Pulsatile |

Definitions

Collapsibility Index = (IVCmax - IVCmin) / IVCmax

Distensibility Index = (IVCmax - IVCmin) / [(IVCmax + IVCmin) / 2]

IVC Variation = IVCmax - IVCmin / ([IVCmax + IVCmin] / 2)

Muller et al. Critical Care 2012, 16:R188

Respiratory variations of inferior vena cava diameter to predict fluid responsiveness in spontaneously breathing patients with acute circulatory failure: need for a cautious use

Laurent Muller*, Xavier Borel*, Mohit Tandan, Guillaume Lorenzi, Nicolas Mihet*, Bernard Rogerme*, Extend: (n): Marc: (n): Iyan Jami: Jean-Yves Efrati* and the Anesthesia Group

Muller et al. Critical Care 2012, 16:R188

128 2
IVC Distensibility

Respiratory changes in inferior vena cava diameter are helpful in predicting fluid responsiveness in ventilated septic patients


How to measure:

• Change to M-Mode
• Set the Doppler 2 cm away from the caval-atrial junction
• Clip a video that shows the IVC through a respiratory cycle
• Measure the smallest and largest diameter


IVC Diameter Collapsibility Depends on Mode of Ventilation

Mode of Ventilation

- Mechanical
- Spontaneous

> 18% Change IVC Distensibility?
- Yes: more likely to be fluid responsive
- No: not likely to benefit

> 40% Change in IVC Collapsibility?
- Yes: more likely to be fluid responsive
- No: unclear benefit to fluid challenge

IVC changes and volume responsiveness:

It’s still an ongoing area that needs additional research, however it can guide management but should be used in context of other clinical data.
Learner Objectives

• Obtain parasternal long and short axis views
• Identify relevant structures in the parasternal views
  • Mitral Valve, Aortic Valve, Interventricular septum
  • Right Ventricular outflow tract
  • Right Ventricle, anterolateral and posteromedial papillary muscles
• Describe the coronary perfusion of the LV walls

PLAX Assessment:

Indications
• Valves: Aortic and Mitral
• RV: function, size, shape
• LV: function, size, shape
• LA: Diameter (assessment of diastolic dysfunction)
References

- Echocardiographer.org
- cor et vasa 57 (2015) e408–e418
Learner Objectives

• Obtain the following apical views: 4 chamber, 5 chamber
• Identify the relevant structures
  • Mitral Valve, Tricuspid Valve, Aortic Valve
  • Right and Left Ventricles, Right and Left Atria

Apical 4C Assessment

Indications:
• Mitral, Tricuspid, and Aortic Valve
• RV function (TAPSE)
• Size of atrial and ventricles
• Wall motion abnormalities
Apical 5C
Indications:
• Allows for assessment of flow across aortic valve — most significantly the VTI for volume responsiveness

Apical 2C
Indications:
• Allows for assessment of inferior and anterior walls
• Allows for Continuous Wave through the Mitral Valve

Apical 5C

Apical 2C
Note Indicator at 12 o’clock

Apical 5C

Apical 2C

2/27/2020
Coronary Perfusion

References

• Echocardiographer.org
• https://web.stanford.edu/group/ccm_echocardio/cgi-bin mediawiki/index.php/Main_views
Learner Objectives

• List different modalities to determine LV normal vs abnormal systolic function
• Demonstrate how to perform the measurements on the ultrasound machine
• Learn how to measure the TAPSE

E point septal separation

• This measures how close the anterior mitral leaflet gets to the interventricular septum during diastole
• In normal patients, the leaflet will be close to the septum because it’s contracting well.
• Patients with poor systolic function, usually have large ventricles, and therefore leaflets do not move as close as the septum

How to estimate cardiac function?

• Methods
  • Fractional Area Change “FAC”
  • E point septal separation “EPSS”
  • Tricuspid Annular Plane Systole Excursion “TAPSE”

Fractional Area Change “FAC”

• Measures the difference between the area from end diastole and end systole
  • FAC = (LVEDA – LVEDA) / LVEDA
  • Normal > 50%
• Upside: Easy to measure
• Downside: Only looks at one image
• Parasternal short axis view
• Measure at Mid Papillary Level

Study from 1999, looking at the correlation of EPSS and EF
Note how far/close the tip of the mitral leaflet gets to the septum

Low EF

Normal EF

Estimation of RV function

How to measure EPSS

• PLAX view
• Use M-Mode and aim over tips of the mitral valve
• Measure the distance between the IVS and the first wave “the E wave”


EPSS

EPSS Values
• Normal function < 5mm
• EF < 50% > 7mm
• EF < 30% > 18mm

When EPSS is bad estimation
• Mitral stenosis (because the mitral valve can’t move)
• Aortic insufficiency (because it closes the leaflet during diastole
• Septal Hypertrophy
• LV Hypertrophy

Tricuspid Annular Systolic Excursion (“TAPSE”)

Indications:
• Assessment of RV function.
• But it is not perfect as it measures it in one dimension.

TAPSE

• Normal Function > 17mm
• Decreased function < 17mm

How to do it
• Patient in apical 4 chamber
• Put M-mode tracing over the lateral annulus of the tricuspid valve
Lung Ultrasound Evaluation

Objectives

• How to Evaluate Pleura
• How to Evaluate for a Pleural Effusion

Ultrasound findings

• Pleural sliding between 2 ribs: (“Bat-Wing”)
• A-Lines: Horizontal lines indicating normal lung surface
• B-Lines Artifact: Large lines from pleural to end of screen
• "Comet-Tails": Small lines from pleural little below (artifact)
• Sea-Shore Sign (M-mode)

Evaluation of Pleura

Bat Wing: the ribs + pleural = bat?
How does it work? A lines
• Normal lung is filled with air: Regularly spaced horizontal lines “A lines” are waves reflected by subpleural air.

CHEST 2005; 127:1690–1695

How does it work? B Lines
• When there is alveolar collapse, waves are transmitted and reflected deeper from the tissue resulting in long vertical beams; these are called B-lines

CHEST 2009; 136:1014–1020

Z Lines (“Comet Tails”)
• Vertical lines that start at the pleural but do NOT extend through the visual field; usually 2-3 cm
• Can look like B Lines but shorter; these are ok

CHEST 2009; 136:1014–1020

Pathology
• Cardiogenic Pulmonary Edema
• ARDS
• Pneumonia
• Pulmonary Fibrosis
• And more!

DETECTION OF PNEUMOTHORAX

B Lines
• Discrete hyperechoic artifact that extends from the pleural line to the end of the screen
• Moves with respiration
• Images below: normal, B7 (7mm apart) and B3 (3mm apart) – more to follow

CHEST 2009; 136:1014–1020
Normal Lung: M-Mode

http://rebelem.com/ultrasound-detection-pneumothorax/

Pneumothorax

• Note the lack of lung sliding; the pleural isn’t moving separate from the chest wall.

Probe Placement

• Linear Probe Preferred due to higher frequency (Curvilinear OK)
• Place in 2nd or 3rd Intercostal Space along Mid Clavicular Line
• Usually a couple of Rib Spaces (for more thorough Examination, go down to diaphragm, and laterally)


Pneumothorax: Lung Point

• Note the lung sliding intermittently appears on ultrasound. This is the where the air separates the parietal pleura from the visceral pleura, and hence the visceral pleura does not appear to move – it’s just hiding beneath the

https://www.youtube.com/watch?v=P1tRdwZDCe

Normal Lung Sliding

• See the pleura sliding back and forth with respirations
• B Lines that extend from the pleural down to the edge of the screen

Pleural Effusions

Ultrasound is more sensitive than x-ray for detecting pleural effusions (using CT as the gold standard).
Which probe?

• A variety of probes can be used; microconvex is probably most preferred, followed by curvilinear, then phase array. Often times, when doing a cardiac ultrasound with a phased array, you can just use it to evaluate the pleural space.

Where to scan?

• The lung is enormous, so you can scan really anywhere. However, in the critically ill patient population, supine (compared to sitting upright) will be more common.

Pleural Effusion: 1

• Right pleural effusion: longitudinal view at the sixth intercostal space, along the posterior axillary line, with the patient in a semi-recumbent position. It is possible to observe (from left to right) a small portion of the liver, the echogenic curvilinear diaphragm, and a significant anechoic pleural effusion with associated pulmonary collapse.

Pleural Effusion: 2

• Pleural Effusion + Collapsed Lung

Pleural Effusion: 3

• Massive Hemothorax, can barely see the lung

Size Matters:

Rule of thumb:

• Depth of 4-5cm of a pleural effusion suggests >1000ml of volume
Volume Responsiveness

Tim Tran, MD
Assistant Professor
Department of Anesthesiology
University of Colorado – Anschutz Medical Campus

Ultrasound Markers of Volume Responsiveness

- IVC Diameter
- LVOT VTI
  - Carotid VTI
  - LVEDA
  - Atrial Septum

We'll focus on the top 2

IVC Diameter

- Why MIGHT IVC Diameter be predictive?

IVC Diameter

<table>
<thead>
<tr>
<th>Collapsibility Index</th>
<th>IVC Variation</th>
</tr>
</thead>
</table>
| \[
\frac{(IVC_{\text{max}}-IVC_{\text{min}})}{IVC_{\text{max}}}
\] |
| \[
\frac{(IVC_{\text{max}}-IVC_{\text{min}})}{(IVC_{\text{max}}+IVC_{\text{min}})/2}
\] |

Definitions

- Collapsibility Index = \[
\frac{(IVC_{\text{max}}-IVC_{\text{min}})}{IVC_{\text{max}}}
\]
- LVOT VTI
- Carotid VTI
- LVEDA
- Atrial Septum

Distensibility Index = \[
\frac{(IVC_{\text{max}}-IVC_{\text{min}})}{(IVC_{\text{max}}+IVC_{\text{min}})/2}
\]

- IVCmax
- IVCmin

J Am Soc Echocardiogr 2010;23:685-713

Muller et al. Critical Care 2012, 16:R188

Does Central Venous Pressure Predict Fluid Responsiveness?

A Systematic Review of the Literature and the Tale of Seven Masks

Paul F. Muller, MD, PhD, Michael Brown, MD, PhD, and Abdul Vellan, MD
Using a threshold dIVC of 18%, responders and non-responders were discriminated with 90% sensitivity and 90% specificity. A strong relation (r=0.9) was observed between dIVC at baseline and the CI increase following blood volume expansion.
How to measure:

- Change to M-Mode
- Set the Doppler 2 cm away from the caval-atrial junction
- Clip a video that shows the IVC through a respiratory cycle
- Measure the smallest and largest diameter

What is VTI?

Area under the curve = velocity (cm/s) * time (s) = cm

Can use VTI as a proxy for stroke volume

Using Left Ventricular Outflow Tract and Velocity Time Integral
How to Measure VTI

- Starting at an apical 4-chamber view, tilt the probe cranial to visualize the LVOT
- Use pulse wave doppler mode
- Place doppler marker over the LVOT

Commentary

- The VTI and IVC Distensibility/Diameter is a data point in the assessment of a patient.
- Ex: If you see a small IVC, a fluid challenge will probably not hurt – it doesn’t mean fluid will work, but that you can probably give it without harming the patient. On the flip side if you see a large IVC and minimal collapsibility, giving fluid will probably harm the patient.

For the math nerds...

\[ CO = A_1 \times V_1 \times HR \times SV \]
\[ A_1 \times \text{cm/sec} = \frac{\text{Vol}}{\text{sec}} \times SV \]
\[ A_1 \times \text{cm} = SV \]
\[ A_1 \times \text{VTI} = SV \implies \text{assuming } A_1 \text{ and HR is constant, } \text{VTI} \sim SV \]
Pathology
Tim Tran

Patient SV
“Less is More”

Patient SV: What’s the pathology?
(1 of 4)

Patient SV: What’s the pathology?
(2 of 4)

Patient SV: What’s the pathology?
(3 of 4)

Patient SV: What’s the pathology?
(4 of 4)
Patient SV: Bicuspid AV

Patient RA: what’s the pathology? (2 of 4)

Patient RA
“Blue Away Red Towards”

Patient RA: what’s the pathology? (3 of 4)

Patient RA: what’s the pathology? (1 of 4)

Patient RA: what’s the pathology? (4 of 4)
Patient RA: what’s the pathology?

Apical 4C View
• Mild Mitral Regurgitation

Patient RA: what’s the pathology?

Apical 4C with CW over TV
• Note Max Velocity 3.5m/s
• PA pressure = 4 V^2 + RA pressure
• 4*3.5^2 = 35mmHG + RA pressure!!!

Patient RA: what’s the pathology?

Apical 4C
• LV Systolic Failure
• RV Size/Function ok

Patient RA: what’s the pathology?

LV Systolic Failure
• EF Low
  • 20-25%
• Global hypokinesis
• No septal bowing

Patient RA: what’s the pathology?

Apical 4C with color doppler over TV
• Severe TR

Patient CL
“Click click click”
Patient CL: What is the Pathology (1 of 1)

• Mechanical Aortic Valve

Patient JW: What’s the Pathology? (1 of 7)

Patient CL: What is the Pathology (1 of 1)

Patient JW: What’s the Pathology? (2 of 7)

Patient JW: What’s the Pathology? (3 of 7)

Patient JW

“You should get that looked at”
Patient JW: What’s the Pathology? (4 of 7)

Patient JW: What’s the Pathology? (7 of 7)

• Poor RV function
• Poor LV function
• AV stenosis (calcified leaflets, cannot see leaflets moving)
• Calcifications at mitral valve, cannot assess stenosis in this image

Patient JW: What’s the Pathology? (1 of 7)

Patient JW: What’s the Pathology? (2 of 7)

• Poor LV EF (24%)

Patient JW: What’s the Pathology? (5 of 7)

Patient JW: What’s the Pathology? (6 of 7)
Patient JW: What’s the Pathology? (3 of 7)
- PSAX at mid-pap
- Poor LV EF (24%)

Patient JW: What’s the Pathology? (4 of 7)
- PSAX at Aortic Valve
- Do not see AV leaflets moving
- Severe Aortic Stenosis

Patient JW: What’s the Pathology? (5 of 7)
- Apical 4 Chamber
- Poor LV function
- RV size ok, but function seems reduced

Patient JW: What’s the Pathology? (6 of 7)
- Apical 4 Chamber
- Mild Tricuspid Regurgitation

Patient JW: What’s the Pathology? (7 of 7)
- Apical 4 Chamber
- Mild Mitral Regurgitation

Patient MW
"Which way is the probe oriented?"
Patient MW: What’s the Pathology (1 of 7)?

Patient MW: What’s the Pathology (2 of 7)?

Patient MW: What’s the Pathology (3 of 7)?

Patient MW: What’s the Pathology (4 of 7)?

Patient MW: What’s the Pathology (5 of 7)?

Patient MW: What’s the Pathology (6 of 7)?
Patient MW: What’s the Pathology (7 of 7)?

Patient MW: What’s the Pathology (1 of 7)?
- Parasternal Long Axis
- AV and MV open
- LV function looks ok
- RV looks dilated, but function ok

Patient MW: What’s the Pathology (3 of 7)?
- Parasternal short axis view at the level of the aortic valve; (technically RV inflow view)
- Severe TR

Patient MW: What’s the Pathology (2 of 7)?
- Parasternal short axis view at the level of the aortic valve; (technically RV inflow view)
- AV opens and closes

Patient MW: What’s the Pathology (4 of 7)?
- Parasternal short axis view at the level of the aortic valve; (technically RV inflow view)
- Severe TR
- Continuous wave Doppler through TV
- Max velocity = 4.5 m/s; P = 4V^2
- RVSP is at least = 4(4.5^2) = 81mmHg!!!

Patient MW: What’s the Pathology (5 of 7)?
- Apical 4 Chamber
- LV systolic function looks ok
Patient MW: What’s the Pathology (6 of 7)?

- Apical 4 Chamber View
- Dilated RV with good function

Patient MW: What’s the Pathology (7 of 7)?

- Parasternal short axis view at the level of the aortic valve; (technically RV inflow view)
- Severe TR

Patient RJ: What’s the pathology (1 of 4)?

Patient RJ: What’s the pathology (2 of 4)?

Patient RJ: What’s the pathology (3 of 4)?

Patient RJ

“I’m feeling a little tired”
Patient RJ: What’s the pathology (4 of 4)?

• Parasternal Long Axis
• AV opens
• Something is dilated

Patient RJ: What’s the pathology (3 of 4)?

• Apical 4 Chamber View
• LV function looks ok
• Dilated RV: it’s larger than the LV! (usually half the size of the LV)

Patient RJ: What’s the pathology (1 of 4)?

• Parasternal Short Axis
• Very dilated RV causing pressure overload, see flattened septum
• LV function looks ok

Patient RJ: What’s the pathology (4 of 4)?

• Continuous wave through the tricuspid valve; velocity is
• Continuous wave Doppler through TV
• Max velocity = 4.5 m/s; 
  \[ P = 4V^2 \]
• RVSP is at least \[ 4(4.5^2) = 81\text{mmHg} \]

Patient LG

“I am a bit short of breath”
Patient LG: What’s the Pathology (1 of 7)?
- RV function ok
- LV Apex looks dilated, not contracting well

Patient LG: What’s the Pathology (4 of 7)?
- Aortic Valve Opens

Patient LG: What’s the Pathology (2 of 7)?
- Parasternal Long Axis View
- Mitral and Aortic Valves open

Patient LG: What’s the Pathology (5 of 7)?

Patient LG: What’s the Pathology (3 of 7)?

Patient LG: What’s the Pathology (7 of 7)? Bonus!
Patient LG: What’s the Pathology (6 of 7)?

- Subxiphoid

<table>
<thead>
<tr>
<th>Diameter</th>
<th>Estimated CVP</th>
</tr>
</thead>
<tbody>
<tr>
<td>≤ 1.5</td>
<td>Significant Collapse</td>
</tr>
<tr>
<td>1.5 – 2.5 cm</td>
<td>&gt; 50% collapse</td>
</tr>
<tr>
<td>1.5 – 2.5 cm</td>
<td>≤ 50% collapse</td>
</tr>
<tr>
<td>&gt; 2.5 cm</td>
<td>&gt; 50% collapse</td>
</tr>
<tr>
<td>&gt; 2.5 cm</td>
<td>≤ 50% collapse</td>
</tr>
</tbody>
</table>

Patient LG: What’s the Pathology (7 of 7)? Bonus! Apical 2 Chamber

Patient LG:

- Left ventricular function is mildly reduced.
- The mid-apical segments of the anteroseptum and anterior walls are akinetic. The distal anterolateral and inferoseptal walls are akinetic.
- The apex is akinetic. There is no evidence of a thrombus in the left ventricle.
- Normal RV systolic function
- The inferior vena cava is normal in size with respiratory collapse, indicating a right atrial pressure of approximately 3 mmHg.
- Estimation of right ventricular systolic pressure is not possible due to incomplete tricuspid regurgitation envelope

Patient AU: What’s the Pathology? (1 of 12)

“...if you squint, you can definitely see it...”

Patient AU: What’s the Pathology? (2 of 12)
Patient AU: What’s the Pathology?
(3 of 12)

Patient AU: What’s the Pathology?
(4 of 12)

Patient AU: What’s the Pathology?
(5 of 12)

Patient AU: What’s the Pathology?
(6 of 12)

Patient AU: What’s the Pathology?
(7 of 12)

Patient AU: What’s the Pathology?
(8 of 12)
Patient AU: What’s the Pathology? (9 of 12)

- PLAX
- Very dilated LV, RVOT
- MV opens
- AV opens

Patient AU: What’s the Pathology? (10 of 12)

- MR present
- No AI
Patient AU: What’s the Pathology? (3 of 12)
• EPSS
• Very far away from the septum suggesting low EF

Patient AU: What’s the Pathology? (6 of 12)
• TAPSE 1.2cm suggesting RV insufficiency

Patient AU: What’s the Pathology? (4 of 12)
• PSAX mid-papillary
• EF 7%, global hypokinesis
• Severely Dilated

Patient AU: What’s the Pathology? (7 of 12)
• A4C view
• Severe MR

Patient AU: What’s the Pathology? (5 of 12)
• A4C
• Severely Dilated LV
• Pacing wire seen in RV
• Moderate RV dilation

Patient AU: What’s the Pathology? (8 of 12)
• A2C
Patient AU: What’s the Pathology? (9 of 12)

- A2C
- Severe MR

Patient AU: What’s the Pathology? (10 of 12)

- MR pressure gradient 61mmHg!
- \[4v^2 = 4 \times (3.9)^2 = 61\]

Patient AU: What’s the Pathology? (11 of 12)

- Subxiphoid View

Patient AU: What’s the Pathology? (12 of 12)

- Subxiphoid Great Vessels
- Normal size, < 50% collapse

Patient SD

“I think I can I think I can”
Patient SD: What’s the Pathology? (2 of 15)

Patient SD: What’s the Pathology? (3 of 15)

Patient SD: What’s the Pathology? (4 of 15)

Patient SD: What’s the Pathology? (5 of 15)

Patient SD: What’s the Pathology? (6 of 15)

Patient SD: What’s the Pathology? (7 of 15)
Patient SD: What’s the Pathology? (1 of 15)

- PLAX
- No stenosis of AV/MV
- RV not dilated
- LV not dilated
- Function seems ok-ish

Patient SD: What’s the Pathology? (2 of 15)

- PLAX with color doppler over the valves
- No AI
- Mild MR

Patient SD: What’s the Pathology? (3 of 15)

- No AS

Patient SD: What’s the Pathology? (4 of 15)

- No AS noted
Patient SD: What’s the Pathology? (5 of 15)
- PSAX – Basal
- Hypokinesis of basal inferior

Patient SD: What’s the Pathology? (8 of 15)
- A4C
- RV OK
- No mitral stenosis

Patient SD: What’s the Pathology? (6 of 15)
- PSAX – Midpapillary view
- Good function, EF 65%

Patient SD: What’s the Pathology? (9 of 15)
- A2C
- Hypokinesis of the basal inferior wall

Patient SD: What’s the Pathology? (7 of 15)
- A4C

Patient SD: What’s the Pathology? (10 of 15)
- A4C
- RV still ok
Patient SD: What’s the Pathology? (11 of 15)
- Apical Long Axis
- Basal Inferolateral Hypokinesis

Patient SD: What’s the Pathology? (14 of 15)
- Small IVC with collapsibility with sniff

Patient SD: What’s the Pathology? (12 of 15)
- TAPSE 1.9cm, normal

Patient SD: What’s the Pathology? (15 of 15)
- Small ASD

Patient SD: What’s the Pathology? (13 of 15)
- Subxiphoid view
- Grossly normal

Patient TK
“You have a what?”
Patient TK: What’s the Pathology? (total of 7 slides)

Patient TK: What’s the Pathology? (total of 7 slides)

Patient TK: What’s the Pathology? (total of 7 slides)

Patient TK: What’s the Pathology? (total of 7 slides)

Patient TK: What’s the Pathology? (total of 7 slides)

Patient TK: What’s the Pathology? (total of 7 slides)
Patient TK: What’s the Pathology? (total of 7 slides)

• PLAX
• Dilated RV, poor RV function
• LVAD in place, very dilated LV in place

Patient TK: What’s the Pathology? (total of 7 slides)

• PLAX
• Trace AI
• Mild MR

TK: Explanation

Patient TK: What’s the Pathology? (total of 7 slides)

• Very dilated LV: diameter is 7.4cm!!!

Patient TK: What’s the Pathology? (total of 7 slides)

• PSAX Mid PAP
• Hypokinetic LV
Patient TK: What’s the Pathology? (total of 7 slides)

• A4C
• Poor RV function
• Poor LV function
• RV PPM wire

Patient TK: What’s the Pathology? (total of 7 slides)

• Subxiphoid
• Dilated IVC

Patient TK: What’s the Pathology? (total of 7 slides)

• Subxiphoid
• Poor RV/LV function
• RV PPM wire
Ultrasound Evaluation for Pneumothorax

Tim Tran, M.D.
Assistant Professor
Department of Anesthesiology
University of Colorado - Anschutz Medical Campus

ACGME Program Requirements

- Using transthoracic ultrasound for the detection of pneumothorax and pleural effusion

Incidence of Pneumothorax

- Supraclavicular Regional Block
  - 6.1% (Anatomic, paresthesia), 1962
  - 0% Retrospective review, UCLA
  - 0% prospective Study, Obese and Non-Obese patients, Rush in Chicago
  - 0.06% Clinically Significant Pneumothorax (requiring chest tube)
    - Infracavicular or Supraclavicular Regional Block

Diagnosis: X-ray vs Ultrasound

- Meta-Analysis of Trauma and ICU patients:
  - Ultrasound: Sensitivity 79%, Specificity 98.4%
  - Chest Radiography: Sensitivity 39.8% Specificity 98.4%

- Meta-Analysis of Trauma, Post-Biopsy, Critically Ill Patients
  - Ultrasound: Sensitivity 88%, Specificity 99%
  - Chest Radiography: Sensitivity 52%, Specificity 100%

Probe Placement

- Linear Probe Preferred due to higher frequency (Curvilinear OK)
- Place in 2nd or 3rd Intercostal Space along Mid-Clavicular Line
- Usually a couple of Rib Spaces (for more thorough Examination, go down to diaphragm, and laterally)
Ultrasound findings

- Pleural sliding between 2 ribs: (“Bat-Wing”)
- A-Lines: Horizontal lines indicating normal lung surface
- B-Lines Artifact: Large lines from pleural to end of screen
- “Comet-Tails”: Small lines from pleural little below (artifact)
- Sea-Shore Sign (M-mode)

Normal Lung: B Lines

- Note B Lines that extend from the pleural down to the edge of the screen

Bat Wing: the ribs + pleural = bat?


Editor note: I think it’s a horrible analogy

Normal Lung: M-Mode

- Sea-Shore Sign (M-mode): note the sea shore, looks like sand

Normal Lung: A Lines

Pneumothorax

- Note the lack of lung sliding; the pleural isn’t moving separate from the chest wall.
Normal Lung: M-Mode

http://rebelem.com/ultrasound-detection-pneumothorax/

Pneumothorax: Lung Point

• Note the lung sliding intermittently appears on ultrasound. This is the where the air separates the parietal pleura from the visceral pleura, and hence the visceral pleura does not appear to move – it’s just hiding beneath the air.

https://www.youtube.com/watch?v=P1tRdw2rDcE

Pneumothorax: how to make the diagnosis

• Lack of lung sliding (although other causes, pneumonia, ARDS, fibrosis, Effusions, Contusions)
• Can also see the “Bar code Sign” in M-Mode
• Lack of B-line artifacts (No B-Lines or Comet Tails)
• Visualization of Lung Point (see exactly where lung sliding disappears underneath the air)

References

• C. Kakazu, V. Tokhner, J. Li, R. Ou, E. Simmons: In the new era of ultrasound guidance, is pneumothorax from supraclavicular block a rare complication of the past?, BMJ British Journal of Anaesthesia, Volume 113, Issue 1, 1 July 2014, Pages 190-191.
• Alan Macfarlane, Keith Anderson: Infracavicular brachial plexus Blocks, Continuing Education in Anaesthesia Critical Care & Pain, Volume 9, Issue 9, 1 October 2009, Pages 139-143.
• Wu Ding, MM; Yuehong Shen, MM; Jianxin Yang, MM; Xiaojun He, MM, and Mao Zhang, MD. Diagnosis of Pneumothorax by Radiography and Ultrasonography A Meta-analysis. CHEST 2011; 140(5):1539-88A.
Ultrasound for Lung Parenchyma and Pleural Effusions
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Assistant Professor
Department of Anesthesiology
University of Colorado - Anschutz Medical Campus

ACGME Program Requirements

• Using transthoracic ultrasound for the detection of pneumothorax and pleural effusion

How does it work? A lines

• Normal lung is filled with air: Regularly spaced horizontal lines “A lines” are waves reflected by subpleural air.

How does it work? B Lines

• When there is alveolar collapse, waves are transmitted and reflected deeper from the tissue resulting in long vertical beams; these are called B-lines

How to scan

From: Ultrasound of extravascular lung water - a new standard for pulmonary congestion
Chest 2005; 127:1690–1695

From: Ultrasound of extravascular lung water - a new standard for pulmonary congestion
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AnnalsATS Volume 10 Number 6|December 2013

174
A Lines
- Horizontal reverberations due to back and forth reflections between the ultrasound probe and the pleura
- This is normal

Wide vs Narrow B-lines
- Wide spaced B lines (7mm or more) aka “B7” Lines indicate: subpleural interlobular septa
  - Interstitial Edema
  - Interstitial pneumonia, pneumonitis
  - Fibrosis/Honeycombing (Interstitial Lung disease)

B Lines
- Discrete hyperechoic artifact that extends from the pleural line to the end of the screen
- Moves with respiration
- Images below: normal, B7 (7mm apart) and B3 (3mm apart) – more to follow

Wide vs Narrow B-Lines
- Narrow spaced B lines (3mm or less) aka “B3 Lines”: indicate ground glass opacities
  - Alveolar edema
  - Pneumonia, pneumonitis
  - Atelectasis
  - Pulmonary Contusion
  - Pleural Disease
  - Neoplasia

Z Lines (“Comet Tails”)
- Vertical lines that start at the pleural but do NOT extend through the visual field; usually 2-3 cm
- Can look like B Lines but shorter; these are ok

Spacing can matter
- The variability the spacing of the B lines can matter:
  - Irregular spacing: ARDS, Pneumonia, pulmonary fibrosis can have B lines that bunch together then are slightly wider due to the heterogenic pathology
  - Regular spacing: Cardiogenic pulmonary edema can have B lines which are more regularly spaced and change from dependent to less dependent areas
Commentary

- Findings on parenchymal lung ultrasound must be taken in context of the patient’s overall condition. Because various pathologies can have similar images, other data points must be considered.

Pleural Effusions

- Ultrasound is more sensitive than x-ray for detecting pleural effusions (using CT as the gold standard).

Where to scan?

- The lung is enormous, so you can scan really anywhere. However, in the critically ill patient population, supine (compared to sitting upright) will be more common.

Which probe?

- A variety of probes can be used; microconvex is probably most preferred, followed by curvilinear, then phased array. Often times, when doing a cardiac ultrasound with a phased array, you can just use it to evaluate the pleural space.

![Position of the probe and the marker on the chest wall according to different methods.](image)

Pleural Effusion: 1

- Right pleural effusion: longitudinal view at the sixth intercostal space, along the posterior axillary line, with the patient in a semi-recumbent position. It is possible to observe (from left to right) a small portion of the liver, the echogenic curvilinear diaphragm, and a significant anechoic pleural effusion with associated pulmonary collapse.

Brogi et al. Critical Care (2017) 21:325
Pleural Effusion: 2

- Pleural Effusion + Collapsed Lung

Brogi et al. Critical Care (2017) 21:325

Pleural Effusion: 3

- Massive Hemothorax, can barely see the lung

Size Matters:

Rule of thumb:
- Depth of 4-5cm of a pleural effusion suggests > 1000ml of volume

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February 2016, Pages 39–45
Wednesday, March 4th
**Post Anesthesia Cognitive Dysfunction in the Older Adult**

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Tufts Medical Center & Tufts University School of Medicine

**Disclosures**

**SAGA**

SOCIETY FOR THE ADVANCEMENT OF GERIATRIC ANESTHESIA

http://www.sagahq.org

**Objectives**

- Review the definition, new nomenclature and incidence of Postoperative Delirium and Postoperative Cognitive dysfunction
- Review the risk factors associated to postoperative cognitive disorders in older patients
- Discuss interventions aimed to prevent postoperative cognitive disorders in older patients

**Cognitive dysfunction after surgery and anesthesia The scope of the problem**

- Acute (average incidence of ~35%)
  - Slower recovery = ↑ length of stay, ↑ $$$
  - ↑ morbidity, mortality, ↑ nursing home placement
- Delayed, Prolonged (average incidence of ~17%)
  - ↑ mortality, ↑ social support dependence

- IM physician
  - Review of records of 1193 patients
  - Age 50 years or older
  - Operations under GA
- Mental deterioration in 120 (10%) patients
- Conclusions
  - Cognitive decline related to anesthetic agents and hypotension
  - "Operations on elderly people should be confined to unequivocally necessary cases"
“Classic” TIME FRAME OF Delirium and POCs

Post-Operative Delirium (POD)

- DSM-IV: A change in mental status, characterized by:
  - a prominent disturbance of attention and reduced clarity of awareness of the environment;
  - an acute onset, developing within hours to days, and tends to fluctuate during the course of the day.

No this Delirium!

- Perioperative Neurocognitive Disorder (PND)
  - Postoperative Delirium (POD): DSM-V delirium criteria, occurs in hospital up to 1 week postop or hospital discharge (whichever happens first)
  - Delayed Neurocognitive Recovery (dNCR): DSM-V criteria for mild or major neurocognitive disorder (based upon ADLs), occurs 1-30 days postop
  - Postoperative Neurocognitive Disorder (pNCD): DSM-V criteria for mild or major neurocognitive disorder, occurs 30 days - 12 months postop
Main clinical features

- Acute onset
- Fluctuating course
- Inattention
- Disorganized thinking
- Alteration in consciousness
- Cognitive deficit (memory, orientation, executive functions)
- Hallucinations
- Psychomotor disturbances
- Lethargy (hypoactive delirium)
- Agitation (hyperactive delirium)
- Alterations of sleep-wake cycle
- Emotional disturbances

Factors contributing to POD

- Patient related
  - Cognitive and behavioral Disorders (Cognitive impairment and dementia, pain, depression, ETOH, sleep deprived)
  - Disease related (Severe comorbidities, renal insufficiency, anemia, hypoxia)
  - Metabolic (poor nutrition, dehydration, electrolyte abnormalities)
  - Functional impairment (poor functional status, immobilization, hearing/visual impairment)
  - Other (>70 yo, polypharmacy and psychotropic meds, risk urinary retention/constipation)
- Patient un-related
  - Restrains
  - Catheters
  - Cardiac surgery
  - CNS drugs
  - Sleep deprivation

Preexisting cognitive dysfunction is a significant risk factor for Post op delirium

- Greene NH et al., Measures of executive function and depression identify patients at risk for postoperative delirium. Anesthesiology 2009
- Smith PJ et al., Executive function and depression as independent risk factors for postoperative delirium. Anesthesiology 2009
- Robinson TN et al., Preoperative cognitive dysfunction is related to adverse postoperative outcomes in the elderly. J Am Coll Surg 2013

Cognitive Reserve and Postoperative Delirium in Older Adults

Amanda Tow, Rose Holtzer, PhD, Cullenling Wang, PhD, Alok Sharan, MD, Sun Jin Kim, MD, Abaron Gladstein, MD, Yousef Blum, MD, and Joe Verghese, MBBS

Prospective observational, orthopedic patients

- Proxys for cognitive reserve included early life and late life (reading, knitting, email, computer games)
- CAAA and MDAS at 22 hrs and 32 hrs
- Late life cognitive reserve decreased incidence and severity of POD
- The more the better, each activity lowered POD risk by 8%
133 patients with baseline frailty assessments
- Non-frail patients: 13% delirium incidence
- Pre-frail and frail patients: 48% delirium incidence
- Frail patients were also at higher risk for the secondary outcome of greater decline in cognition from baseline to 1 month, but not baseline to 1 year, after surgery

Hughes et al. A&A Jan 2020

Anesth Analg 2019;129:507-14

Preoperative screening for dementia or other pre-existing cognitive impairment using a formal measurement scale


Table 3. Precipitating Factors Associated With Postoperative Delirium

<table>
<thead>
<tr>
<th>Intraoperative</th>
<th>Postoperative</th>
<th>Medication Exposure</th>
</tr>
</thead>
<tbody>
<tr>
<td>Surgical severity</td>
<td>Anemia</td>
<td>Benzodiazepines</td>
</tr>
<tr>
<td>Surgical duration</td>
<td>Pain</td>
<td>Dohexalhydroxine</td>
</tr>
<tr>
<td>Surgical approach</td>
<td>Sleep disturbances</td>
<td>Scoflamine</td>
</tr>
<tr>
<td>Cardiovascular</td>
<td>Proximal</td>
<td>N-adrenaline</td>
</tr>
<tr>
<td>Hypothermia</td>
<td>Hypoxia</td>
<td>Suxamethem</td>
</tr>
<tr>
<td>Depth of sedation/</td>
<td>Mechanical</td>
<td>Midazolam-naeceptor</td>
</tr>
<tr>
<td>burn injury</td>
<td>ventilation</td>
<td>Antagonism</td>
</tr>
</tbody>
</table>

Hughes et al. A&A Jan 2020

Pathophysiology

Mantz, Jean. Case Example: Perioperative Delirium in Elderly Surgical Patients
Anesthesiology. 112(1):189-189, January 2010

Copyright International Anesthesia Research Society.
**Impact of Delirium**
- Morbidity
- Risk of injury
- CV/neurological events
- POCD after ICU delirium
- Mortality
- Loss of autonomy
- Increased LOS
  - 6.0 days vs. 4.6
- Nursing home placement
- Health Care costs
  - Average additional cost $3000

**Prevention and Management**
- Identification patient at risk
  - Baseline cognitive impairment
  - Mini-mental Exam
  - DEAR Score (Age, cognition, ADL’s, hearing/visual impairment, chemical use)
  - Dementia/depression
  - Family
  - Consider Geriatric consultation
- Avoid/minimize/treat Delirium related factors
  - No definitive evidence about anesthetic agents or anesthesia type technique minimizing PDD
  - No definitive evidence of using EEG (but controversial)
  - No definite evidence of pharmacological prophylaxis preventing PDD
- Hospital Elder Life Program

**Diagnosis: CAM-ICU**

Acute onset of mental status changes or a fluctuating course

And

Inattention

Plus

Disorganized Thinking or Altered Level of Consciousness

**Postoperative delirium screening using a formal measurement scale**

**Modified Hospital Elder Life Program: Effects on Abdominal Surgery Patients**

- Modified HELP in elderly patients after elective abdominal surgery
- Interventions:
  - Early mobilization (ambulation or active ROM exercise 3 x daily)
  - Nutritional assistance
  - Cognitive activities 3 x daily (orientation and stimulating activities, such as discussing current events or word games)
  - No postop delirium in intervention group (n = 172) 16.7% in the historical control group (n = 77)
Management

- Seek/treat cause
- Medical issues a frequent cause of Delirium

Hyperactive Delirium
- Haloperidol
- Atypical antipsychotics
- Avoid Benzodiazepines

PREVENTION AND MANAGEMENT OF POST-OP DELIRIUM

<table>
<thead>
<tr>
<th>Preoperative</th>
<th>Perioperative</th>
<th>Postoperative</th>
</tr>
</thead>
<tbody>
<tr>
<td>- Cognitive and Behavioural Disorders (Mini-Cog)</td>
<td>- Review delirium assessment</td>
<td>- Postoperative intervention</td>
</tr>
<tr>
<td>- Medical issues</td>
<td>- Causation</td>
<td>- Return Dental, Hearing aids, glasses</td>
</tr>
<tr>
<td>- Metabolic</td>
<td>- Regional anaesthesia</td>
<td>- Avoid delirium-causing drugs (mostly benzodiazepines, anticholinergics)</td>
</tr>
<tr>
<td>- Functional impairment</td>
<td>- Avoidance</td>
<td>- Postoperative intervention</td>
</tr>
<tr>
<td>- Other</td>
<td>- Avoidance of causes of delirium</td>
<td>- Nursing interventions</td>
</tr>
<tr>
<td>- Medical consult</td>
<td>- Avoidance</td>
<td>- Avoid delirium-causing drugs (mostly benzodiazepines, anticholinergics)</td>
</tr>
<tr>
<td>- Pain (Levels of Socioeconomic deprivation)</td>
<td>- Avoidance</td>
<td>- Postoperative intervention</td>
</tr>
</tbody>
</table>

Delirium Free passport. ©Ruben Azocar

Hughes et al A&A Jan 2020
Delayed neurocognitive recovery (dNCR) and disorder (dNCD) AKA POCD

- Deterioration of intellectual function presenting as impaired memory or concentration
- Not detected until days or weeks after anesthesia
- Duration of several weeks to permanent
- Diagnosis is only warranted if:
  - corroborated with neuropsychological testing
  - evidence of greater memory loss than one would expect due to normal aging
  - this is a challenge in the literature

Pre-existing cognitive impairment, a risk factor

- Two similar studies
- In patients presenting for elective hip joint arthroplasty, 32% had previously unidentified preoperative cognitive impairment Silber et al. Anesthesiology 2018
- 340 patients aged >50 yr having coronary angiography, 51.7% had previously unidentified mild cognitive impairment (MCI). Scott et al. 2018; J Am Heart

Implications of dNCR and dNCD (POCD)

- Abrupt decline in cognitive function heralds:
  - Loss of independence
  - Withdrawal from society
  - Leaving the labor market prematurely
  - Dependency on social transfer payments
  - Death


POCD Incidence

Long-term postoperative cognitive dysfunction in the elderly: ISPOCD1 study

- Collaborative research effort:
  - Members from 8 European countries and USA
  - 13 hospitals
  - Research conducted from 1994 - 1996

ISPOCD1

- POCD occurred in 26% of patients at one week after surgery and in 10% of patients at three months after surgery
  - This data suggests that anesthesia and surgery can cause long-term POCD
- Increasing age, duration of anesthesia, little education, a second operation, perioperative infections and respiratory complications were risk factors for early POCD, but only age was for late POCD
- Hypotension and/or hypoxemia not related to occurrence of POCD

Cognitive Reserve Threshold Theory for Cognitive Decline

A: Protective factor (greater brain Reserve Capacity) no impairment
B: Vulnerability factor (less brain reserve capacity), impairment

Satz Neuropsychology 1993; (7):273.
A Prospective Study Evaluating The Relationship Between Age and POCD

- Single site - University of Florida: 1999 - 2002
- 1200 patients undergoing elective surgery
  - Young - 18 to 39 years of age
  - Middle-aged - 40 to 59 years of age
  - Elderly - 60 years and older
- Controls - primary family members
- Study design identical to ISPOCD study
  - Same psychometric test battery
  - Outcome Endpoints:
    - POCD (primary) and mortality (secondary)

Monk, T et al. Anesthesiology. 2008

Results

- POCD
  - Common in all age groups at discharge (33-44%)
  - 3 months after surgery the POCD incidence was:
    - 4-5% in those younger than 65
    - 13% in adults older than 60 years particularly on those with lower educational achievement
  - Associated with increased one-year mortality

Consent

- Consensus: ALL patients over age 65 years should be informed of the risks of PND including confusion, inattention and memory-problems after an operation.

- WHY?
  - PND is orders of magnitude more common than other risks patients are consented for related to surgery and anesthesia.
  - Consent includes other risks we do not currently have the ability to prevent in all cases
  - Educating patients and families sets realistic expectations, and can facilitate planning/risk management

Regional vs. GA and dNCR

- It sounds intuitive that Regional anesthesia might have different implications for cognitive outcomes vs. GA, but clinical data do not support this hypothesis
  - Decreased pulmonary complications
  - Sympatholytic effects: decreased blood loss, decreased risk of DVT
  - Analgesia in immediate postoperative period
  - But no change on cognitive outcomes
- The studies have important limitations: many are older, are limited to neuraxial anesthesia, and are confounded by the fact that patients also received high doses of I.V Sedatives.
Consent

► Who?
  ► Ideally both Surgeon and Anesthesiologist:
  ► Both surgery and anesthesia believed to contribute to PND
  ► Promotes ‘multidisciplinary’ team care and joint decision making for older patients (recognizes PND can be a long term complication)

► When?
  ► Ideally well in advance of surgery
  ► This is a major challenge!

Preoperative provision of information to patient or family regarding the risk of developing delirium or other cognitive disorders after surgery


Pre-op Neurocognitive Assessment

► Consensus: Baseline cognition should be objectively evaluated with a brief screening tool during preoperative evaluation in ALL patients over the age of 65 and in any patient with risk factors for pre-existing cognitive impairment.

► Why?
  ► Cognitive capacity is important for informed consent
  ► We assess numerous other organ systems prior to OR
  ► Risk stratification

Feasibility and Rationale for Incorporating Frailty and Cognitive Screening Protocols in a Preoperative Anesthesia Clinic

A&A 2019;129:830-838

Frailty and cognitive impairment in predicting mortality among oldest-old people. Qulei He, Bingle Ding, Ming Yang, Biao Ding and Yaqun Wei

► Out of 705 participants. Prevalence of frailty was 63.7%, Cognitive impairment was 74.2%, and the
  Frailty Prevalence + Cognitive impairment = 50.3%.

► Combined frailty and cognitive impairment was associated with increased risk of death (age, gender, education level, and other potential confounders adjusted);
  Hazard ratio was 2.13 (95% confidence interval 1.39, 3.24)
Intraoperative management

- Consensus: Anesthesiologists should:
  - Monitor age-adjusted end-tidal MAC fraction
  - Strive to optimize cerebral perfusion (avoid relative hypotension)
  - And perform EEG-based anesthetic management in older adults. (Further research is needed to evaluate and compare specific brain function monitors, methods and approaches)
  - In addition:
    - Maintain normothermia
    - Avoid certain drugs

Can pre-op cognitive training help?

- Cognitive training at 6-10 weeks postop showed attention and memory benefits following CABG de Tournay-Jetté E et al. J Behav Med. 2012
- 3 hours of preoperative cognitive pneumonic skill training decreased postop cognitive dysfunction in elderly patients after major GI surgery (Sanfilippo et al. AMJ Med 1995)
- Preop environmental enrichment can mitigate adverse effects of anesthesia and surgery on postop cognitive function in aged animals. (Kawano T et al. Anesthesiology 2015)

Postoperative follow up and management

- Consensus: More studies are needed to evaluate the efficacy, feasibility and cost-effectiveness of various strategies to assess short- and long-term cognitive outcomes after hospital discharge, to optimally manage these disorders, and to clarify who should follow patients after surgery for these disorders and what patients should be told about the current understanding regarding recovery from these disorders.

### Table 3: Medications Commonly Avoided by Anesthesiologists That Should Be Averted or Used With Caution to Alleviate Postoperative Delirium

<table>
<thead>
<tr>
<th>Medication or Class of Medication</th>
<th>Examples</th>
<th>Reasons for Avoiding</th>
</tr>
</thead>
<tbody>
<tr>
<td>Halogenated anesthetics</td>
<td>Isoflurane, Propofol, Ketamine</td>
<td>Central anticholinergic effects, CNS depression</td>
</tr>
<tr>
<td>Nondepolarizing muscle relaxants</td>
<td>Vecuronium, Pancuronium</td>
<td>Risk of postoperative ileus, paralytic ileus</td>
</tr>
<tr>
<td>Antidepressants</td>
<td>Amitriptyline, Nortriptyline</td>
<td>Risk of postoperative ileus, paralytic ileus</td>
</tr>
<tr>
<td>Benzodiazepines</td>
<td>Midazolam, Zolpidem</td>
<td>Risk of postoperative ileus, paralytic ileus</td>
</tr>
<tr>
<td>Selective serotonin reuptake inhibitors</td>
<td>SSRIs</td>
<td>Neuronal effects, neuroplastic effects</td>
</tr>
<tr>
<td>Selective norepinephrine reuptake inhibitors</td>
<td>SNRIs</td>
<td>Neuroplastic effects, neuroplastic effects</td>
</tr>
</tbody>
</table>

Randomized controlled trial

**Intervention:**
- Daily preoperative cognitive training battery (BrainHQ, Post Science)
- Specifically targets attention, working memory, and visuospatial processing (Briand, Post Science Corporation, San Francisco, CA)

**Primary Outcome:**
- % of Delirious patients (vs non interventional group)

**Secondary Outcomes:**
- Cognitive Function (Attention, focus, memory, brain processing speed), Hospital LOS, Length of ICU stay, Physical Therapy

**Feasibility data:**
- Most common reasons for declining enrollment were lack of computer access (n=19), time commitment (n=9), and feeling overwhelmed (n=9).
- In the training group, only 5 of 29 (17%) included patients were able to complete the prescribed 7 days of training, and 14 of 29 (48%) opted out of training once home.
- Most common reasons were feeling overwhelmed (n=4) and computer difficulties (n=3).
**Prevention of Early Postoperative Decline**

*Objective:* to determine whether using a brain training program in the time leading up to as well as after heart surgery will reduce confusion and cognitive loss that can occur after surgery.

*Intervention:* use of a neurocognitive training program (Lumosity) for 10 days preoperatively, and then for four weeks postoperatively.

---

**Prevention of Early Postoperative Decline: A Randomized, Controlled Feasibility Trial of Perioperative Cognitive Training.**

- 45 pts. age 60-90 undergoing cardiac surgery at least 10 days from enrollment
- Feasibility was evaluated by enrollment patterns and adherence to protocol
  - Sixty-five percent of eligible patients were enrolled
  - Declining pts most commonly cited: time commitment (21%), lack of interest in the research study (21%), or no desire to use an iPad (17%)
  - Median interquartile range adherence (as % of prescribed minutes played) was:
    - Preoperatively 39% (20%-68%), Immediately postop, 6% (0%-37%), and 19% post-discharge (0%-56%)
- POD and POCD were assessed using the CAM and the Montreal Cognitive Assessment
- POD incidence: CT group 5/20 [25%] versus control 3/20 [15%]; P = .69
- POCD incidence: CT group 53% versus control 37%; P = .33

---

**Brain Health Initiative: A New ASA Patient Safety Initiative**

Support research
Develop support material for patient and providers
Convene stakeholders for the implementation of strategies to prevent POD
Conclusions

- Perioperative Cognitive Disorders are common and have significant impact in outcomes and healthcare costs
- There are now concrete recommendations to minimize/prevent PCD
- Cognitive Pre-habilitation has failed so far due to enrollment issues
- ASA Brain Health initiative a good resource for patients and patients
Liability in Anesthesiology: Lessons Learned from Closed Claims

Karen B. Domino, MD, MPH
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Department of Anesthesiology & Pain Medicine
Professor of Neurologic Surgery (Adjunct)
University of Washington, Seattle
kdomino@uw.edu
No financial disclosures

Objectives
1. Describe causes of anesthesia-related injuries and trends in anesthesia liability
2. Cite contributors to malpractice claims after an adverse event
3. Discuss how to reduce liability after an adverse event

General findings
• Situational awareness
• Difficult intubation
• Communication failures affecting liability
• Communication after an adverse event

Overview

Types of Anesthesia Management

Most Common Complications

Most Common Damaging Events
Injuries by Type of Anesthesia in Surgical and OB Claims 2000 or later

- MAC (n=286)
- General (n=1671)
- Regional (n=384)

% of claims

<table>
<thead>
<tr>
<th></th>
<th>Death</th>
<th>Permanent Nerve Injury</th>
</tr>
</thead>
<tbody>
<tr>
<td>MAC</td>
<td>*</td>
<td>*</td>
</tr>
<tr>
<td>General</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Regional</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

*p<0.001 compared to Regional

N=11,036

Trends in Death and Brain Damage

% Death or Severe Brain Damage in Year

- 1970-76: 73%
- 1977-78: 36%
- 1979-80: 36% - 38%
- 1981-82: 41% - 52%
- Avg. = 46%

Frequency and Type of Situational Awareness Errors Contributing to Death and Brain Damage

A Closed Claims Analysis

Christian M. Schulz, M.D., Amanda Burden, M.D., Karen L. Pozner, Ph.D., Shawn L. Mincer, M.S.W., Randolph Steadman, M.D., Klaus J. Wagner, M.D., Karen B. Domino, M.D., M.P.H.

What We Already Know About This Topic

- Anesthesiology has been lauded as an industry leader in patient safety; however, preventable deaths still occur.

What This Tells Us That Is New

- Situational awareness errors resulting in death or brain damage remain prevalent causes of malpractice claims in the 21st century.

Human Factors Skills

- Situational Awareness
- Decision Making
- Communication
- Leadership & Teamwork
- Workload Management
- Patient Safety

Commander and leadership of stricken destroyer Fitzgerald to be relieved for collision

Washington – The skipper of the USS Fitzgerald and two top sailors from the ship’s leadership team will be relieved for losing “situational awareness” in the hours leading up to a fatal June collision that left seven sailors dead, the service’s deputy chief said Thursday.
Anesthesia Situational Awareness Errors

SA errors contributed directly to death or brain damage in 74% of 266 claims (kappa=0.694)

Inadequate Perception: Unaware of Critical Information

- Failure to gather information via:
  - History and/or physical exam
  - Diagnostic tests or imaging
  - Monitors - including failure to monitor
- Unaware of:
  - Actions of other team members
  - Equipment function or problems
- Hidden information
  - Visual barrier (drapes)

Most Common Damaging Events in Claims with Situational Awareness Errors (n=198)

- Inadequate ventilation/oxygenation 24%
- Difficult intubation 11%
- Pulmonary aspiration 10%
- Hemorrhage 10%
- Equipment 7%
- Medication 7%
- Regional block 2%

Inadequate Comprehension

- Failure to understand the significance of information
  - Information was misunderstood (e.g., ET CO₂=0)
  - Failure to make correct diagnosis
  - Failure to comprehend the cause and meaning of information (e.g., treat hypotension, fail to treat cause)

Inadequate Projection

- Failure to forecast future events when situation is understood
  - Poor planning for future events
  - Poor anesthetic plan
  - Poor or absent back-up plan

Situational Awareness

- Inadequate perception
  - What is the information?
- Inadequate comprehension
  - What does this mean?
- Inadequate projection
  - What is likely to occur?
Conclusions re Situational Awareness

- Situational awareness errors are common
- Situational awareness is enhanced by teamwork and simulation:
  - Communication (role clarity, information sharing)
  - Mutual support (call for help, checklists)
  - Leadership (briefs, huddles, shared mental models)

102 difficult intubation events 2000 and later
- Compared to 93 events 1993-1999
- Patients sicker (78% ASA 3-5)
- More emergency surgeries (37%)
- More in non-periop locations (23%)

“Can’t Intubate- Can’t Oxygenate”

Outcomes in Difficult Tracheal Intubation Claims Over Time

Timing of Periop Difficult Intubation 2000-2012 (n=79)

Current Difficult Airway Management—Not Good Enough!

“Iit is time for us to lift standards in crisis management for airway difficulties through a more rigorous approach to training, certification, and equipment availability…”
Contributors to Malpractice Claims after an Adverse Event

- Communication issues: 80%
- Physician attitudes: 35%
- Failure in communication: 35%
- Providers blame previous care: 7%
- Unrealistic patient expectations: 5%


Reasons Patients Sue

- Seek answers providers don’t give
- Billing disputes
- Feel details are missing or not truthful
- Emotional and financial desperation
- React to your actions

Goldsmith LS. Medscape Oct 23, 2018

Malpractice Claims after Adverse Outcome

- Poor relationship between patient and provider
- Expense/fee arrangements
- Patient expectations for compensation

Types of Liability-Related Communication Failures

- Informed Consent: 35%
- Inadequate Documents: 29%
- Poor Witness: 28%
- Post Event: 15%
- Finger Pointing: 8%
- Altered/False Records: 6%

Posner et al.: Anesthesiology 2017; A3099

Informed Consent Issues in Closed Claims

- Block complications: 48%
- Equipment complications: 20%
- GA complications: 14%
- Positioning complications: 12%
- Other: 6%

n=65 informed consent failures
Informed Consent in Reasonable Patient Standard

- Disclosure of risks/benefits/alternatives
- Risks important to patient in decision
- “Material” risks
  - Common complications
  - Rare, but severe, risks

Disclosure of Risks of Regional Anesthesia

- 79 respondents from 12 regional fellowship programs
- Neuraxial block
  - Headache
  - Local pain/discomfort
  - Infection
- Peripheral nerve block
  - Transient neuropathy
  - Local pain/discomfort
  - Infection
- 20% or less disclosed severe complications

Brull et al. Reg Anesth Pain Med 2007; 32; 7-11

Documentation of Informed Consent

- Signed surgical consent form/verbal consent for anesthesia
- Separate anesthesia signed consent form
- Web-based consent
- Tailor risk discussion to patient-INDIVIDUALIZE
- Do not use medical jargon
- Document specific risks in medical record
- Signature does not guarantee understanding or protection against liability

Types of Liability-Related Communication Failures

- n=185 Failures
- % of claims
- Informed Consent
- 35%
- Inadequate Documents
- 29%
- Poor Witness
- 28%
- Post Event
- 15%
- Finger Pointing
- 8%
- Altered/False Records
- 6%

Types of Liability-Related Communication Failures

Cardiac Arrest During Hip Surgery

- 58 y.o. ASA 3 man
- Bupivacaine epidural
- Cardiac arrest-45 min
- O₂ saturation 75-80%
- Fat embolism
- No notes re drugs, activities
- Times off in addendum vs. code records

Common Documentation Problems in Closed Claims Database

- Preop eval (including airway)
- Informed consent (special risks)
- Anesthetic management details
  - Airway, block, eyes, lines, positioning
  - Monitoring failures/discrepancies
  - Intraop adverse events management
  - Writing “no complication” when one occurred
**Good Documentation Practices**

- Write or type legibly.
- Remove artifacts or document as an artifact.
- Document additional patient care monitoring.
- Document fluids, EBL, UO at regular intervals.
- Document all medications.
- Document specific surgical requests.
- Describe details/sequence of adverse events.
- Document patient/family visits.

**Types of Liability-Related Communication Failures**

- Informed Consent: 35%
- Inadequate Documents: 29%
- Poor Witness: 28%
- Post Event: 15%
- Finger Pointing: 8%
- Altered/False Records: 6%

n=185 Failures

Posner et al.: Anesthesiology 2017; A3099

**Communication assumes special importance when things go wrong.**

**Characteristics of Good Defendants**

- Not too old
- Board certification
- Professional and pleasant
- Composure under stress
- Offer clinical and evidence-based explanations
- Knowledgeable re literature and current practice
- Non-technical language

**Responses After an Adverse Event**

- Debrief with surgeon in OR first
- Accompany surgeon to discuss with family
- Empathetic communication
- Do not speculate re causes
- Family most concerned with immediate care
- Describe follow-up process
- Contact risk management, malpractice insurer
- Disclosure, communication, resolution processes
Disclosure After Adverse Event

- Process/Performance Improvement
- Rapid Response
- Report
- Investigation
- Open Communication

Domino’s Recommendations: How to Avoid Lawsuit

- Don’t be a jerk
- Good communication
- Informed consent
- Thorough documentation
- Witness preparation
- Error disclosure

Communication and Resolution Programs Reduce Malpractice Costs

- University of Michigan Health System
- “3Rs” program at COPIC-Colorado
- University Illinois, Chicago
- Veterans Affairs
- Washington State
- Disclosure
- Compensation

Summary

1. Trends in closed claims
2. Situational awareness, difficult intubation
3. Communication factors affecting liability
4. Communication and resolution process

The Disclosure of Unanticipated Outcomes of Care and Medical Errors: What Does This Mean for Anesthesiologists?

- Disclosure is a process
- Involve/consult “disclosure coach”
- Patient-centered approach to disclosure
- Careful collaboration between all stakeholders

Souter KJ & Gallagher TH: Anesth Analg 2012;114:615-21
Ultrasound-Guided Regional Anesthesia Workshop

Kyle Marshall, MD
CRASH 2020

DISCLOSURE

There are NO disclosures for any faculty participating.

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Inge Tamm-Daniels, MD
Jillian Vitter, MD
Chris Ciarallo, MD
Roland Flores, MD

Principles of Regional Anesthesia

Before you Block:

- Know how to manage Local Anesthetic Toxicity!
- Know your anatomy - targets and danger spots
- Position your patient to optimize view and ergonomics
- Optimize picture (depth/gain)
- Use in-plane view when possible
- Don’t advance needle if unsure of position
- Aspirate before you inject, inject incrementally
- Paresthesia, painful or difficult injection? Pull back, re-direct
- Know what successful LA spread looks like

Ultrasound Basics

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

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

Ultrasound Basics

- Depth
  - Find ideal depth!
  - Use as little depth as needed for a block
  - Improves image
- Deeper the structure, worse the picture
- If deeper than 5cm, consider curvilinear
Ultrasound basics

- Gain:
  - Amplifies returning sound waves, to make signal brighter or darker
  - Newer machines are optimized

- Too little
- Too much

Ultrasound Basics

- First: Gel is your friend, it is required to see anything
- Second: Hold your probe, support your hand on the patient
- Third: Small movements are better than big movements

- Find your favorite view, and stick with it!
  - Only small changes in anisotropy
  - Anisotropy: probe stays in same place, rock it slightly to change view

- Don’t chase your needle!
  - Improve needle placement
    - So that changes in anisotropy will make it visible
  - Look at your hands, before the screen
  - Practice!

Format for CRASH 2020

- Basic
  - Interscalene/Supraclavicular, TAP, Adductor, Popliteal/iPACK

- Advanced
  - Infraclavicular, Paravertebral, Fascia iliaca/Femoral
  - Advanced Plane Blocks: PECs, Erector Spinae, Serratus Ant.

- LESS Lecture, MORE demonstration.
- 9 stations with models
- Blue Phantom/needle station for practice!
  - If you are beginner, this is a great place to start!

Thank you to our Vendors!!

- Mindray: Rob Kimbrough
- Philips: Aaron Rhoades, David Tamberlin
- Sonosite: Kristi Howe

BEER & WINE - END @ 1630!

I’m really just in it for the apres ski beers and outdoor hot tub.
Overview . . .

- Anesthetic neurotoxicity summary and update
- Pediatric Opioid Stewardship
- “New” Blocks on the Kid

Liam is 2 years old . . .

- Sleep disordered breathing
- Presenting for T&A
- Mom asks: “How will anesthesia impact Liam when he begins school?”

FDA Drug Safety Communication . . . 2016/17

Health care professionals should balance the benefits of appropriate anesthesia in young children and pregnant women against the potential risks, especially for procedures that may last longer than 3 hours or if multiple procedures are required in children under 3 years. Discuss with parents, caregivers, and pregnant women the benefits, risks, and appropriate timing of surgery or procedures requiring anesthetic and sedation drugs.
Animal Evidence . . . What do we know?

- Anesthetic/sedative exposure
- Altered neural & glial activity
- Altered cognitive & behavioral development

Animal Evidence . . . Controlling homeostasis

- Damage still occurs!

Animal Evidence . . . Timing vs Duration

- Vulnerable Time
- Amount of Exposure

Animal Evidence . . . What do we know?

- Anesthetic/sedative exposure
- Altered neural & glial activity
- Altered cognitive & behavioral development

Inhaled AND IV agents

Limitations of Animal Studies . . .

1. Healthy animals
2. No painful/surgical stimuli

Conclusion from Animal Studies . . .

- Neurons and glial cells are vulnerable
- May correlate with cognitive and emotional impairment
Notable challenges with clinical studies...

- Stage of development?
- Duration or threshold?
- Neurodevelopmental outcome?

Academic Performance Primary Outcome...

- Number of studies: 12 (2009 - 2017)
- Study size range: 100 - 159,000+
- Age range of anesthesia exposure: < 12 mo - 12 yrs
- Age at academic assessment: 5 - 18 years old

Adapted from Davidson et al. Anesthesiology 2018; 128:840-53

Academic Performance Primary Outcome...

- “evidence of a very small difference”
- Increased risk is less than other factors
- Insufficient power to determine risk of multiple exposure
- “Best studies” showed no difference

Adapted from Davidson et al. Anesthesiology 2018; 128:840-53

Developmental/Behavioral Diagnosis Primary Outcome...

- Number of studies: 10 (2009 - 2017)
- Study size range: 100 - 109,000+
- Age range of anesthesia exposure: ≤ 1yr - 4 yrs
- Age at diagnosis: 5 - 18 years old

Adapted from Davidson et al. Anesthesiology 2018; 128:840-53
Clinical Diagnosis Primary Outcome . . .

- Increased risk of behavioral or learning disability diagnosis
- Risk is greater with multiple exposures

Neuropsychologic Testing Primary Outcome

<table>
<thead>
<tr>
<th>Number of studies</th>
<th>8 (2014 - 2018)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Study size range</td>
<td>28 - 3000+</td>
</tr>
<tr>
<td>Age range of anesthesia exposure</td>
<td>≤ 60 wks PCA - 4 yrs</td>
</tr>
<tr>
<td>Age at time of testing</td>
<td>6 - 11 years old</td>
</tr>
</tbody>
</table>

Adapted from Davidson et al. Anesthesiology 2018; 128:840-53

Conclusions from Clinical Studies . . .

- Very limited data in kids exposed > 3 yo
- Limited data on a “safe” duration
- Single relatively short exposures not associated with increased risk
- More studies are needed
IN THE SETTING OF SINGLE, SHORT (< 60 MIN) EXPOSURE

PubMed Search: “Opioid Crisis or Epidemic”
345,886
1/1/2017 – 12/31/2019!

13,052 poisonings
† 165%
1–4 yo: † 205%
15–19 yo: † 176%

Opioid Stewardship
Opioid Free

Opioid Sparing

Adequate pain control is essential to recovery
- Long-term effects of persistent postsurgical pain
- Does intraoperative opioid exposure lead to long-term abuse?

- Appropriate opioid use
- Appropriate education
- Knowledge of pain trajectories

- Opioid preparations
- Titration parameters
- Delivery systems (i.e., PCA)

Pediatric Anesthesia. April 2019

JAMA Pediatrics 2016; 170(12): 1195-1201
- Non-opioid medications
- Regional anesthesia
- Non-pharmacologic

- Codeine & tramadol
- Co-prescription with other sedatives
- One size DOES NOT FIT ALL

- Highest pain scores → ED and morning of POD 1
- ↓ Pain and opioid use by POD 3
- < 25% of prescribed opioid was used

"Every opioid prescription to a pediatric patient should be viewed as a prescription to the family"
Opioid Stewardship Summary . . .
- Opioids are NOT a looming danger
- Multimodal analgesia
- Thoughtful Opioid prescribing
- Education, education, education

Multimodal Analgesia
- Non-opioid medications
- Regional anesthesia
- Non-pharmacologic

“New” Blocks on the Kid
- Quadratus lumborum (QL)
- Erector Spinae Plane (ESP)
- Pudendal Nerve

Quadratus Lumbarum (QL)
- Single injection → supra- & infra-umbilical
- Potential for visceral analgesia
- Longer duration of action

Quadratus Lumbarum (QL) - Anatomy

<table>
<thead>
<tr>
<th>Quadratus Lumbarum (QL)</th>
<th>QLB1 (Lateral)</th>
<th>QLB2 (Posterior)</th>
<th>QLB3 (Anterior)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Injection Site</td>
<td>Lateral to QL</td>
<td>Posterior to QL</td>
<td>Anterior to QL</td>
</tr>
<tr>
<td></td>
<td>(btn QL &amp; PM)</td>
<td></td>
<td>(btn QL &amp; PM)</td>
</tr>
<tr>
<td>Coverage</td>
<td>T7-L1</td>
<td>T7-L2</td>
<td>T6-L2</td>
</tr>
<tr>
<td>Indications</td>
<td>Abd surgery</td>
<td>Abd surgery</td>
<td>Abd surgery</td>
</tr>
<tr>
<td></td>
<td>below umbilicus</td>
<td>above or below</td>
<td>above or below</td>
</tr>
<tr>
<td></td>
<td></td>
<td>umbilicus to</td>
<td>umbilicus to</td>
</tr>
<tr>
<td></td>
<td></td>
<td>~T6</td>
<td>~T6</td>
</tr>
</tbody>
</table>
Fewer patients in the QL group required analgesia in the first 24 hrs
- Mean FLACC pain scores post-op were lower in QL group
- Parent satisfaction was “higher” in QL group → 9 vs 8.32

- Simplicity and safety
- Extensive, multidermatomal sensory blockade
- Amenable to catheters

QL group used less post-operative fentanyl in the first 24hrs
- Similar pain scores and nausea post-op in both groups
US-guided ESP block at case end → 14 mL 0.5% bupivacaine
Post-op analgesia: metamizole, acetaminophen
Only mild pain reported 32 hrs post-op

US-guided Pudendal block

¬ US-guided ESP block at case start → 0.2 mL/kg of 0.25% bupivacaine
¬ Post-op analgesia: single dose of acetaminophen 18hrs postop

Pudendal block . . . Benefits
¬ Numbs genitalia . . . Urology etc
¬ Lasts longer than caudal
¬ Legs can still wiggle
¬ Pretty easy to perform

Pudendal block . . . Practical notes
¬ LA dosing: 0.2 mL/kg per side (0.2% ropivacaine or bupivacaine
¬ Not a practical location for nerve catheter placement
¬ Clinicians should be cautious with caudal blocks in these patients
¬ 395 hypospadias repairs
¬ Caudal associated with 13-fold ↑ in surgical complication
¬ Only mild pain reported 32 hrs post-op
Pudendal group . . .
  a. Lower post-op pain scores
  b. Greater duration of pain control
  c. Greater family satisfaction

Regional Anesthesia and Pain Medicine.
2016, 41(5): 610-615

Pudendal block group . . .
  1. Lower post-op pain scores
  2. Zero additional analgesics

“New” Blocks on the Kid
  ❖ Quadratus lumborum (QL)
  ❖ Erector Spinae Plane (ESP)
  ❖ Pudendal Nerve

IN THE SETTING OF SINGLE, SHORT (< 60 MIN) EXPOSURE

Thank You!
Objectives

1. Discuss complications and anesthetic concerns in spine surgery.
2. Describe practice improvements to improve safety in spine surgery.
3. Identify the effects of anesthetic drugs and hypotension on evoked potentials.
4. Describe ERAS pathways for spine surgery.

Overview

- Spine surgery safety
  - Major complications
  - Anesthetic complications
- Practice improvements
  - Risk assessment/patient selection
  - Patient preparation
  - Surgical/anesthesia advances
  - ERAS pathways

Major Complications and Mortality After Surgery for Lumbar Stenosis

Deyo et al.: JAMA 2010; 303:1259-65
• Retrospective cohort study from VA Health System
• Noncardiac surgery 1999-2014 (spine surgery subset)
• 704,901 patients (spine: 56,285 [8%] patients)
• NSQIP outcomes
  • Morbidity & mortality
  • “Failure to rescue”

Massarweh NN et al.: JAMA Surgery 2016;151:1157-65

30-Day Outcomes

Blood Flow to Optic Nerve

Positioning Concerns

• Brachial plexopathy
  • Head in neutral position
  • Arm position
  • Head holder
  • Eye checks

Decreased O₂ Delivery to Optic Nerve

- MAP
- Hb
- Vascular disease
- Vasopressors
- Abnormal autoregulation
- Emboli
Compartment Syndrome of the Optic Nerve

Optic Nerves Entering Optic Canal

MULTIVARIATE STAGE 4 MODEL
Potentially Modifiable Intraop Management Factors for Ischemic Optic Neuropathy

<table>
<thead>
<tr>
<th>Factor</th>
<th>OR (95% CI)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Male</td>
<td>2.53 (1.35-4.91)</td>
</tr>
<tr>
<td>Obesity</td>
<td>2.83 (1.52-5.39)</td>
</tr>
<tr>
<td>Wilson frame</td>
<td>4.30 (2.13-8.75)</td>
</tr>
<tr>
<td>Anesthesia hrs (OR per 1 hr)</td>
<td>1.39 (1.22-1.58)</td>
</tr>
<tr>
<td>EBL (OR per 1 L)</td>
<td>1.34 (1.13-1.61)</td>
</tr>
<tr>
<td>Colloid as % of non-blood replacement (OR per 5%)</td>
<td>0.67 (0.52-0.82)</td>
</tr>
</tbody>
</table>

POVL Study Group: Anesthesiology 2012; 116:15-24

ASA Practice Advisory:
Periop Visual Loss – Updated Report

- Informed consent for high-risk
- Head neutral/level with heart
- Continuously monitor BP in high-risk
- Deliberate hypotension in high-risk only if essential on case-by-case basis
- Colloids along with crystalloids
- Vasopressors: insufficient evidence
- Staged procedures

Anesthesiology 2019; 130:12-30

Rubin et al.: Anesthesiology 2016; 125:457-64

- National Inpatient Sample 1998-2012
- 2,511,073 surgeries
- Incidence: 1.02/10,000
- Risk factors for ION
  - Male sex
  - Age
  - Obesity
  - Transfusion

Rubin et al.: Anesthesiology 2016; 125:457-64

Incidence per 10,000 surgeries

Year | 1998-2000 | 2010-12 |
---   | ---        | ---       |
216   | 216        | 216       |

Rubin et al.: Anesthesiology 2016; 125:457-64
### Damaging Events in Spine Claims

![Chart showing percentages of events in Cervical and Thoracic/Lumbar spine claims.](chart)

- **Cervical (n=55)**
  - Difficult Intubation: 20%
  - Hemorrhage: 0%
  - Positioning/Padding: 10%

- **Thoracic/Lumbar (n=152)**
  - Difficult Intubation: 15%
  - Hemorrhage: 5%
  - Positioning/Padding: 15%

* p < 0.05
** p < 0.01


### Special Considerations for Cervical Spine Procedures

- Possible difficult airway
  - Videolaryngoscopy does not reduce occiput-C2 motion
- Careful extubation with reintubation back-up
- Consider not extubating
  - More than 3-4 levels
  - Long antero-posterior procedures
  - Patient factors

### Airway Obstruction from Anterior Cervical Hematoma

- Secure in OR if time
- Open wound
- Caution sedation/GA
- Edema/distortion of larynx
- Avoid repeated laryngoscopies
- Move quickly to surgical airway

### Risk Factors for Postoperative Airway Compromise

**Surgical**
- Exposure of >3 vertebral bodies
- Exposure of C2-C4 levels
- Blood loss > 300 ml
- Operative time > 5 hours
- Anterior/posterior approach

**Patient**
- Morbid obesity
- Obstructive sleep apnea
- Pulmonary disease
- Cervical myelopathy
- Prior anterior cervical surgery

**Anesthetic**
- Suboptimal airway visualization
- Multiple intubation attempts
- Need for fiberoptic intubation

**Institutional**
- No 24 hour in-house anesthesia care
- No 24 hour in-house surgical staff

Palumbo et al. Open Orthoped 2012;6:018-113

### Practice Improvements

- Risk stratification, pt. selection
Patient Risk Factors for Morbidity/Mortality

- Patient >75 yrs.
- ASA Class >3
- Massive obesity
- Medical comorbidities
  - DM, CHF, dialysis
- Chronic steroids
- Poor functional status
- Frailty/weight loss

Prehabilitation

- Functional capacity
- Cardiorespiratory function
- Muscle function
- Modifiable risk factors
  - Anemia
  - Smoking
  - Comorbidities

Predicting 30-day Complications after Complex Spine Surgery

Risk stratification, pt. selection
Prehabilitation
Surgical/anesthesia advances
- Shorten surgery/decrease EBL
- 3D surgical planning
- Imaging
- Minimally invasive surgery
- Neuromonitoring

Practice Improvements

Risk stratification, pt. selection
Prehabilitation
Surgical/anesthesia advances
- Shorten surgery/decrease EBL
- 3D surgical planning
- Imaging
- Minimally invasive surgery
- Neuromonitoring


- Multicenter retrospective cohort study 2005-2017
- Elective single-stage lumbar instrumented fusion
- Minimally invasive lateral vs. open procedure
- 1484 patients (1292 minimally invasive vs. 768 open)
- 30 day and 2 year follow-up

### Surgical Success by Approach

Nayer et al.: World Neurosurg 2018;116:e744-49

<table>
<thead>
<tr>
<th>Months After Surgery</th>
<th>Surgical Approach</th>
<th>OP</th>
<th>MIL</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>100%</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>97.5%</td>
<td></td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>95%</td>
<td></td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>92.5%</td>
<td></td>
<td></td>
</tr>
<tr>
<td>8</td>
<td>90%</td>
<td></td>
<td></td>
</tr>
<tr>
<td>10</td>
<td>87.5%</td>
<td></td>
<td></td>
</tr>
<tr>
<td>12</td>
<td>85%</td>
<td></td>
<td></td>
</tr>
<tr>
<td>14</td>
<td>82.5%</td>
<td></td>
<td></td>
</tr>
<tr>
<td>16</td>
<td>80%</td>
<td></td>
<td></td>
</tr>
<tr>
<td>18</td>
<td>77.5%</td>
<td></td>
<td></td>
</tr>
<tr>
<td>20</td>
<td>75%</td>
<td></td>
<td></td>
</tr>
<tr>
<td>22</td>
<td>72.5%</td>
<td></td>
<td></td>
</tr>
<tr>
<td>24</td>
<td>70%</td>
<td></td>
<td></td>
</tr>
<tr>
<td>26</td>
<td>67.5%</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

\( p = 0.0032 \)

### Anesthetic Implications-SSEP

- Reproducible waveforms
- Stable anesthetic doses
- Volatile anesthetics < 1.0 MAC
- Nitrous oxide alone or with < 0.5 MAC
- Intravenous anesthetics-less effect
- Etomidate/ketamine increase amplitude

Banoub et al.: Anesthesiology 2003; 99:716-37

#### Common Use of Neuromonitoring

- Spinal Cord Function
  - SSEP
  - MEP
- Nerve Root Function
  - EMG

Banoub et al.: Anesthesiology 2003; 99:716-37

#### Motor Evoked Potential Monitoring


#### Motor Evoked Potential Responses with Isoflurane

Motor Evoked Potential Responses with Propofol


Dexmedetomidine Load on Evoked Potentials

Mahmoud et al.: Anesthesiology 2010; 112:1364-73

Anesthetic Implications - MEP

- Stable anesthetic and physiological milieu
- Avoid bolus doses of propofol at critical points
- Total intravenous anesthesia
  - Remifentanil/sufentanil
  - Propofol (<150 mcg/kg/min)
  - Dexmedetomidine (decrease propofol dose)
  - Etomidate or ketamine
- Desflurane (<0.5 MAC)

Intraop Loss of MEPs with Instrumentation

- 60 y.o. ASA 2 man
  - T11 – L2 spinal fusion
  - Preop BP 130-85 (MAP=100)
  - Intraop MAP 60–65
  - Loss MEP with instrumentation

Dexmedetomidine and Evoked Potentials

- Double blind RCT (40 adults)-cervical lami
  - TIVA (propofol 140 mcg/kg/min; remifentanil 0.2 mcg/kg/min with BIS monitoring)
  - Placebo vs. dexmedetomidine
    - 0.6 mcg/kg over 10 min/0.6 mcg/kg/hr infusion
    - Target plasma concentration 1 ng/ml
  - No difference in SSEP latency or amplitudes
  - No difference in MEP amplitudes over 3 hours


Intraop Loss of MEPs with Instrumentation

- 60 y.o. ASA 2 man
  - T11 – L2 spinal fusion
  - Preop BP 130-85 (MAP=100)
  - Intraop MAP 60–65
  - Loss MEP with instrumentation
    - Phenylephrine x3: MAP 70, then MAP 55–60 for 2 hours
    - No return MEP
    - Patient unable to move legs
Changes in SSEP/MEP

- Surgical vs. anesthetic?
- Elevate blood pressure to 10% above baseline
- Correct physiologic concerns
  - Hypothermia
  - Anemia
  - Positioning

Multidisciplinary Initiative in Adult Scoliosis Surgery

- Single center academic medical center, QI design
- n=71 pre-intervention; n=69 post-intervention
- Multidisciplinary intervention
  - Multidisciplinary preop conference
  - Mandatory patient education
  - Dual surgeons (neuro/ortho)
  - Complex spine anesthesia team/protocol
  - Rapid treatment of blood loss/coagulopathy


Practice Improvements

- Risk stratification, pt. selection
- Prehabilitation
- Surgical/anesthesia advances
  - Shorten surgery/decrease EBL
  - 3D surgical planning
  - Imaging
  - Minimally invasive surgery
  - Neuromonitoring
- Standardization/ERAS

Multidisciplinary Initiative in Adult Scoliosis Surgery

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  - Mandatory patient education
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  - Complex spine anesthesia team/protocol
  - Rapid treatment of blood loss/coagulopathy


Complex Spine Anesthesia Protocol

Prep
- Antibiotics
- Sedation/Anxiolytics
- Standardized Anesthesia

Intra
- Anesthesia induction
- Endotrace insertion (if needed)
- 50% reduction in propofol
- Maintain CVP

Recovery
- Standardized Anesthesia
- Endotrace insertion
- Above 80% SpO2 by day 5

Sethi R et al.: Spine Deformity 2014;2:95-103

ERAS Protocols for Spine Surgery

Prep
- Metabolism correction
- Sedation
- Standardization

Intra
- Metabolism management
- Fluid balance management
- Antibiotics (if indicated)

Post
- Standardized care
- Pressure ulcer prevention

TXA in Spine Surgery

- 10 mg/kg load, followed by 1mg/kg/h in adults
- 1gm load, 1gm over 8 hours
- Renal excretion
- Side effects: seizures, thrombotic complications (rare)
Pain Management

- Multimodal pain management
  - Preop gabapentin
  - Ketamine infusion
  - Lidocaine infusion
  - Preop epidural or spinal opioids
  - Acetaminophen
  - Local anesthetic to wound-vital in minor surgery!
  - Eliminate remifentanil ASAP
  - Load with long-lasting ASAP prior to wake-up

ICU and Hospital Length of Stay (LOS)

Risk of Complications After Adult Scoliosis Surgery

- Single center retrospective cohort design
- 267 ERAS vs. 183 traditional care
- Before – after QI design
- Concurrent “no-pathway patients” (n=108)
- Reduced ICU admission (60 vs. 48%)

Summary

- Complications decreasing
- Practice improvements
  - Surgical and anesthetic advances
- Neuromonitoring with MEP
  - Stable anesthesia
  - TIVA or desflurane <0.5 MAC
  - Treat loss of signals
- ERAS pathways
  - Patient selection/prep
  - Coagulation/blood loss
  - Multimodal pain management
What are common myopathies we see in children?

- Neuromuscular Disease (myopathy)
- Cerebral Palsy
- Mitochondrial Myopathies
- Muscular Dystrophies
- Congenital Myopathies

Cerebral Palsy Overview . . .
- 1.5 - 4 per 1000 live births
- Boys > Girls
- Black children > White (White = Hispanic)
- > 50% can walk independently
- 1/3 limited or no ability to walk

Cerebral Palsy Preop Concerns?

<table>
<thead>
<tr>
<th>Home Meds</th>
<th>Respiratory</th>
<th>Pre-med</th>
<th>Seizure Hx</th>
</tr>
</thead>
<tbody>
<tr>
<td>Baclofen</td>
<td>Chronic pneumonia</td>
<td>Pre-op anxiety</td>
<td>30-60%</td>
</tr>
<tr>
<td>Dantrolene</td>
<td>Reactive airways</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Anti-seizure</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

CP - What are your intraoperative considerations?
- MAC
  - cognitive impairment
  - Related to seizure meds
CP - What are your intraoperative considerations?

- MAC
  - cognitive impairment
  - seizure meds
- Neuromuscular blockers

Succinylcholine & Hyper-K+
- Extra junctional SCH-N receptors
- "Immature" SCH-N receptors
- CP . . .
  - Minimal abnormal SCH-N receptors
  - Theory = muscles were never "normally" innervated

Which myopathies would you avoid volatile agents in?

- MH Risk
  - Central Core & Multicore dz
  - King-Denborough syndrome
- "MH-like" reaction
- Duchenne’s
- Acidosis
  - Certain mitochondrial myopathies

CP - Would you use succinylcholine?
One month old male presents for inguinal hernia repair . . .

What else would you like to know?

- Past Medical History/Presentation . . .
  - Born at 33 weeks gestation
  - Home O₂ at birth but weaned off 3 weeks ago
  - Gunky right eye but exam is otherwise normal
  - Appropriately NPO
  - No concerning physical exam findings

You decide to provide a general anesthetic because your surgeon is not comfortable with doing this under spinal alone . . .
A couple of other discussion points . . .

- What is the set up in your practice for identifying these patients?
- What if your anesthetic was a spinal rather than GETA?

Procedural Anesthesia

- Why do you prefer your choice of anesthetic?
- Benefits vs. Disadvantages

Procedural Anesthesia

- 15 year old girl with h/o ALL
- Lumbar puncture + Intrathecal chemotherapy
- What is your anesthetic of choice?
Special thank you to James Thomas, MD

Perioperative Management of Type 1 Diabetes Mellitus (T1D)

- A 10-year-old male with type 1 diabetes mellitus presents for tonsillectomy and adenoidectomy.

Discussion Points:
- What preoperative evaluation is necessary for this patient?
- Can his insulin pump and continuous glucose monitor (CGM) be used perioperatively?
- How should his glucose levels be managed perioperatively?
- What are the postoperative concerns related to his diabetes management?
Preoperative Assessment

- **Pre-op Evaluation**
  - Glycemic control - HbA1c, frequency of hypo/hyperglycemic episodes and DKA
  - Home insulin regimen - type of insulin, method(s) of delivery, dosing parameters
  - Anticipatory guidance - NPO and insulin administration instructions for patients
  - Schedule as “first case”
- **Day of Procedure**
  - Current glucose level
  - Dose and timing of the most recent short- and long-acting insulin administered

Insulin Regimens

<table>
<thead>
<tr>
<th>Basal-Bolus Regimen</th>
<th>Insulin Pump</th>
</tr>
</thead>
<tbody>
<tr>
<td>Basal Insulin</td>
<td>Intermediate or long-acting insulin subq bolus (daily/BID) Rapid-acting continuous subq insulin infusion</td>
</tr>
<tr>
<td>Bolus Insulin</td>
<td>Rapid-acting insulin subq bolus (PRN)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Duration of Action</th>
<th>Name</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rapid</td>
<td>Lispro (Humalog), Aspart (Novolog), Glulisine (Apidra), Aspart (Fiasp)</td>
</tr>
<tr>
<td>Short</td>
<td>Regular</td>
</tr>
<tr>
<td>Intermediate</td>
<td>NPH</td>
</tr>
<tr>
<td>Long</td>
<td>Detemir (Levemir), Glargine (Lantus), Degludec (Tresiba)</td>
</tr>
</tbody>
</table>

Insulin Dosing Parameters

- **Insulin-to-Carbohydrate (I:C) Ratio**
  - Ratio of insulin administered to carbohydrate consumed
  - I:C 1:10 = 1 unit of insulin per 10g of carbohydrates
- **Correction Factor (CF) or Insulin Sensitivity Factor (ISF)**
  - Expected decrease in blood glucose (BG) after administering 1 unit of insulin
  - CF: 50 = 1 unit of insulin will decrease BG by 50mg/dL

Perioperative Insulin Administration

- **Preop**
  - Continue basal insulin. Do not administer short-acting insulin boluses while fasting.

- **Minor Procedure**
  - Continue home subcutaneous insulin regimen

- **Major Procedure**
  - Or Critically ill patient
    - Convert to intravenous insulin infusion

Continuous Glucose Monitors (CGMs)
Recommendations for Insulin Pumps and CGMs

- **Insulin Pumps**
  - Radiology: Must remove for MRI. Recommend removal for CT or HK scans, cardiac catheterization, AKCI/PPI implantation and therapeutic radiation. If used during X-ray, remove from the field and cover with a lead apron.
  - Electrocautery: Confirm pump has a plastic (not metal) infusion needle and position pump away from the cautery site.

- **CGMs**
  - Do not use during MRI, CT or electrocautery.
  - CGM readings can be used to follow trends, but BG should be confirmed prior to initiating treatment.

Glucose Management

- Administer insulin correction factor
- Increase BG checks to q30min
- Rule out DKA

- Perioperative glucose target
- Titrate insulin infusion to this range
- Check BG hourly

- Initiate hypoglycemia treatment
- Administer dextrose or glucagon
- Check BG q15min until >100mg/dL

Postoperative Management

- Check BG on arrival to PACU and at least hourly
- Continue insulin and infusions until patient demonstrates normal PO intake, then convert to home regimen
- Refractory PONV
  - Interferes with return to home insulin regimen
  - Can be a sign of DKA

Now what?

- Should I stay of should I go now
- If I go there will be trouble
- And, if I go it will be double

32 year old woman presenting to the ED with acute appendicitis.

- PLAN?
- Additional information?
- PMH = Hypoplastic Left Heart Syndrome s/p Fontan Completion
• 15-25% survival of patients prior to treatment availability

• 85-95% survive to adulthood

Long term Survival by complexity of CHD

<table>
<thead>
<tr>
<th>%95%</th>
<th>Moderate</th>
<th>Severe</th>
</tr>
</thead>
<tbody>
<tr>
<td>Simple</td>
<td>Atrial septal defect</td>
<td>Anomalous pulmonary venous drainage</td>
</tr>
<tr>
<td>Moderate</td>
<td>Patent ductus arteriosus</td>
<td>Patent foramen ovale</td>
</tr>
<tr>
<td>Severe</td>
<td>Ventricular septal defect (marred, small, no assoc)</td>
<td>Transposition of the great arteries</td>
</tr>
</tbody>
</table>

Challenges of Adult Patients

- 42% patients in N. America had gaps of >3 years in their care; (mean age 19 yrs. +/- 9 mos.)
- Life events: Independence, jobs, marriage, family
- Common reason for gaps:
  - Geography
  - "feeling well"
  - "changing or losing insurance"
  - "financial problems"
  - "lost track of time"
  - decreased parental involvement
  - Increased risk of developing cardiac sx
  - 3x more likely to require intervention

Key points

- No specific method (careful with neuroaxial blockade)
- Try to ascertain baseline
  - Anatomy, Fenestration, Function ➔ Oxygen Saturation
  - PVR
- Paradoxical Emboli
- Preload, Afterload
- Mechanical Ventilation
Effect of mechanical ventilation

Fontan circulation prefers spontaneous ventilation/negative intrathoracic pressure.
Positive pressure and PEEP can reduce, stagnate, or reverse Fontan flow.

Mean increase in PBF 38%
40% increase in PBF
Decrease with return of PPV

Shekerdemian, J Am Coll Cardiol, 1999

PALS Review - Case 1
Out-of-Hospital Arrest

You are at a public playground and you notice an approximately 5-year-old boy collapse to the ground. What are the appropriate emergency response steps in this situation?

- Witnessed versus unwitnessed collapse?
- Single versus two or more rescuers?
- Compression rate and depth?
- Rescue breaths and airway management?

PALS Review - Case 2
Intraoperative Arrest

A 3-month-old girl is undergoing endoscopic strip craniectomy for repair of a sagittal suture craniosynostosis. Approximately 1 hour into the procedure, the patient becomes hypotensive and RBC transfusion is started empirically. Five minutes later, the arterial line waveform is lost. What are the appropriate emergency response steps in this situation?

- Compressions and ventilation?
- Medications?
- Shock?
- Underlying cause?
- Candidate for ECMO (ECPR)?
- Post-resuscitation goals?

Pediatric BLS

Dr. Tom Glenn, MD
HLHS
A five-year-old boy undergoes an uneventful ORIF for a humerus fracture. In the PACU, the pulse oximeter displays a heart rate of 200/min. What are the appropriate emergency response steps in this situation?

- Assessment?
- Vagal maneuvers?
- Medications?
- Shock?
Introduction to NORA

Defining NORA: Non-Operating Room Anesthesia

- All procedures performed in off-site locations
- NEVER: occurs inside an operating room
- USUALLY: for procedures performed by proceduralists or interventionalists
- OFTEN: entails newly developed procedures (novel to anesthesia team)

In contrast, Anesthesia training:
- NEVER: Outside of OR, unless on ‘NORA’ rotation
- USUALLY: Working with surgeons performing familiar operations

NORA: OUTLINE

- Introduction to NORA
- NORA Closed Claims
- Case Presentations
- Closing Remarks
- Q & A with Panel

Why NORA?

- OR suite unnecessary
- Decreased cost
- Experienced personnel
- Supplies readily available
- Efficient
- Specialized equipment

- More complex procedures + sicker patients
  - + less appropriate sedation cases
  - + greater need for anesthesiologists

Angela Selzer, MD

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University of Colorado

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But WHY?
Introduction to NORA

**NORA Needs**
- Gastroenterology
- Interventional Cardiology
- Interventional Neurology
- Interventional Pulmonology
- Interventional Radiology
- Echocardiography
- Electromyography
- Nuclear Medicine
- Radiology
- Sleep Endoscopy
- Future??

Challenge: Culture Gap

<table>
<thead>
<tr>
<th>PROCEDURALIST</th>
<th>ANESTHESIOLOGIST</th>
</tr>
</thead>
<tbody>
<tr>
<td>Used to working w/o anesthesia</td>
<td>Used to working in OR with surgeons</td>
</tr>
<tr>
<td>Limited understanding or appreciation of anesthesia</td>
<td>Limited understanding or appreciation of procedure</td>
</tr>
<tr>
<td>Limited knowledge of patient</td>
<td>Limited patient information</td>
</tr>
<tr>
<td>Anesthesia = “obstructionist”</td>
<td>Proceduralists = “cavalier”</td>
</tr>
<tr>
<td>Case starts are variable</td>
<td>1st case start at 730am</td>
</tr>
<tr>
<td>Efficiency = ?</td>
<td>Efficiency = Efficiency</td>
</tr>
<tr>
<td>Not Primary Team</td>
<td>Not Primary Team</td>
</tr>
</tbody>
</table>

Overcoming Challenges: Bridging the Culture Gap

- Communication
- Mutually Agreed Upon Expectations
- Reassessment & Reevaluation
- NORA Team

Lack of effective teamwork results in inefficient use of anesthesia & hospital resources

and

negatively impacts patient care
Introduction to NORA

**Challenges: Space**
- Where do we put anesthesia?
  - Established procedure suites constructed without a plan for anesthesia
  - New procedure suites designed without anesthesia input
  - Procedural location in remote area of hospital
  - Monitoring interference from specialized equipment

**Results in:**
- Access issues: gases, medical vacuum, emergency equipment
- Cramped area for machine, cart and anesthesia team
- Difficult access to additional equipment or medications
- Delayed assistance during emergencies

Introduction to NORA

**ASA Minimum Standards for NORA**

<table>
<thead>
<tr>
<th>Requirement</th>
<th>Details</th>
</tr>
</thead>
<tbody>
<tr>
<td>Reliable oxygen source and delivery method: Nasal cannulas, face mask, FIO2 cylinders</td>
<td>Availability of staff for assistance of provider and ability to request additional help</td>
</tr>
<tr>
<td>Adequate anesthetic drugs, monitoring equipment and supplies</td>
<td>Emergency cart with defibrillator and emergency drugs for CPR</td>
</tr>
<tr>
<td>Scavenger system for inhaled gases</td>
<td>Meet building codes and facility standards</td>
</tr>
<tr>
<td>Self-inflating resuscitation bag to deliver 90% O2 with positive pressure ventilation</td>
<td>Unobstructed access to the patient, equipment and emergency supplies</td>
</tr>
<tr>
<td>Adequate lighting and outlets</td>
<td>Adequate suction</td>
</tr>
<tr>
<td>Sufficient space for personnel</td>
<td>Provision of adequate PACU care</td>
</tr>
</tbody>
</table>

*American Society of Anesthesiologists Guidelines for Nonoperating Room Anesthetizing Locations*

Approved by the ASA House of Delegates on October 15, 2003 and Last approved 2018

Closed Claims from NORA

**Karen B. Domino, MD, MPH**

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NORA Cases in NACOR

n=12,252,846 cases 2010-13

Woodward et al. Anesthesiology Clin 2017:35:969-81

235
Location of NORA Cases in NACOR

Major Adverse Outcomes in NORA in NACOR

- Hemodynamic instability 0.10%
- Upgrade of care 0.10%
- Respiratory complications 0.9%
- Resuscitation 0.03%
- Death 0.02%

All complications, except anaphylaxis and awareness, occurred more often in OR.

NORA Location in NACOR vs. Claims

Characteristics of Malpractice Claims in NORA vs. OR Locations

MAC Respiratory Events Preventable by Monitoring

NORA n=85
OR n=1445
*p<0.001*

Characteristics of Malpractice Claims in NORA vs. OR Locations

Inadequate O₂/ventilation

N=1530 claims 2000-14

NORA Cases in NACOR vs Claims

Characteristics of Malpractice Claims in NORA vs. OR Locations

N=1530 claims 2000-14

*n=1,900,043 cases 2010-13* Woodward et al. Anesthesiology Clin 2017;35:569-81

*n=1900 claims 2000-12* Woodward et al. Anesthesiology Clin 2017;35:569-81

*n=1900 claims 2000-12* Woodward et al. Anesthesiology Clin 2017;35:569-81


*N=1900 claims 2000-12* Woodward et al. Anesthesiology Clin 2017;35:569-81

Characteristics of Malpractice Claims in NORA vs. OR Locations

- Inadequate oxygenation/ventilation: 32%
- Aspiration of gastric contents: 9%
- Difficult intubation: 4%
- Esophageal intubation: 6%
- Cardiac events: 13%
- Adverse/allergic drug reaction: 5%

Severity of Injury in NORA vs. OR Claims

- Temporary or nondisabling: NORA n=85, OR n=1445
- Permanent or disabling: NORA n=85, OR n=1445
- Death: NORA n=85, OR n=1445

Liability in NORA vs. OR Claims

- Substandard Care: NORA n=85, OR n=1445
- Payment Made: NORA n=85, OR n=1445

Common Damaging Events in NORA Claims

- Inadequate oxygenation/ventilation
- Aspiration of gastric contents
- Difficult intubation
- Esophageal intubation
- Cardiac events
- Adverse/allergic drug reaction

Aspiration in GI Suite

- 45 yo, 90 kg man for ERCP
- Propofol, fentanyl, ketamine
- Started propofol 80 mcg/kg/min
- Regurgitated, then apneic
- Difficulty rolling supine
- Difficult Ambu ventilation
- Severe bradycardia to cardiac arrest
- Resuscitated, brain dead

Cardiac Arrest in Cath Lab

- 71 yo, ASA 4 man with CAD, cardiomyopathy for defibrillator placement
- Cath lab monitors, no ETCO2
- Midazolam 2mg/fentanyl 100mcg
- Agitated—propofol infusion
- Bradycardia, SpO2 not working
- Resp/cardiac arrest-CPR
- Unable to be resuscitated
Lessons Learned from NORA Claims

- Anesthesia machine/cart
- Same care/standards as OR
- Consider endotracheal tube in prone position
  - Obesity
  - OSA
  - Anticipated difficult airway
  - Chronic pain/opioid dependence
  - Substance use disorder
  - Long procedure
- Be prepared for emergencies
- Availability of resuscitation equipment/personnel

NORA: CASE #1: GI Suite

- 74 yo M with dysphagia for EGD
- Hx: CAD, HL, HTN, TIA 3 weeks ago (resolution of symptoms)
- Labs: None
- VS: BP 148/74, HR 84, O2Sat 94% RA
- Exam: Elderly, deconditioned male. Unable to give much history. Forgot about TIA, remembers having an MRI. Otherwise unremarkable

Go or NO GO??

Safety of Sedation and NORA

- Record of safety
- When things go wrong, they can go VERY wrong
- Same care/standards as in OR
- Be prepared to handle emergencies

NORA: CASE #1: GI Procedures

What are the issues here?

NORA: Case Presentations

CASE #1: GI Suite
CASE #2: Interventional Pulmonology
CASE #3: Radiation Oncology
CASE #4: Radiology Suite

NORA: CASE #1

Factors

OPEN BOOKING PROCESS
INADEQUATE SCREENING PROCESS
PROCEDURALIST DOESN'T KNOW PATIENT
LOCATION OF PROCEDURE
POST-ANESTHETIC CARE
NORA: CASE #1

- Recent stroke or TIA:
  - Increased risk of perioperative stroke, MI, and death for nine months.
  - Significant decrease in risk after 3 months
- Recommendation:
  - Wait at least 3 months, for non-urgent surgery
  - Consider waiting 9 months for truly elective cases
  - Ensure patient has had appropriate CVA workup

NORA: CASE #2

Thoughts?

NORA: CASE #2:

Factors

- Planned Procedure
- Goals of Care
- Anesthesia Plan
- Equipment
- Backup

NORA: CASE #2: IP Suite

- 58 yo F for flex/rigid bronch with laser ablation
- CC: Worsening SOB/DOE for ~6 months
- PMH: 50 pk year smoker quit 1mo ago
- Exam:
  - On BiPAP, FiO2 80%
  - VS: BP 127/63, HR 109, RR 24, SpO2 94%
  - Lung exam: stridor w/ b/l wheezing
- Pt dyspneic, unable to lie flat
- Normal appearing upper airway
### Management of Central Airway Masses in the IP Suite

<table>
<thead>
<tr>
<th>Technique</th>
<th>Options</th>
<th>Considerations</th>
</tr>
</thead>
<tbody>
<tr>
<td>Induction</td>
<td>Awake Fiberoptic</td>
<td>Location of mass</td>
</tr>
<tr>
<td></td>
<td>Inhalational</td>
<td>Patient cooperation</td>
</tr>
<tr>
<td></td>
<td>Intravenous</td>
<td>Ability to lie supine</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Ability to ventilate</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Safety of neuromuscular blockade</td>
</tr>
<tr>
<td>Airway</td>
<td>LMA</td>
<td>Procedural technique (Flex vs. Rigid)</td>
</tr>
<tr>
<td>Management</td>
<td>Tracheostomy</td>
<td>Location of mass</td>
</tr>
<tr>
<td></td>
<td>Jet Ventilation</td>
<td>Airways anatomy</td>
</tr>
<tr>
<td></td>
<td>ETT</td>
<td>Size of LMA/ETT</td>
</tr>
<tr>
<td></td>
<td>Heliox</td>
<td>Hypertensive Inflation</td>
</tr>
<tr>
<td></td>
<td>V-V ECMO</td>
<td>Goals of Care</td>
</tr>
<tr>
<td>Maintenance</td>
<td>Inhalational</td>
<td>Procedural technique</td>
</tr>
<tr>
<td></td>
<td>Intravenous</td>
<td>Risk of Fire</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Bleeding (high, T+B, Lung Isolation)</td>
</tr>
<tr>
<td>Extubation</td>
<td>Yes/No/Maybe?</td>
<td>Baseline status</td>
</tr>
<tr>
<td></td>
<td>Nasal Cannula</td>
<td>Risk of reintubation/location of stents</td>
</tr>
<tr>
<td></td>
<td>Face Mask</td>
<td>Avoidance of positive pressure</td>
</tr>
<tr>
<td></td>
<td>CPAP/BiPAP</td>
<td>Disposition: PACU/ICU</td>
</tr>
</tbody>
</table>

### Case Presentations

**Debra Faulk, MD**  
Associate Professor  
Children’s Hospital of Colorado  
University of Colorado  
Department of Anesthesiology

### Adults vs Kids

The same...but different

**What We See:**  
**What Kids See:**

### NORA: Case #2

- Goals of care discussion
- Inhalational induction
- Rigid standby for backup
- LA to cords
- 8.0 ETT placed proximal to mass
- TIVA maintenance
- Mass biopsied, lasered and stented
- Extubated to BiPAP
- Recovered in OR PACU

### NORA: Case #2

- References

[https://aabronchology.org/tag/anesthesia-2/](https://aabronchology.org/tag/anesthesia-2/)
Goals of Sedation?

**Kids:**
- Pain relief
- Anxiety relief
- Stop undesired movement

**Adults:**
- Pain relief
- Anxiety relief
- And...

"There's nothing a little duct tape can't fix."

---

**NORA: CASE #3: Radiation Oncology**

- 9yo, 40Kg girl with autism and speech delays presented with history of nausea/vomiting x 3 days and behavioral changes x 1 wk (angry, violent outbursts with hitting). She was found to have a craniopharyngioma and underwent debulking surgery 2 wks ago. Presents now for simulation planning and a 6 wk course of radiation to the tumor bed.

- Cranial nerve palsy following resection - R pupil fixed and dilated and unable to open eye.
- Extreme anxiety with port access - cries to the point of gagging and emesis
- During the evaluation of the mass, the patient refused to get on to the MRI table
- Per MOC, the shorter time they can be in the treatment room, the better

**Questions:**

- What are considerations for this child’s treatment course?
- How will you proceed with sedation/anesthesia?
- How will you monitor this patient?

---

**Step 1: Simulation planning and making the mask**

**Step 2: Begin 6 wk course of XRT**

**Making the mask:**
How we approach these kiddos at CHCO

NORA: CASE #4: Radiology
- 9yo, 29kg boy presenting for MRI brain
- HPI: New onset recurrent migraines, no hx of trauma, exposures or accompanying symptoms.
- Hx:
  - Ex 35-wk triplet with ADHD; no other remarkable history
  - URI 2 wks ago, now resolved
- PE: well appearing, normal vital signs

How will you proceed?

Goals of Sedation:
- Anxiety Relief
- Pain Relief
- Stopping undesired movement
To Sedate or Not to Sedate...

Levels of Sedation

- Minimal Sedation (formerly anxiolysis)
- Moderate Sedation (formerly conscious sedation)
- Deep Sedation
- General Anesthesia

Continuum of Sedation

<table>
<thead>
<tr>
<th>Normal response to verbal commands</th>
<th>Purposeful response to verbal commands or light stimulation</th>
<th>Purposeful response to repeated or painful stimulation</th>
<th>Un arousable to painful stimulation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Minimal Sedation</td>
<td>Moderate Sedation/Analgesia</td>
<td>Deep Sedation/Analgesia</td>
<td>General Anesthesia</td>
</tr>
<tr>
<td>Airway maintained</td>
<td>Airway maintained</td>
<td>Airway maintained</td>
<td>CV function maintained</td>
</tr>
<tr>
<td>CV function maintained</td>
<td>CV function maintained ??</td>
<td>CV function maintained ??</td>
<td>CV function maintained ??</td>
</tr>
</tbody>
</table>

Special Considerations in the MRI Suite

- How does the danger of ferromagnetic objects affect your delivery of anesthesia?
- Considerations for monitoring these patients?
- Other considerations - thermoregulation (may actually get too hot in the 3T scanner), auditory dangers, pressure injury, code response
Kids don’t always tell us everything...

CC: Headache
DX: Screw in nose

References:


References

American Society of Anesthesiologists Guidelines for Nonoperating Room Anesthetizing Locations Approved by the ASA House of Delegates on October 15, 2003 and last amended on October 16, 2013


RESOURCES


https://sambahq.org/
SAMBA 2020: May 13-16 Orlando, FL


Bonus Case #1: Respiratory Arrest in GI Lab

- 48 y/o. 95 kg woman for ERCP
- Midazolam 2 mg, fentanyl 150 mcg
- Propofol 10 mg iv, then 60 mcg/kg/min
- Bradycardia (HR 35) → atropine 1.0mg
- SpO₂ to 75%
- Roll over for resuscitation
- Brain damage, support withdrawn

NORA: Bonus Cases

Audience Case Examples?

#1: Respiratory Arrest in GI Lab
#2: Severe Bradycardia during Colonoscopy
#3: NICU Procedure

Venous Air Embolism During ERCP

- During complex ERCP, pressurized air can enter the venous system through micro-tears at the ampulla
- Multiple reports in GI literature
- Venous air embolism
- Abrupt loss of circulation

What Do We Do About It?

- Preparedness
- Aggregation of cases (already 4 in AIRS)
- Care with dissection of duodenum
- Lower insufflating pressures
- Change to CO₂ for distending gas?
- Positive pressure ventilation?
Bonus Case #2:
Severe Bradycardia during Colonoscopy
- 63 y.o., 130 kg ASA 3 man with HTN, CAD, NIDDM
- No ETCO2
- Propofol 50 mg x 2
- HR 45/min, SpO2 86%
- Atropine 0.4 mg x 2
- HR 25/min-treated with ephedrine, stop procedure
- Difficult to ventilate/intubate
- Ventricular fibrillation
- Defibrillator non-functional
- Resuscitated, but brain dead

Bonus Case #3:
NICU
- 2mo, 2.8kg ex 30wk preemie with NEC and free air on abd x-ray
- Had been managed medically for NEC until increasing abd distention noted and free air found on x-ray
- Hx: Born to addicted mother with poor prenatal care
- Structurally normal heart with small PFO
- CLD – steroids at birth and intubated x 2wks, then extubated to scuba mask and weaned to NC
- Apnea/bradycardia - hr of caffeine therapy, last event 1 wk ago.
- Grade II IVH
- ROP
- VS: BP 72/40, HR 122, RR 25, O2Sat 95% on 2L HHFNC
- Labs: Hb 12, WBC 8.7, Plt 180, Glc 78, ABG: 7.39/41/90/27/-1
- PICC line, 24G Scalp IV, NGT, femoral arterial line
- TPN running
- Exam: sedate baby, working to breathe with distended abdomen and dusky lower extremities.

What do you do besides curse under your breath and wish you were skiing instead?

What are your concerns?
How will you prepare?
How will you anesthetize and monitor this baby?

Challenges of the Bedside NICU Case:
- Preparation in a foreign land
- Resource limitations
- Space limitations
- Help in a foreign land
- CODE in a foreign land?
DISCLOSURE

- There are NO disclosures for any faculty participating.

Kyle Marshall, MD
Olivia Romano, MD
Marina Shindell, DO
Inge Tamm-Daniels, MD
Jillian Vitter, MD
Chris Ciarallo, MD
Roland Flores, MD

BEER & WINE – END @ 1630!

Thank you to our Vendors!!

- Mindray: Rob Kimbrough
- Philips: Aaron Rhoades, David Tamberlin
- Sonosite: Kristi Howe

Advanced Ultrasound Workshop

- Infraclavicular
- Paravertebral
- Fascia Iliaca/Femoral
- Advanced Plane Blocks
  - PECs I&II
  - Serratus Anterior
  - Erector Spinae
- LESS Lecture, MORE demonstration.
- 9 stations with models
- Blue Phantom/needle station for practice!
Friday, March 6th
Objectives

1. Recognize risk factors and causes of perioperative stroke.
2. Describe causes and prevention of perioperative spinal cord injury.
3. Discuss the etiology of and prevention of peripheral nerve injury.

Overview

- Stroke
- Spinal cord injury
  - Cervical
  - Thoracic
- Peripheral nerve injury (PNI)

Preop Risk Factors for Perioperative Stroke

- Advanced age (>70 yrs)
- Female
- Hypertension, heart disease
- Atrial fibrillation
- History of stroke or transient ischemic attack
- Carotid artery stenosis
- Abrupt discontinuation of antithrombotic therapy

Incidence of Stroke After Various Surgical Procedures

<table>
<thead>
<tr>
<th>Procedure</th>
<th>Risk of Stroke (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>General surgery</td>
<td>0.08-0.7</td>
</tr>
<tr>
<td>Peripheral vascular surgery</td>
<td>0.8-3.0</td>
</tr>
<tr>
<td>Resection of head and neck tumors</td>
<td>4.8</td>
</tr>
<tr>
<td>Carotid endarterectomy</td>
<td>5.5-6.1</td>
</tr>
<tr>
<td>Isolated CABG</td>
<td>1.4-3.8</td>
</tr>
<tr>
<td>Valve surgery</td>
<td>4.8-9.7</td>
</tr>
<tr>
<td>Aortic repair</td>
<td>8.7</td>
</tr>
</tbody>
</table>

Selim: NEJM 2017;356:706-13
Perioperative Acute Ischemic Stroke by Age and Surgery

Bateman et al.: Anesthesiology 2009;110:231-8

Risk of Major Cardiac Events

Jørgensen et al: JAMA 2014;312:269-77

Risk of Ischemic Stroke

Jørgensen et al: JAMA 2014;312:269-77

Additional Risk Factors for Periop Stroke

- Renal insufficiency
- Emergency surgery
- Valvular heart disease
- Postoperative hypotension
- Patent foramen ovale

- Periop stroke risk with multiple risk factors = 2 - 3%

Question 1?

1. The most common mechanism of perioperative stroke is:
   a. Hypotension
   b. Embolic
   c. Hemorrhagic
   d. Thrombotic

Jørgensen et al: JAMA 2014;312:269-77
Mechanisms of Perioperative Stroke

- Embolic: 62%
- Hypotension: 9%
- Hemorrhagic: 1%
- Thrombotic: 1%
- Lacunar: 3%
- Unclassified: 14%
- Multiple: 10%

Preop Prep for High Stroke-Risk Patients

- Screen for risk factors and communicate
- Consider delaying elective surgical cases for at least 9 months after prior stroke
- Management of anticoagulants
  - Stop warfarin 5 d. preop, bridge high-risk patients
  - Stop direct oral anticoagulants 1-3 d preop, don’t bridge, restart 1-3 d postop
  - Insufficient evidence for continuing ASA re stroke

Type of Perioperative Stroke

- Large-Vessel Territory: 62%
- Not Classified: 30%
- Small-Vessel/Lacunar: 7%

Cerebral Blood Flow Autoregulation

Lower Limit of Autoregulation in Humans

<table>
<thead>
<tr>
<th>Study</th>
<th>Mean (Range or SD)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Strandgaard (1976)</td>
<td>73 ± 9</td>
</tr>
<tr>
<td>Waldemar (1989)</td>
<td>79 (57-101)</td>
</tr>
<tr>
<td>Larsen (1994)</td>
<td>79 (53-113)</td>
</tr>
<tr>
<td>Olsen (1995)</td>
<td>88 (76-101)</td>
</tr>
<tr>
<td>Olsen (1996)</td>
<td>79 (73-101)</td>
</tr>
<tr>
<td>Joshi (2012)</td>
<td>66 (43-90)</td>
</tr>
</tbody>
</table>

Drummond: Anesthesiology 2019;128:759-71
Blood Pressure in Beach Chair Position

BP = 95/45 (MAP = 68)
10-12 cm ↓ 9 mmHg
BP = 105/65 (MAP = 78)
20 cm ↓ 15 mmHg
BP = 120/80 (MAP = 93)

Cerebral Blood Flow in Acute Injury

Drummond: Anesthesiology 2019;128:759-71

Intraoperative Hypotension and Perioperative Ischemic Stroke after General Surgery

A Nested Case-control Study
Jilles B. Bijker, M.D., Suzanne Persoon, M.D., Linda M. Peelen, Ph.D., Karel G. M. Moons, Ph.D., Cor J. Kalkman, M.D., Ph.D., L. Jaap Kappelle, M.D., Ph.D., Wilton A. van Klei, M.D., Ph.D.

- Case-control study
- Non-cardiac/non-neurosurgical surgery
- 42 stroke cases (0.09% of 48,241 patients)
- 252 controls (matched for age, surgery type)
- Determine effect of intraop hypotension

Recommendations re Blood Pressure Management

- Cardiac surgery: avoid hypotension
- Intraoperative hypotension, during CPB, associated with stroke
- Non-cardiac surgery: No specific BP thresholds
- Beach chair position
- Gradient brachial artery & brain (12-24 mmHg)
- Approach induced hypotension with caution

SNACC 2020 Guidelines for Periop Care of Patients at High Risk for Stroke

Association of Intraop Hypotension and Postop Stroke

Bijker et al. Anesthesiology 2012;116:658-64

Postoperative Stroke Patients Evaluation and Care

- Protocol for emergency evaluation
- Focused on large vessel occlusion
- CT/MRI before initiating Rx
- Perfusion imaging for suspected large-vessel occlusion
- Multidisciplinary discussion thrombolysis vs. thrombectomy
- Endovascular thrombectomy if indicated
- Transfer to stroke center

SNACC 2020 Guidelines for Periop Care of Patients at High Risk for Stroke
Lessons re Periop CVA
- Preop optimization high-risk patients/surgeries
  - Cerebrovascular disease, atrial fibrillation, HTN
  - Bridge therapy for warfarin, platelet inhibitors
- Caution re absolute or relative hypotension
  - High stroke-risk patients, brain pathology, and sitting position
- Ultrasound to avoid carotid artery cannulation
- Effective systems to evaluate, Rx, & transfer

Causes of Spinal Cord Injury in Closed Claims
- Cervical cord (n=26)
  - Cord compression (7)
  - Positioning (4)
  - Surgical (3)
  - Epidural hematoma (3)
  - Hypotension (3)
  - Embolic event (1)
- Thoracic cord (n=9)
  - Hypotension (7)
  - 3 spine procedures
  - 4 other procedures
  - Epidural hematoma (2)

Intraop Loss of MEPs with Spine Instrumentation
- 60 y.o. ASA 2 man
- T11 – L2 spinal fusion
- Preop BP 130-85 (MAP=100)
- Intraop MAP 60–65mmHg
- Loss MEP with instrumentation

Spinal Cord Blood Flow

Intraop Loss of MEPs with Spine Instrumentation
- 60 y.o. ASA 2 man
- T11 – L2 spinal fusion
- Preop BP 130-85 (MAP=100)
- Intraop MAP 60–65
- Loss MEP with instrumentation
- Phenylephrine x3: MAP 70, then MAP 55–60 for 2 hours
- No return MEP
- Patient unable to move legs

Perfusion Pressure

Drummond: Anesthesiology 2019;128:759-71
Question 2:

1. During general anesthesia, the most common factor associated with cervical spine injury is:
   a. Difficult tracheal intubation
   b. Unstable cervical spine
   c. Intraoperative hypotension
   d. Cervical spondylosis

Cervical Spinal Cord Injury

- Cervical spondylosis 81%
- Surgical complication 24%
- Trauma 19%
- Pre-existing cord injury 19%

n=37

Hindman et al.: Anesthesiology 2011;114:782-95

Cervical Spinal Cord Injury

• General anesthesia claims
• 37 cervical spinal cord injuries (+11 nerve root)
• Narratives reviewed by 3 independent teams

Hindman et al.: Anesthesiology 2011;114:782-95

New Mechanisms of Cervical Spine Injury

- Most without:
  - Airway difficulty
  - Unstable C-spine

- Procedures:
  - Sitting/extension
  - Cervical spine
  - Cervical spondylosis

n=37

Hindman et al.: Anesthesiology 2011;114:782-95
Closed Claims Lessons: Spinal Cord Injury

- Unstable cervical spine infrequent cause of cervical cord injury
- Cervical spondylosis: avoid hyperextension
- Avoid hypotension, keep up spinal cord perfusion
- Raise BP to normal or above if loss MEP, SSEP during surgical manipulation

Closed Claims PNI Case

- 48 y.o. ASA 2 woman
- Robotic hysterectomy
- Lithotomy
- Left arm tucked, right arm on board
- Steep Trendelenburg
- 5 hour procedure
- Right brachial plexopathy

Incidence of Periop PNI

- Brachial plexus
  - No recent estimates of classic injury
  - Post-sternotomy: 0.5-1.07%
- Ulnar nerve: 0.04-0.52%
- Lower extremity: 1.6%
  - Lateral cutaneous nerve of thigh: 0.04%
  - Common peroneal nerve: 0.3%
  - Sciatic nerve: 0.3%
  - Obturator nerve: 0.5%

Closed Claims PNI Case

- 48 y.o. ASA 2 woman
- Robotic hysterectomy
- Lithotomy
- Left arm tucked, right arm on board
- Steep Trendelenburg
- 5 hour procedure
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  - Lateral cutaneous nerve of thigh: 0.04%
  - Common peroneal nerve: 0.3%
  - Sciatic nerve: 0.3%
  - Obturator nerve: 0.5%

https://www.asra.com/education/image-gallery

Midline Sagittal MRI of Cervical Stenosis

In neutral position
In extension
In flexion

Hindman et al.: Anesthesiology 2011;114:782-85

Question 3:

1. The most common mechanism of perioperative peripheral nerve injury is:
   a. Surgical factors, including use of tourniquet
   b. Multifactorial
   c. Intraoperative positioning and padding
   d. Pre-existing neuropathy
### Patient Surgical Characteristics of PNI vs. Other Claims (1990-2013)

<table>
<thead>
<tr>
<th></th>
<th>PNI (n=420)</th>
<th>Other (n=3,034)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Male (%)</td>
<td>59*</td>
<td>49*</td>
</tr>
<tr>
<td>ASA PS 1-2 (%)</td>
<td>67*</td>
<td>50*</td>
</tr>
<tr>
<td>Elective case (%)</td>
<td>91*</td>
<td>83*</td>
</tr>
<tr>
<td>Age (yrs.)</td>
<td>47 (14)</td>
<td>46 (20)</td>
</tr>
<tr>
<td>Surgical Position (%)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Supine</td>
<td>59*</td>
<td>76*</td>
</tr>
<tr>
<td>Lithotomy</td>
<td>16*</td>
<td>6*</td>
</tr>
</tbody>
</table>

*p<0.01


### Most Common PNI in Claims

- Brachial Plexus: 36%
- Ulnar: 30%
- Sciatic: 10%
- Radial: 8%
- Femoral: 4%


### Causes of Injuries in PNI Claims

- None identified: 188 (45%)
- Positioning or padding: 126 (30%)
- Pre-existing neuropathy: 30 (7%)
- Surgery: 25 (6%)
- Peripheral line infiltration: 19 (5%)
- Other: 32 (8%)

n=420


### Severity of Injury in PNI Claims

- Temporary: PNI (n=420) 40%, Other (n=3,034) 20%
- Permanent Non-Disabling: PNI (n=420) 20%, Other (n=3,034) 40%
- Permanent Disabling or Death: PNI (n=420) 40%, Other (n=3,034) 40%

*p<0.01


### Pathophysiology of Peripheral Nerve Injury

- Compression
- Stretching
- Systematic hypotension or proximal arterial occlusion
- Inflammation

Peripheral Nerve Insults (duration and severity)

Underlying neuronal reserve (or underlying neuronal neuropathy)

Peripheral nerve injury

Abnormal Intraop SSEP

- Prone spine surgery/park bench position
  - 2.2% ischemia due to position
- Cardiac surgery (1-6% PNI)
  - 2/3 patients with abnormal SSEP
- Shoulder surgery (4-8% PNI)

Closed Claims Lessons: Periop PNI

- Most PNI are multifactorial
  - Nerve insult (duration and intensity)
  - Neuronal reserve
- Most ulnar nerve injuries are defensible
- Position injuries result in payments
- SSEP monitoring promising

Summary

- Delay elective surgery for ≥9 months after prior stroke
- Most periop strokes are embolic; hypotension may play role
- Cervical spondylosis key in cervical cord injury
- Hypotension in spine injury, especially thoracic
- Most PNI multifactorial, appropriate care
Objectives

- To review (very briefly!) the proposed mechanisms of cancer metastasis and recurrence and the immune system’s role in limiting cancer spread
- To illustrate the effects of the perioperative period on these mechanisms and defenses
- To introduce the implications of anesthetic management choices in cancer outcomes

Anesthesiologists: The Physicians of the Perioperative Period

Why is surgery so problematic for cancer recurrence?

- Handling and disruption of the tumor may release cells into circulation
- Removal of primary tumor may lead to decrease of circulating anti-angiogenic factors
- Increase in local and systemic release of growth factors after surgery
- And probably most importantly... perioperative immunosuppression

The immune system and cancer

<table>
<thead>
<tr>
<th>Powers for good</th>
<th>Forces of evil</th>
</tr>
</thead>
<tbody>
<tr>
<td>CD4 Th1 cells</td>
<td>CD4 Th2 cells</td>
</tr>
<tr>
<td>IL-2</td>
<td>IL-4</td>
</tr>
<tr>
<td>IFN-γ</td>
<td>IL-10</td>
</tr>
<tr>
<td>CD8+ cytotoxic lymphocytes</td>
<td>CD4 Th17 cells</td>
</tr>
<tr>
<td>Natural killer cells</td>
<td>CD4 regulatory T (T-reg) cells</td>
</tr>
<tr>
<td>Myeloid-derived suppressor cells (MDSCs)</td>
<td></td>
</tr>
<tr>
<td>Tumor-associated Macrophages</td>
<td></td>
</tr>
</tbody>
</table>
How does surgery affect this balance?

- Most significant factor: The surgical stress response
  - Sympathetic nervous system activation resulting in catecholamine release
  - Interferes with NK activity
  - Shifts the immune response to Th2 (immunosuppression) predominance
  - These actions are primarily via β2 receptors.
  - Hypothalamic-pituitary-adrenal axis activation
  - Increased ACTH production leads to increased glucocorticoid release
  - Glucocorticoids kill immature T cells and shift the immune response to favor Th2.

How can we ameliorate these negative influences and give our patients the best chances for survival?

- Anesthesia technique?
- Analgesic technique?
- Blood transfusion management
- Are the cardiologists right? SHOULD we avoid hypotension and hypoxemia? The answer may SHOCK you.

Inhaled Agents vs. TIVA

- Anesthetic consequences
  - Hypotension
  - Hypothermia
  - Transfusion
  - Medication effects
- Immunosuppression response is biochemically evident within hours of surgery and lasts for several days, with a peak around the third postoperative day.

Surgery is a bad thing...

- Anesthetic drugs and host defense

<table>
<thead>
<tr>
<th>Drug</th>
<th>Adverse effect</th>
</tr>
</thead>
<tbody>
<tr>
<td>Volatile agents</td>
<td>Inhibit NK cell cytotoxicity</td>
</tr>
<tr>
<td>Propofol</td>
<td>Reduces NK cell number</td>
</tr>
<tr>
<td>Thiopental</td>
<td>Reduces NK cell number</td>
</tr>
<tr>
<td>Ketamine</td>
<td>Reduces NK cell number and activity</td>
</tr>
<tr>
<td>Midazolam</td>
<td>Reduces IL-8 levels</td>
</tr>
</tbody>
</table>
Inhaled agents

- Inhaled agents are associated with pro-cancer effects
- Mechanisms are unclear but clearly complex and multifactorial, and include immunomodulation and effect on tumor stem cells
- Halothane, isoflurane, and sevoflurane have all been long demonstrated to suppress NK cell activity and lymphocyte function, but recent research has revealed much more wide-ranging and complex effects on the immune system

In the lab: a sampling of observed effects

- Exposure to isoflurane has been shown to increase the resistance of colon cancer cells to the effects of anticancer drugs
- Isoflurane exposure increases melanoma metastasis in mice
- Isoflurane has been demonstrated to enhance the malignancy of head and neck squamous cell carcinoma cell lines
- Isoflurane enhances ovarian and renal cell tumor growth and malignant potential
- Nitrous oxide is associated with acceleration of lung and liver metastasis in animal models
- Sevoflurane has been demonstrated to promote the proliferation of glioma stem cells

Direct immunomodulating effects of volatile anesthetics

- Exposure to isoflurane has been shown to increase the resistance of colon cancer cells to the effects of anticancer drugs
- Isoflurane exposure increases melanoma metastasis in mice
- Isoflurane has been demonstrated to enhance the malignancy of head and neck squamous cell carcinoma cell lines
- Isoflurane enhances ovarian and renal cell tumor growth and malignant potential
- Nitrous oxide is associated with acceleration of lung and liver metastasis in animal models
- Sevoflurane has been demonstrated to promote the proliferation of glioma stem cells

Propofol: The anesthesiologist’s friend

- Does suppress NK activity in vitro; BUT...
- Probably does not do so significantly in vivo at clinically relevant concentrations (whereas ketamine and thiopental appear to be very immunosuppressive)
- Mouse studies suggest that propofol increases CTL activity against tumor cells
- Increases Th1/Th2 ratio, which is good
- Has some COX-2 inhibitory activity, which is also good
- In humans, propofol-remifentanil anesthesia was associated with increased IL-10 activity in patients undergoing open cholecystectomy
- In patients undergoing supratentorial tumor excision, patients had less immunosupression under propofol anesthesia compared to isoflurane.
Is TIVA superior to inhaled agents?

Very possibly.

Wigmore et al.

- Retrospective cohort study of more than 7,000 patients who had general anesthesia for cancer surgery over 3 year period
- Patients who received both techniques, were under 16 yo, or who were having emergent surgery were excluded
- 3316 patients received inhalational agents; 3714 received propofol/remifentanil TIVAs
- Statistical analysis used 2607 matched pairs

Overall Group and Matched Group

Overall survival
Role of pain in cancer recurrence

- Acute pain activates the stress response via the SNS and the HPA axis.
- Pain may have additional immunosuppressive effects, possibly mediated via endogenous opioids’ effect on the μ3 receptor.
- Animal studies show a substantial decrease in NK cell activity in response to the infliction of pain.

Pain management and tumor growth

- Opioids
  - Morphine may be problematic.
  - Inhibits spontaneous and cytokine-enhanced NK cell cytotoxicity; appears to be mediated by the μ opioid receptor.
  - Animal data suggest that morphine is proangiogenic and promotes breast cancer and non-small cell lung tumor growth.
  - However, a few studies have shown protective effects.
  - Fentanyl and possibly other synthetic opioids have similarly contradictory data.
  - Doesn’t bind to μ3; actually appears to increase NK activity.
  - Several studies show no significant immunosuppressive effects.
  - On the other hand, rat studies again show tumor-promoting effects.

Overall and recurrence-free survival

- Colon cancer and epidurals
  - 2012 retrospective study by Cummings of over 42,000 patients from the linked Medicare-Surveillance, Epidemiology, and End Results database.
  - Patients were all over 66 years old with non-metastatic colon cancer who underwent open colectomy.
  - 22.9% received epidurals.
  - Patients who received epidurals were more likely to be younger, male, white, married, and Midwestern.
  - No significant difference in perioperative complications.
  - Found no significant difference in cancer recurrence (odds ratio 1.05, CI [0.95, 1.15], p = 0.28).
Survival Benefit

- Five-year survival was 61% in the epidural group and 56% in the traditional pain management group.
- Median survival was 7.24 years in the epidural group versus 6.09 years.


Adjusted data

<table>
<thead>
<tr>
<th>Table 2: Association between Epidural Use and All-cause Mortality</th>
</tr>
</thead>
<tbody>
<tr>
<td>Models</td>
</tr>
<tr>
<td>--------</td>
</tr>
<tr>
<td>Modal 1A</td>
</tr>
<tr>
<td>Modal 1B</td>
</tr>
<tr>
<td>Modal 1A</td>
</tr>
<tr>
<td>Modal 1B</td>
</tr>
<tr>
<td>Modal 1C</td>
</tr>
</tbody>
</table>

Other modalities

- Local anesthetics: Possible tumor inhibiting effect via direct affects on EGF receptors or via inhibition of the voltage-gated sodium channels on cancer cells.
- COX-2 inhibitors: Promising in animal models.
- COX is over-expressed in many cancers.
- Prostaglandins inhibit NK cytotoxicity.
- Long-term use is associated with reduced incidence of cancer.

Peripheral nerve blocks

- Exadaktylos and colleagues retrospectively studied 129 consecutive patients who underwent mastectomy and axillary clearance in an Irish hospital.
- 50 patient received paravertebral blocks in addition to general anesthesia, while the remaining 79 received general anesthesia and postoperative morphine analgesia.
- No significant difference between the groups in terms of patient factors, surgical details, tumor presentation, or prognostic factors.
- The median pain scores were less in the paravertebral group.

How about toradol?

- IF COX-2 blockers are promising, what about our intraoperative NSAIDs?
- Somewhat new area of interest.
- Theory: May reduce tumor adhesion to endothelial cells and invasive potential. But mainly...

Paravertebral block for breast cancer surgery
More than 200 studies have described an association between perioperative blood transfusion and increased risk of cancer recurrence.

The implications of transfusion have been investigated for many cancer types, including colorectal, bladder, breast, head and neck, endometrial, esophageal, hepatocellular, prostate, and kidney.

Why? Same story -- immunosuppression.

Historical fun fact: Perioperative transfusions were observed to enhance the survival of transplanted kidneys, thus tipping us off that transfusion might suppress the immune system.

Transfusion-related immunomodulation (TRIM)

Mechanism is not totally clear.

- Leukocyte mediated? Probably not, since removal of white cells doesn’t fix it.
- Seems to involve induction of Treg cells, which suppress CD4 and CD8 cells.
- May also be related to arginine depletion, which suppresses T-cell function.

Linder et al recently published a retrospective study of 2060 patients undergoing radical cystectomy for bladder cancer at the Mayo Clinic.

62% (1279 patients) received transfusion with a median of 2 transfused units.

Results were complicated, but showed an increased risk of both recurrence and mortality for transfused patients.
Outcomes

Bladder cancer

Cochrane Review: Transfusions and colorectal cancer
- 2006 meta analysis of 36 studies with a total of over 12,000 patients undergoing curative resection of colorectal cancer
- Twenty-three of the studies showed a detrimental effect of perioperative transfusion on cancer recurrence
- Pooled data estimated that transfusion yielded an overall odds ratio of 1.42 (95% CI 1.2-1.67)
- Effect appeared to be dose-related; patients receiving 3 or more units had double the risk of recurrence compared to patients receiving 1 or 2 units
- Timing of the transfusion (pre-, intra-, or post-operative) did not seem to make a significant difference

Hypotension and hypoxemia: Shockingly not helpful in cancer patients

Multivariate Analysis

Okay, but why particularly?
Hypotension study

- 1991 retrospective study of 116 patients who had undergone complete hepatic resection for colorectal metastasis.
- "Baseline" MAP was defined as the MAP at surgery start.
- Hypotension was defined as any value less than 80% of baseline MAP.
- Of all the variables analyzed, the single most predictive factor for future recurrence was the number of hypotensive episodes during surgery ($p<0.00001$).

- Hypotensive episodes and recurrence-free survival

Conclusions

- Cancer is complicated. Anesthesiology is complicated. The interplay between the two is significant, but in general incompletely understood. Ongoing research is critical.
- The perioperative period is a critical time for cancer patients due to the attendant immunosuppression.
- Many of our anesthetic drugs, particularly volatile agents and opioids, likely significantly contribute to this immunosuppression.
- Pain is bad. Treat it aggressively, but consider avoiding opioids (particularly morphine) if possible. Consider NSAIDs and lidocaine.
- Blood transfusions should be avoided when possible.
- Hypoxia and hypotension continue to be bad ideas.

Esophageal cancer and hypotension

- 2012 retrospective study of 53 patients who had undergone complete resection of esophageal cancer.
- Defined hypotension as SBP<70 for all patients.
- Found significant difference in 1-year cancer-specific survival for patients who had one or more hypotensive episodes ($p<0.0002$).