

CRASH 2018

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CRASH 2018 Program

Sunday, February 25

Afternoon

4:00-5:00 pm **Obesity, OSA, and Thoracic Anesthesia** – Jay B. Brodsky, MD

5:00-6:00 pm **Anesthesia in Traumatic Brain Injury** – Kenneth M. Brady, MD

6:00-6:30 pm **Q&A**

6:30-7:30 pm **Opening Night Reception**

Monday, February 26

Morning

7:00-8:00 am **What's New in Obstetric Anesthesia from 2017?** – Joy L. Hawkins, MD

8:00-9:00 am **Anesthesia for Bariatric Surgery** – Jay B. Brodsky, MD

9:00-9:30 am **Q&A**

9:30 am **Recess/View Exhibits**

3:30 pm **View Exhibits/Après Ski**

Afternoon

4:00-6:00 pm **OB Anesthesia Panel** – Joy L. Hawkins, MD; Rachel Kacmar, MD

4:00-6:00 pm **ICU Panel** – Jason Brainard, MD; Breandan Sullivan, MD; Thomas Scupp, MD

4:00-6:00 pm **Workshop: Comprehensive Airway Management** – David Abts, MD; Bethany Benish, MD; Marina Shindell, DO; Brian Somerset, MD; Jennifer Zieg, MD

Tuesday, February 27

Morning

7:00 – 8:00 am **Neuromonitoring – What and When?** – Kenneth M. Brady, MD

8:00 – 9:00 am **Anesthesia for the Chronic Pain Patient** – Racheal Rzasa Lynn, MD

9:00 – 9:30 am **Q&A**

9:30 am **Recess/View Exhibits**

3:30 pm **View Exhibits/Après Ski**

CRASH 2018 Program

Afternoon

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

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

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

Wednesday, February 28

Morning

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

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

9:00 – 9:30 am **Q&A**

9:30 am **Recess/View Exhibits**

3:30 pm **View Exhibits/Après Ski**

Afternoon

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

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

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

CRASH 2018 Program

Thursday, March 1

Morning

7:00 – 8:00 am **Update of Pediatric Anesthesia** – Lawrence Schwartz, MD

8:00 – 9:00 am **Post-Operative Delirium** – Kenneth M. Brady, MD

9:00 – 9:30 am **Q&A**

Afternoon

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

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

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

Friday, March 2

Morning

7:00 – 8:00 am **The Changing Landscape of Opioid Analgesics: An FDA Perspective** – Jeffrey Galinkin, MD

8:00 – 9:00 am **Cardiac Anesthesia Update** – Karsten Bartels, MD

9:00 – 9:30 am **Q&A**

10:00 am **Adjourn**



University of Colorado
Anschutz Medical Campus

School of Medicine

Disclosure of Relevant Financial Relationships

CRASH

Colorado Review of Anesthesia for Surgicenters and Hospitals

Feb 25 – Mar 2, 2018
Vail, CO

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The following faculty/contributors have reported commercial affiliation associate with this conference as follows:

Name	Affiliation	Organization
Ken Brady	Co-Inventor of a Neuromonitoring Technology – not yet available	Medtronic
Jay Brodsky	Consultant	Ambu
Jeffrey Galinkin	Grant & Research Support Consultant Stock/Shareholder	Novartis Purdue, TEVA, Astra-Zeneca, Roxanne/BI Claro Laboratories

All other contributors have reported no commercial affiliation associated with this conference or intentions to discuss unapproved uses for drug products and/or devices.

Racheal Rzasa-Lynn and Olivia Romano have reported intentions to discuss unapproved uses for drug products and/or devices.

ACKNOWLEDGEMENT

We extend our appreciation to

Cook Medical

Fujifilm SonoSite

Karl Storz

Medtronic

Mindray

PAJUNK Medical Systems

Philips

Salter Labs

Verathon

for equipment provided for the workshops at

CRASH 2018

We also welcome our Exhibitors

Air Force Recruiting Service

Allied Powers

Belmont Instrument Corporation

Elsevier

Fujifilm SonoSite

Karl Storz

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Preferred Physicians Medical

Salter Labs

Sharkey, Howes & Javer

USAP

Verathon Medical

Vyaire Medical

WilMarc Medical

Sunday

Obesity, Obstructive Sleep Apnea (OSA), and Thoracic Anesthesia

Jay B. Brodsky, MD
 Professor (Anesthesiology)
 Stanford University Medical Center
 Stanford, California
 Jbrodsky@stanford.edu

February 25, 2018

Disclosure

Ambu, DK
 Airway Management Advisory Board

Goals and Objectives

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

INDICATIONS

LUNG SEPARATION/ISOLATION (“absolute”)

Protect healthy lung
 hemorrhage, empyema, lung lavage

Special procedures
 broncho-pleural fistula, bronchial disruption,
 giant bullae or cysts, broncho-pulmonary lavage

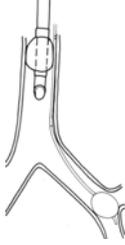
SELECTIVE LUNG COLLAPSE (“relative”)

Improve Surgical Exposure
 Thoracic Surgery: Lung and mediastinum
 General Surgery: Esophagus
 Cardiac Surgery: Heart and great vessels
 Orthopedic Surgery: Spinal column – thoracic approach
 Neurosurgery: Nerves and sympathetic chain

Lung Isolation and Selective Collapse



Double-lumen tube



Bronchial blocker

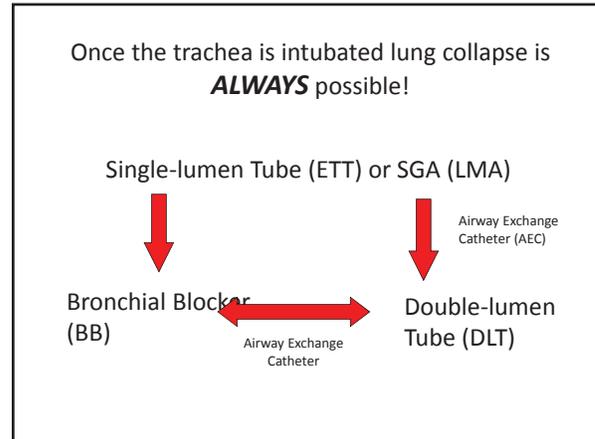
The DLT vs BB “Controversy”

- Gayes JM. Pro: One-lung ventilation is best accomplished with the Univent endotracheal tube. J Cardiothorac Vasc Anesth (1993) 7:108-112
- Cohen E. Pro: The new endobronchial blockers are preferable to double-lumen tubes for lung isolation. J Cardiothorac Vasc Anesth (2008) 22: 920-924
- Neustein SM. Pro: Bronchial blockers should be used routinely for providing one-lung ventilation. J Cardiothorac Vasc Anesth (2015) 29: 234-6
- Slinger P. Con: The Univent tube is not the best method of providing one-lung ventilation. J Cardiothorac Vasc Anesth (1993) 7: 108-112
- Slinger P. Con: The new endobronchial blockers are preferable to double-lumen tubes for lung isolation. J Cardiothorac Vasc Anesth (2008) 22: 925-929
- Brodsky JB. Con: A bronchial blocker is not a substitute for a double-lumen endobronchial tube. J Cardiothorac Vasc Anesth (2015) 29: 237-239

- For most patients either a DLT or BB can be safely used – the choice is one of personal preference
- No significant differences in the quality of lung isolation
- Both have advantages in specific clinical situations

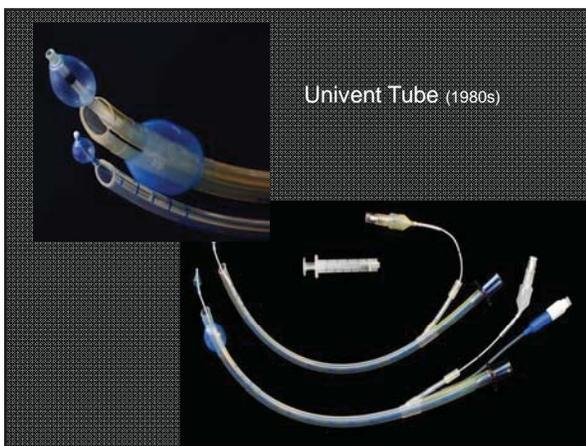
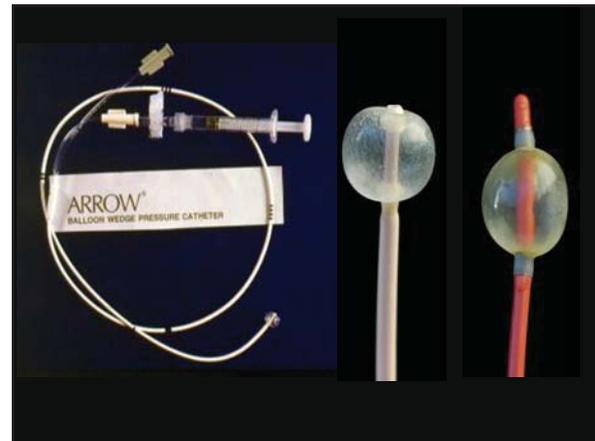
Anesthesiologists should be skilled in both techniques

Clayton-Smith A, et al. A comparison of the efficacy and adverse effects of double-lumen endobronchial tubes and bronchial blockers in thoracic surgery: A systemic review and meta-analysis of randomized controlled trials. J Cardiothor Vasc Anesth (2015) 29: 955-966



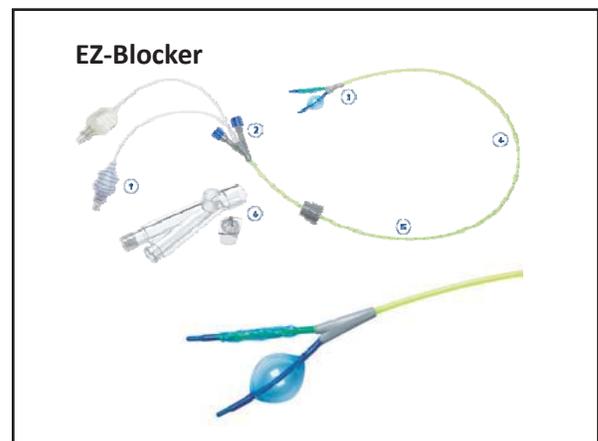
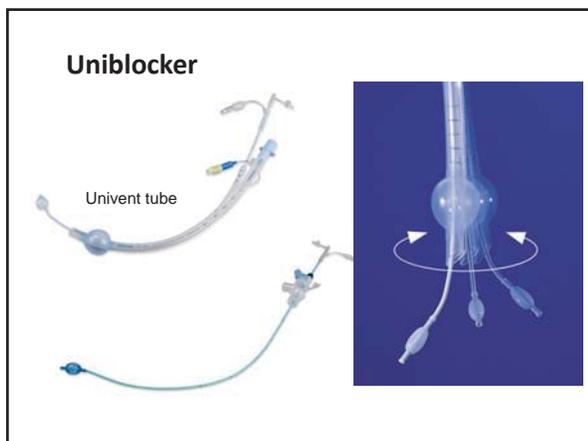
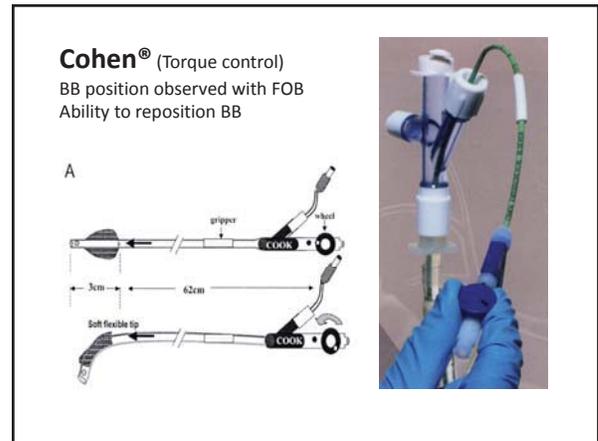
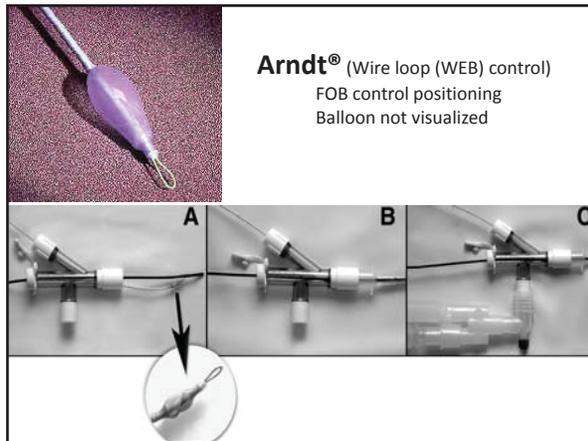
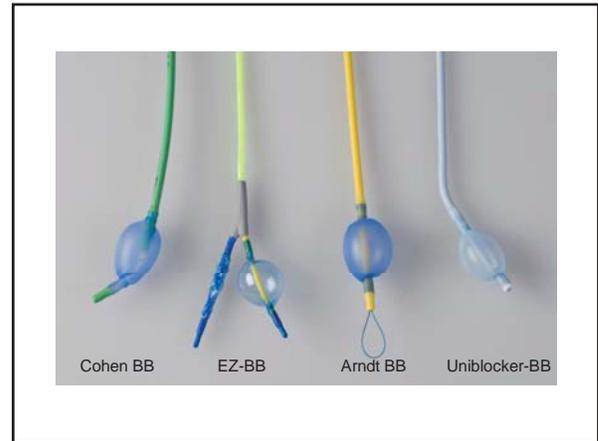
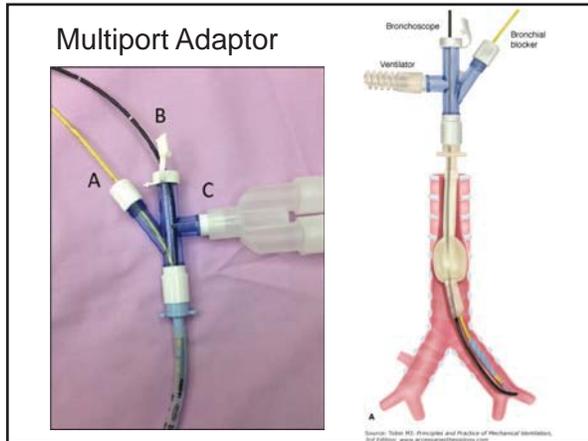
Bronchial Blockers: Advantages

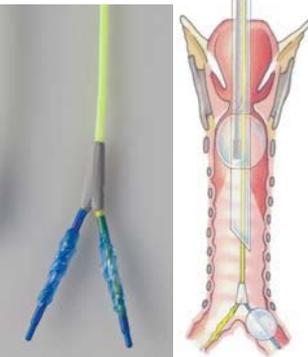
- Can be used with any endotracheal tube (oral, nasal, tracheostomy) or LMA
- Not necessary to change to ETT if *potential* or *planned* postoperative ventilation (“difficult airway”)
- Allows selective lobar blockade
- ETT fits in very small adult airways; technique of choice in pediatrics



Fiberoptic Bronchoscopy

Oxorn D. Use of fiberoptic bronchoscope to assist placement of a Fogarty catheter as a bronchial blocker. Can J Anaesth (1987) 34: 427-8.





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

Brodsky JB, et al. Sequential bilateral lung isolation with a single bronchial blocker. Anesth Analg Case Reports (2013) 1: 17-18

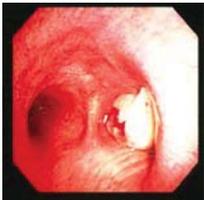
EZ-Blocker is only BB that can be placed “blindly” without bronchoscopy

- Use in very small ETT (no pediatric FOB available)
- During emergencies (“blind” without FOB)
- When airway cannot be visualized ie hemorrhage

Miller CA, Sabhlok S, Brodsky JB. “Blind” placement of a bronchial blocker in a patient with a difficult airway. J Cardiothorac Vasc Anesth. 2013 Oct;27(5):e61-2.

Bronchial Blocker - Contraindications

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



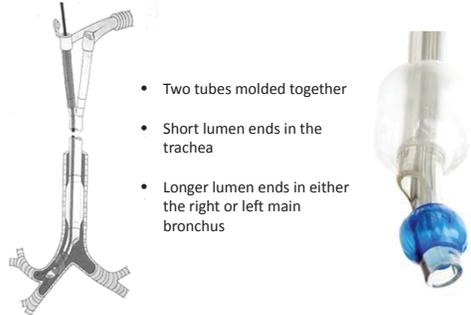
DLT can always be positioned in the opposite bronchus

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



BB cannot collapse entire right lung

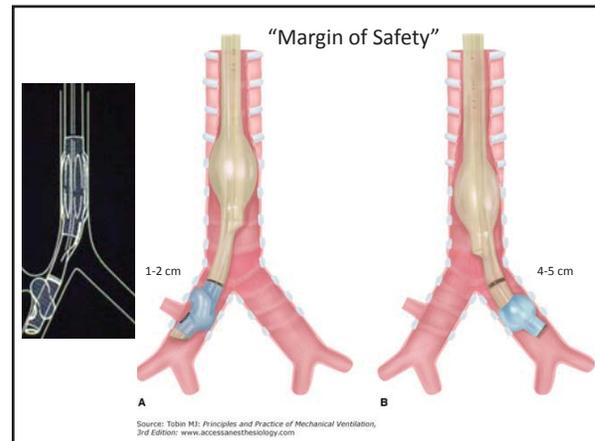
Double-lumen Tubes



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



(1950) Carlens (1962) Robertshaw



What is a Difficult Airway? *

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

ASA Task Force: Practice Guidelines for the Management of the Difficult Airway. Anesthesiology 1993; 78: 597-602

- * <1993 "difficult airway" was called "difficult intubation"
- ** 2013 - difficulty with SGA placement/ventilation added

Difficult Airway

Obesity (mask ventilation, DL)

+

OSA (MV, laryngoscopy)

+

Thoracic Surgery (special tubes)

Double-lumen Tube – Laryngoscopy

Bullard Laryngoscope
Shulman GB, et al: Double lumen tube placement with the Bullard laryngoscope. Can J Anaesth 1999; 46: 232-4

WuScope
Smith CE, et al: Fiberoptic laryngoscopy (WuScope) for double-lumen endobronchial tube placement in two difficult-intubation patients. Anesthesiology 2002; 93: 906-7

Pentax-Airway
Yu HD, et al: Usefulness of the WuScope to facilitate double-lumen endotracheal tube placement in patients with ankylosing spondylitis. Chang Gung Med J 2011; 34: 218-23

Macintosh
Poon KH, et al: The Airway Scope for difficult double-lumen tube intubation. J Clin Anesth. 2008; 20: 319

Macintosh
Suzuki A, et al: Double lumen tube placement with the Pentax-Airway Scope. Can J Anaesth. 2007; 54: 853-4

Macintosh
Purugganan RV, et al: Video laryngoscopy versus direct laryngoscopy for double-lumen endotracheal tube intubation: a retrospective analysis. J Cardiothorac Vasc Anesth 2010; 26: 845-8

LMA C Trach
Karaboyk L: Placement of a double-lumen tube using LMA C Trach and an exchanger catheter in difficult airway intubation – A case report. Korean J Anesthesiol 2012; 65: 565-7

AirTraq
Harabayashi Y, et al: The AirTraq laryngoscope for placement of double-lumen endobronchial tube. Can J Anaesth. 2007; 54: 955-7

AirTraq
Salazar H, et al: Double lumen tube insertion in awake patients through the AirTraq laryngoscope in 2 cases of expected difficult airway. Rev Esp Anesthesiol 2011; 58: 315-7

AirTraq
Wasem S, et al: Comparison of the AirTraq and the Macintosh laryngoscope for double-lumen tube intubation: a randomised clinical trial. Eur J Anaesthesiol 2013; 30: 180-8

Glidescope
Omrubi X, et al: Use of Glidescope for double lumen endotracheal tube insertion in an awake patient with difficult airway. Rev Esp Anesthesiol Reanim 2013; epub

Bonfils Intubation Fiberscope
Ben B, et al: Using the Bonfils intubation fiberscope with a double-lumen tracheal tube. Anesthesiology. 2005; 102: 1290-1

Lighted Stylets (Trachlight)
Chen KY, et al: Double-lumen endobronchial tube intubation in patients with difficult airways using Trachlight and a modified technique. Anesth Analg. 2007; 105: 1425-9

O'Connor
O'Connor CJ, et al: Use of lighted stylets to facilitate insertion of double-lumen endobronchial tubes in patients with difficult airway anatomy. J Clin Anesth. 2006; 18: 618-9

Scanzillo
Scanzillo MA, et al: Lighted stylet for placement of a double-lumen endobronchial tube. Anesth Analg. 1995; 81: 205-6

Watanabe
Watanabe R: Modified long Trachlight wand for a double-lumen endobronchial tube. J Anesth. 2004; 18: 144-5

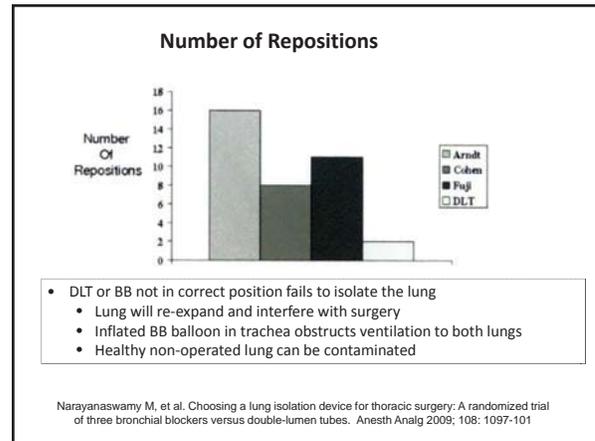
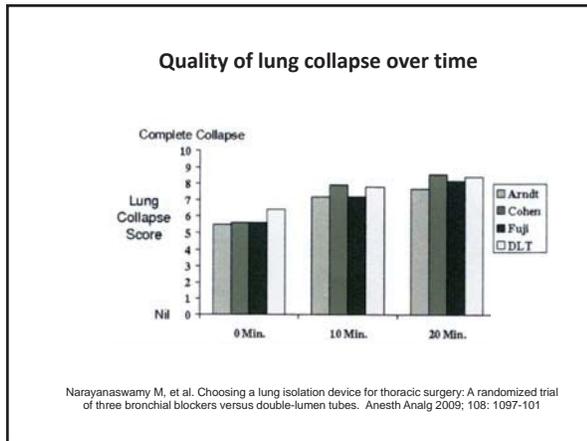
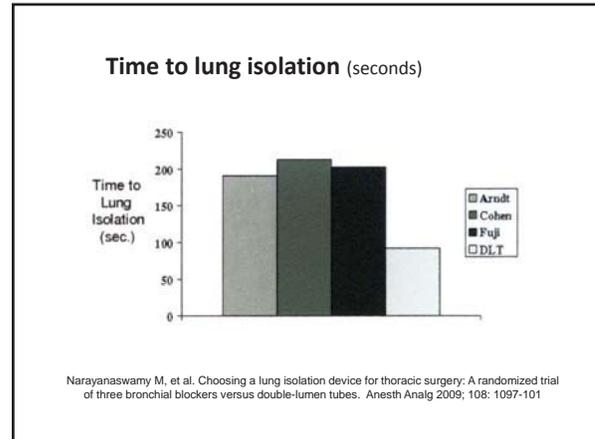
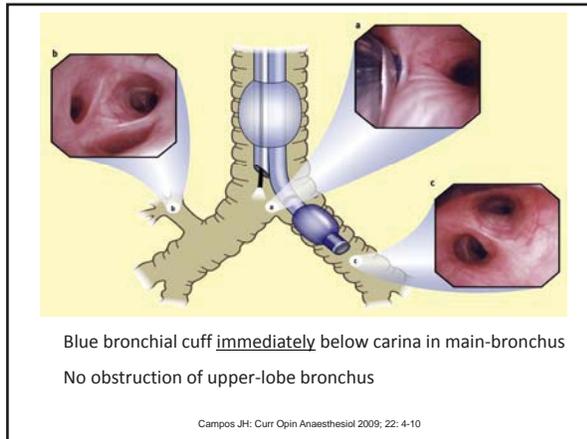
Clarus Video System/Trichlight
YR, et al: The use of the Clarus Video System for double-lumen endobronchial tube intubation in a patient with a difficult airway. Korean J Anesthesiol 2013; 65: 85-8

Yang
Yang M, et al: Double-lumen tube tracheal intubation using a rigid video-stylet: a randomised controlled comparison with the Macintosh laryngoscope. Br J Anaesth 2013; epub

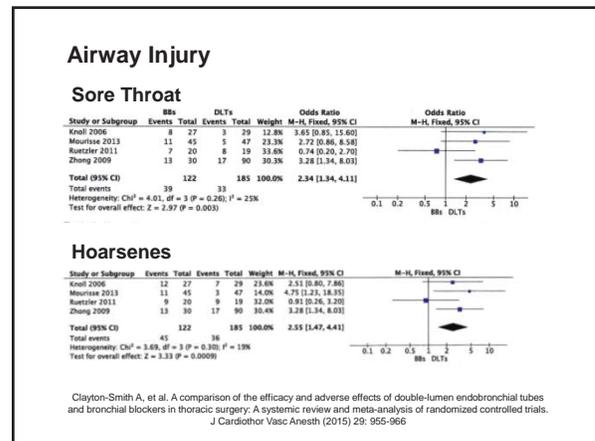
Glidescope

- Chen A, et al: Glidescope-assisted double-lumen endobronchial tube placement in a patient with an unanticipated difficult airway. J Cardiothorac Vasc Anesth. 2008; 22: 170-2
- Hernandez AA, et al: Using a Glidescope for intubating with a double lumen endotracheal tube. Can J Anaesth. 2005; 52: 658-9
- Bustamante S, et al: Sequential rotation to insert a left double-lumen endotracheal tube using the Glidescope. Can J Anaesth 2010; 57: 282-3
- Hsu HT, et al: Comparison of the Glidescope® videolaryngoscope and the Macintosh laryngoscope for double-lumen tube intubation, Anaesthesia 2012; 67: 411-5

Bussieres JS, et al. A customized stylet for Glidescope® insertion of double lumen tubes. Can J Anesth 2012; 59: 424-5



DLT	Bronchial Blocker
<ul style="list-style-type: none"> Increased risk of serious airway (tracheal and/or bronchial) trauma due to rigidity and diameter of DLT 	<ul style="list-style-type: none"> Less risk of trauma since BB inserted through a standard ETT



Postoperative Ventilation - **Double-lumen Tube**

Ventilate with DLT

or

Exchange for ETT

Deflate bronchial cuff

or

Deflate both cuffs

Pull DLT above carina

Re-inflate tracheal balloon



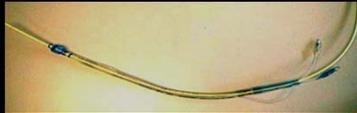
AEC with relatively large o.d. /DLT with relatively small i.d.



Mort TC and Surette A-M. Airway Management, Anesthesiology News 2017-18

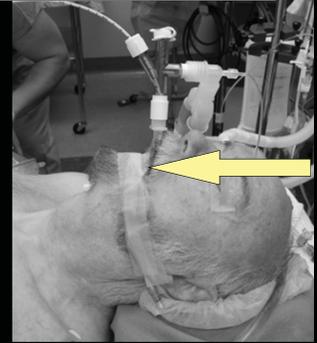
Lubricate the AEC

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



Never advance against resistance

Do not insert past 25-26 cm at lips – risk of airway laceration



Laryngoscopy lifts supraglottic tissue - facilitates tube passage at the glottis

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



Have rescue jet ventilation available if the airway is lost



Conclusion Of Surgery - Bronchial Blocker

- Withdraw BB
- Ventilate through ETT



Favors DLT

- Displacement less frequent
- CPAP easily applied
- Allows suctioning before re-inflation of operative lung
- Lungs can be re-expanded and collapsed during surgery
- Used for operations on contra-lateral lung if main bronchus is obstructed
 - faster and easier to place – “blind” placement possible
 - more rapid lung deflation
 - sequential surgery
 - technique when lung isolation absolutely essential (eg bronchopulmonary lavage)
 - “split lung” ventilation in ICU

Favors BB

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

Obstructive Sleep Apnea (OSA)

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

“Difficult airway” and OSA



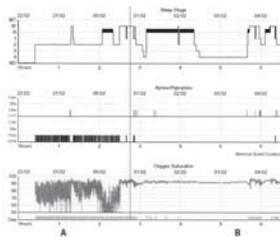
70 - 90% of all patients scheduled for bariatric surgery have OSA

Increased amount of pharyngeal tissue

Obstruction during mask ventilation

Increased tracheal intubation and extubation difficulties

Polysomnography (PSN) - “Sleep Study”



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

National Sleep Study (Polysomnography) Procedure Pricing Summary

National Minimum Price	\$1,150 (Lebanon, PA)
National Average Price	\$2,625
National Maximum Price	\$5,000 (Durant, OK)

Sleep Study (Polysomnography) Cost Averages Around the Country

Phoenix, AZ Sleep Study (Polysomnography) Cost Average	\$2,400
Washington, DC Sleep Study (Polysomnography) Cost Average	\$2,475
Philadelphia, PA Sleep Study (Polysomnography) Cost Average	\$2,850
Houston, TX Sleep Study (Polysomnography) Cost Average	\$2,475
Miami, FL Sleep Study (Polysomnography) Cost Average	\$2,625
Dallas, TX Sleep Study (Polysomnography) Cost Average	\$2,400
Chicago, IL Sleep Study (Polysomnography) Cost Average	\$2,625
Los Angeles, CA Sleep Study (Polysomnography) Cost Average	\$2,850
New York, NY Sleep Study (Polysomnography) Cost Average	\$3,100
Atlanta, GA Sleep Study (Polysomnography) Cost Average	\$2,475

American Society of Anesthesiologists Task Force on Perioperative Management of patients with obstructive sleep apnea. **PRACTICE GUIDELINES FOR THE PERIOPERATIVE MANAGEMENT OF PATIENTS WITH OBSTRUCTIVE SLEEP APNEA**
Anesthesiology 2006; 104:1081-93

A. Clinical signs and symptoms suggesting the possibility of OSA

1. Predisposing physical characteristics
 - a. BMI 35 kg/m² [95th percentile for age and gender]*
 - b. Neck circumference 17 inches (men) or 16 inches (women)
 - c. Craniofacial abnormalities affecting the airway
 - d. Anatomical nasal obstruction
 - e. Tonsils nearly touching or touching in the midline

STOP-BANG Questionnaire for Obstructive Sleep Apnea (OSA)

SNORE: Do you snore loudly? (Snoring heard through closed door)

TIRED: Do you feel tired, sleepy, fatigued, during daytime?

OBERVED: Has anyone seen you stop breathing during sleep?

BLOOD **P**RESSURE: Do you have or are you being treated for high blood pressure?

BMI: Is your BMI > 35kg/m²?

AGE: Are you older than 50?

NECK **C**IRCUMFERENCE: Is your neck circumference > 40 cm? Size 16 collar

GENDER: Are you a male?

+3 probable OSA
+5 high likelihood OSA

Chung F, et al. Screening for obstructive sleep apnea before surgery: why is it important? Current Op Anaesthesiol (2009) 22: 405-11

“Safe” Sleep Disordered-Breathing Anesthetic Guidelines: Perioperative management of the obese surgical patient. Anaesthesia (2015)

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

Consensus Statement:
 J Society for Obesity and Bariatric Anaesthesia
 Obstetric Anaesthetist’s Association
 Royal College of Anaesthetists
 British Association of Day Surgery
 Resuscitation Council (UK)
 Difficult Airway Society
 Association of Anaesthetists of Great Britain & Ireland

“Restrictive” fluid management in thoracic surgery

(1984) **Post-Pneumonectomy Pulmonary Edema (PPE)**

10 cases of fatal acute lung injury following pneumonectomy

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

Zeldin RA, et al. Postpneumonectomy pulmonary edema. J Thorac Cardiovasc Surgery 1984; 87: 359-365

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

Slinger P (1999) Post-pneumonectomy pulmonary edema: is anesthesia to blame? Curr Opin Anaesthesiol 12: 49-54

Acute Lung Injury (ALI) - risk factors

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

Licker M, et al (2003) Risk factors for acute lung injury after thoracic surgery for lung cancer. Anesth Analg 97: 1558-65

Possible Mechanisms PPE

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

Baudouin SV (2003) Lung injury after thoracotomy. Br J Anaesth 91: 132-42

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

McGovern I, et al (2007) Pain relief after thoracotomy. Brit J Anaesth 98: 844-5

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

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

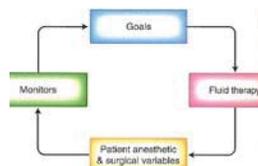
- Recent findings question the relationship between fluid administration and ALI after lung resection
- Growing interest in tissue hypo-perfusion resulting from **inadequate** fluid resuscitation and acute kidney injury after lung resection
- Recommend Goal-directed (GD) fluid therapy

Assaad S, et al (2013) Fluid management in thoracic surgery. Curr Opin Anaesthesiol 26: 31-39

Goal Directed (GD) Fluid Management

Monitor for Inadequate Perfusion

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



GOAL Directed (GD) Fluid Replacement

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

GD Replacement (using hemodynamic parameters)

- Less pneumonia
- Less renal complications
- Earlier return of bowel movement
- Shorter hospital stay

Corcoran T, et al (2012) Perioperative fluid management strategies in major surgery: a stratified met-analysis. Anesth Analg 114: 640-51

Fluid Guidelines for Thoracic Surgery

Use **Goal Directed** fluid replacement

Monitor hemodynamic parameters (ABG)

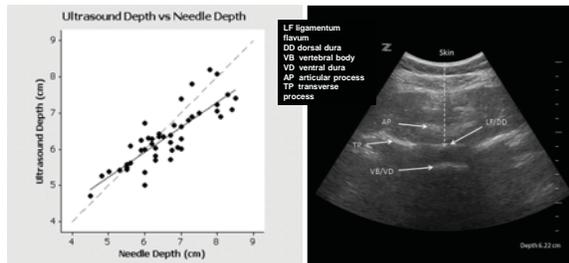
- **Crystalloids** – limit average adult to < 2.0 L during procedure (< 3.0 L during POD #1)
- **Colloids** – if additional fluid needed to maintain cardiovascular stability and renal function (intra-operatively and post-operatively)
- **Blood** - replace blood loss with blood

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

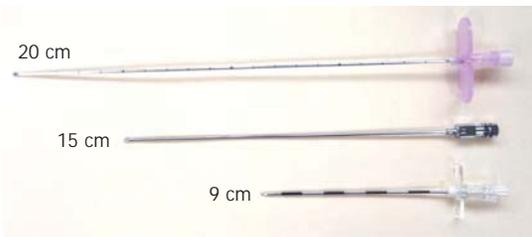
Slinger PD. **PRO: Every postthoracotomy patient deserves thoracic epidural analgesia.** J Cardiothorac Vasc Anesth (1999) 13:350-4



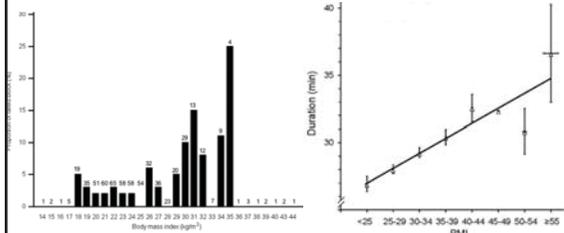
Ultrasound imaging used to measure depth to epidural space



Baiki M, et al. Ultrasound imaging of the lumbar spine in the transverse plane: The correlation between estimated and actual depth of the epidural space in obese parturients. Anesth Analg 2009; 108: 1876-81



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



Epidural catheter can pull out > 1 cm
Advance > 4 cm into epidural space

	Body Mass Index (kg/m ²)		
	< 25 n = 46	25-30 n = 116	> 30 n = 92
Change FLEX to UP (cm)	0.23 ± 0.17	0.33 ± 0.28	0.38 ± 0.30*
Change UP to LAT (cm)	0.48 ± 0.41	0.51 ± 0.41	0.69 ± 0.66†
Change FLEX to LAT (cm)	0.67 ± 0.42	0.75 ± 0.48	1.04 ± 0.69†
Ranges of Change FLEX to LAT (cm)	0-1.9	0-2.72	0.11-4.28

Hamilton et al. Changes in the position of epidural catheters associated with patient. Anesthesiology. 1997; 86:778-84

Epidural Analgesia

Urinary retention	Motor block – delays ambulation?
Nausea	Hypotension – delays ambulation
Pruritis	Respiratory Depression
Hypotension (intraoperative)	Failed block
Neurologic Injury	Dural Puncture
– Trauma during placement	– High block
– Epidural hematoma	– Spinal headache
– Epidural abscess	

Grant RP. **CON: Every postthoracotomy patient deserves thoracic epidural analgesia.** J Cardiothorac Vasc Anesth (1999) 13:350-4

No evidence of major advantage for TEA

- TEA has rare (but serious) risks
- TEA only for high-risk patients

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

Paravertebral Block (ICN block)

- Intercostal nerves are not enveloped by fascial sheath
- Also blocks sympathetic ganglia, posterior intercostal rami, nerves to costovertebral joints

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

Hypotension following thoracotomy

Study	PVB n/N	Epidural n/N	OR (fixed) 95% CI	Weight %	OR (fixed) 95% CI
De Castro et al ¹	3/25	13/22	0.13 (0.01, 2.80)		
Mathews et al ²	8/5	24/65	0.03 (0.00, 0.58)		
Simion et al ³	1/50	4/40	0.08 (0.04, 1.12)		
Richardson et al ⁴	3/48	27/27	0.08 (0.00, 1.10)		
Shen et al ⁵	0/20	1/20	5.56 (0.21, 15.86)		
Leaver et al ⁶	2/14	25/11	0.15 (0.02, 0.88)		
Total (95% CI)	145	138		100.00	0.12 (0.04, 0.34)

Test for heterogeneity: $\chi^2=2.95$, $df=6$ ($P=0.72$), $I^2=0\%$
Test for overall effect: $Z=4.51$ ($P<0.0001$)

FAVORS PVB FAVORS TEA

Davies RG et al (2006) A comparison of the analgesic efficacy and side-effects of paravertebral vs epidural blockade for thoracotomy – a systematic review and meta-analysis of randomized trials. Br J Anaesth 96: 418-426

Paravertebral Block (PVB) vs Thoracic Epidural Analgesia (TEA)

Urinary retention

Study	PVB n/N	Epidural n/N	OR (fixed) 95% CI	Weight %	OR (fixed) 95% CI
Mathews et al ¹	1/10	8/9	0.06 (0.00, 0.87)	21.54	0.06 (0.00, 0.87)
Shen et al ²	0/20	6/20	0.04 (0.00, 0.89)	28.59	0.04 (0.00, 0.89)
Richardson et al ³	0/46	11/49	0.42 (0.13, 1.32)	35.96	0.42 (0.13, 1.32)
Leaver et al ⁴	1/14	13/15	0.38 (0.05, 2.54)	13.59	0.38 (0.05, 2.54)
Total (95% CI)	100	93		100.00	0.23 (0.10, 0.51)

Total events: 16 (PVB), 36 (Epidural)
Test for heterogeneity: $\chi^2=4.13$, $df=3$ ($P=0.25$), $I^2=27.4\%$
Test for overall effect: $Z=3.34$ ($P<0.0004$)

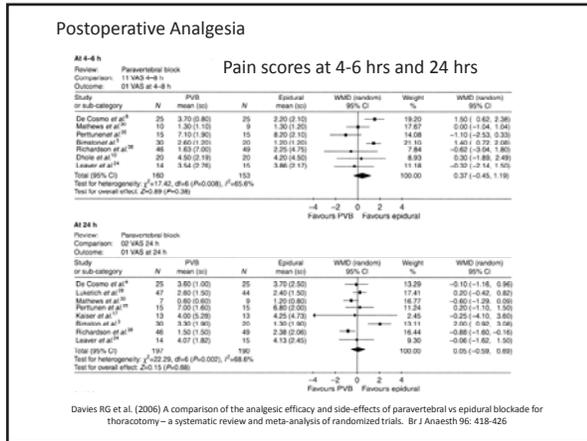
Nausea and vomiting

Study	PVB n/N	Epidural n/N	OR (fixed) 95% CI	Weight %	OR (fixed) 95% CI
De Castro et al ¹	0/25	3/25	0.00 (0.00, 4.04)	8.95	0.00 (0.00, 4.04)
Mathews et al ²	2/5	9/15	0.24 (0.01, 2.63)	16.24	0.24 (0.01, 2.63)
Richardson et al ³	7/20	7/20	0.57 (0.16, 1.97)	26.14	0.57 (0.16, 1.97)
Richardson et al ⁴	2/48	10/49	0.18 (0.04, 0.86)	37.40	0.18 (0.04, 0.86)
Leaver et al ⁵	3/14	4/15	1.53 (0.31, 7.44)	10.00	1.53 (0.31, 7.44)
Total (95% CI)	130	124		100.00	0.47 (0.24, 0.93)

Total events: 17 (PVB), 29 (Epidural)
Test for heterogeneity: $\chi^2=4.24$, $df=4$ ($P=0.48$), $I^2=1.1\%$
Test for overall effect: $Z=3.17$ ($P<0.0008$)

FAVORS PVB FAVORS TEA

Davies RG et al (2006) A comparison of the analgesic efficacy and side-effects of paravertebral vs epidural blockade for thoracotomy – a systematic review and meta-analysis of randomized trials. Br J Anaesth 96: 418-426



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



Do morbidly obese patients tolerate one-lung ventilation?

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

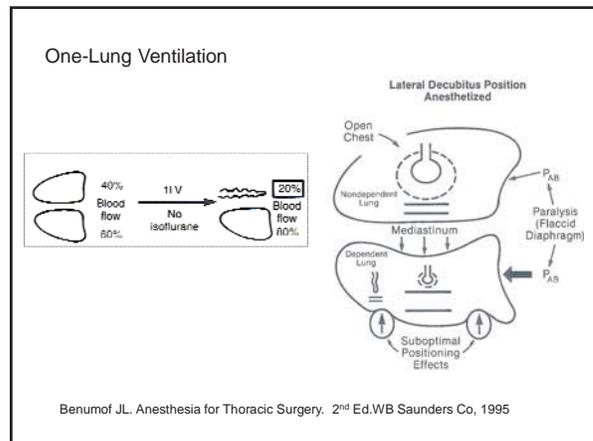
Anesthesiology, 57:132-134, 1982

Reprinted from ANESTHESIOLOGY, Vol. 57, No. 2, August 1982

One-lung Anesthesia in Morbidly Obese Patients

JAY B. BRODSKY, M.D.,* JANET WYSER, M.B., CH.B.,* JAN EHRENWERTH, M.D.,* RONALD C. MERRELL, M.D.,† ROY B. COHN, M.D.‡

	P _a O ₂ (mmHg)	
	Group 1 (n = 8)	Group 2 (n = 8)
Preoperative (room air)	77.6 ± 1.6 (57-98)	79.0 ± 1.5 (66-96)
Intraoperative (100 per cent O ₂)*	318.3 ± 11.5 (195-443)	130.3 ± 7.5 (72-230)
Postoperative (room air)		
Day 1	64.9 ± 1.2 (56-76)	60.9 ± 1.0 (48-75)
Day 2	62.3 ± 1.0 (51-67)	58.6 ± 1.0 (47-72)



Volume Controlled One-Lung Ventilation

(Controversy 2006)

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

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

“Protective OLV” minimizes VALI

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

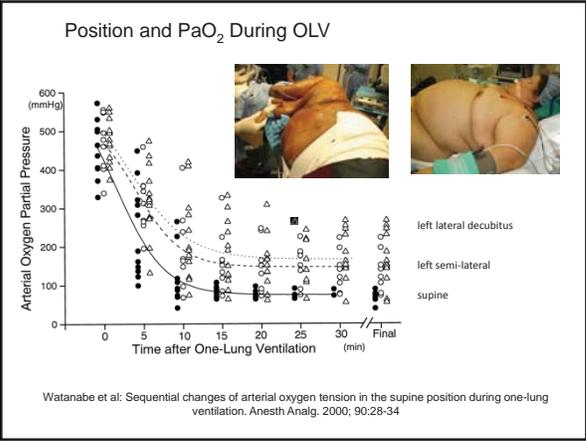
Della Rocca G, et al. Acute lung injury in thoracic surgery. *Curr Opin Anaesthesiol.* 2013; 26: 40-6

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

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

• **NO ADVANTAGE TO “PROTECTIVE” OLV**

Ahn HJ, et al. Comparison between conventional and protective one-lung ventilation for ventilator-assisted thoracic surgery. *Anaesth Intensive Care* 2012; 40: 780-8





Anesthesia in Traumatic Brain Injury

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



Disclosures

- IP for monitoring technology licensed to Medtronic



Set up audience participation

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



Test question



Outline

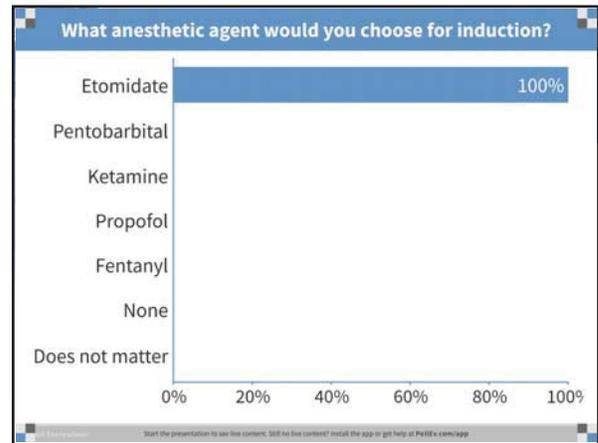
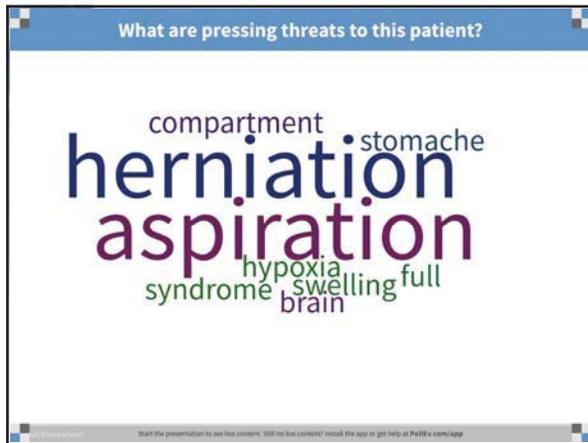
- Case-based care-decisions:
 - ICP monitoring and management
 - Ventilation
 - Anesthetic agents
 - Temperature management
 - CPP management
 - Steroids
 - DVT prophylaxis
 - Seizure management and prophylaxis



Case #1: Multi-system trauma

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

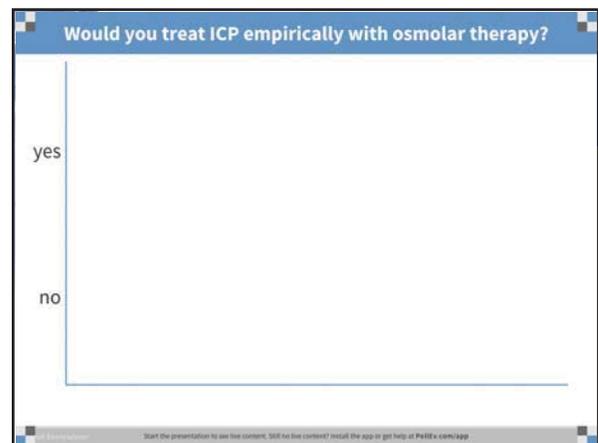
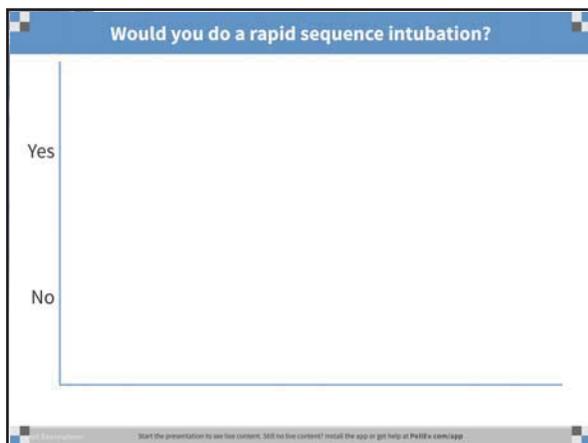
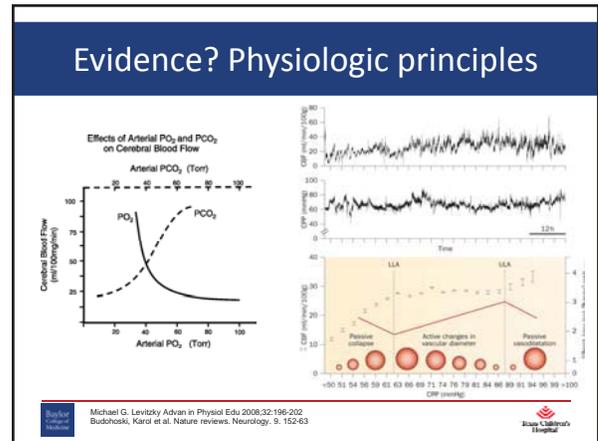


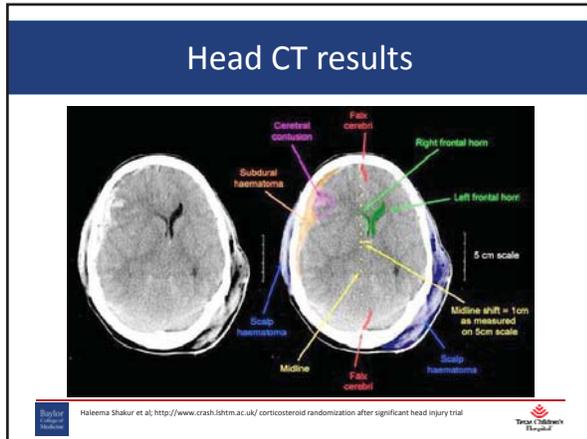


Acute brain trauma management

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

Smith, Julian et al. (2006), Textbook of Surgery, Wiley-Blackwell, p. 446





Would you monitor ICP in this patient?

Yes

No

Start the presentation to see live content. Still no live content? Install the app or get help at [PallEx.com/app](#)

Brain Trauma Foundation Guidelines 4th edition

12. INTRACRANIAL PRESSURE MONITORING
LEVEL I AND II A

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

LEVEL II B

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

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

Brain Trauma Foundation Guidelines 3rd edition

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

Kerr M, Crago EA. Nursing management: acute intracranial problems. In: O'Brien PG, Giddens JF, Bucher L, eds. Medical-Surgical Nursing: Assessment and Management of Clinical Problems. St Louis, Mo: CV Mosby Inc; 2004: 1493-1524.

ICP monitoring kerfuffle

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

Posted to the OR

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

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

Elevated ICP

Frequent ICP elevations lasting 10-20 minutes with associated decrease in $P_{BT}O_2$

- Sedated, paralyzed, 36.5°C
- SpO_2 98%, TV450, rate 12, PIP 24, PEEP 4, F_iO_2 40%
- HR 80, ICP, ABP, $P_{BT}O_2$ shown on right.
- Na 142, Hb 10.3, 7.43/37/120

ICP is 45 mmHg positioning for angiography injection

What is your first response?

- Ventilate to CO2 25
- Propofol or other IV anesthetic
- Raise the ABP with phenylephrine
- Administer hypertonic saline or mannitol
- Cool the patient to 34 degrees
- Administer 100% oxygen
- Give steroids

BTF guidelines: Osmolar therapy

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

How do you use the forced air warmer in this patient with severe TBI?

- Set to low and cool the patient to 34 degrees
- Set to high and do not allow the temperature to exceed 36.5 degrees
- Set to high and use normally

BTF guidelines: hypothermia

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

Rank your preference of anesthetic maintenance agents

- Pentobarbital
- Propofol
- Volatile anesthetic
- Dexmedetomidine
- Benzodiazepene
- Remifentanyl

BTF guidelines: Anesthetic

- Administration of barbiturates to induce burst suppression measured by EEG as prophylaxis against the development of intracranial hypertension is not recommended.
- High-dose barbiturate administration is recommended to control elevated ICP refractory to maximum standard medical and surgical treatment. Hemodynamic stability is essential before and during barbiturate therapy.
- Although propofol is recommended for the control of ICP, it is not recommended for improvement in mortality or 6-month outcomes. Caution is required as high-dose propofol can produce significant morbidity.

What is your ventilation strategy?

Low TV; high PEEP; permissive hypercapnea

nl TV; low PEEP; normocapnea

nl TV; low PEEP; hyperventilation to hypocapnea

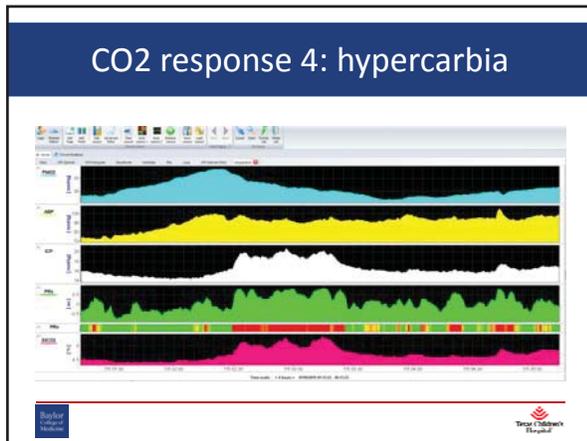
BTF guidelines: Ventilation

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

CO2 response 1: Vasoconstriction

CO2 response 2: Pressure Passive

CO2 response 3: Preserved CBF



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

Would you give this patient steroids for brain swelling?

Yes

No

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

Case #2: DVT concerns

78 year old man falls from third stair.

- GCS 12: eyes open to voice(3) confused(4) localizes to pain(5).
- CT shown on right:
- Pelvic fracture of superior and inferior pubic rami.

- ### How would you prevent DVT in this patient
- pneumatic compression devices only
 - LMWH or heparin at admission
 - LMWH or heparin only after stable CT for 24-48 hrs
 - coumadin after stable CT for 24-48 hrs
 - aspirin only

BTF guidelines: DVT prophylaxis

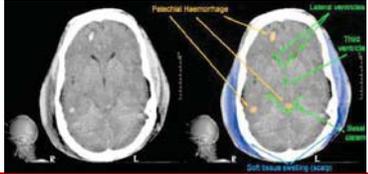
- LMWH or low-dose unfractionated heparin may be used in combination with mechanical prophylaxis. However, there is an increased risk for expansion of intracranial hemorrhage.
- In addition to compression stockings, pharmacologic prophylaxis may be considered if the brain injury is stable and the benefit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

Case #3: Surgery in setting of TBI

11 year old boy pedestrian struck.

- GCS 10: eyes open to pain(2) inappropriate words(3) localizes pain(5)
- HR 130, ABP 145/95, R 45 S_pO₂ 95% NRB
- Rib fractures on CXR
- CT shown

Admitted to the ICU for observation

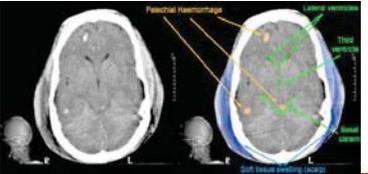


Case #3: Surgery in setting of TBI

11 year old boy pedestrian struck.

- Overnight his GCS fluctuates from 7 to 12, agitated and combative
- CXR in AM shows massive pleural effusion and mediastinal shift
- HR: 125; ABP 95/45; R 45; S_pO₂ 90% NRB

Posted for thoracotomy/hematoma evacuation



How would you rank the effectiveness of the following recommendations?

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

What concern about this patient most influenced your decision?

Summary

- Wear a helmet when skiing

Monday

WHAT'S NEW IN OBSTETRIC ANESTHESIA FROM 2017?

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

GOALS & OBJECTIVES

Discuss how literature from the past year may:

1. Change clinical practice in obstetric anesthesia via new **guidelines and policies**.
2. Give best practices for **analgesic and anesthetic techniques** during labor and delivery.
3. Optimize and expedite management of **obstetric and anesthetic complications**.
4. Alter practices affecting the **fetus and newborn**.

NEW GUIDELINES AND POLICIES

BIRTH DATA – 2016

Provisional U.S. birth data from 2016:

- 3.9 million births, down 1%
- Birth rate for teenagers age 15-19 declined 9%
- 77% of women began prenatal care in the 1st trimester
- Cesarean delivery rate declined for the 4th year to 32%
- Preterm birth rate rose for the 2nd year to 9.8%

Natl Vital Statistics System #002, June 2017

MATERNAL MORTALITY

Why did maternal mortality rates (per 100K live births) increase in the United States?

- Retrospective review of deaths from 1993-2014.
- MMRs ↑ from 7.55/100K in 1993 to 21.5/100K in 2014.
- Improvements in surveillance accounted for almost all of the change and highlight past under-estimation.
- Complete ascertainment of maternal deaths is a challenge.

Obstet Gynecol 2017; 129: 91

MATERNAL MORTALITY

The CDC published its 2011-13 update on U.S. pregnancy-related maternal mortality:

- 17 deaths per 100K live births (stable).
- 15% of births were to women > 35, but 30% of deaths were in this age group.
- Hemorrhage, HTN and anesthesia causes declined.
- Cardiovascular, CVA and other medical conditions ↑.
- African-American women's death rates 3.4 times higher.

Obstet Gynecol 2017; 130: 366

MATERNAL MORTALITY

The case for a national maternal mortality review committee:

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

Obstet Gynecol 2017; 130: 198

MATERNAL MORTALITY

Rural health care and the Maternal Health Compact:

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

N Engl J Med 2017; 376: 1304

Am J Obstet Gynecol 2017; 216: 179

TRAUMA MORTALITY

What is the impact of trauma on maternal mortality?

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

Am J Obstet Gynecol 2017; 217: 590

MORTALITY DUE TO VIOLENCE

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

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

Am J Obstet Gynecol 2017; 217: 556

DISASTER PREPAREDNESS

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

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

Obstet Gynecol 2017; 130: e291

DIAGNOSTIC IMAGING

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

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

Obstet Gynecol 2017; 130: e210

MARIJUANA USE

ACOG Committee Opinion: Marijuana use during pregnancy and lactation.

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

Obstet Gynecol 2017; 130: e205

DEALING WITH THE BIRTH PLAN

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

Medscape.com/885375

HOME BIRTH

ACOG Committee Opinion: Planned home birth

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

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

VAGINAL SEEDING

ACOG Committee Opinion: Vaginal seeding

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

Obstet Gynecol 2017; 130: e274

ANALGESIA FOR LABOR

ACOG PRACTICE BULLETIN

#177: *Obstetric Analgesia and Anesthesia*

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

Obstet Gynecol 2017; 129: e73

ACOG COMMITTEE OPINION

#687: *Approaches to Limit Intervention During Labor & Birth*

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

Obstet Gynecol 2017; 129: e20

RESOLVING OP POSITION

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

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

J Clin Ultrasound 2017; 45: 472

NPO STATUS IN LABOR

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

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

Obstet Gynecol 2017; 129: 473

INTRAVENOUS FLUIDS

Does glucose supplementation shorten labor course?

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

Am J Obstet Gynecol 2017; 216: 508

INTRAVENOUS FLUIDS

Do high-dose IV fluids, standard dose fluids with glucose, or high-dose fluids with glucose affect labor?

- 274 G1 randomized to 125 ml/hr D5NS, 250 ml/hr NS or 250 ml/hr D5NS.
- No difference between groups in total length of labor, length of first stage, length of second stage or cesarean delivery rates.

Am J Obstet Gynecol 2017; 217: 208

NITROUS OXIDE

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

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

(continued)

NITROUS OXIDE

Response from the APSF Committee on Technology:

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

Anesthesia Patient Safety Foundation Newsletter 6/17

NITROUS OXIDE

What is the relationship between analgesic effectiveness and patient satisfaction comparing nitrous, CSE, both?

- Standardized survey on postpartum day 1 over 3 years
- Only half who used nitrous reported high analgesia scores.
- > 90% using neuraxial analgesia had high scores
- Women who had poor or intermediate analgesia scores while using nitrous *still* had high satisfaction scores.
- Analgesia is not the only contributor to satisfaction.

Anesth Analg 2017; 124: 548

NITROUS OXIDE

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

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

REMIFENTANIL

A study to identify monitoring that could be used as early warning alerts for apnea when using R-PCA in labor:

- 53% of women had apneic episodes.
- Pulse oximetry missed most episodes of apnea.
- ET CO₂, respiratory rate, and integrated pulmonary index detected most apnea, but many false positives occurred.
- Continuous observation at bedside is best.

Anesth Analg 2017; 124: 1211

REMIFENTANIL

Survey on use of remifentanil PCIA during labor in 84 academic teaching centers in the U.S.:

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

Anesth Analg 2017; 124: 1208

REMIFENTANIL

Editorial: *Is it really an option to consider?*

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

Anesth Analg 2017; 124: 1029

REMIFENTANIL

A Cochrane review compared remifentanyl for labor analgesia versus other forms of pain relief. Results:

- 20 poor quality RCTs with 3569 women.
- No conclusions can be drawn about side effects or comparisons with other analgesics.
- No studies compared R with nitrous or no analgesia.
- More research is needed on maternal and neonatal safety, i.e. apnea, respiratory depression, Apgars.

Cochrane Database of Systematic Reviews 2017:CD011989

USE OF NEURAXIAL

When universal health care is available, is poverty associated with less than expected anesthetic care in pregnancy?

- French study; calculated a “deprivation index”
- Women who were *deprived* were less likely to complete an anesthesia pre-evaluation in 3rd trimester (the norm).
- They were just as likely to use neuraxial analgesia in labor.
- Why are they less likely to complete their antepartum care?

Anesth Analg 2017; 125: 925

EPIDURAL PLACEMENT

Does use of music during epidural placement ↓ anxiety? No.

- Used patient-preferred music on Pandora® versus none.
- No difference in pain scores or patient satisfaction with the procedure between groups. Music group had ↑ anxiety scores after placement.
- In the music group, more wanted music for future epidural placements (84% vs 45%).

Anesth Analg 2017; 124: 542

EPIDURAL PLACEMENT

FDA Drug Safety Communication:

“Rare but serious allergic reactions have been reported with the widely used skin antiseptic products containing chlorhexidine gluconate. Although rare.....has increased over the last several years. We are requesting the manufacturers of OTC antiseptic products containing chlorhexidine gluconate to add a warning about this risk.”

- 43 cases reported worldwide with 2 anaphylactic deaths

www.FDA.gov 2/2/2017

EPIDURAL PLACEMENT

Does high versus low epidural catheter placement change analgesic requirements during labor?

- 148 G1 laboring women randomized to ultrasound-confirmed L1-2 or L4-5 interspace for placement.
- L4-5 placement required more boluses in early labor for abdominal pain but had less perineal labor pain.
- No differences in PCEA requirements or satisfaction.
- Instrumental delivery rate: 15% low vs 5% high (p=.06)

Anesth Analg 2017; 125: 1969

EPIDURAL PLACEMENT

Does loss of resistance to saline provide better labor analgesia at 30 minutes than loss of resistance to air?

- 400 parturients were randomized to LOR air or saline.
- There was no difference between groups in onset time, pain score reduction, degree of motor block, or overall efficacy of the block after 30 minutes.

Anesth Analg 2018; 126: 532 (PAP 2017)

DURAL PUNCTURE EPIDURAL

Comparison of DPE, CSE (combined spinal-epidural), and E (epidural) techniques for labor analgesia:

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

Anesth Analg 2017; 124: 560

MAINTENANCE: PIEB

Review article: *Epidural analgesia for labor; continuous infusion versus programmed intermittent bolus*

- PIEB benefits include lower local anesthetic requirements, less breakthrough pain, improved patient satisfaction, less motor block and instrumental delivery
- Optimal combinations of bolus volume, rate, time interval, and drug concentrations are not known.

Anesthesiol Clin 2017; 35: 1-14

MAINTENANCE: PIEB

What is the optimal time interval between boluses using programmed intermittent epidural bolus (PIEB) technique for maintenance during labor analgesia?

- Double-blind sequential allocation trial for ED90
- Bolus dose was fixed at 10 ml 0.0625% bupivacaine + 3.3 µg/ml fentanyl; first dose 1 hour after initial epidural bolus
- The optimal interval was about 40 minutes (versus 30, 50 or 60 minute intervals)

Anesth Analg 2017; 124: 537

EPIDURAL & OUTCOMES

Systematic review of epidural analgesia using low concentration local anesthetics versus non-epidural analgesia for labor analgesia:

- 10 small RCT of low quality using 1809 women
- No differences in duration of second stage, instrumental birth rate, cesarean delivery rate, or duration of the first stage of labor.

Anesth Analg 2017; 124: 1571

EPIDURAL & OUTCOMES

Should epidural infusions be maintained in the second stage of labor, or will pushing be prolonged?

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

Obstet Gynecol 2017; 130: 1097

EPIDURAL MEDICATIONS

Epidural neostigmine reduces local anesthetic requirements similar to opioids. Compared to fentanyl:

- 4 groups → 0.125% bupivacaine + fentanyl 2µg/ml, or neostigmine 2, 4, or 8 µg/ml.
- There were no differences in the 4 groups in local anesthetic consumption and satisfaction was similar.
- Neostigmine is more expensive, now on production shortage, and has same effects as fentanyl.

Anesthesiology 2017; 127: 50

EPIDURAL MEDICATIONS

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

A&A Case Reports 2017; 8: 297

EPIDURAL & POSITION

Is it preferable for a woman to be upright in bed or lying down while pushing with an epidural? Will it improve spontaneous delivery rates?

- 3093 G1 were randomized to upright or lying position during the 2nd stage of labor.
- Spontaneous vaginal birth was 6% more likely in the lying-down group; no differences in other outcomes.

BMJ 2017; 359: 4471

EPIDURAL & PP DEPRESSION

If women intend to have epidural analgesia for labor but do not receive it, are they at higher risk for postpartum depression (PPD) due to untreated pain and unmet expectations?

- No ↑ in PPD if she planned an epidural but did not receive.
- + protective effect for those who intended and received E.
- ↑ PPD if she did not plan for an epidural but received one.
- Was this due to a physically difficult delivery, a sense of personal failure, other issues?

Anesth Analg 2017; PAP (Orbach-Zinger)

POSTPARTUM OPIOIDS

How often do women with uncomplicated vaginal delivery fill a prescription for opioid medication?

- 164,720 Medicaid-enrolled women in Pennsylvania
- 12% filled a prescription and 14% of those filled a 2nd
- 28% had a PPTL or perineal laceration
- Predictors for opioids with no complicating reason for them → tobacco use, mental health condition.

Obstet Gynecol 2017; 129: 431

POSTPARTUM TUBAL LIGATION

Review: *Postpartum tubal sterilization: making the case for urgency*

- In 2016 ACOG reiterated: "The immediate postpartum period following vaginal delivery or at the time of cesarean delivery is the ideal time to perform sterilization because of technical ease and convenience for the woman." Yet fewer than half of women who request the procedure actually obtain it.
- Unplanned repeat pregnancy is a large problem in the U.S.
- Anesthesiologists should advocate as perioperative physicians.

Anesth Analg 2017; PAP (Richardson)

ANESTHESIA FOR CESAREAN DELIVERY

PREVENTING CESAREANS

QI project to reduce cesareans in nulliparous, singleton, vertex pregnancies using guidelines from ACOG, SMFM, labor support practices:

- 434 women before, 401 women after implementation.
- Cesarean rate dropped from 28% to 20%.
- Provider compliance with guidelines improved from 86% to 92% and use of labor support measures also improved.

Obstet Gynecol 2017; 130: 1082

PREVENTING INFECTION

Can use of SSI bundles reduce infection rates after cesarean?

- Systematic review although no RCTs.
- Pooled rates went from 6% → 2%.
- Rates of superficial or deep SSI went from 6% → 1%.
- Rates of endometritis were low and did not change.

Obstet Gynecol 2017; 130: 735

PREVENTING INFECTION

An economic evaluation of adjunctive azithromycin prophylaxis for cesarean delivery:

- Used data from a prior trial that showed avoidance of endometritis (NNT 43) and wound infection (NNT 24).
- Use of azithro resulted in hospital savings of \$360 per unscheduled cesarean.
- This antibiotic adjunct is likely to become routine for unscheduled cesarean deliveries.

Obstet Gynecol 2017; 130: 328

PREVENTING INFECTION

Is adding azithromycin to standard cephalosporin regimens for cesarean prophylaxis cost-effective?

- Model based on 700,000 cesareans per year in the U.S. occurring during labor or after ROM.
- Adding azithromycin led to 16K fewer cases of endometritis, 17 fewer sepsis, 8 fewer VTE, and 1 less maternal death.
- Use of azithromycin led to ↓ costs and ↑ quality of life.

Obstet Gynecol 2017; 130: 1279

PREVENTING INFECTION

The optimal perioperative antibiotic regimen for obese women having cesarean delivery is unknown. RCT of 403 women compared oral cephalexin and metronidazole vs. placebo for 48 hours postoperatively in addition to standard IV cephalosporin preoperatively.

- SSI ↓ to 6.4% in the oral abx group vs. 15% in placebo.
- No serious adverse events such as allergic reaction.

JAMA 2017; 318: 1026

PREVENTING INFECTION

Does vaginal cleaning before cesarean reduce postoperative endometritis?

- Systematic review of 16 trials and 4837 women.
- Povidone-iodine on a sponge stick for 30 seconds.
- Cleansing ↓ rates of endometritis 4.5% vs. 9%
- Benefit limited to women in labor 8% vs. 14%) or with ruptured membranes (4% vs. 20%).

Obstet Gynecol 2017; 130: 527

AORTO-CAVAL COMPRESSION

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

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

Anesthesiology 2017; 127: 241 & 212

AORTO-CAVAL COMPRESSION

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

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

Anesth Analg 2017; 125: 1975

CHOICE OF ANESTHETIC

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

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

Anesth Analg 2017; 124: 1914

GENERAL ANESTHESIA

Review: *The future of general anaesthesia in obstetrics*

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

BJA Education 2017; 17: 79

GENERAL ANESTHESIA

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

A&A Case Reports 2017; 9: 216

GENERAL ANESTHESIA

Review: *Cricoid pressure controversies*

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

Anesth Analg 2017; 126: 738

GENERAL ANESTHESIA

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

Anesthesiology News, Frost Series #326, April 2017

SUGAMMADEX

Is Sugammadex appropriate to use during cesarean? Yes.

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

Core Evidence 2013; 8: 57

RISK FACTORS FOR PPH

What are the associations between postpartum hemorrhage after an elective vs. intrapartum cesarean?

- Single center using EBL > 1500 ml or need for transfusion.
- Pre-labor or elective cesarean: highest odds ratios were general anesthesia (OR 22.3), multiple gestations (OR 8.0), and placenta previa (OR 6.3).
- Intrapartum: general anesthesia (OR 5.4), multiple gestations (OR 3.2), and predelivery Hgb < 10 g/dL (OR 3.0).

Anesth Analg 2017; 125: 523

NEURAXIAL & ULTRASOUND

Double-blinded RCT of ultrasound vs. palpation (& sham ultrasound) for CSE placement prior to cesarean delivery.

- 108 non-obese women; single, experienced anesthesiologist doing all placements. Excluded known difficulties.
- No difference in success rate on first attempt, number of needle passes and skin punctures, or patient satisfaction.
- Ultrasound was slightly faster (median 30s difference).

Anesth Analg 2017; 124: 851

NEURAXIAL & HYPOTENSION

Can a baseline toe perfusion index predict the incidence of hypotension (as a marker for aortocaval compression) after spinal for cesarean?

- 100 healthy parturients, results using right and left toe PI
- After induction of spinal anesthesia, toe PI did not change in hypotensive patients; increased in normotensive women.
- Good predictor that reflects amount of AC compression.

Anesth Analg 2017; 125: 1560

NEURAXIAL & HYPOTENSION

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

Can J Anesth 2017; 64: 991

NEURAXIAL & PRESSORS

Do prophylactic phenylephrine infusions (low dose, fixed rate) lower the incidence of severe (< 70% baseline) hypotension when compared to boluses?

- Context of low resource countries without access to pumps.
- A recent South African report found > 50% of anesthetic maternal mortality was due to spinal hypotension.
- Risk of severe hypotension was ↓ with infusion: 47% vs. 62%, RR 0.84 with no ↑ risk of hypertension.

Anesth Analg 2017; 125: 904

NEURAXIAL & PRESSORS

Would computer-controlled boluses of phenylephrine give more precise control of BP than infusions?

- 214 healthy women having spinal for elective cesarean.
- Precision was greater in the bolus group and phenylephrine consumption was smaller.
- No difference in cardiac output, N&V, neonatal outcome.
- Bolus is an alternative but no real clinical differences.

Anesth Analg 2017; 125: 117

NEURAXIAL & PRESSORS

What is the relative potency of norepinephrine to phenylephrine for bolus treatment of hypotension?

- 180 healthy women having spinal for cesarean.
- NE: 4-12 µg or phenylephrine: 60-200 µg given in random allocation
- NE ED50 = 10 µg and phenylephrine ED50 = 137 µg
- Estimated relative potency ratio = 13 P:1 NE

Anesthesiology 2017; 127: 934

NEURAXIAL & PRESSORS

What is the ED90 for norepinephrine as an intermittent bolus to prevent spinal hypotension during cesarean delivery?

- 40 healthy parturients having elective cesarean
- Prospective, double-blind, up-down sequential allocation of NE 3-8 µg dosed to keep maternal BP at 100% of baseline.
- ED90 = 6 µg
- Prior study found 7.6 µg NE = 100 µg phenylephrine.

Anesth Analg 2017; 125: 212

CRYSTALLOIDS & CESAREAN

Study compared LR to NS for perioperative fluid management during cesarean delivery.

- RCT of 500 women having spinal for cesarean
- Mean fluid volume = 2380 ml
- Incidence of acidosis (pH < 7.32) when discharged from PACU: 38% in NS group, 29% in LR group, p=.04
- 32% in NS group had venous pH < 7.32 vs. 19% in LR.
- No difference in maternal morbidity, neonatal outcomes.

Anesth Analg 2017; 125: 533

NEURAXIAL & OBESITY

What is the effect of maternal obesity on decision-to-delivery interval (DDI) and neuraxial failure?

- 842 emergency cesareans, BMI < 30 vs. BMI > 35
- ↑ BMI = longer DDI: 38 vs. 33 minutes
- Neuraxial failure was more common: 8.5% vs. 3.7%
- Epidural top-up was faster than initiating CSE.

Acta Anaesth Scand 2017; 61: 609

NEURAXIAL & HEIGHT

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

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

Acta Anaesth Scand 2017; 61: 824

NEURAXIAL & PRURITUS

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

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

Anesth Analg 2017; 124: 1930

SPINAL EPINEPHRINE

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

- 60 patients received 0, 100 µg, or 200 µg epinephrine with 1.5 ml 0.75% bupivacaine
- Onset and side effects were similar between groups.
- Compared to no epinephrine, 200 µg prolonged time to T10 regression by 40 minutes (range 15-60) and also prolonged motor block. *Why not CSE?*

Anesth Analg 2017; PAP (Katz)

NEURAXIAL FOR ECV

Neuraxial anesthesia improves the success rate for external cephalic version (ECV) for breech presentation and lowers the cesarean delivery rate. Does increasing the spinal bupivacaine dose ↑ ECV success rate?

- 240 women randomized to 2.5, 5, 7.5, or 10 mg spinal bupivacaine 0.5% + 15 µg fentanyl.
- No difference between groups → ~50% success in each.
- Time to discharge was prolonged 60 minutes with 7.5 and 10 mg as compared to 2.5 mg.

Anesthesiology 2017; 127: 625

NEURAXIAL FOR ECV

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

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

Anesthesiology 2017; 127: 596

OXYTOCIN

Does the oxytocin infusion rate influence total EBL?

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

Anesth Analg 2017; 124: 857

OXYTOCIN

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

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

Can J Anesth 2017; 64: 820

HYPOTHERMIA

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

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

Anesth Analg 2018; 126: 190

HYPOTHERMIA

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

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

Can J Anesth 2017; 64: 919

POSTOPERATIVE PAIN

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

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

Br J Anaesth 2017; 118: 762

INTRATHECAL MORPHINE

What is the incidence of hypercapnic events (by TeCO₂ monitoring) after IT morphine for cesarean?

- 108 healthy women, 150 µg morphine in their spinal.
- 32% had a sustained hypercapnic event (> 50 for > 2 min)
- Median time to the event was 5 hours.
- Higher baseline TeCO₂ → more hypercapnic events (5% if < 31 mmHg, 23% if 32-38, and 77% if > 38)

Anesth Analg 2017; 124: 872

LOCAL ANESTHETICS

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

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

Anesth Analg 2017; 125: 907

LOCAL ANESTHETICS

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

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

Anesth Analg 2017; 124: 1291

LOCAL ANESTHETICS

RCT of intra-peritoneal lidocaine for cesarean analgesia.

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

Anesth Analg 2017; 124: 554

OPIOID PRESCRIPTIONS

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

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

Obstet Gynecol 2017; 130: 36

OPIOID PRESCRIPTIONS

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

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

Obstet Gynecol 2017; 130: 29

POST-DELIVERY PAIN

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

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

Anesthesiology 2017; 127: 684

BUPRENORPHINE

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

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

Anesthesiology 2017; 126: 1180

ANESTHETIC COMPLICATIONS

MATERNAL ARREST - CANADA

The Canadian Institute for Health Information database was used to generate information about maternal cardiac arrest.

- Incidence of 1:12,500 over 13 years 2002-15.
- Common etiologies: postpartum hemorrhage, heart failure, AFE, and complications of anesthesia.
- 71% survived to hospital discharge overall, but 100% survival for anesthesia-related complications.

Anesth Analg 2017; 124: 890

MATERNAL MORTALITY

Anesthesia-related maternal mortality in low-income and middle-income countries (systematic review):

- Risk of death 1.2 per 1000 procedures
- Anesthesia accounted for 2.8% of all maternal deaths and 3.5% of direct maternal deaths and 13.8% of deaths after cesarean delivery.
- General anesthesia > neuraxial (OR 3.3)

Lancet Glob Health 2016; 4: e320

ASA CLOSED CLAIMS DATA

What is the anesthesiologist's liability for newborn death and brain damage and in newborn resuscitation?

- 29% of OB anesthesia malpractice claims are for newborn death and brain damage (vs. 71% related to maternal care).
- Anesthesia care may have contributed in 33%: delay, poor communication (level of urgency), substandard care (mismanagement of difficult intubation or high block).
- Delay = not in hospital or inappropriate choice of regional anesthesia rather than general
- Most resuscitation claims dropped as "Good Samaritan"

ASA Monitor 2017; 81: 16 (February)

ASA CLOSED CLAIMS DATA

Review of OB anesthesia claims from 2000-2011 (vs. 1990s):

- 68% cesarean, 32% vaginal delivery; ↑ proportion C/S.
- Proportion association with GA ↑ from 19% to 25%.
- Respiratory events ↓, but CV events ↑ related to hemorrhage rather than maternal cardiac disease.
- Maternal death ↑ 13-24% and is the most common injury.
- ↑ claims paid, payments ↑, ↑ substandard care.

Clin Obstet Gynecol 2017; 60: 431

ASA CLOSED CLAIMS DATA

CHARACTERISTICS	INCIDENCE PRE-2000	INCIDENCE 2000-11
Mother's age > 35 years ↑	14%	25%
Mother was obese ↓	55%	39%
Emergency case ↓	73%	49%
Patient condition / surgery ↑	12%	27%
Maternal death ↑	13%	24%
Maternal minor injuries ↓	32%	20%
Substandard care ↑	24%	35%
Claim was paid ↑	43%	55%
Median payment made ↑	\$352,600	\$570,000

ASA CLOSED CLAIMS DATA

Major causes of maternal death by type of anesthesia:

NEURAXIAL ANESTHESIA	GENERAL ANESTHESIA
Excessive blood loss - 25%	Excessive blood loss – 53%
High block / total spinal – 20%	Embolic events – 16%
Embolic events – 20%	Difficult intubation – 6%
Neuraxial cardiac arrest – 5%	Other respiratory events – 6% (aspiration, bronchospasm, etc.)

ASA CLOSED CLAIMS DATA

Other take-home points from the database:

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

ASPIRATION RISK

Ultrasound assessment of gastric contents in labor:

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

Acta Scand Anaesth 2017; 61: 730

UPDATED PRACTICE GUIDELINES

Practice Guidelines for preoperative fasting and the use of pharmacologic agents to reduce the risk of pulmonary aspiration: application to healthy patients undergoing elective procedures.

- NPO unchanged: 2 hours for clear liquids, 4 hours breast milk, 6 hours light meal or non-human milk, 8 hours for fried foods, fatty foods or meat.

Anesthesiology 2017; 126: 376

IT CATHETER MIGRATION

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

A&A Case Reports 2017; 9: 357

INADVERTENT IT INJECTIONS

Review of reported events, sequelae, management.

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

Acta Anaesth Scand 2017; 61: 11

NERVE INJURY

What are the risk factors for nerve injury after neuraxial anesthesia for labor and delivery?

- Case cohort study of 20,000 women; 19 had peripheral nerve injuries (1%); 15 associated with OB care.
- 4 cases of nerve root injury due to the Tuohy needle.
- Risk factors: gestational age > 41 weeks (OR 3.8), late initiation of block (OR 8.2), repeated anesthetic procedures (OR 2.8), forceps delivery (OR 9.8), birth weight > 3500 grams (OR 6.8).

Acta Anaesth Scand 2017; 61: 1203

RETAINED EPIDURAL CATHETER

Case report of difficult removal; after multiple attempts by the anesthetist it was recovered minus the distal 6 cm. What now?

- Perform prompt disclosure to your patient, group leaders and hospital risk manager.
- No RCTs available, but expert opinion is to leave the tip in place. Risks of removal are thought to outweigh any benefits.
- Resolution: CT showed the remaining catheter clearly; patient requested removal so taken to OR → GA → neurosurgery easily removed fragment under fluoro with a small incision.

ASA Monitor 2017; 81: 30

ANTI-COAGULATION

VTE is a major risk in OB patients. ACOG guidelines now recommend that women delivering via cesarean and those with risk factors receive mechanical and often pharmacologic prophylaxis. SOAP Consensus Statement on anesthetic mgt:

- Reviews PK and PD of anti-coagulants in pregnancy.
- Practical guide to mgt ante-, intra-, and post-partum when women are receiving LMWH or unfractionated heparin.
- Suggestions for multi-disciplinary communication.

Anesth Analg 2017; PAP (Leffert)

ANTI-COAGULATION

Systematic review of spinal-epidural hematoma to identify cases associated with neuraxial and thrombo-prophylaxis.

- None of the hematoma cases involved OB patients.
- They found 28 parturients who had neuraxial before the recommended ASRA time limit without complication.
- They found 52 parturients who had neuraxial *while* receiving LMWH without complication.
- Reassuring but need better registries and details.

Anesth Analg 2017; 125: 223

THROMBOCYTOPENIA

What is the risk of epidural hematoma requiring decompression in thrombocytopenic (defined as < 100K) parturients?

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

Anesthesiology 2017; 126: 1053

THROMBOCYTOPENIA

Canadian experience with obstetric neuraxial anesthesia in the setting of immune thrombocytopenia (ITP):

- No complications of neuraxial in 136 pregnancies with ITP, with the lowest platelet count being 45K.
- Highlights the institutional variation in placement of neuraxial anesthesia at low platelet counts.
- Upper 95% CI for platelet counts < 100K = 5.5%.

Br J Anaesth 2017; ? :1067

THROMBOCYTOSIS

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

A&A Case Reports 2017; 9: 172

EPIDURAL HEMATOMA

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

A&A Case Reports 2017; 9: 123

ABDOMINAL HEMATOMA

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

A&A Case Reports 2017; 8: 257

LIPID EMULSION

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

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

Clin Tox 2017; 55: 617

LIPID FOR AFE

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

A&A Case Reports 2017; 8: 64

UPDATED PRACTICE GUIDELINES

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

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

Anesthesiology 2017; 126: 585

EPIDURAL FEVER

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

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

Anesth Analg 2017; 125: 2134

EPIDURAL FEVER

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

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

Anesthesiology 2017; 127: 942

HEADACHE

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

Non-invasive and conservative:

- Bedrest, prone positioning, abdominal binders

Non-invasive and pharmacologic:

- NSAIDs, caffeine and theophylline, ACTH (Cosyntropin®), gabapentin or Lyrica®, sumatriptan, methylergonovine

Invasive: EBP, epidural morphine, acupuncture, occipital nerve blocks, sphenopalatine ganglion blocks

Anesth Analg 2017; 124: 1219

HEADACHE

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

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

Reg Anesth Pain Med 2017; 42: 709

HEADACHE

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

A&A Case Reports 2017; 9: 289

HEADACHE

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

A&A Case Reports 2017; 9: 233

HEADACHE

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

A&A Case Reports 2017; 8: 36

NON-OBSTETRIC SURGERY

ACOG Committee Opinion #696: *Nonobstetric Surgery During Pregnancy* (joint statement with ASA)

- Emphasizes obstetric consultation before surgery.
- Discusses fetal monitoring before and after viability.
- “No currently used anesthetic agents have been shown to have any teratogenic effects in humans when using standard concentrations at any gestational age.”

Obstet Gynecol 2017; 129: 777

PREGNANCY TESTING

ASA statement from the Committee on Quality Management and Departmental Administration (QMDA):

1. Indications for preoperative pregnancy screening
2. Accuracy of early pregnancy testing
3. **Medicolegal concerns** → “routine pregnancy testing may pose greater medicolegal risk to anesthesiologists due to failure to check the result or failure to document informed consent of risk of miscarriage prior to elective surgery.”
4. Ethical considerations
5. Recommendations

EPIDURAL & BREASTFEEDING

Controversial topic: does epidural analgesia for labor that includes fentanyl impair breast-feeding?

- RCT of term, multiparous women who had breastfed successfully before and who received epidural analgesia.
- Randomized to epidural bupivacaine alone, B + fentanyl 1 µg/ml, or B + fentanyl 2 µg/ml
- Frequency of breastfeeding at 6 weeks was > 94% and no different between groups.

Anesthesiology 2017; 127: 614

CASE REPORTS: ALLERGY

Epidural local anesthetic allergic reaction caused difficult intubation scenario in emergent cesarean.

A&A Case Reports 2017; 9: 84

Hairdresser with anaphylaxis to PCN during GA for cesarean had skin testing positive for muscle relaxants, opioids and midazolam. Cross-sensitization to hair products.

A&A Case Reports 2017; 9: 151

CASE REPORTS: RESPIRATORY

Massive hemoptysis during emergency cesarean with GA → alveolar hemorrhage due to lupus.

A&A Case Reports

Airway arteriovenous malformation in pregnancy.

Can J Anesth 2017; 64: 1071

CASE REPORTS: CARDIAC

Chest pain and ECG changes of ischemia during cesarean → aberrant right coronary artery coursing between the aorta and pulmonary artery.

A&A Case Reports 2017; 9: 119

Cesarean for breech in a patient with Marfan's s/p aortic dissection and aortic root replacement. She developed hypotension and syncope that was only relieved by full lateral position under GETA.

A&A Case Reports 2017; 8: 93

CASE REPORTS: NEURO

GA for elective cesarean delivery for cavernous brainstem malformations s/p a stroke 4 years before. Intubated with opioids, extubated to an LMA before emergence to prevent hypertension and coughing.

A&A Case Reports 2017; 9: 54

Neurally mediated syncope and cardiac arrest during cesarean, precipitated by hypotension from regional, NTG, preeclampsia and fundal pressure.

A&A Case Reports 2017; 8: 96

CASE REPORTS: RARE SYNDROMES

Loeys-Dietz Syndrome → connective tissue disorder predisposing to aortic and arterial aneurysms; can have aortic dissection and uterine rupture.

A&A Case Reports 2017; 9: 182

MELAS Syndrome → mitochondrial encephalopathy, lactic acidosis, and stroke-like symptoms. G2P0 with very complicated peripartum course.

A&A Case Reports 2017; 9: 38

OBSTETRIC & MEDICAL COMPLICATIONS

COSTS OF PREECLAMPSIA

What is the annual health and cost burden of preeclampsia to mothers and infants in the U.S.?

- Epidemiologic analysis of multiple databases.
- PEC ↑ adverse events from 4.6% to 10% in mothers; from 7.8% to 15% in infants.
- Cost burden during the first year was \$1.03 billion for mothers and \$1.15 billion for infants = \$2.18 billion.
- The cost burden for infants ↑ as gestation age ↑.

Am J Obstet Gynecol 2017; Sept: 235-7

PREECLAMPSIA SCREENING

USPSTF recommendations: Women should be screened for PEC with BP measurements throughout pregnancy.

- Preeclampsia is not yet preventable.
- Early diagnosis and management may prevent maternal sequelae, e.g. seizures, organ failure.
- Early delivery is the only effective treatment, but often necessitates preterm birth.

JAMA 2017; 317: 1661/1629/1668/1700

PREECLAMPSIA PREVENTION

What has the effect been of the USPSTF 2014 recommendations for aspirin for PEC prevention?

- Retrospective cohort study of 2 academic institutions before/after aspirin was used to prevent *recurrent* PEC.
- Confounders were accounted for in multivariate analysis.
- Rates of recurrent preeclampsia were decreased by 30%.

Am J Obstet Gynecol 2017; 217: 365

PREECLAMPSIA PREVENTION

Does low-dose aspirin during pregnancy reduce the risk of *preterm* preeclampsia? Yes.

- 1776 women at high risk for preeclampsia were randomized to 150 mg aspirin daily or placebo at < 14 weeks gestation.
- Preterm PEC occurred in 1.6% in the aspirin group vs. 4.3% in the placebo group, **OR 0.38** (95% CI 0.20-0.74, p=0.004).
- Good adherence, no differences in other adverse events.

N Engl J Med 2017; 377: 613

HYPERTENSION TREATMENT

National Partnership for Maternal Safety: Consensus Bundle on Severe Hypertension During Pregnancy and the Postpartum Period

- Published concurrently in major journals for anesthesiologists, obstetricians, midwives, L&D nursing.
- Includes sections on Readiness, Recognition & Prevention, Response, and Reporting & Systems Learning

Anesth Analg 2017; 125: 540

HYPERTENSION TREATMENT

Editorial: Key considerations for the anesthesiologist.

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

Anesth Analg 2017; 125: 383

LATE CONSEQUENCES OF PEC

What is the association between recurrent PEC and cardiovascular hospitalizations later in life?

- Quebec database identified women up to 25 years after a pregnancy with recurrent, non-recurrent or no PEC.
- Women with recurrent PEC had higher incidence of CV hospitalization than women with non-recurrent or no PEC: 281/1000 vs. 168/1000 vs. 73/1000.
- Recurrent PEC → 2x the risk of heart disease and 3x the risk of cerebrovascular disease compared with no PEC.

Heart 2017; 103: 235

HEMORRHAGE

ACOG Practice Bulletin: Postpartum Hemorrhage

- Have guidelines for routine use of uterotonics.
- Escalate quickly to other interventions if uterotonics fail.
- Consider TXA when initial medical therapy fails.
- Have a multi-disciplinary response team, an escalating PPH protocol, and a functioning massive transfusion protocol.
- Transfuse fixed ratios of PRBC, FFP and platelets.
- Adopt and implement a hemorrhage bundle.

Obstet Gynecol 2017; 130: e168

AMNIOTIC FLUID EMBOLISM

Current research in AFE with implications:

- Insulin-like growth factor binding protein-1 is the only lab test that can confirm a diagnosis of AFE.
 - An Australia-New Zealand reported “only” a 15% mortality rate in 33 AFE cases – improving survival.
 - Report of 3 cases where AFE presented as isolated coagulopathy without cardiovascular collapse.
 - 90% of parturients transfused with FFP:PRBC ≥ 1 survived compared with only 40% survival if transfusion ratio < 1 .
- Obstet Gynecol 2017; 129: 941

REBOA FOR PPH?

Resuscitative endovascular balloon occlusion of the aorta (REBOA) is being used in trauma with data gathered from clinical registries and retrospective case descriptions. This review provides principles and considerations for the anesthesiologist.

- Could this be a rare but lifesaving technique to consider in life-threatening postpartum hemorrhage?
- Anesth Analg 2017; 125: 884 & 715 (graphic)

THE WOMAN TRIAL

Early administration of TXA reduces death in bleeding trauma patients. What are the effects in postpartum hemorrhage?

- 20K women, 193 hospitals in 21 countries randomized to receive 1 gram TXA or placebo + usual care during PPH after vaginal delivery or CS.
 - Death due to bleeding \downarrow **19%** overall (1.5% vs. 1.9%), RR 0.81.
 - Death \downarrow **31%** if given within 3 hours (1.2% vs. 1.7%), RR 0.69.
 - No difference in hysterectomy or other causes of death.
 - No difference in venous or arterial thromboembolic events.
- Lancet 2017; 389: 2105

TXA IN OBSTETRICS

Byproducts of fibrinolysis (D-dimer and plasmin-antiplasmin complexes) are \uparrow in bleeding parturients.

- Increases are attenuated by TXA \rightarrow good rationale for use.
- The WOMAN Trial showed efficacy and no adverse events.
- However, most subjects were from Central Africa and South Asia. 7% were not even transfused before death. Interventions such as Bakri balloon or B-Lynch sutures were uncommon.
- Are the results generalizable to high resource countries?
- Adverse effects can occur \rightarrow death after accidental neuraxial injection, thrombosis, seizures.

APSF Newsletter 2017; October: 34

TXA AND THROMBOSIS

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

A&A Case Reports 2017; 9: 90

OBESITY

What is the association between maternal obesity and major intraoperative complications during cesarean?

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

Am J Obstet Gynecol 2017; 216: 614

SUBSTANCE ABUSE

ACOG: *Opioid Use and Opioid Use Disorder in Pregnancy*

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

Obstet Gynecol 2017; 130: e81

OPIOID DEPENDENCE

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

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

AM J Obstet Gynecol 2017; 216 : 226

BUPRENORPHINE DOSING

Pharmacokinetic study on buprenorphine dosing during pregnancy:

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

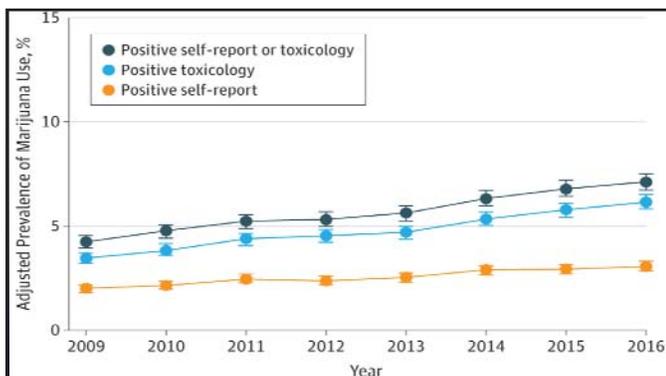
Am J Obstet Gynecol 2017; 217: 459

MARIJUANA USE

Trends in prenatal marijuana use 2009-16:

- Kaiser Permanente Northern California uses universal screening via self-report and urine toxicology.
- Prevalence increased significantly over time from 4% to 7%, especially ≤ age 24.
- 22% < age 18 and 19% age 18-24 tested positive by toxicology
- 79% reported perceiving little to no harm in prenatal use.

JAMA 2017; 318: 2490



MARIJUANA RISKS

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

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

Am J Obstet Gynecol 2017; 217: 478

MARIJUANA RISKS

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

JAMA 2017; 317: 129

MENTAL HEALTH

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

- Perinatal mood disorders affect 1 in 7 and can have profound effects on mothers and their infants, even up to suicide and infanticide → significant patient safety issue.
- Bundle: Readiness / Recognition and Prevention / Response / Reporting and Systems Learning recommendations.
- Joint publication with ACOG, AWHONN and Midwifery.

Obstet Gynecol 2017; 129: 422

CONGENITAL HEART DISEASE

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

Circulation 2017; 135: e50-e87

CARDIAC ULTRASOUND

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

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

Br J Anaesth 2017; 118: 527

CARDIAC ULTRASOUND

Is focused cardiac ultrasound exam feasible in term parturients? Yes → images of sufficient quality for clinical decision-making were obtained in all patients by an operator with limited experience.

Acta Anaesth Scand 2017; 61: 1105

Lung ultrasound using a 2-5MHz curvilinear probe available on L&D guided management by detecting pulmonary edema in preeclamptic patients with dyspnea.

Obstet Gynecol 2017; 129: 525

CARDIAC CASE REPORTS

1. Emergency cesarean → CPR → Takotsubo Syndrome.

Obstet Gynecol 2017; 129: 521

2. Cardiac arrest at home → peri-mortem cesarean after 27 minutes → ROSC → mother died, infant with cerebral palsy.

A&A Case Reports 2017; 8: 72

3. Patient with Fontan physiology s/p emergency cesarean for cardiac decompensation → 6 weeks postpartum presented with IVC thrombus and bilateral pulmonary emboli → survived.

A&A Case Reports 2017; 9: 136

CARDIAC CASE REPORTS (2)

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

A&A Case Reports 2017; 8: 105

PULMONARY HYPERTENSION

Does etiology and severity of pulmonary hypertension affect outcomes? Do current therapies influence outcomes?

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

Obstet Gynecol 2017; 129: 511

ARDS IN PREGNANCY

The 2006-2012 Nationwide Inpatient Sample was used to find a cohort of 2808 pregnant women ventilated for ARDS:

- 9% mortality rate.
- Rate of ARDS ↑ over time from 36.5 per 100K to 60.
- Factors that were associated with higher death rate = prolonged mechanical ventilation, renal failure requiring hemodialysis, liver failure, AFE, influenza, septic obstetric emboli and puerperal infection.

Obstet Gynecol 2017; 129: 530

INFECTION

Surviving Sepsis Campaign: International Guidelines for Management of Sepsis and Septic Shock

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

JAMA 2017; 317: 847

MATERNAL ECMO

Single-center report of 11 maternal cases that used ECMO:

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

Anesth Analg 2017; 125: 1275

ZIKA CONSIDERATIONS

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

Anesth Analg 2017; 124: 1918

VACCINATION

A Danish registry examined women who had the quadrivalent HPV vaccine during pregnancy. Vaccination during pregnancy was not associated with a significantly higher risk of adverse pregnancy outcomes than no such exposure.

N Engl J Med 2017; 376: 1223

Review article on current maternal immunization recommendations. Includes immunology of pregnancy.

N Engl J Med 2017; 376: 1256

THE FETUS AND NEONATE



TERATOGENICITY

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

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

N Engl J Med 2017; 376: 2245

SSRI USE & AUTISM

Does SSRI use in pregnancy ↑ risk of childhood autism spectrum disorder?

- Yes: Quebec registry of 145K full term infants → 2nd or 3rd trimester exposure associated with aOR 1.87.
- No: Ontario registry of 36K term infants → no significant association compared to unexposed children or to unexposed siblings.

JAMA Pediatr 2016; 170: 117

JAMA 2017; 317: 1544

SSRI USE & AUTISM

- No: Swedish registry 1.6 million offspring of women with 1st trimester exposure compared to unexposed cohort → small ↑ risk of preterm birth but no ↑ risk of autism spectrum or ADHD.

JAMA 2017; 317: 1553

- Editorial: Essential to distinguish risk from SSRI treatment vs. risk from severe depression requiring treatment. Children of mothers with depression are at risk for developmental disturbances.

JAMA 2017; 317: 1533

TERATOGENICITY

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

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

JAMA 2017; 318: 1700

TERATOGENICITY

What is the association between ACE inhibitor exposure in 1st trimester and risk of anomalies?

- 1.3 million pregnancies in Medicaid database.
- Initial results showed ↑ risk of overall malformations, cardiac and CNS specifically.
- After adjusting for chronic HTN and other confounders, there was no significant risk in any congenital malformations.

Obstet Gynecol 2017; 129: 174

TERATOGENICITY

The USPSTF issued updated guidelines supporting folic acid consumption before and during pregnancy to prevent neural tube defects.

- Applies to all women of child-bearing age; pregnancies may be unplanned and the neural tube closes (or not) by 28 days.
- Significant benefits in reducing risk of fetal NTD and no negative side effects from supplementation.
- Grade A evidence: take 400-800 µg daily.

JAMA 2017; 317: 183

FETAL SURGERY

ACOG Committee Opinion: Maternal-Fetal Surgery for Myelomeningocele

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

Obstet Gynecol 2017; 130: e164

FETAL SURGERY

Case report: Healthy G1 at 25 weeks having open MMC repair using high-dose sevoflurane (2.5 MAC) for uterine relaxation. Hemodynamically stable. 3 episodes of grand mal seizures that responded to benzodiazepines or propofol. No postop neurologic deficits and no history of seizures or neurologic problems could be elicited.

- Sevoflurane can cause epileptiform activity; risk factors → female, rapid onset, high alveolar concentration.

Br J Anaesth 2017; 118: 634

FETAL SURGERY

Description of one site's anesthetic management for 59 minimally invasive fetoscopic surgeries for spinal bifida, using a pulse contour analysis system (PiCCO) to guide fluid and vasopressor management.

- < 1 MAC desflurane, remifentanyl infusion, preop atosiban.
- Achieved adequate fetal anesthesia and uterine relaxation with no need for postoperative tocolytics.
- No intraoperative pulmonary edema; 1 mild postop case.

Anesth Analg 2017; 125: 219

SCREENING FOR PRETERM DELIVERY

Would universal screening by serial cervical length and/or vaginal fetal fibronectin predict spontaneous preterm birth in nulliparous women? No.

- 9410 women: 91% term births, 4% medically indicated preterm deliveries, 5% spontaneous preterm deliveries.
- Neither test had good predictive accuracy for PT birth.
- Findings do not support routine use of these tests.

JAMA 2017; 317: 1047

SCREENING FOR PRETERM DELIVERY

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

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

JAMA 2017; 317: 1025

PRETERM DELIVERY: PESSARY

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

- 300 with asymptomatic short cervical length (22 mm or less at 18 weeks gestation) on ultrasound were randomized to pessary or no; otherwise usual care.
- 7.3% in the pessary group delivered < 34 weeks vs. 15% in the control group.

JAMA 2017; 318: 2317, 2299

PRETERM DELIVERY: PROGESTERONE

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

- Meta analysis of 10 RCT with 1586 patients
- First trimester use reduced miscarriage risk: RR 0.72.
- Synthetic progesterone > natural
- Oral, IM > vaginal administration
- No impact on preterm birth or neonatal mortality.

Fertil Steril 2017; 107: 430

PRETERM DELIVERY: GENETICS

Are there genetic associations with risk of preterm birth?

- Large data set of 43K women of European ancestry.
- Gestational duration used as a continuous trait and preterm birth < 37 weeks as a dichotomous outcome.
- Variants at 6 loci were associated with length of gestation.
- Variants at 3 loci were associated with preterm birth.
- These genes were previously found to have roles in uterine development, maternal nutrition and vascular control.

N Engl J Med 2017; 377: 1156

DELAYED CORD CLAMPING

ACOG Opinion: Delayed umbilical cord clamping after birth

- Term infants: ↑ Hgb levels and improves iron stores and may have developmental benefits. May ↑ jaundice, so monitor.
- Preterm infants → improved transitional circulation, better red blood cell volume, ↓ need for transfusion, ↓ risk of NEC, IVH.
- No ↑ risk of postpartum hemorrhage for the mother.
- ACOG recommends a delay of at least 30-60 seconds after birth for all vigorous infants.

Obstet Gynecol 2017; 2017; 129: e5

MECONIUM STAINING

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

- Do not routinely provide intrapartum suctioning whether vigorous or not.
- Full Pediatrics team should be present in case intubation is needed.
- Resuscitation should follow the same principles whether meconium-stained or not.

Obstet Gynecol 2017; 129: e33

HEAD COOLING

Hypothermia for 72 hours at 33.5 degrees C for neonatal encephalopathy reduces death and disability. Would cooling longer (120 hours) or colder (32.0 degrees C) improve outcomes even more?

- 364 term neonates randomized to one of 4 groups
- Trial stopped early (planned 726 infants) for futility
- No difference in death or moderate to severe disability at 18 months. Underpowered?

JAMA 2017; 318: 57

HEAD COOLING

Hypothermia initiated < 6 hours after birth reduces death and disability for term infants (> 36 weeks) with encephalopathy. What about initiating at 6-24 hours?

- 83 infants maintained at 33.5 degrees C for 96 hours and 85 infants were maintained at 37 degrees.
- Small 3.5% improvement in death or disability at 18 months. 76% probability of *any* reduction in death or disability, 64% of at least 2% less death/disability.

JAMA 2017; 318: 1550

NEWBORN SCREENING

Has state implementation of screening for critical congenital heart disease improved infant death rates?

- State policies may be mandatory or voluntary.
- In mandatory screening states: early infant deaths from heart disease ↓ by 33.4% or 3.9 deaths / 100K births.
- No decrease was seen with voluntary screening.

JAMA 2017; 318: 2111

STILLBIRTH

Which diagnostic tests are most useful in the work-up for causes of a stillbirth?

- Database of 512 stillbirths with extensive work-ups.
- % of time each test provided a cause of death: placental pathology 65%, fetal autopsy 42%, genetic testing 12%, testing for anti-phospholipid antibodies 11%. Others test were helpful < 10% of the time.

Obstet Gynecol 2017; 129: 699

STILLBIRTH

Is there a difference in sleep practices in women who experience a stillbirth compared to live pregnancies at a similar gestation?

- 291 women with stillbirth > 28 weeks gestation.
- Supine sleep the night before the stillbirth ↑ risk 2.3-fold compared to left side sleep.
- Other findings in stillbirth group: more likely to sleep < 5.5 hours, get up to the bathroom, take a daily daytime nap.

BJOG 2018; 125: 254

EXTREME PREMATUREITY

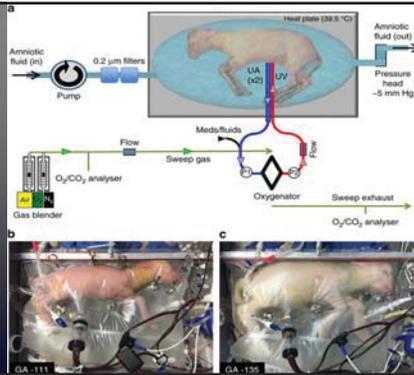
Demonstration of an extracorporeal device used to support extremely premature fetal lambs for up to 4 weeks without apparent physiologic derangement or organ failure.

- Pumpless AV circuit
- Closed sterile environment
- Umbilical vascular access

Nat Commun 2017; 8: 15112

Biobag system design

- a. Closed fluid environment with low-resistance oxygenator, continuous fluid exchange.
- b. Lamb at 107 days gestation on day 4 of support.
- c. Same lamb on day 28 of support with growth and maturation.



EXTREME PREMATUREITY

What is the expected survival and neuro-developmental outcome for infants born at 22-24 weeks gestation?

- 4274 infants at 11 centers comparing 2000-3 to 2008-11
 - Survival ↑ from 30% to 36%.
 - Survival without impairment ↑ 16% to 20%.
 - Survival with disability did not change: 15% to 16%.
- N Engl J Med 2017; 376: 617

EXTREME PREMATUREITY

What is the educational performance for infants born at 23-24 weeks gestation compared to term?

- 1.5 million singleton Florida children born 1992-2002.
 - 65% born 23-24 wks were ready to start kindergarten.
 - 1.8% considered gifted were born 23-24 weeks.
 - 33.5% considered low-performing were born early.
 - FCAT test scores were 0.66 lower compared to full term.
- JAMA Pediatr 2017; 171: 764

EXTREME PREMATUREITY

Ventilation techniques have improved for infants born < 28 weeks. Effects on lung function at 8 years?

- Longitudinal follow-up of survivors born in 1991, 1997, and 2005 in Australia.
 - More use of non-invasive techniques (nasal CPAP).
 - Duration of support and oxygen dependence *increased*.
 - Air flows / FEV1 were *worse* for cohort born in 2005.
- N Engl J Med 2017; 377: 329

BMI AND CEREBRAL PALSY

Is risk of CP increased with maternal overweight and obesity?

- Swedish population-based retrospective cohort study.
- 1.4 million children, CP in 2.13 per 1000 live births.
- The adjusted HR of CP were overweight: 1.22, obesity grade 1: 1.28, obesity grade 2: 1.54, obesity grade 3: 2.02.
- Association was limited to term births and partly mediated through asphyxia-related neonatal complications.

JAMA 2017; 317: 925

NEWBORN INFECTION

Case report (Oregon): Infant with respiratory distress diagnosed as having GBS infection at birth. Treated and discharged. Recurrence 5 days later – same sensitivities as initial infection. Woman had asked to keep her placenta, and registered with a company that turns it into “pills” to be taken like vitamins for mood and energy boosts. She was taking 2-3/day, and cultures showed the same GBS cultured from the baby → “high maternal colonization from consumption of GBS-infected placental tissue”.

JAMA 2017; 318: 511

NEWBORN INFECTION

Case report (Arizona): 2 cases of Legionnaires' Disease in newborns that presented with severe respiratory distress and abnormal chest x-ray. Both had been home water births in tubs filled with municipal tap water. Cultures and antigen testing revealed Legionella, probably related to its growth in plumbing systems and warm water. Both survived after treatment with azithromycin. An additional case was identified in Texas.

CDC MMWR 2017; 66: 590

ETHICS & DRUG ABUSE

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

Obstet Gynecol 2017; 129: 164

NEONATAL ABSTINENCE SYNDROME

Is buprenorphine a better treatment than morphine for NAS?

- Double-blind RCT of 63 infants with signs of NAS
- Duration of treatment was shorter with B: 15 vs. 28 days.
- Median length of stay was shorter with B: 21 vs. 33 days.
- 15% needed adjunct phenobarbital in the B group vs. 23% in the morphine group.

N Engl J Med 2017; 376: 2341

OPIOID EPIDEMIC

Opioid Use in Pregnancy, Neonatal Abstinence Syndrome, and Childhood Outcomes – Executive Summary

- Joint workshop with ACOG, AAP, SMFM, CDC and March of Dimes to review the evidence, make recommendations, and identify areas for further research.
- Excellent section on peripartum pain management (p. 15).
- Suggestions for management of prenatal care including methadone vs. buprenorphine, intrapartum/postpartum care, and neonatal care.

Obstet Gynecol 2017; 130: 10

NEUROTOXICITY: REVIEWS & EDITORIALS

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

NEUROTOXICITY - CLINICAL

What is the association between anesthesia and surgery before age 4 and academic performance at 16 + IQ testing at military conscription (Sweden)?

- 2 million children born from 1973-1993; compared those with 1 surgical exposure before age 4 to unexposed children.
- Mean difference of 0.41% lower school grades and 0.97% lower IQ scores in the exposed group.
- The surgery vs. no surgery differences were markedly *less* than the differences associated with sex, maternal educational level, or month of birth during the same year.

JAMA Pediatr 2017; 171: e163470

NEUROTOXICITY - CLINICAL

Is exposure to general anesthesia before age 3 associated with adverse neurodevelopmental outcomes?

- Mayo database of children born 1996-2000; outcomes ascertained via medical and school records.
 - Multiple exposures (but not single) were associated with ADHD and learning disabilities: HR = 2.17.
 - Single exposures → ↓ reading and language achievement.
- Anesthesiology 2017; 127: 227

NEUROTOXICITY - CLINICAL

What is the vulnerable age in children for exposure to anesthetics versus that seen in animal studies?

- Observational cohort study from Medicaid claims; single exposure < age 5 to common surgeries matched to an unexposed cohort (1 exposed to 5 propensity-matched).
 - ↑ risk of mental disorder (developmental delay, ADHD) at all ages of exposure; overall HR 1.26 (95% CI 1.22-1.30).
 - Small but significant ↑ risk; timing doesn't matter.
- Anesth Analg 2017; 125: 1988

NEUROTOXICITY - CLINICAL

What does MRI imaging show when children have received general anesthesia during infancy?

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

NEUROTOXICITY - ANIMAL

Does dexmedetomidine provide protection in the developing brain against anesthesia with sevoflurane?

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

NEUROTOXICITY - ANIMAL

Could dexmedetomidine be an alternative anesthetic or adjunct to avoid neurotoxicity?

- Neonatal rats were exposed to varying doses of dexmedetomidine or sevoflurane.
 - D did not cause brain injury but did not mitigate S-associated injury.
 - D provided less anesthesia and pain control.
- Br J Anaesth 2017; 119: 492

AND WE'LL SEE
WHAT'S NEW IN 2018!

THE END



Anesthesia for Bariatric Surgery

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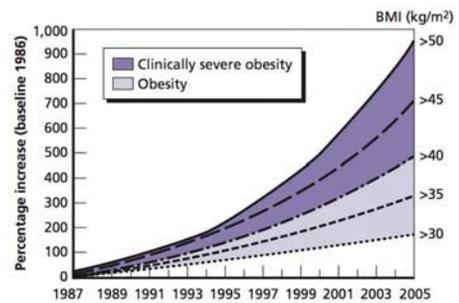
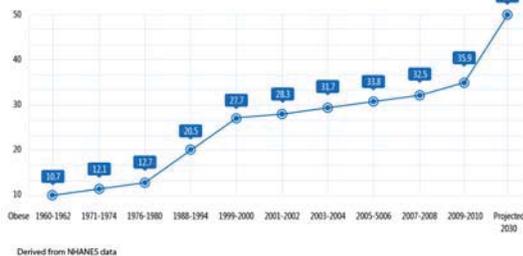
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February 26, 2018

Anesthesia for Bariatric Surgery: Goals and Objectives

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

Prevalence of Obesity Among U.S. Adults Aged 20-74



Why is “Ideal Body Weight” Important?

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

Vecuronium	IBW	
Rocuronium	IBW	
Cis-Atracurium	IBW	
Propofol (induction)	LBW	
Fentanyl	LBW	
Sufentanil	LBW	
Remifentanil	LBW	
Succinylcholine	TBW	
Sugammadex	TBW (IBW, LBW)	

There is a no physiologic basis for IBW

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

Uninsured (with health problems) were excluded *

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

Met Life - Ideal Body Weight Tables

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

Ideal Body Weight Tables

Metropolitan Life Insurance Company (1942-1943)

Table 1 Proposed range of ideal weights for women, ages 21 and over, Metropolitan Life Insurance Company

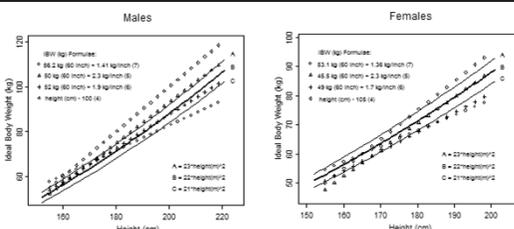
Height (inches above)	Weight in pounds (in ordinary dress)		
	Small frame	Medium frame	Large frame
5'0"	105-111	112-120	119-129
5'1"	107-113	114-122	121-131
5'2"	109-115	117-125	124-134
5'3"	111-117	120-128	127-137
5'4"	113-119	124-132	131-141
5'5"	115-121	127-135	135-145
5'6"	117-123	130-138	139-149
5'7"	119-125	134-142	143-153
5'8"	121-127	138-146	147-157
5'9"	123-129	142-150	151-161
5'10"	125-131	146-154	155-165
5'11"	127-133	150-158	159-169
6'0"	129-135	154-162	163-173

Table 2 Ideal weights for men, ages 21 and over, Metropolitan Life Insurance Company

Height (inches above)	Weight in pounds (in ordinary dress)		
	Small frame	Medium frame	Large frame
5'2"	116-123	124-131	131-142
5'3"	118-125	127-134	134-145
5'4"	121-128	130-137	137-148
5'5"	123-130	134-141	141-152
5'6"	125-132	137-144	144-155
5'7"	127-134	141-148	148-159
5'8"	129-136	145-152	152-163
5'9"	131-138	149-156	156-167
5'10"	133-140	153-160	160-171
5'11"	135-142	157-164	164-175
6'0"	137-144	161-168	168-179
6'1"	139-146	165-172	172-183
6'2"	141-148	169-176	176-187
6'3"	143-150	173-180	180-191

Ideal Body Weight (kg) Formulas

MEN	WOMEN
Height (cm) – 100	Height (cm) – 110
Height (cm) -102	Height (cm) - 105
50 kg (60 in) + 2.3 kg/in	45.5 kg (60 in) + 2.3 kg/in
52 kg (60 in) + 1.9 kg/in	49 kg (60 in) + 1.7 kg/in
56.2 kg (60 in) + 1.41 kg/in	53.1 kg (60 in) + 1.36 kg/in
22 x M ²	22 x M ²

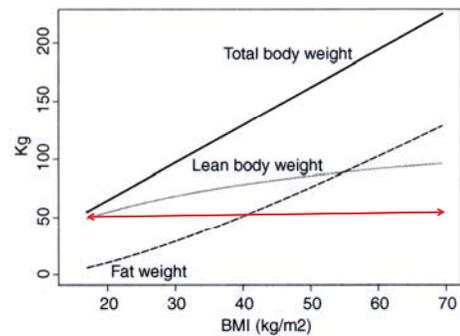


Ideal Body Weight (kg) (IBW) = (22)(m²)

Lemmens H, Brodsky JB. Estimating Ideal Body Weight. Obes Surg (2005) 15:1082-3

Lean Body Weight (LBW) in a normal weight patient

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



Janmahasatian Formula

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

$$LBW (kg) = \frac{9270 \times TBW (kg)}{8780 + (244 \times BMI (kg.m^{-2}))} \text{ (women)}$$

LBW in Obesity (BMI > 30 kg/m²)
IBW + 20 - 30%

What is "OBESITY"?

Fat comprises *greater than normal* percentage of body weight

Why are 2 out of 3 American women "overweight"?

Body Mass Index (BMI = kg/m²)

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

Average Weight for American Adults (1998)

↓

Body Mass Index values for males and females aged 20 and over, and selected percentiles by age: United States, 2007-2010. Source: "Anthropometric Reference Data for Children and Adults: United States" from CDC DHHS^[1]

Age	Percentile								
	5th	10th	15th	25th	50th	75th	85th	90th	95th
Men BMI (kg/m²)									
20 years and over (total)	20.7	22.2	23.2	24.7	27.8	31.5	33.9	35.8	39.2
20-29 years	19.4	20.7	21.4	22.9	25.6	29.9	32.3	33.8	36.5
30-39 years	21.0	22.4	23.3	24.9	28.1	32.0	34.1	36.2	40.5
40-49 years	21.2	22.9	24.0	25.4	28.2	31.7	34.4	36.1	39.6
50-59 years	21.5	22.9	23.9	25.5	28.2	32.0	34.5	37.1	39.9
60-69 years	21.3	22.7	23.8	25.3	28.8	32.5	34.7	37.0	40.0
70-79 years	21.4	22.9	23.8	25.6	28.3	31.3	33.5	35.4	37.8
80 years and over	20.7	21.8	22.8	24.4	27.0	29.6	31.3	32.7	34.5
Women BMI (kg/m²)									
20 years and over (total)	19.5	20.7	21.7	23.3	27.3	32.5	36.1	38.2	42.0
20-29 years	18.8	19.9	20.6	21.7	25.3	31.5	36.0	38.0	43.9
30-39 years	19.4	20.6	21.6	23.4	27.2	32.8	36.0	38.1	41.6
40-49 years	19.3	20.6	21.7	23.3	27.3	32.4	36.2	38.1	43.0
50-59 years	19.7	21.3	22.1	24.0	28.3	33.5	36.4	39.3	41.8
60-69 years	20.7	21.6	23.0	24.8	28.8	33.5	36.6	38.5	41.1
70-79 years	20.1	21.6	22.7	24.7	28.6	33.4	36.3	38.7	42.1
80 years and over	19.3	20.7	22.0	23.1	26.3	29.7	31.6	32.5	35.2

World Health Organization Classification by BMI (1998)

Classification	BMI (kg/m ²)	Risk of co-morbidities
Underweight	< 18.5	Low
NORMAL range	18.5 – 24.9	Average
Overweight (pre-obese)	25.0 – 29.9	Increased
Obese	≥ 30.0	Moderate
Class I	30.0 – 34.9	Severe
Class II	35.0 – 39.9	Very severe
Class III	≥ 40.0	

June 17, 1998

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

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

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

Czerniawski AM. From Average to Ideal. The evolution of the height and weight table in the United States, 1836-1943. Social Science History (2007) 31: 273-296

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

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

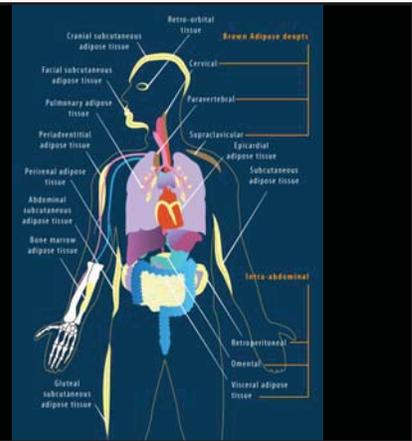
Kucumski RJ, Flegel KM. Criteria for definition of overweight in transition: background and recommendations for the United States. Am J Clin Nutr 2000; 72: 1074-81

BMI measures weight



BMI is not a direct measure of obesity!

Distribution and type of fat



Distribution (and type) of fat is most important



Peripheral
hips
buttocks thighs
(female)



Central
upper body
waist
(male)

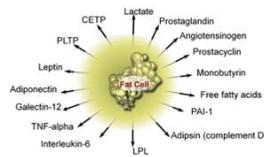
Metabolic Syndrome

- Waist circumference**
>102 cm (men) and >88 cm (women)
- Serum triglycerides**
 ≥ 150 mg/dl
- HDL cholesterol**
<40 mg/dl (men) and <50 mg/dl (women)
- Systolic blood pressure**
 ≥ 130 mmHg and/or diastolic ≥ 85 mmHg or on treatment for hypertension
- Fasting serum glucose**
 ≥ 110 mg/dl or on treatment for diabetes

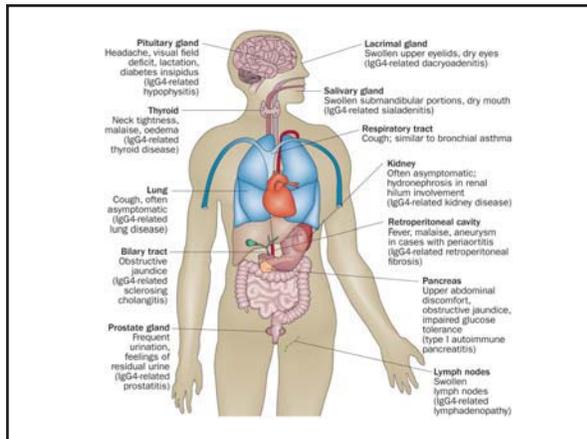


CENTRAL OBESITY

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



BMI		Waist less than or equal to 40 in. (men) or 35 in. (women)	Waist greater than 40 in. (men) or 35 in. (women)
18.5 or less	Underweight	---	N/A
18.5 - 24.9	Normal	---	N/A
25.0 - 29.9	Overweight	Increased	High
30.0 - 34.9	Obese I	High	Very High
35.0 - 39.9	Obese II	Very High	Very High
40 or greater	Obese III	Extremely High	Extremely High

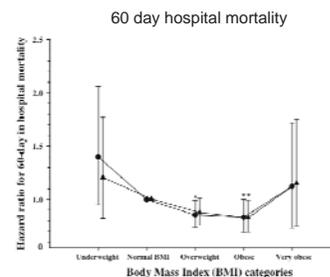


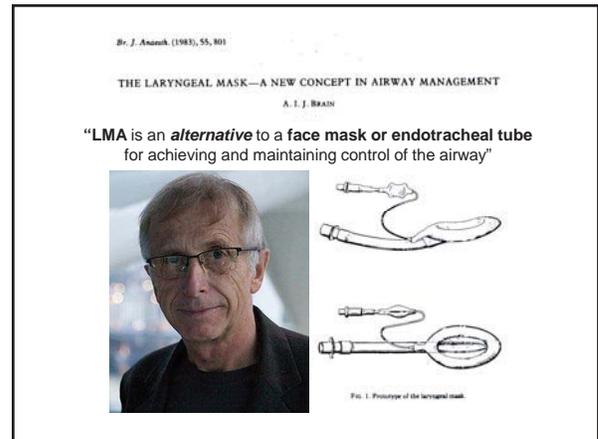
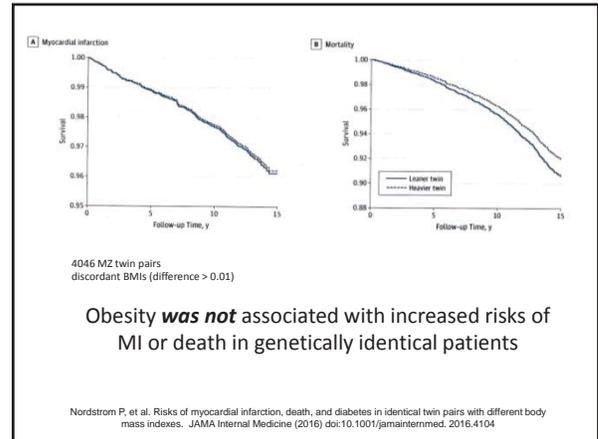
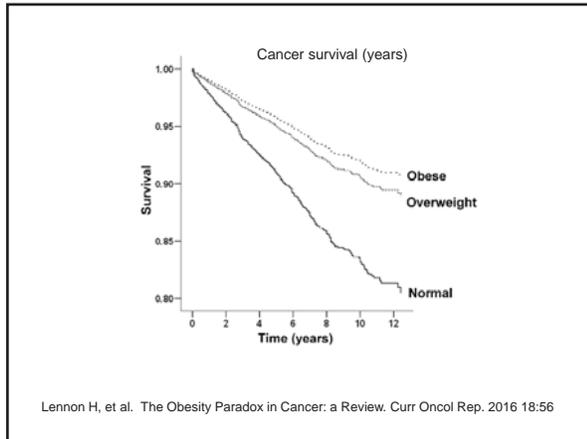
MYTH:

Being overweight/obese is ***always*** bad for your health

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

Obesity Paradox





Indications - LMA

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

To be used in:

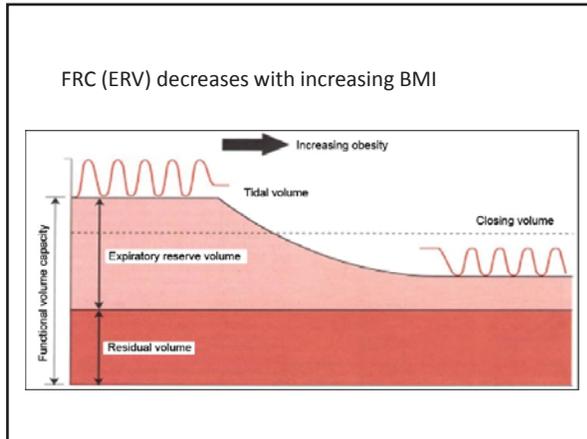
- **Spontaneously breathing** patients
- **Supine** or **lithotomy positions** only

Brain AIJ (1983) The laryngeal mask- a new concept in airway management. *Br J Anaesth* 55: 801

LMA: Contra-indications

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

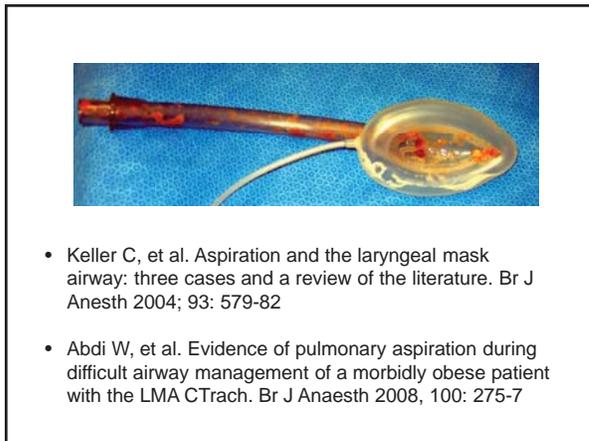
Brain AIJ (1983) The laryngeal mask- a new concept in airway management. *Br J Anaesth* 55: 801



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

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

- Potential Risk Factors for Gastric Aspiration in Obesity**
- Delayed gastric emptying (???)
 - Decreased pH gastric fluid (???)
 - Increased gastric fluid volume (???)
 - High incidence hiatal hernia and GERD
 - Diabetic with gastroparesis
 - Increased abdominal pressure (laparoscopy, lithotomy)
 - Previous gastric banding



4th National Audit Project of The Royal College of Anaesthetists and The Difficult Airway Society
Major complications of airway management in the UK
 Report and findings March 2011

Approximately 2.9 million anaesthetics in UK

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

4th National Audit Project of The Royal College of Anaesthetists and The Difficult Airway Society
Major complications of airway management in the UK
 Report and findings March 2011

- Morbidly obese at increased risk of regurgitation and aspiration (50% of deaths in NAP-4)
- Obese patients had increased frequency of aspiration associated with use of supraglottic devices (LMAs)....

BJA Major complications of airway management in the UK: Results of the Fourth National Audit Project of the Royal College of Anaesthetists and the Difficult Airway Society
British Journal of Anaesthesia
Cook TM, et al. BJA (2011) 106:617-31

- ETT achieves the best protection against aspiration and can enable increased pressure during ventilation
- second-generation SGAs with improved seal **may be safer** in obesity – but (in 2011) no evidence available

Role of 2nd Generation SGAs in Obesity?



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

- SOBA recommends tracheal intubation for patients with BMI > 35 kg/m²
- ETT should be the default airway (in obesity) with justification for the use of a SGA



Are the airways of morbidly obese patients are “difficult”

Answer: Yes and No!

What is a Difficult Airway?

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

ASA Task Force: Practice Guidelines for the Management of the Difficult Airway.

Shiga T, et al. Predicting Difficult Intubation in Apparently Normal Patients: A Meta-analysis of Bedside Screening Test Performance. Anesthesiology 2005; 103: 429-37

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

Juvin P, et al. Difficult tracheal intubation is more common in obese than in lean patients. Anesth Analg 2003; 97:595-600

Brodsky JB, et al. Morbid obesity and tracheal intubation. Anesth Analg 2002; 94:732-6

Voyagis GS, et al. Value of oropharyngeal Mallampati classification in predicting difficult laryngoscopy among obese patients. Eur J Anaesthesiol 1998; 15:330-4

Ezri T, et al. Prediction of difficult laryngoscopy in obese patients by ultrasound quantification of anterior neck soft tissue. Anaesthesia 2003; 58:1111-4

Face Mask Ventilation (MV)

Grade	Description
1	Ventilated by mask
2	Ventilated by mask with oral airway/ adjuvant with or without muscle relaxant
3	Difficult ventilation (inadequate, unstable, or requiring two providers) with or without muscle relaxant
4	Unable to mask ventilate with or without muscle relaxant

Grade 3



Kheterpal S, et al. Incidence and predictors of difficult and impossible mask ventilation. *Anesthesiology* (2006) 105:885-91

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

Grade 3 mask ventilation	
Body mass index ≥ 30 kg/m ²	< 0.0001
Beard	< 0.0001
Mallampati III or IV	< 0.0001
Age ≥ 57 yr	0.002
Jaw protrusion—severely limited	0.018
Snoring	0.019



Kheterpal S, et al. Incidence and predictors of difficult and impossible mask ventilation. *Anesthesiology* 2006; 105: 885-891

Anesthesiology 2006, 105:885-91 Copyright © 2006, the American Society of Anesthesiologists, Inc. Lippincott Williams & Wilkins, Inc.

Incidence and Predictors of Difficult and Impossible Mask Ventilation

Sachin Kheterpal, M.D., M.B.A., Richard Han, M.D., M.P.H., Kevin K. Tremper, Ph.D., M.D., Amy Shanks, M.S., J. Alan K. Tan, Ph.D., & Michael O'Riada, M.D., M.S.; Thomas A. Luchini, M.D., M.S.

Table 5. Airway Outcome Independent Predictors

Factor	P Value
Grade 3 mask ventilation	
Body mass index ≥ 30 kg/m ²	< 0.0001
Beard	< 0.0001
Mallampati III or IV	< 0.0001
Age ≥ 57 yr	0.002
Jaw protrusion—severely limited	0.018
Snoring	0.019
Grade 3 or 4 mask ventilation and difficult intubation	
Jaw protrusion—limited or severely limited	< 0.0001
Thick/obese neck anatomy	0.019
Sleep apnea	0.036
Snoring	0.049
Body mass index ≥ 30 kg/m ²	0.053

“Intubation” Difficulty Score (IDS)

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

IDS < 5 = not difficult
IDS \geq 5 = difficult

Juvin P, et al. Difficult **tracheal intubation** is more common in obese than lean patients. *Anesth Analg* (2003) 97:595-600

IDS	Lean (BMI < 30) (n=134)	Obese (BMI > 35) (n=129)
> 1	61.9%	43.3%
< 5	35.8%	41.1%
> 5	2.3% (n=3)	15.5% (n=20)

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

AIRWAY

Juvin P, et al. Difficult **tracheal intubation** is more common in obese than in lean patients. *Anesth Analg* (2003) 97: 595–600

Potential “Difficult” Tracheal Intubation Predictors

ABNORMAL FACIAL ANATOMY and/or DEVELOPMENT

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

INABILITY TO OPEN MOUTH

- Masseter muscle spasm
- Temporo-mandibular joint dysfunction
- Facial burns
- Post-radiation fibrosis
- Scleroderma

CERVICAL IMMOBILITY/ABNORMALITY

- Short neck/ or obesity + large neck circumference
- Poor cervical mobility (eg ankylosis spondylitis)
- Previous cervical spine and/or neck surgery
- Presence of cervical collar
- Post-radiation fibrosis

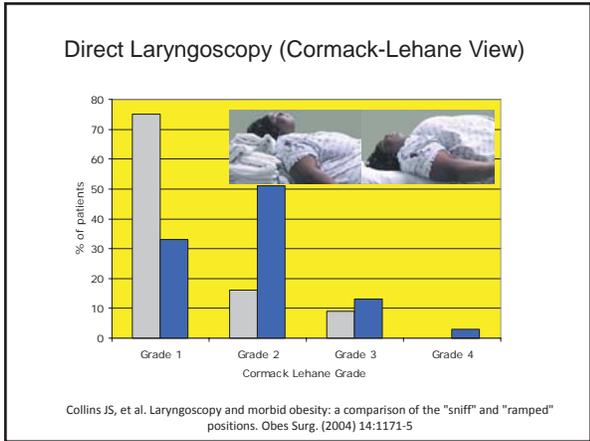
PHARYNGEAL and/or LARYNGEAL ABNORMALITY

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

Stanford Anesthesia Residents – Direct Laryngoscopy
100 Consecutive Morbidly Obese Patients

1 st attempt	92%	(92/100)
2 nd attempt	5%	(5/100)
3 rd attempt	2%	(2/100)
Failed	1%	(1/100)

Brodsky JB, et al. Morbid Obesity and Tracheal Intubation. Anesth Analg 2002; 94: 732



Shiga T, et al. Predicting Difficult Intubation in Apparently Normal Patients: A Meta-analysis of Bedside Screening Test Performance. Anesthesiology 2005; 103: 429-37

- Ezri T, et al. Anaesthesia 2003;58:1111-4
- Juvin P, et al. Anesth Analg 2003;97:595-600
- Brodsky JB, et al. 2002;94:732-6
- Voyagis GS, et al. Eur J Anaesthesiol 1998;15:330-4

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

All 4 studies stated... "**magnitude of obesity did not influence laryngoscopy difficulty!**"

What Should You Look For?

Mallampati Score III/IV

Probability of Problematic Intubation

Neck Circumference (> 60 cm)

Always be prepared for a difficult tracheal intubation

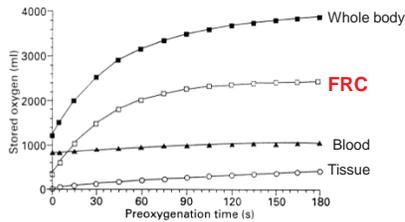
Routine Position Anesthetic Induction – Supine

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

Pre-oxygenation

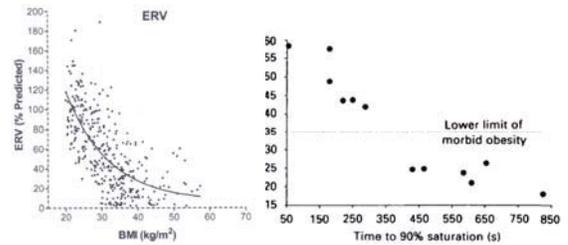
Normally patients are pre-oxygenated with 100% oxygen via a tight-fitting facemask for:

- 3 min at tidal volume ventilation
- 8 vital capacity breaths within 60 s



Benumof JL. Preoxygenation: Best Method for Both Efficacy and Efficiency? *Anesthesiology* 1999;91:603

FRC and SAP inversely proportional to BMI

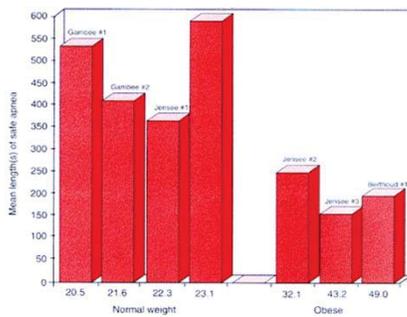


Jones RL, et al (2006) The effects of body mass index on lung volumes. *Chest* 130: 827-833

Berthoud MC, et al (1991) Effectiveness of Preoxygenation in Morbidly Obese Patients. *Br J Anaesth* 67: 464-6

Safe Apnea Period (SAP)

Time_(sec) to SpO₂ 90 - 92%

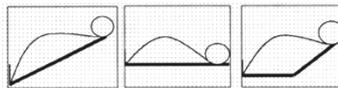


4th National Audit Project of The Royal College of Anaesthetists and The Difficult Airway Society

Major complications of airway management in the UK

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

Position and SAP and SpO₂ Recovery Times in Morbidly Obese Patients



Safe Apnea Period (seconds)	178±55 (1 vs 3: p<0.05)	123±24	153±63
Recovery Time (seconds)	80±30	206±64	97±41
Lowest SaO ₂ (%)	83±4 (2 vs 1: P<0.001)	82±5	83±4 (2 vs 3: P<0.001)

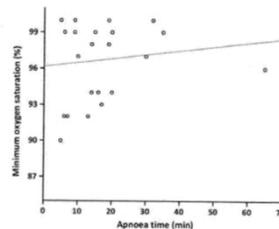
Data is Mean±Standard Deviation.

Boyce et al (2003) A preliminary study of the optimal anesthesia positioning for the morbidly obese patient. *Obes Surg* 13: 4-9

Transnasal Humidified Rapid-Insufflation Ventilatory Exchange (THRIVE)

Optiflow™

CPAP continuous delivery 100% O₂ up to 70 L/min



Average SAP (> 90% SpO₂) 17 min until airway secured in 25 difficult airway patients (12 obese)

Patel A, et al. Transnasal humidified rapid-insufflation ventilatory exchange (THRIVE): a physiological method of increasing apnoea time in patients with difficult airways. *Anaesthesia* (2015) 70: 323-329

Nasal Oxygen Insufflation and SAP

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

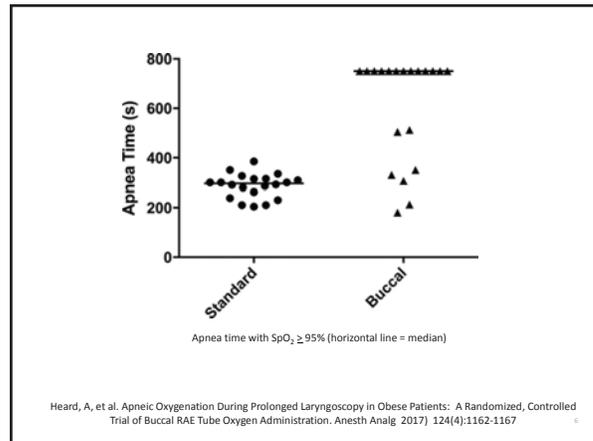
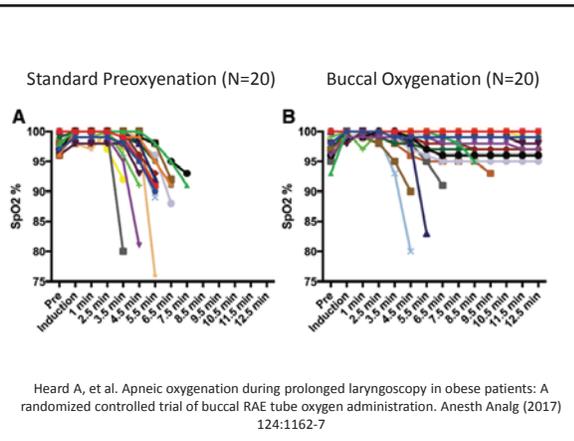
- 5 L/min nasal O₂ during laryngoscopy
- 16/17 pts – SpO₂ 100% after 4 mins apnea

Baraka AS, et al. Supplementation of pre-oxygenation in morbidly obese patients using nasopharyngeal oxygen insufflation. *Anaesthesia* (2007) 62:769–773

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



Heard A, et al. Apneic oxygenation during prolonged laryngoscopy in obese patients: A randomized controlled trial of buccal RAE tube oxygen administration. *Anesth Analg* (2017) 124:1162-7



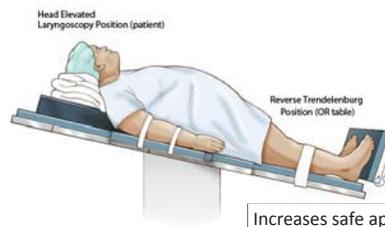
Positive Pressure Face Mask and P-LMA Ventilation and SAP

	FM (n=52)	PLMA (n=48)
SAP (seconds)	205.0±48.2	337.4±61.0
Range	96–320	176–456
Recovery time (seconds)	49.7±6	42.1±5
Range	36–68	30–56
Lowest SpO ₂	63.4±7	62.6±6.4
Range	43–79	49–74

Sinha A, et al. ProSeal™ LMA Increases Safe Apnea Period in Morbidly Obese Patients Undergoing Surgery under General Anesthesia. *Obes Surg* (2013) 23: 580–584

“Ideal” Position for Morbidly Obese Patient

Improves view during direct laryngoscopy

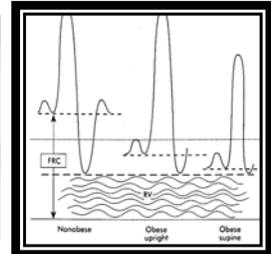


Mechanical Ventilation and Obesity

Reduce atelectasis during and after anesthetic induction

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

Mechanical Ventilation and Obesity
Supine



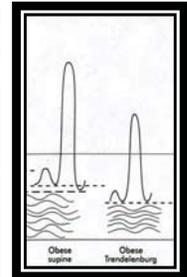
Increased intra-abdominal pressure (IAP) → decreased chest wall compliance and lung volume

Lithotomy



Further reduction in chest wall compliance and lung volumes

Trendelenburg



Greatest reduction in chest wall compliance and lung volumes

Effects of Capnoperitoneum during Laparoscopy



Respiratory Mechanics

Peak Inspiratory Pressure (PIP) Increased
Respiratory Compliance Decreased

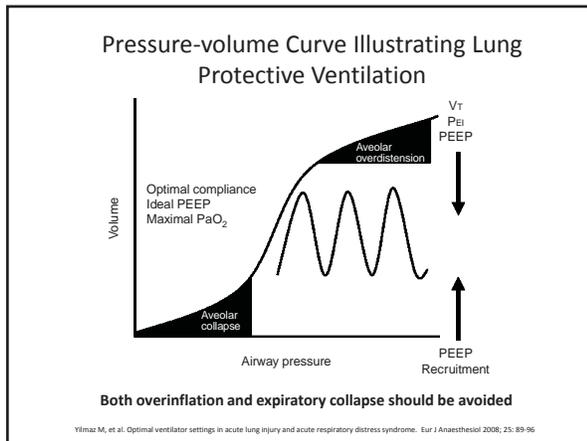
Ventilator Changes (to reduce PIP and CO₂)

Respiratory Rate Increased
Tidal Volume Decreased
Minute Ventilation Increased

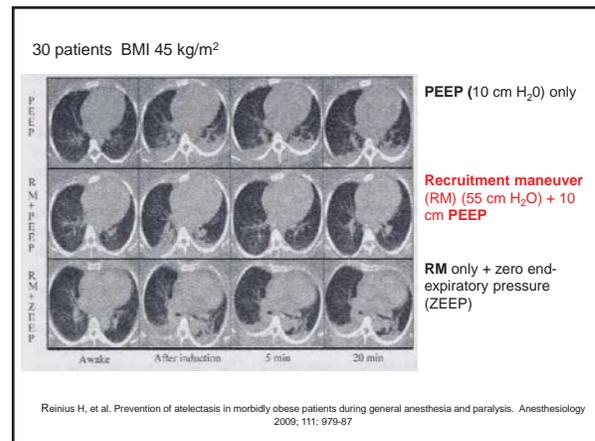
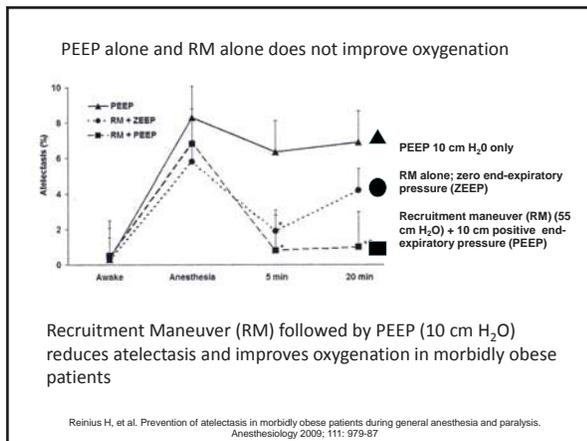
Nguyen NT, Wolfe BM. The physiologic effects of pneumoperitoneum in the morbidly obese. Ann Surg 2005; 241:219-226

Avoid Lung Overdistention

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



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



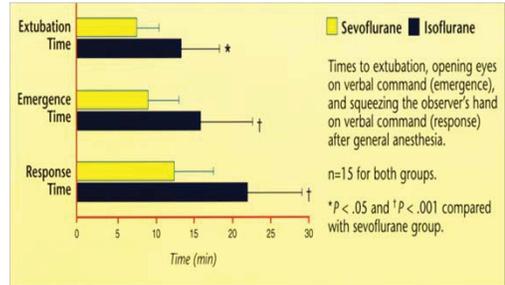
- ### Maintain post-operative lung expansion
- CPAP or BIPAP immediately after tracheal extubation
 - Keep patient's upper body elevated
 - Supplemental nasal or mask oxygen
 - Maintain good pain control (limit opioids)
 - Use incentive spirometry
 - Encourage early ambulation

Is there is a "best" anesthetic for morbidly obese patients?

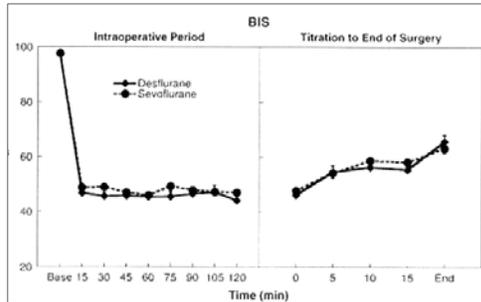
Desflurane is least fat soluble - less deposition in fat - ? faster recovery from anesthesia

	Desflurane	Sevoflurane	Isoflurane	Halothane	N ₂ O
Fat	27	48	45	51	2.3
Blood	0.42	0.69	1.46	2.54	-
Brain	1.3	1.7	1.6	1.9	1.1
Heart	1.3	1.8	1.6	1.8	-
Liver	1.3	1.8	1.8	2.1	0.8
Kidney	1.0	1.2	1.0	1.2	-
Muscle	2.0	3.1	2.9	3.4	1.2

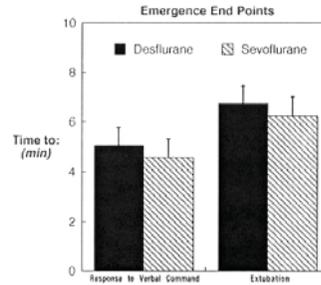
Solubility of Inhaled Anesthetics



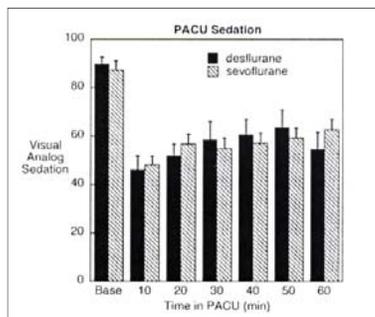
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Arañ SR, et al. Choice of volatile anesthetic for the morbidly obese patient: sevoflurane or desflurane. J Clin Anesth 2005; 17: 413-9



Arañ SR, et al. Choice of volatile anesthetic for the morbidly obese patient: sevoflurane or desflurane. J Clin Anesth 2005; 17: 413-9

Remifentanyl

Table 2. Recovery profile (min): duration to achieve required stages of post-anesthesia recovery from ending of surgery and discontinuation of propofol infusion

	Group R	Group A	Group F
Response to verbal command	3.00±0.97	3.70±1.78	3.77±1.67
Spontaneous respiration	3.25±1.21*	4.00±1.57	4.16±1.57
Adequate respiration	4.85±1.71*	5.40±2.50	6.36±2.08
Safe extubation	5.60±2.02*	5.90±2.46	7.32±2.15

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

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



Remifentanil

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

Administered by bolus or infusion

Remifentanil

Administered with either propofol infusion or inhalational anesthetic (**isoflurane**)

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

??? Increased post-operative pain

??? Increased nausea and vomiting

Dexmedetomidine

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

Table 2. Perioperative Need for Phenylephrine, β -Blocker and Discontinuation of Study Medication Infusion, Time from Turning Off the Desflurane to Patients' Extubation, First Spontaneous Eye Opening, Following Simple Commands, Tracheal Extubation, and the Duration of the Postanesthesia Care Unit (PACU) Stay

	Control (n = 20)	Dex 0.2 (n = 20)	Dex 0.4 (n = 20)	Dex 0.8 (n = 20)
Rescue phenylephrine [n (%)]	4 (20)	2 (10)	4 (20)	10 (50)*
Rescue β -blocker [n (%)]	5 (25)	3 (15)	1 (5)	0 (0)*
Transient discontinuation of study drug [n (%)]	2 (10)	2 (10)	3 (15)	3 (15)
Time to eye opening (min)	6 \pm 3	3 \pm 3	6 \pm 4	8 \pm 6
Time to follow simple commands (min)	6 \pm 3	6 \pm 3	6 \pm 4	9 \pm 6
Time to tracheal extubation (min)	7 \pm 3	5 \pm 3	6 \pm 4	9 \pm 6
Duration of the PACU stay (min)	104 \pm 33	81 \pm 31*	82 \pm 24*	87 \pm 24*
Nausea/vomiting in PACU [n (%)]	13/3 (65/15)	5/1 (25/5)*	6/0 (30/0)*	9/2 (45/11)
Required antiemetic therapy [n (%)]	14/70	6/30*	6/30*	2/10*
Nausea score ^a				
Upon arrival in PACU	3 \pm 3	1 \pm 1*	2 \pm 3	1 \pm 2
At 30 min	3 \pm 3	1 \pm 2*	1 \pm 2*	1 \pm 2*
At 60 min	3 \pm 3	2 \pm 3	1 \pm 2*	1 \pm 3

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

Tufanogullari B, et al. Dexmedetomidine Infusion During Laparoscopic Bariatric Surgery: The Effect on Recovery Outcome Variables. *Anesth Analg* (2008) 106:1741-8

Colorado Review of Anesthesia for SurgiCenters and Hospitals 2018

Breandan L Sullivan MD

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Intensive Care Unit Panel

Interactive Case Presentation:

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

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

Source Control Surgery

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

Fluid management with severe electrolyte disturbances

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

Bedside Anesthesia in the Intensive Care Unit

- When is a patient too sick to travel to the operating room?

Acute Respiratory Distress Syndrome

- Referral for Veno-venous ecmo?

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

2. Rhodes et al. Surviving Sepsis Campaign: International Guidelines for Management of Sepsis and Septic Shock: 2016. March 2017 Volume 45. Number 3. 486-552
3. Takauji S, Hayakawa M et al. Respiratory extracorporeal membrane oxygenation for severe sepsis and septic shock in adults: a propensity score analysis in a multicenter retrospective observational study. *Acute Med Surg.* 2017 Jul 17;4(4):408-417

Apneic Oxygenation

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Disclosures

- None

Objectives

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

Steps in Anesthetic

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

Increase apneic window

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

Is there a way to increase apneic window during induction?

STUDIES ON DIFFUSION RESPIRATION.* III. ALVEOLAR GASES AND VENOUS BLOOD pH OF DOGS DURING DIFFUSION RESPIRATION †

WILLIAM B. DRAPER, M.Sc., M.D., RICHARD W. WHITEHEAD, M.A., M.D.,
AND JOSEPH N. SPENCER, Ph.D.
WITH THE TECHNICAL ASSISTANCE OF DAVID L. G. BISHOP, B.S.,
AND THOMAS M. PARRY, B.A., M.D.

Denver, Colorado

Received for publication March 26, 1947

- 12 "medium sized mongrel dogs"
- 45 minutes of respiratory arrest
- Airway kept patent
- 6-8 lpm of oxygen administered

528 W. B. DRAPER, R. W. WHITEHEAD AND J. N. SPENCER

TABLE 1
ALVEOLAR GASES AND VENOUS BLOOD pH

Dose No.	Control After Denitrogenation (Under Anesthesia)			Minutes of Diffusion Respiration			Minutes After Diffusion			Recovery				
	pH	CO ₂	O ₂	15	30	45	15	30	60					
				pH	pH	CO ₂	CO ₂	pH	pH		CO ₂	CO ₂		
F1	7.45	5.5	88.5	—	6.92	6.79	49.0	33.0	—	7.34	6.0	7.40	6.0	Complete and permanent
F2	7.47	Invalid	—	—	6.82	6.70	42.6	28.9	—	7.10	6.4	7.23	4.9	Complete and permanent
F3	7.42	6.5	86.3	—	6.84	6.83	38.2	26.9	—	7.16	Invalid	7.29	Invalid	Complete and permanent
F4	7.40	5.0	86.0	—	6.88	6.81	42.6	Invalid	—	7.25	6.0	7.38	3.3	Complete and permanent
F5	7.40	4.1	89.0	—	6.91	6.78	46.1	34.1	—	7.22	4.8	7.33	4.5	Complete and permanent
F6	7.43	6.3	87.4	—	6.80	6.73	37.0	25.9	—	7.20	6.0	7.30	6.1	Complete and permanent
F7	7.38	7.0	76.9	—	6.83	6.76	44.2	30.5	—	7.29	5.5	7.23	3.5	Complete and permanent
F8	7.39	7.5	87.5	7.03	6.80	6.82	37.5	24.5	6.90	7.20	6.0	7.30	4.0	Complete and permanent
F9	7.38	7.0	83.5	7.06	6.92	6.80	33.5	21.5	7.10	7.24	5.5	7.30	5.5	Complete and permanent
F10	7.47	7.0	87.5	7.09	6.88	6.77	33.0	26.0	7.29	7.40	5.0	7.48	4.0	Complete and permanent
F11	7.40	6.4	86.0	7.06	6.83	6.83	35.3	25.1	7.10	7.21	6.3	7.23	6.4	Complete and permanent
F12	7.38	6.4	91.6	7.02	6.81	6.96	36.2	36.5	7.11	7.23	6.3	7.23	5.4	Complete and permanent
Avg.	7.40	6.2	85.9	7.03	6.80	6.78	34.7	28.3	7.10	7.25	6.3	7.32	4.8	

APNEIC OXYGENATION IN MAN

M. JACK FRUMIN, M.D., ROBERT M. EPSTEIN, M.D., GERALD COHEN, PH.D.

Accepted for publication June 25, 1959; presented at the Annual Meeting of the American Society of Anesthesiologists, Inc., Miami Beach, Florida, October 9, 1959. The authors are in the Departments of Anesthesiology and Biochemistry, College of Physicians and Surgeons, Columbia University, and the Anesthesiology Service, The Presbyterian Hospital, New York, New York.

- Eight essentially healthy patients scheduled for variety minor procedures
- Induced, intubated and then denitrogenated for 30 min
- ETT, connected to circle apparatus, with 100% oxygen, and apnea was allowed to persist for 30-55 min
- Reservoir bag
 - moved -> more suxx (avg 500mg)
 - Emptied -> refilled with O₂ - required 2-3 liters q 15 min

TABLE 1
APNEIC OXYGENATION IN MAN

Subject Number	Duration of Apnea (minutes)	Lowest Arterial Saturation (per cent)	Lowest Arterial pH	Highest PaCO ₂ (mm. Hg)	Average Rate of Rise of PaCO ₂ (mm. Hg/minute)
1	30	100	—	—	—
2	45	100	—	—	—
3	55	100	—	—	—
4	45	100	6.88	160	3.0
5	18	99	6.97	130	4.9
6	45	98	6.87	160	3.0
7	53	98	6.72	250	3.5
8	38	100	6.96	130	2.7

Gas exchange during regular breathing

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

Can J Anesth/J Can Anesth (2017)

Gas Exchange during apnea

Aventilatory mass flow (AVMF)

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

Can J Anesth/J Can Anesth (2017)

Nishimura *Journal of Intensive Care* (2013) 3:15
DOI 10.1186/1026-015-0084-5

JOURNAL OF INTENSIVE CARE

REVIEW Open Access

High-flow nasal cannula oxygen therapy in adults

Masaji Nishimura

Figure 1 Principle setup of high-flow nasal cannula oxygen therapy. An oxygen blender, allowing from 0.21 to 1.0 F_iO₂, generates up to 60 L/min flow. The gas is heated and humidified through an active heated humidifier and delivered via a single-limb heated inspiratory circuit. The patient breathes the continuously heated and humidified medical gas through nasal cannulae with a large diameter.

Nishimura *Journal of Intensive Care* (2015) 3:15
DOI: 10.1186/s40560-015-0084-5

JOURNAL OF INTENSIVE CARE

REVIEW Open Access

High-flow nasal cannula oxygen therapy in adults
Masaji Nishimura

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

THRIVE

- T - transnasal
- H - humidified
- R - rapid
- I - insufflated
- V - ventilatory
- E - Exchange

Transnasal Humidified Rapid-Insufflation Ventilatory Exchange (THRIVE): a physiological method of increasing apnoea time in patients with difficult airways
Anaesthesia 2015, 70, 323–329

Patel et al. The Royal National Throat Nose and Ear Hospital, London, UK

- Extended apnea times in 25 patients with difficult airways (12 obese, 9 with stridor) undergoing hypopharyngeal or laryngo-tracheal surgery.
- Used HFNC oxygen, in 40° head-up position, initially for pre-oxygenation, and continuing during IV induction of anesthesia and neuromuscular blockade until a definitive airway was secured. Upper airway patency was maintained with jaw-thrust.
- The median apnea time was 14 min
- No patient desaturated < 90%.

NO DESAT

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

Can J Anaesth / Can Anaesth (2017) 64:416–427
DOI: 10.1007/s12630-016-0802-z

REVIEW ARTICLE/BRIEF REVIEW

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

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

Can J Anaesth / Can Anaesth (2017) 64:416–427
DOI: 10.1007/s12630-016-0802-z

REVIEW ARTICLE/BRIEF REVIEW

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

Fig. 1 Schematic diagram showing the four possible locations of the tip of the cannula or catheter in the upper airway (A) just inside the nares; (B) nasopharynx; (C) trachea; and (D) main stem bronchi

Paper	Design	Setting / Situation	Sample Size	Control Group	Apneic (AO) Oxygenation	Results
Ramachandran et al 2010	RCT	Elective Surgery w/ BMI 30-35	30 = 15 control 15 intervention	No additional nasal O2	Nasal prongs: O2 at 5 L min	1. Duration (max 6 min) SpO2 > 95% AO: 5.29 min Control 3.49 min 2. Lowest SpO2 AO: 94% Control 87
Christodoulou et al 2013	RCT	ASA 1-3 Elective Surgery	41 = 14 control	No O2 insufflation	Nasal Prongs at 1) 5 L min or 2) 10 L min	Mean PaO2 > 10 L min > 5 L min > no treatment
Lee et al 1998	RCT	ASA 1-3 tympanomastoidectomies	46 = 23 control 23 intervention	No additional O2	Nasal prongs: O2 at 5 L min	Apneic for 3 min Treatment group > PaO2 and less PaCO2 increase
Patel et al	Prospective Study	OR: difficult airways	25 = 15 male 10 female	None	HFNC with O2 at 70 L min	1) Median apnea time = 14 min 2) No patient SpO2 < 90%

Adapted from table Wong et al 2017

Can J Anesth/ Can Anesth (2017) 64:416-427
DOI: 10.1007/s12630-016-0802-z

REVIEW ARTICLE/BRIEF REVIEW

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

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

British Journal of Anaesthesia, 118 (3): 444-51 (2017)
doi:10.1093/bja/aeu448
Respiration and the Airway

RESPIRATION AND THE AIRWAY

Spontaneous Respiration using IntraVenous anaesthesia and Hi-flow nasal oxygen (STRIVE Hi) maintains oxygenation and airway patency during management of the obstructed airway: an observational study

A.W.G. Booth*, K. Vidhani, P.K. Lee, C.-M. Thomsett
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British Journal of Anaesthesia, 118 (3): 444-51 (2017)
doi:10.1093/bja/aeu448
Respiration and the Airway

STRIVE Hi management of the obstructed airway

Editor's key points

- High-flow nasal oxygen is potentially useful in patients who are breathing spontaneously during general anaesthesia, but its efficacy has not been assessed.
- A retrospective assessment of 30 patients indicated that high-flow nasal oxygen may be effective in preventing hypoxia, hypercapnoea, and complete airway obstruction in patients who are breathing spontaneously during total i.v. anaesthesia.

Anesthesia 2015, 70, 1286-1306
doi:10.1111/ane.13260

Guidelines

Obstetric Anaesthetists' Association and Difficult Airway Society guidelines for the management of difficult and failed tracheal intubation in obstetrics*

The anaesthetist should consider attaching nasal cannulae with 5 L min B1 oxygen flow before starting pre-oxygenation, to maintain bulk flow of oxygen during intubation attempts

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

British Journal of Anaesthesia, 115 (6): 827-48 (2015)

- Preoxygenation using a 20–25° head-up position and continuous positive airway pressure has been shown to delay the onset of hypoxia in obese patients.
- The duration of apnoea without desaturation can also be prolonged by passive oxygenation during the apnoeic period (apnoeic oxygenation).
- This can be achieved by delivering up to 15 litres min⁻¹ of oxygen through nasal cannulae, although this may be uncomfortable for an awake patient.

Can J Anesth/J Can Anesth (2013) 60:1119–1138

The difficult airway with recommendations for management – Part 2 – The anticipated difficult airway

Pre- and peri-intubation oxygenation

All patients with an anticipated difficult tracheal intubation and planned post-induction intubation should be pre-oxygenated with 100% oxygen for three minutes of tidal volume breathing, eight vital capacity breaths over 60 sec,⁸⁵ or until F_gO₂ exceeds 90%.⁸⁶ (Strong recommendation *for*, level of evidence *B*). There is evidence that oxygen desaturation with apnea can be further postponed if pre-oxygenation is undertaken with the patient in the semi-seated (Fowler's) position or with the stretcher or table in the reverse Trendelenburg position.⁸⁷⁻⁹¹ Apneic oxygenation⁹² via nasopharyngeal catheter^{93,94} or nasal cannula⁹⁵ may also be beneficial during attempted tracheal intubation.

Preoxygenation and Prevention of Desaturation During Emergency Airway Management

Scott D. Weingart, MD, Richard M. Levitan, MD
Annals of Emergency Medicine 2012 59, 165-175.

Sequence of Preoxygenation and Prevention of Desaturation

(Assuming 2 oxygen regulators*)

Preoxygenation Period

- Position the patient in a semi-recumbent position (~20°) or in reverse Trendelenburg. Position the patient's head in the ear-to-sternal-notch position using padding if necessary.
- Place a nasal cannula in the patient's nares. Do not hook the nasal cannula to oxygen regulator.
- Place patient on a non-rebreather mask at the maximal flow allowed by the oxygen regulator (at least 15 lpm, but may allow a much greater uncalibrated flow)
- If patient is not saturating > 90%, remove face mask and switch to non-invasive CPAP by using ventilator, non-invasive ventilation machine, commercial CPAP device, or BVM with PEEP valve attached. Titrate between 5-15 cm H₂O of PEEP to achieve an oxygen saturation > 98%. Consider this step in patients saturating 91-95%.
- Allow patient to breath at tidal volume for 3 minutes or ask the patient to perform 8 maximal exhalations and inhalations
- Attach a BVM to oxygen regulator and set it to maximal flow (at least 15 lpm). If the patient required CPAP for preoxygenation, attach a PEEP valve to the BVM set at the patient's current CPAP level

Preoxygenation and Prevention of Desaturation During Emergency Airway Management

Scott D. Weingart, MD, Richard M. Levitan, MD
Annals of Emergency Medicine 2012 59, 165-175.

Sequence of Preoxygenation and Prevention of Desaturation

(Assuming 2 oxygen regulators*)

Apneic Period

- Push sedative and paralytic (preferably rocuronium, if the patient is at risk for rapid desaturation)
- Detach face mask from the oxygen regulator and attach the nasal cannula. Drop the flow rate to 15 lpm.
- Remove the face mask from the patient.
- Perform a jaw thrust to maintain pharyngeal patency.
- If the patient is high risk (required CPAP for preoxygenation), consider leaving on the CPAP during the apneic period or providing 4-6 ventilations with the BVM with a PEEP valve attached. Maintain a two-hand mask seal during the entire apneic period to maintain the CPAP.

Intubation Period

- Leave the nasal cannula on throughout the airway management period to maintain apneic oxygenation.

* If 3 regulators are available, attach reserve face mask, BVM, and nasal cannula to them. If only one regulator is available, consider using a stand-alone oxygen tank to offer a second source of oxygen.

DAS Difficult intubation guidelines – overview

Difficult Airway Society 2015 guidelines for management of unanticipated difficult intubation in adults¹
Br J Anaesth. 2015;115(6):827-848. doi:10.1093/bja/aev371

Obstetric Anaesthetists' Association and Difficult Airway Society guidelines for the management of difficult and failed tracheal intubation in obstetrics

Master algorithm – obstetric general anaesthesia and failed tracheal intubation

© Obstetric Anaesthetists' Association/Difficult Airway Society (2015)

Obstetric Anaesthetists' Association and Difficult Airway Society guidelines for the management of difficult and failed tracheal intubation in obstetrics

Table 4 Key features of Plan D.
CICO, can't intubate can't oxygenate

- CICO and progression to front-of-neck access should be declared
- A didactic scalpel technique has been selected to promote standardized training
- Placement of a wide-bore cuffed tube through the cricothyroid membrane facilitates normal minute ventilation with a standard breathing system
- High-pressure oxygenation through a narrow-bore cannula is associated with serious morbidity
- All anaesthetists should be trained to perform a surgical airway
- Training should be repeated at regular intervals to ensure skill retention

Anaesthesia
Volume 70, Issue 11, pages 1286-1306, 8 OCT 2015 DOI: 10.1111/anae.13260
<http://onlinelibrary.wiley.com/doi/10.1111/anae.13260/full>

Obstetric Anaesthetists' Association and Difficult Airway Society guidelines for the management of difficult and failed tracheal intubation in obstetrics

Failed intubation, failed oxygenation in the paralysed, anaesthetised patient

CALL FOR HELP

Continue 100% O₂,
Declare CICO

Plan D: Emergency front of neck access

Continue to give oxygen via upper airway
Ensure neuromuscular blockade
Position patient to extend neck

Anaesthesia
Volume 26, Issue 11, pages 1286-1306, 8 OCT 2015 DOI: 10.1111/anae.13260
<http://onlinelibrary.wiley.com/doi/10.1111/anae.13260/full>

Obstetric Anaesthetists' Association and Difficult Airway Society guidelines for the management of difficult and failed tracheal intubation in obstetrics

Scalpel cricothyroidotomy

Equipment: 1. Scalpel (number 10 blade)
2. Bougie

3. Tube (cuffed 6.0mm ID)

Laryngeal handhake to identify cricothyroid membrane

Palpate cricothyroid membrane

Transverse skin incision through cricothyroid membrane
Turn blade through 90° (sharp edge caudally)
Slide coude tip of bougie along blade into trachea
Railroad lubricated 6.0mm cuffed tracheal tube into trachea
Ventilate, inflate cuff and confirm position with capnography
Secure tube

Impalpable cricothyroid membrane

Make an 6-10cm vertical skin incision, caudal to cephalad
Use blunt dissection with fingers of both hands to separate tissues
Identify and stabilise the larynx.
Proceed with technique for palpable cricothyroid membrane as above

Post-operative care and follow up

- Position surgery unless immediately life threatening
- Urgent surgical review of otolaryngology site
- Document and follow up as in main flow sheet

Anaesthesia
Volume 26, Issue 11, pages 1286-1306, 8 OCT 2015 DOI: 10.1111/anae.13260
<http://onlinelibrary.wiley.com/doi/10.1111/anae.13260/full>

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9. C. Frerik, V. S. Mitchell, A. F. McNarry, C. Mendonca, R. Bhargath, A. Patel, E. P. O'Sullivan, N. M. Woodall, I. Ahmad, Difficult Airway Society 2015 guidelines for management of unanticipated difficult intubation in adults, *BJA: British Journal of Anaesthesia*, Volume 115, Issue 6, 1 December 2015, Pages 827-848.

Tuesday



Neuromonitoring – What and When?

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



Disclosures

- IP for monitoring technology licensed to Medtronic



Set up audience participation

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



Test question



Outline

- NIRS
 - Fun with Beer-Lambert
- Autoregulation
 - Lassen's curves...
- EEG
 - Fourier Transforms!!!



Take your beta blockers and buckle in.



My opinion regarding NIRS monitoring



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

The evidence for NIRS monitoring is moderate. It is indicated for some of my patients

The evidence for NIRS monitoring is weak. It is not indicated but may prove helpful with more study

NIRS is potentially harmful and a waste of money

Start the presentation to see live content, \$88. No live content? Install the app or get help at PollEv.com/app



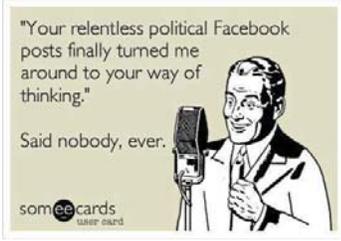
If you anesthetize for cardiac or high-risk vascular cases, do you use NIRS

Always
Most cases
Some cases
Rarely
Never

Start the presentation to see live content. Still no live content? Install the app to get help at PASEX.com/app

Religion, Politics, and Neuromonitoring

"Your relentless political Facebook posts finally turned me around to your way of thinking."
Said nobody, ever.



someecards user card

Barcoor
Texas Children's Hospital

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

True
False

Start the presentation to see live content. Still no live content? Install the app to get help at PASEX.com/app

Cochrane Database Review of Pulse-Oximetry

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

Barcoor
Cochrane Library
Pedersen: Pulse oximetry for perioperative monitoring. Cochrane Database of Systematic Reviews 2014
Texas Children's Hospital

believe that pulse oximetry improves the safety of anesthesia

True
False

Start the presentation to see live content. Still no live content? Install the app to get help at PASEX.com/app

Pascal's Wager and Neuromonitoring

	YOU'RE RIGHT!	YOU'RE WRONG!
BELIEF	ETERNAL JOY	NOTHING
ATHEISM	NOTHING	ETERNAL SUFFERING

Barcoor
Texas Children's Hospital

Part I: Reflectance NIRS

Singh GP. Near-infrared spectroscopy-current status. J Neuroanaesthesia Crit Care 2016;3, Suppl S186-9

Beer-Lambert Law: brains in cuvettes?

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

$$A = \log \frac{I_0}{I} = \epsilon lc$$

Borrowing from the pulse-oximeter

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

CMRO2/CBF: Jugular Sat and NIRS

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

Iweda et al. Anesthesia and analgesia 2018.

What do you consider to be a low NIRS?

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

What is a low Cerebral Oximetry?

Case: Cardiopulmonary Bypass

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

- Baseline NIRS: R-65%; L-68% on 0.21 FiO₂
- After starting bypass: R-42%, L-44%
- ABG: 7.35/37/150; Hb: 7.0; T: 35.9°C
- Pump flow 100% (2.4 L/m²), ABP: 55 mmHg

– What is your intervention?

What is your preferred intervention?

- Raise the PCO₂ by 10 torr
- Transfuse a unit of PRBC
- Lower the temperature by 1 degree C
- Increase the pump flow rate by 10%
- Increase the ABP by 10 mmHg
- None of the above- NIRS is bogus and these interventions are harmful!

What causes low cerebral oximetry?

$$DO_2 = CBF \times CaO_2$$

$$CBF = (ABP - ICP) / CVR$$

$$CaO_2 = (Hb \times 1.39 \times SaO_2) + (PaO_2 \times 0.003)$$

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

ANESTHESIOLOGY

The Journal of the American Society of Anesthesiologists, Inc.

Cerebral Desaturation

The flowchart outlines the following steps for managing cerebral desaturation:

1. Initial desaturation of 10%: Verify head position, check arterial desaturation of 10%.
2. Treat and find etiology: Hypotension → Treat arterial pressure.
3. Treat and find etiology: PaO₂ abnormal → Systemic saturation.
4. Treat and find etiology: PaCO₂ abnormal → PaCO₂ > 38 mmHg → Correct hyperventilation; PaCO₂ < 32 mmHg → Consider red blood cell transfusion.
5. Treat and find etiology: PaCO₂ normal → PaCO₂ > 50 mmHg → Hypocarbica.
6. Treat and find etiology: Hemodynamic acid-base/electrolyte imbalance → Optimize cardiac function or volume status.
7. Hypothermia and sepsis medication: Consider transfusion.
8. Refractory ICP: Consider ICP → Cerebral imaging (CT/MRI/US).
9. Cerebral O₂ consumption: Normal → Intra-aortic pressure; Increased → Consider transfusion.

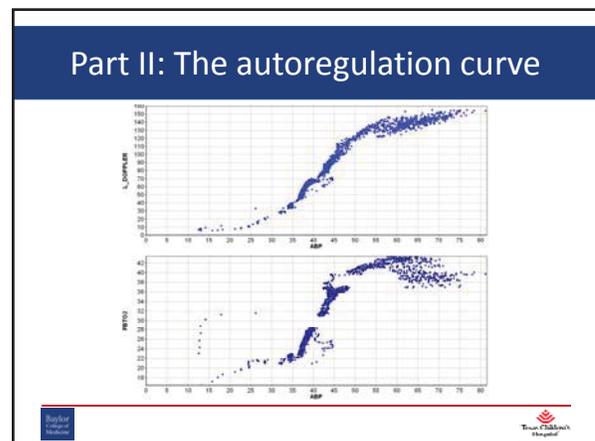
One more NIRS case: A pt on bypass for aortic root replacement is cooled to 18 degrees with pH stat management. The NIRS increases to max values. Interpretation?

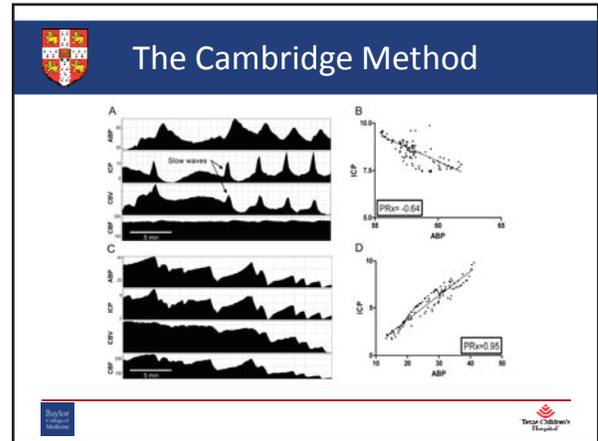
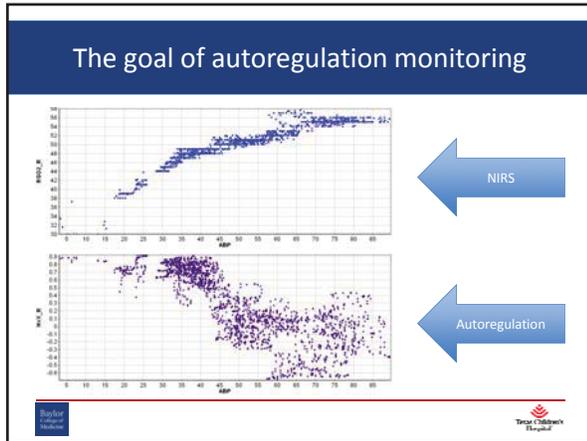
This is expected with pH-stat, but not alpha-stat management

This is possibly due to a progressive hemorrhage under the sensor.

Abnormally high NIRS values are as dangerous as low NIRS values

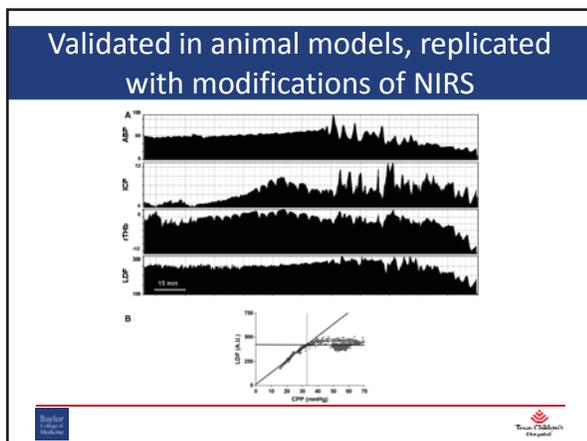
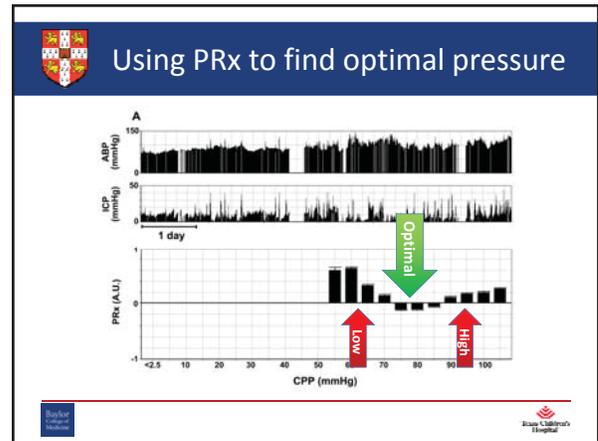
The sweep on the bypass oxygenator is too low





Single best answer: Cerebrovascular Pressure Autoregulation

- Matches cerebral blood flow to metabolic demand
- Is mediated by changes in cerebral vascular tone
- Causes increased ABP when ICP increases
- Causes cerebral vasodilation during hypoxia
- Fails when ABP is less than 50 mmHg



Autoreg monitoring in adult CPB

- RCCT
- R01 funded (Charles Hogue PI- year 8 of 10)
- Perfusionist to keep ABP > LLA vs standard
 - Increase flows primary
 - Vasoconstrictors secondary
- MRI data not yet available

Autoreg monitoring in adult CPB

- Post-op delirium

redacted

Autoreg monitoring in adult CPB

Safety monitoring data	Control (n=140)	Autoregulation (n=139)
Stroke (in-hospital)	4	5
Dialysis*	4	2
Renal Injury*	17	4
Sepsis*	7	0
Prolonged mechanical ventilation*	11	7
MSOF*	5	0
Single inotrope >24 hr	19	18
Multiple inotrope >48 hr*	9	4
New IABP	12	9
Death (in-hospital)*	9	2

Part III: EEG

What is depicted by these progressive EEG changes?

Anesthetic Depth

Hypothermia

Ischemia

All of the above

Start the presentation to see the content. If it has content recall the app or get help at [Pediaa.com](#) app

EEG Changes and Ischemia

CBF (ml-100 g•min)	EEG Change	Cellular Response
35-50	Normal	•Decreased Protein Synthesis
25-35	Loss of Faster Frequencies (8-14 Hz)	•Anaerobic Metabolism •Neurotransmitter Release (i.e. glutamate)
18-25	Increasing Slower Frequencies (4-7 Hz)	•Lactic Acidosis •Declining ATP
12-18	Increasing Slower Frequencies (1-4 Hz)	•Sodium-Potassium Pump Failure •Increased Intracellular Water Content
<10-12	Suppression	•Calcium Accumulation •Anoxic Depolarization •Cell Death

Foreman B, Claassen J. Quantitative EEG for the detection of brain ischemia. *Critical Care*. 2012;16(2):216. doi:10.1186/cc12120.

Comparing Anesthetic Depth and Ischemic EEGs

Raw EEG patterns:

← 1 second →

CBF (ml-100 g•min)

Wildes TS, Winter AC, Maybrier HR, et al. Protocol for the Electroencephalography Guidance of Anesthesia to Alleviate Geriatric Syndromes (ENGAGES) study: a pragmatic, randomised clinical trial.

EEG 101: Greek waves

Wave Name	Wave Frequency (Hz)	Relevance to Anesthesia
Slow	<1	Increase in Amplitude during anesthesia
Delta	1-4	Increase in Amplitude during anesthesia
Theta	5-8	Increase in Amplitude during anesthesia
Alpha	9-12	Increase in Amplitude during anesthesia
Beta	13-25	Decrease in Amplitude during anesthesia
Gamma	26-80	Decrease in Amplitude during anesthesia

The Secret in the Secret Sauce

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

The EEG spectrogram

Clinical Electroencephalography for Anesthesiologists: Part I: Background and Basic Signatures Anesthesia, 2015

What happens to the EEG under GA?

Clinical Electroencephalography for Anesthesiologists: Part I: Background and Basic Signatures Anesthesia, 2015

Spectral edge decreases with propofol anesthesia

Propofol light sedation

Propofol deep sedation

200 mg propofol bolus

Clinical Electroencephalography for Anesthesiologists: Part I: Background and Basic Signatures Anesthesia, 2015

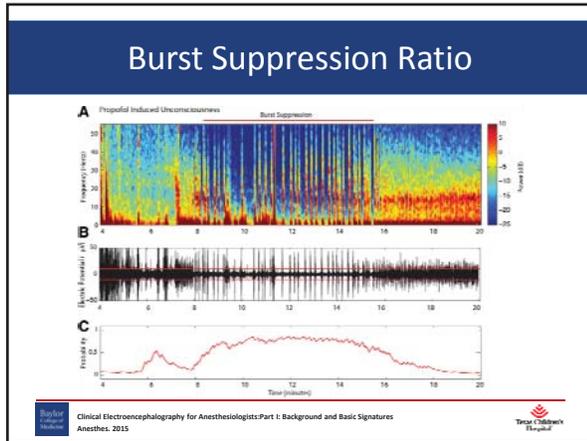
During CPB with deep hypothermia at 18 degrees the EEG spectral pattern is shown. What is your interpretation?

Anesthesia is too deep causing burst suppression

The ABP is too low causing ischemic burst suppression

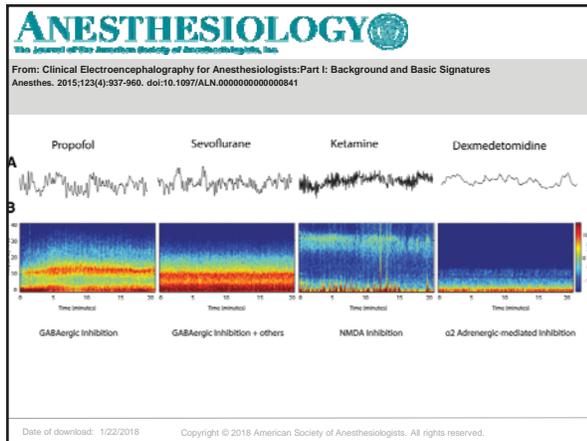
The brain is inadequately cooled and there is too much EEG activity

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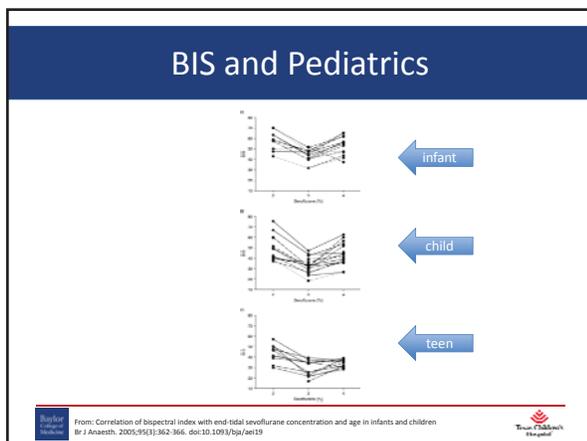
A patient under volatile anesthetic with low ABP has the EEG spectogram in A. Due to movement ketamine is given, resulting in B. What is your interpretation?

- The increased EEG power at 35 Hz is indicative of increased arousal
- The decreased EEG power at 10 Hz is indicative of increased arousal
- The decreased EEG power at 10 Hz is due to ischemia from hypotension
- This is the normal EEG effect of ketamine



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

- The infant is in pain. Give more fentanyl.
- The high BIS is inaccurate due to EMG activity.
- The BIS is not reliable in infants. Higher sevo concentration has been shown to correlate with higher BIS.
- The higher BIS is due to higher MAC concentrations in infants.



Summary

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

Chronic Pain Management in the Perioperative Period

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

Conflicts

- None

Learning Objectives

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

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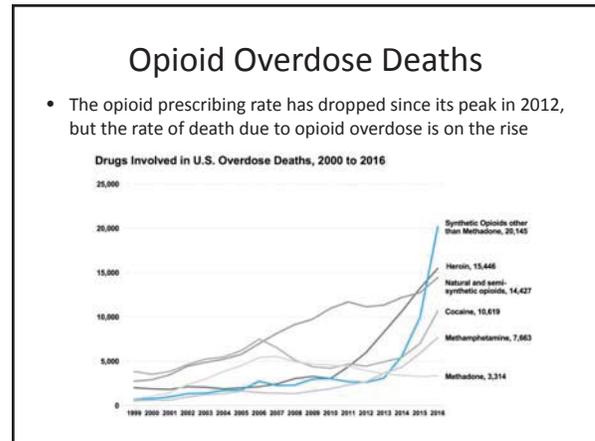
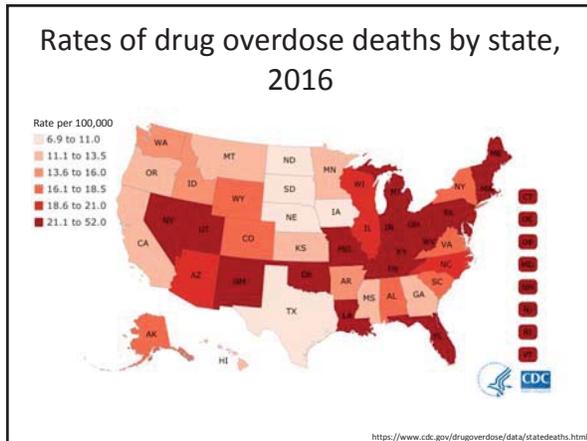
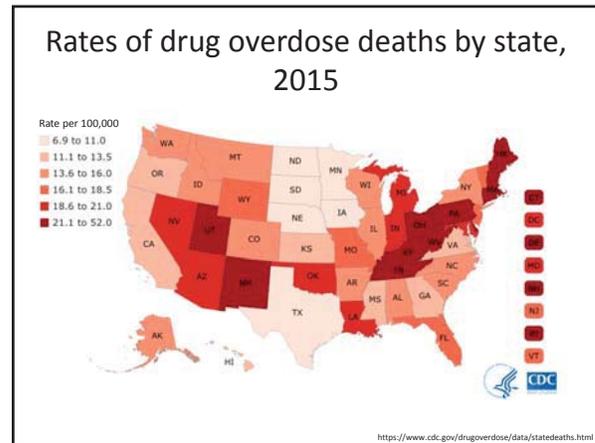
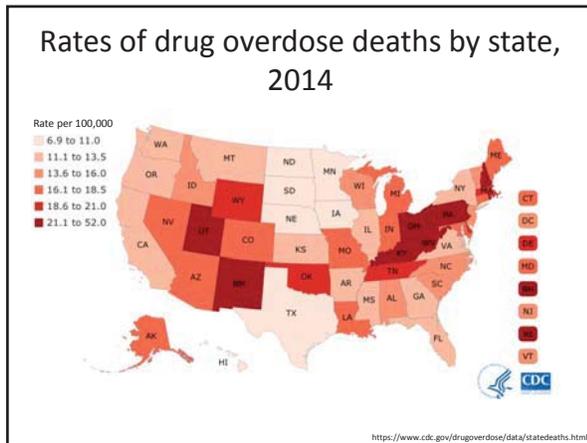
Chronic Pain

- Pain lasting >3 months or beyond the “normal time” of tissue healing
- In 2012, it was estimated that almost 40 million Americans have persistent pain that occurs daily or on most days
 - 1 out of 5 patients with chronic non-cancer pain is being treated with opioids

Nahin RL. Estimates of pain prevalence and severity in adults: United States, 2012. J Pain. 2015;16(8):769-80.
 Dowell D, Haegerich TM, Chou R. CDC Guideline for prescribing opioids for chronic pain—United States, 2016. JAMA. 2016;315(15):1624-1645.

Management of Patient on Chronic Opioid Therapy

- Why is it challenging?
 - Tolerance and inadequate analgesia from standard opioid regimens
 - Fear of respiratory depression at high doses
 - Lower pain threshold among patients on chronic opioid therapy
 - Opioid-induced hyperalgesia?
 - Fear of relapse if history of OUD
 - No evidence that exposure to opioids for acute pain increases relapse risk
 - Has been suggested that the stress of uncontrolled pain may trigger relapse
 - Concern about diversion
- Important part of pre-operative evaluation includes Expectations
 - What is patient’s pre-operative pain baseline?
 - What is patient’s target number?
 - 0/10 is not a reasonable goal!
 - Focus on function (ambulation, PT, sleep) rather than #



Management of Patient with OUD

- No RCTs of acute pain management in patients on maintenance therapy for OUD
- Has not actually been studied in opioid-tolerant patients, but it is widely recommended to use a multi-modal approach in such patients where opioids may be ineffective
 - regional anesthesia
 - NSAIDs or COX-2 Inhibitors
 - acetaminophen
 - NMDA antagonists
 - α_2 agonists
 - anti-convulsants

Sen S, Arulkumar S, Corneet EM, Gayle JA, Flower RR, Fox CJ, et al. New Pain Management Options for the Surgical Patient on Methadone and Buprenorphine. Curr Pain Headache Rep. 2016;20(3):36.

Methadone

- Long-acting
 - Half-life is >1 day (15-40 hours)
 - Highly lipophilic
 - High bioavailability (36-100%)
 - Protein bound: α 1-acid glycoprotein
 - Metabolized by CYP450 \rightarrow inactive metabolites (fecal and renal clearance)
 - High inter-individual variability!
 - 2 isomers
 - R-isomer is NMDA receptor antagonist
 - 40% of pain relief from methadone is via non-opioid activity (ie, can't block with naloxone)
 - S-isomer is an agonist at mu and delta opioid receptors
 - Binding at mu receptor prevents withdrawal, reduces craving
 - Causes tolerance that reduces euphoria with additional opioid use

Sen (2016)
Goodman and Gilman
J Pain Symp Mgmt 28(5):497-504, 2004

Methadone

- Variable opioid conversion
- Higher doses of chronic opioid equivalent to less methadone/MED than lower doses
- morphine → methadone ≠ methadone → morphine
- Conversions for chronic opioid use:

MED/day	<100	101-300	301-600	601-800	801-1000	>1001
MED:methadone	3:1	5:1	10:1	12:1	15:1	20:1

Methadone	Factor
Up to 20 mg/day	4
21-40 mg/day	8
41-60 mg/day	10
>60 mg/day	12

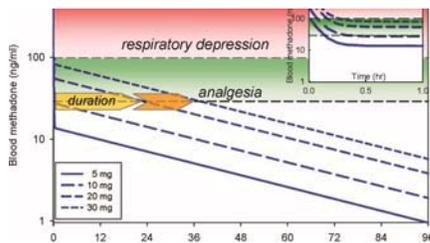
<http://www.aacnmeddirectors.wa.gov/MethadoneFactors.asp>
 Journal of Community Hospital Internal Medicine Perspectives. 2012;2(4):10-3402/jchimp.v2i4.19541.

Methadone: Perioperative Management

- Continue daily dose before, during and after surgery
 - Verify correct dose with prescribing physician
 - If cannot take daily PO methadone post-op, can give IV:
 - Given high but wide-ranging bioavailability (30-100%), variable pharmacokinetics, use 2:1 ratio for oral:IV
 - May need to escalate to 3:2, 1:1 or even 1:2
 - Best to divide parenteral dose into BID to QID
 - Rapid onset IV (4 min) despite long half-life
 - Commonly held that duration of analgesic effect is 8hr vs 24hr dosing for OUD maintenance/withdrawal avoidance
 - Thus may divide single daily dose into TID to help with pain
 - Pharmacokinetics suggest that a single large dose (>20mg IV) provides a prolonged analgesic effect (but in opioid-naïve patients)
 - Relationship between elimination half-life and effect depends on dose

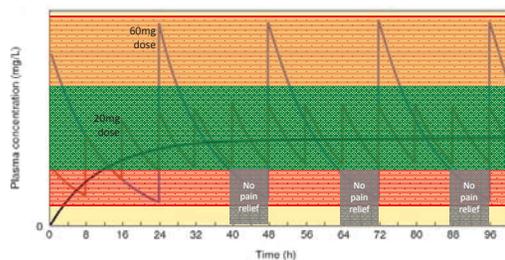
Anesth Analg. 2011 Jan; 113(1): 13-16
 Ther Clin Risk Manag. 2017;13:1163-73

Methadone Pharmacokinetics: Dose and duration of analgesic effect



Kharasch, E. D. (2011). Intraoperative methadone: Rediscovery, reappraisal, and reinvigoration? *Anesthesia and Analgesia*, 112(1), 13-16.

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



Hofford NG. Pharmacokinetics & Pharmacodynamics: Rational Dosing & the Time Course of Drug Action. In: Katzung BG, eds. *Basic & Clinical Pharmacology*, 14e New York, NY: McGraw-Hill

Buprenorphine

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

Buprenorphine

- 33 times as potent as morphine (IV to IV)
 - Antagonist at kappa-opioid receptors
 - May be involved in efficacy in opioid-induced hyperalgesia, but this phenomenon only studied in healthy volunteers
 - Partial agonist at mu-opioid receptors
 - High affinity for the receptor: binds tightly, but doesn't activate fully
 - Slow dissociation ($t_{1/2}$ = 166 min vs 7min for fentanyl); 50% by 1 hr vs 100% by 1 hr) → plasma levels may not parallel clinical effects
 - Less respiratory depression
 - Ceiling effect (no increase in agonist effects at dose >32mg/day)
 - 16mg SL occupies 79-90% of μ -opioid receptors but doses >24-32mg do not result in greater opioid effect despite >95% receptor occupancy
 - Reduced risk of respiratory depression vs full μ -opioid receptor agonists
 - Can precipitate withdrawal in opioid dependent patient

https://www.deadiversion.usdoj.gov/drug_chem_info/buprenorphine.pdf. Am J Psychiatry. 2007; 164:979.
 Drug Alcohol Depend. 2009; 99: 345-349. Br J Anaesth. 1985;57(2):192-6. Acta Anaesthesiol Scand. 1980;24(6):462-8.

Buprenorphine

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

https://www.deadiversion.usdoj.gov/drug_chem_info/buprenorphine.pdf; Am J Psychiatry. 2007; 164:979. Drug Alcohol Depend. 2009; 99: 345-349. Br J Anaesth. 1985;57(2):192-6. Acta Anaesthesiol Scand. 1980;24(6):462-8.

Buprenorphine

- 30-35% bioavailable SL but high first-pass hepatic metabolism when taken orally
 - Hepatic metabolism by CYP450 to *active* metabolite, norbuprenorphine (20% of parent compound activity)
 - Renal clearance of metabolites, but most drug is excreted unchanged in feces

Sen 2016. Walter and Inturrisi, 1995. Anderson, 2017. Johnson, 2005. Palliat Med 20:517-523 (2006) Goodman and Gilman

Buprenorphine for Pain

- Butrans
 - transdermal patch
 - 5-20mcg/hr dose
 - Patch worn for 7 days
 - Single application C_{max} for 20mcg/hr patch 0.48ng/ml
 - Steady state achieved after 3 days
 - For 10mcg/hr patch, steady state C_{max} 0.2ng/ml
 - Must taper to ≤ 30 mg MED
 - “may not provide adequate analgesia” for patients requiring >80 MED/day
- Belbuca
 - buccal film
 - 75-900mcg
 - Bioavailability 46-51%
 - Mean C_{max} 1200mcg 1.43+/-0.45ng/mL
 - Once to twice daily
 - $T_{1/2}$ 4-15 hours
 - Must taper to ≤ 30 mg MED
 - “may not provide adequate analgesia” for patients requiring >160 mg MED/day

https://www.accessdata.fda.gov/drugsatfda_docs/label/2015/207932s000b1.pdf

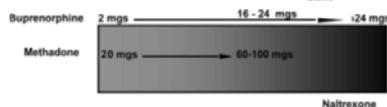
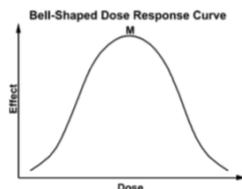
Buprenorphine Induction

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

Drug Alcohol Depend. 2003;70(2 Suppl):S59-77. https://www.suboxone.com/content/pdfs/SUBUTEX_Prescribing_Information.pdf

Buprenorphine

- In non-opioid-tolerant patients, low doses of BUP produce analgesia like a full mu-agonist
 - 0.3mg IV typical intra-op
- However, at higher doses, its analgesia is not as effective as that of a full mu-agonist



Drug Alcohol Depend. 2003;70(2 Suppl):S59-77. Johnson, 2005

Buprenorphine: perioperative challenges

- High affinity, only partial agonist → acute pain difficult to treat with other opioids
- Case reports
 - 47 y/o woman with chronic pain on bup/nal 16mg BID, gabapentin, SNRI and nabilone (synthetic THC) having thoracic surgery. Bup/Nal continued
 - Good pain control until POD5 with epidural, intraoperative ketamine and hydromorphone PCA, worsening. By POD11, in addition to bup/nal using ~1300 MED per day in hydromorphone (PO + IV)
 - Bup/nal dose halved to QD and pain control improved immediately; IVPCA d/c'd 10 days later and Bup/nal halved again with transition to PO hydromorphone
 - Yet buprenorphine has been shown to reduce hyperalgesia and central sensitization in addition to direct analgesic effects!

Can J Anaesth. 2014;61(9):826-31.

Buprenorphine Can Make Post-Operative Pain Difficult to Control

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

Can J Anaesth. 2014;61(9):826-31. J Opioid Manag. 2009;5(3):175-9. Pain Med. 2013;14(8):1187-91.

Adjunctive Medications to Reduce Pain in Patients Maintained on BUP

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

J Opioid Manag. 2009;5(3):175-9. Anesthesiology. 2010;113(3):639-46.

Buprenorphine: Perioperative Management

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

Anderson, 2017. Drug Alcohol Depend. 2016;166:26-31.

Buprenorphine: Perioperative Management

- Strategy 1: Discontinue buprenorphine prior to surgery
 - Gradual taper over 2-3 weeks w/ decrease by 2mg/day and off **72 hours** before surgery (Sen, 2016)
 - Can taper rapidly over 3 days but higher relapse rates (Sen, 2016)
 - If can't tolerate withdrawal, replace with methadone or other opioid
 - Goal window without buprenorphine depends on dose (Anderson, 2017)
 - 0-4mg per day – stop 24 hours before surgery
 - >4-8mg per day – stop 48 hours before surgery
 - >8-12mg per day – stop 48 hours before surgery
 - >12mg per day – need preop plan with buprenorphine prescriber
 - OR transition to oral methadone in ratio of 1:5; typically 30-40mg/day
 - titrate methadone by 5-10mg/day
 - Use additional full mu agonists for acute pain
 - Post-op:
 - Discharge on pure opioid agonist with plan to taper and resume buprenorphine w/ outpatient maintenance clinic
 - OR inpatient induction with buprenorphine once acute pain controlled
 - Reschedule elective case if patient doesn't hold?

Anderson, 2017. Sen 2016. Ann Intern Med. 2006;144(2):127-34.

Buprenorphine: Perioperative Management

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

Sen 2016. Br J Clin Pharmacol 1983; 12(2):117-22. Clin J Pain 2008; 24: 93-97

Buprenorphine

Table 2. µ-Opioid Receptor Binding Affinities (KI) for Commonly Used Opioids and Antagonists

Opioid	KI (nM)
Sufentanil	0.1380 ¹
Buprenorphine	0.2157¹
Hydromorphone	0.3654 ¹
Morphine	1.168 ¹
Fentanyl	1.346 ¹
Naloxone	1.518 ¹
Methadone	3.378 ¹
Remifentanyl	21.1 ⁴
Oxycodone	25.87 ³
Hydrocodone	41.58 ³
Codeine	734.2 ³
Tramadol	12,486 ¹

Leighton BL, Crook LW. Case Series of Successful Postoperative Pain Management in Buprenorphine Maintenance Therapy Patients. Anesth Analg. 2017;125(5):1779-83.

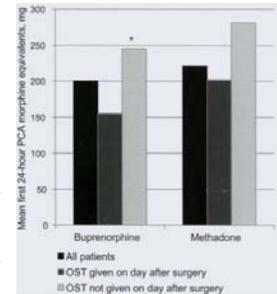
Buprenorphine: Perioperative Management

- Strategy 2: Continue buprenorphine throughout the perioperative period
 - Discontinuation of buprenorphine in stressful pre-operative period may risk relapse
 - Numerous case reports of successful pain management despite concomitant SL buprenorphine treatment. Tactics include:
 - Treat acute pain with higher-than-usual doses of opioid agonists
 - Use opioids with higher intrinsic affinity for the receptor: Hydromorphone, fentanyl, morphine
 - » Use PCA
 - Divide once daily dose of buprenorphine (opioid maintenance) into TID or QID dosing to better match the pharmacodynamics of analgesia
 - Half life for effective analgesia shorter than half life of the drug
 - Only for mild to moderate pain due to ceiling effect at doses >32mg/day SL
 - Consider additional sublingual or IV buprenorphine
 - 0.3mg IV = 10mg morphine IV; usually 0.3-0.6mg IV intraoperatively
 - Employ multimodal pain management

Sen 2016. Br J Clin Pharmacol 1981; 112(2):117-22. Clin J Pain 2008; 24: 93-97

Post-operative pain management on continuous buprenorphine

- Retrospective review: patients on methadone (n=29) or buprenorphine (n=22) who required IV PCA for post-op pain (w/o LA techniques)
 - Similar intra-operative MED
 - Average pre-op buprenorphine dose 13.7±6.6mg/day (range 4-32mg)
 - 63% received dose day of surgery, 50% also give day after
 - Those who did not receive BUP dose the day after surgery had significantly higher (p=0.02) PCA MED for first 24 hours than those given their usual dose
 - No difference in pain scores for BUP vs methadone, trend towards more pain if dose held



Anaesth Intensive Care. 2013;41(2):222-30.

Post-operative pain management on continuous buprenorphine

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

Am J Ther. 2010;17(5):523-8.

Post-operative pain management in patients on buprenorphine

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

Anesth Analg. 2017;125(5):1779-83.

Perinatal buprenorphine management

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

(Sen 2016). (Meyer 2007)

Perinatal buprenorphine management

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

Am J Drug Alcohol Abuse. 2009;35(3):151-6.

Perinatal buprenorphine management

- Neuraxial anesthesia safe and preferred
 - IT opioids are fine but may not be enough to prevent withdrawal if maintenance opioid discontinued
 - **Avoid** mixed (κ)agonist-(μ)antagonists like nalbuphine, butorphanol and pentazocine, which can precipitate withdrawal
 - regional techniques (TAP blocks) as adjunct to IT as needed for pain in first 24 hours

(Sen, 2016). Goodman and Gilman's Pharmacological Basis of Therapeutics 13th Ed. Br J Anaesth. 2012;109(5):679-87.

Buprenorphine: Legal Issues

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

https://www.samhsa.gov/programs-campaigns/medication-assisted-treatment/legislation-regulations-guidelines/special

Buprenorphine: Legal Issues

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

https://www.samhsa.gov/programs-campaigns/medication-assisted-treatment/legislation-regulations-guidelines/special

Buprenorphine: Legal Issues

- In addition, an exception known as the “three-day rule” allows a provider without a Waiver to **administer** but NOT **prescribe** buprenorphine for the treatment of withdrawal symptoms while arranging for referral for treatment as long as:
 - Only one day’s medication is given at a time and
 - Treatment is not carried out for >72 hours
 - This 72-hour period cannot be renewed/extended

https://www.samhsa.gov/programs-campaigns/medication-assisted-treatment/legislation-regulations-guidelines/special

Buprenorphine: Continue or Hold?

- 37 y/o woman on buprenorphine (8mg SL TID) for chronic pelvic pain who underwent 2 surgeries
 - Also on chronic lorazepam 1mg QID
 - 1st: buprenorphine continued:
 - pt reported uncontrolled pain
 - 2nd: buprenorphine discontinued 5 days prior and replaced with hydromorphone 4mg Q4-6 hrs (max 20mg/d)
 - Pain control on hydromorphone adequate before surgery
 - Fentanyl challenge: patient tolerant to effects, remaining alert and conversant after 1000µg IV
 - Given ketorolac intraop, also additional 100µg fentanyl; required 1000µg more fentanyl prior to arrival in PACU
 - » Complaining of pain but appeared comfortable
 - » Hydromorphone PCA and ketorolac continued post-op
 - » Discharged home on hydromorphone with plan to follow-up with buprenorphine provider
- Tolerance? Hyperalgesia? Both?

J Anesth Clin Res. 2013;3(250).

Opioid-Induced Hyperalgesia

- First described in animals
 - Chronic opioid exposure results in lower pain threshold in most pain models tested
- Data in humans more limited
 - Unknown what minimum daily MED will cause tolerance or OIH
 - Described within one month of chronic oral morphine use (range 30-120mg/day)
 - Clearly described for remifentanyl
 - Reports of pain improving following opioid detoxification

Drug Alcohol Depend. 2001;63(2):139-46. Pain. 2001;90(1-2):91-6.

Opioid-Induced Hyperalgesia

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

Drug Alcohol Depend. 2001;63(2):139-46. Pain. 2001;90(1-2):91-6. Can J Anaesth. 1999;46(9):872-7. J Anaesthesiol Clin Pharmacol. 2015;31(1):375-9. Korean J Pain. 2015;28(2):199-201. J Clin Anesth. 2012;25(1):26-31. J Invet Surg. 2012;7-12

Opioid-Induced Hyperalgesia: Possible Treatments

- NMDA antagonists: ketamine, memantine
 - glutamate receptor and ion channel
 - Activated in setting of prolonged morphine
 - activated allows flux of cations (Na^+ , K^+ , Ca^{2+})
 - NMDA receptor mediated neuronal apoptosis in the dorsal horn
- Adrenergic blockade?
 - Alpha: successful use of dexmedetomidine (clonidine?) to treat refractory pain in opioid tolerant patients
 - beta blockers?
 - Propranolol reduces secondary hyperalgesia seen with remifentanyl
 - Can be used for opioid-sparing anesthetic

Pain. 2012;153(5):974-81.

Pre-operative Opioid Weaning

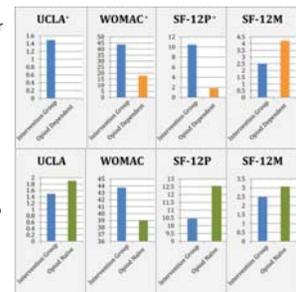
- Numerous studies documenting poor outcomes in patients on chronic opioid therapy
 - Infection
 - Odds increased by 50% in highest opioid use vs lowest
 - GI complications
 - Ileus
 - Respiratory complications
 - Respiratory depression with atelectasis and pneumonia
 - Increased length of stay, discharge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

Preoperative Reduction of Opioid Use Before Total Joint Arthroplasty

Long-Co L. Nguyen, BA, BS ^a, David C. Sing, BS ^a, Kevin J. Bozic, MD, MBA ^{b,*}

^a University of California San Francisco School of Medicine, San Francisco, California
^b Department of Surgery and Perioperative Care, Dell Medical School, University of Texas at Austin, Austin, Texas

- 3 cohorts of patients prior to joint arthroplasty:
 - Patients who weaned chronic opioid by >50% before surgery
 - Patients who maintained baseline chronic opioid dose
 - Opioid-naïve patients
- Functional outcomes
 - Patients who weaned fared better on all measures than those who did not and had post-surgical functional outcomes comparable to opioid-naïve patients



J Arthroplasty. 2016;31(19 Suppl):282-7.

Other adjuncts: Anticonvulsants

- Gabapentinoids: pregabalin and gabapentin
 - Bind $\alpha_2\delta$ subunit of N-type voltage-gated Ca^{2+} channel \rightarrow reduce neuronal excitability
 - May also impact immune pathways in pain
 - These effects may explain animal evidence and reports of **reduction in opioid-induced hyperalgesia**
 - Typical doses:
 - gabapentin 300-1200mg pre-op (300-600mg TID)
 - pregabalin 75-300mg (75-150mg BID)

Other adjuncts: Gabapentinoids

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

Multimodal Pain Management: Membrane stabilizers

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

Reduce doses in renal dysfunction

Chou et. Al. J Pain (2016); 17: 131-157

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

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

Chou et. Al. J Pain (2016); 17: 131-157. Anesth Analg. 2010;110(4):1170-9. Cochrane Database of Systematic Reviews 2015, Issue 11. Art. No: CD010794

Multimodal Pre-treatment: COX-2 Inhibitor

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

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

Clin J Pain. 2015 Oct;31(10):903-8. Chou et. Al. J Pain (2016); 17: 131-157

NSAIDs

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

Gupta Curr Pain Headache Rep 2016

NSAIDs

- Perioperatively, NSAIDs/COX-2 inhibitors:
 - Reduce opioid requirements and thus opioid-induced side effects like nausea, vomiting, somnolence
 - Improve patient satisfaction
 - Reduce PACU times
 - Reduce post-operative morbidity
- Similar efficacy for nonselective NSAIDs and COX-2 inhibitors
 - Formulation may matter: liquid ibuprofen faster and better analgesia than tablet
- Lower NNT than APAP (3.0 v 3.9)
- Effective in a wide range of surgeries, from ambulatory procedures to abdominal surgery to orthopedic surgery and spine surgery (laminectomy/discectomy)

Gupta Curr Pain Headache Rep 2016. PAIN 107:86-90 (2004)

NSAID Precautions

- Renal
 - 2007 Cochrane review found only transient, clinically insignificant reduction in renal function in adults without pre-operative renal impairment (Lee, 2007)
- Hematologic
 - Bleeding risk: a 2007 meta-analysis found no significant difference in postoperative bleeding between ketorolac and control group (Gobble, 2014)
 - However, there may be a greater risk of bleeding (GI and operative) among patients ≥75 years old, with a dose-response relationship (Strom, 1996)
 - Lower OR of GI but not surgical bleeding when ketorolac given <5 days
- ASA-induced asthma
- Cardiovascular
 - COX-2 inhibition leads to reduction in PG synthesis and relative over-production of thromboxane A2 → increased vasoconstriction without reduced platelet aggregation (COX-1)

...

NSAID precautions

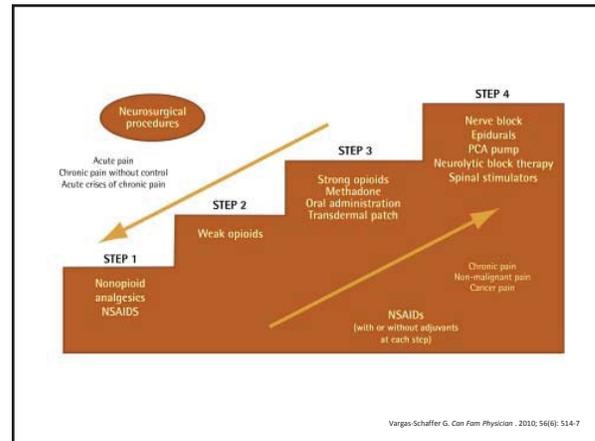
- Surgical
 - Anastomotic leakage after colonic resection → use with caution in colorectal surgery
 - Bone fusion: concern from animal studies
 - 2011 meta-analysis of clinical trials examining effects of perioperative NSAIDs in spinal fusion
 - **normal dose** (ketorolac <120mg/day, diclofenac <300mg in all, celecoxib 200-600mg/day), **short-duration** (<14 days) NSAIDs had **NO adverse effects on fusion rates**
 - » At high doses, ketorolac may impair spinal fusion

Local Anesthetic Techniques for Opioid-Tolerant Patients

- Epidural anesthesia can be effective
 - more lipophilic opioids superior to morphine for opioid-tolerant patients
 - Likely need systemic opioids to prevent withdrawal
- Role of peripheral nerve blockade not well studied in opioid tolerant patients
 - Animal evidence of a dose-dependent loss of local anesthetic potency in sciatic nerve with opioid tolerance
 - These effects persist for >30 days after morphine discontinuation, but morphine tolerance resolved within 7 days of stopping
 - Corresponding clinical data is sparse although some such reports exist

Learning Objectives

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



Indications for Intrathecal Drug Delivery

- Pain unresponsive to high doses of opioids (VAS ≥ 5 despite ≥200mg MED)
- Intolerable side effects from opioids
 - Chronic non-cancer pain
 - Postherpetic neuralgia
 - Peripheral neuropathy
 - Failed back surgery syndrome
 - CRPS
 - Visceral pain (eg, pancreatitis)
 - Cancer pain
 - Life expectancy >3 months
- CLEAR pain diagnosis
- Failure of conservative treatment

Intrathecal Drug Delivery for Pain Common Medications

Table 14. Cancer or Other Terminal Condition-Related Pain With Diffuse Nociceptive or Neuropathic Pain.

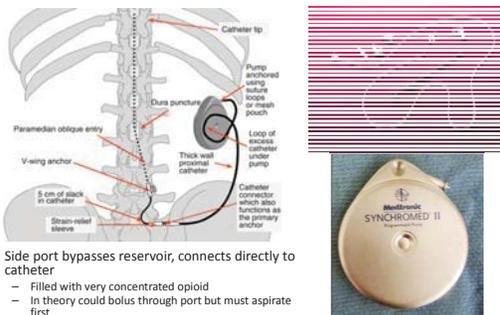
Line 1A	Ziconotide	Morphine		
Line 1B	Hydromorphone	Morphine or hydromorphone + bupivacaine		
Line 2	Morphine or morphine + clonidine	Morphine or hydromorphone + ziconotide		
Line 3	Hydromorphone or morphine or fentanyl + bupivacaine + clonidine	Ziconotide + bupivacaine	Hydromorphone or morphine or fentanyl + bupivacaine + ziconotide	Sufentanil
Line 4	Sufentanil + epinephrine	Baclofen	Sufentanil + clonidine	Bupivacaine + clonidine
Line 5	Sufentanil + bupivacaine + clonidine	Sufentanil + bupivacaine	Sufentanil + clonidine + ziconotide	Sufentanil + clonidine + ziconotide
Line 6	Opoid ^a + bupivacaine + clonidine + adjuvant ^b			

^aOpoid (all known intrathecal opioids).
^bAdjuvants include midazolam, ketamine, octroate.

IT Pump Placement



Botros MM & Christo PJ. J Pain Res 2014; 7: 615-626.

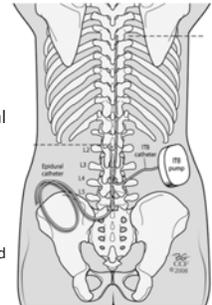


- Side port bypasses reservoir, connects directly to catheter
 - Filled with very concentrated opioid
 - In theory could bolus through port but must aspirate first
 - Risk of infection, etc.
 - Preferable to perform single shot spinal below IT entry

Rork JF et al. J Pain Symptom Manage. 2013 Dec;46(6):859-73
Botros MM & Christo PJ. J Pain Res 2014; 7: 615-626.

Implications for Anesthesia

- Neuraxial anesthetic techniques
 - Risk of damage to catheter
 - 20g silastic catheter
 - Infection
 - Communication between epidural and intrathecal around catheter?
 - Numerous case reports of successful epidural analgesia for labor in patients with IDDS
 - Entry described both above and below IT catheter entry
 - Use of ultrasound: identify and avoid catheter as well as dural puncture?
 - Prophylactic antibiotics?



Other IT Pump Issues

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



Spinal Cord Stimulation



How does it work?

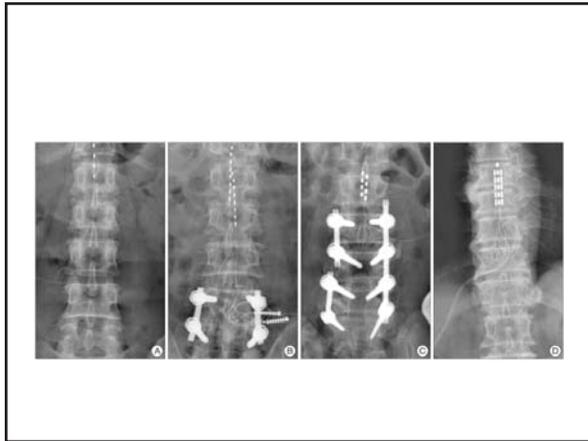
- The neurostimulator delivers mild electrical impulses to the leads located within the epidural space
 - Stimulation targets dorsal column neurons to spinal cord, **not** the nerve roots
 - Lead location does NOT follow typical dermatomal locations
- This disrupts pain signals traveling between the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

Indications: Chronic Pain

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

SCS: Epidural Anatomical Considerations

- Paddle**
 - placed through incision at level of electrodes
 - Requires laminectomy
- Percutaneous**
 - typically enter the epidural space at least 2 levels below lowest electrode in lead
 - Most commonly between T12/L1 or L2/L3
 - Anchored to supraspinous ligament one level below entry
- Final position of contacts determined by pain region:**
 - Pelvis: S2-S4
 - Legs: T9-L1
 - Low back: T8-T10 (T8-T9 most common)
 - Abdomen: T5-T7
 - Chest, angina: C6-T2
 - Arms: C4-T1
 - Leads terminating in thoracic or cervical spine may enter from lumbar and course w/in epidural space or be tunneled subcutaneously from flank/buttock IPG site to enter epidural space in thoracic/cervical spine
 - Also may be placed subcutaneously along peripheral nerves
 - Eg, occiput, face, sciatic nerve



SCS: Anatomical Considerations

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

Electromagnetic Interference

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

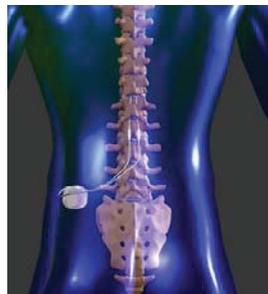
Perioperative Sources of EMI

- Electrocautery
 - Bipolar OK
 - Monopolar is incompatible
 - If must use monopolar (endoscopy, eg), then:
 - Turn SCS OFF
 - Turn voltage to "0"
 - Place grounding pad far from IPG and leads
 - Interrogate after surgery
- INCOMPATIBLE with:
 - Diathermy
 - Lithotripsy
 - (TMS)
- Interrogate post-op
- Imaging
 - CT scans OK but can cause temporary increase in stimulation → Turn voltage to "0" and device OFF
 - MRI
 - Most devices INCOMPATIBLE
 - Several newer devices MRI CONDITIONAL (head/extremities vs full body) but most only at 1.5 Tesla
 - Ultrasound
 - Don't place directly over IPG
 - Defibrillation:
 - Place paddles as far from device as possible and perpendicular to leads



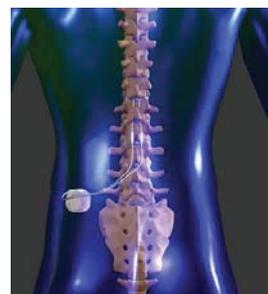
Neuraxial Anesthesia and SCS

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



Neuraxial Anesthesia and SCS

- Epidural catheter could disrupt stimulator leads
 - Lead migration is a common complication
 - Reports???
 - Fibrous tissue develops around epidural leads and may protect from this
 - SCS lead diameter 1.3-1.6mm, paddle + 20g catheter < 0.8mm
 - Epidural anesthesia has been used successfully w/o SCS complication for labor analgesia
 - SCS leads placed from T12/L1; do not attempt of leads enter epidural space from low lumbar
- Risk of infection of SCS hardware
- Risk/Benefit of neuraxial
- Discuss with chronic pain physician



Conclusions

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

IMPROVING OPIOID PRESCRIPTION SAFETY AFTER SURGERY

Karsten Bartels, M.D.



University of Colorado
Anschutz Medical Campus

Conflicts of Interest

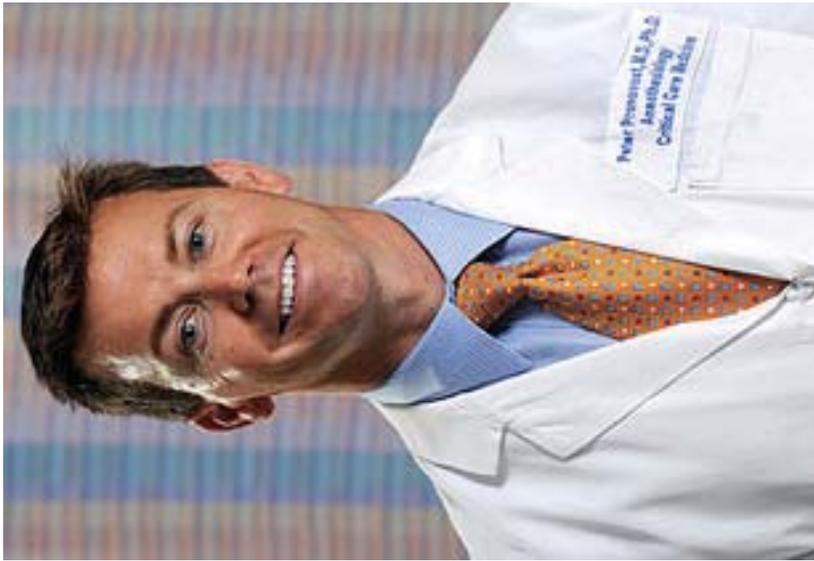
None

Funding

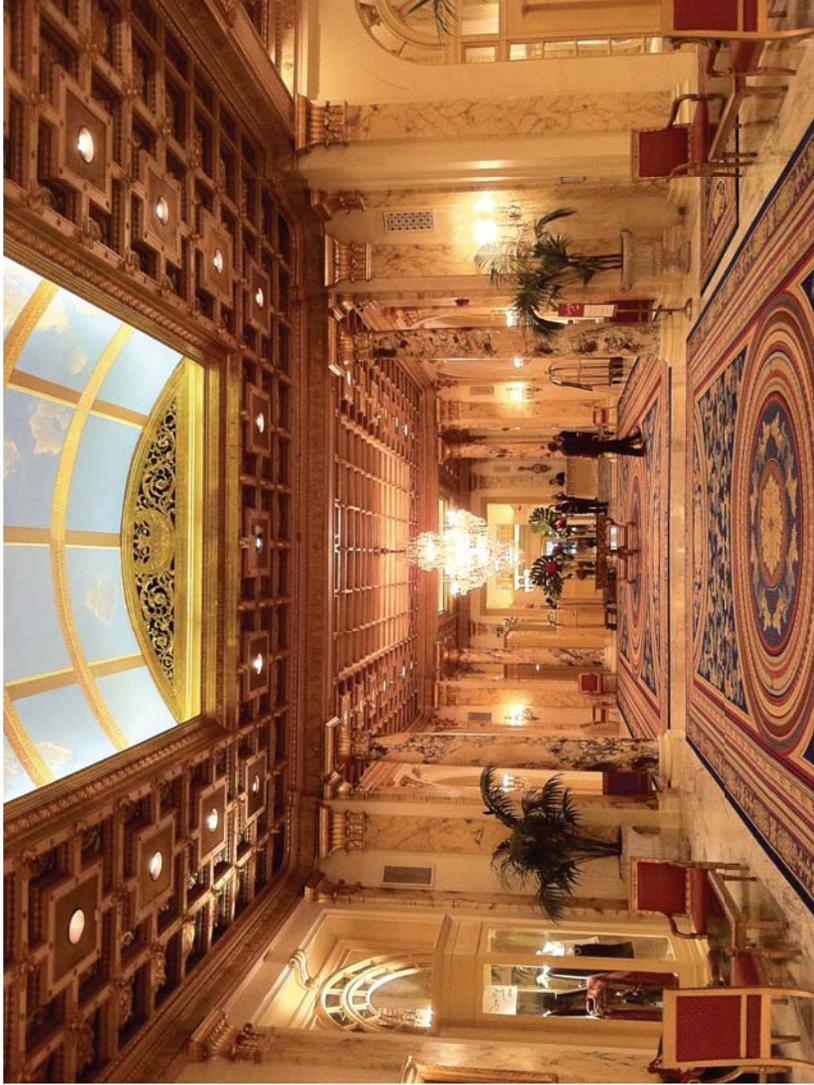
NIH / NIDA #K23DA040923

**Improving Opioid Prescription Safety After
Surgery**

Primum Non Nocere



Peter Pronovost, MD



The Fairmont Copley Plaza, Boston MA

Definition of Pain

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

From Part III: Pain Terms, A Current List with Definitions and Notes on Usage" (pp 209-214)
Classification of Chronic Pain, Second Edition, IASP Task Force on Taxonomy, edited by H. Merskey and N. Bogduk, IASP Press, Seattle, ©1994

**Chronic pain is pain that
persists or recurs
for longer than three months**

Epidemiology / Women

In developed countries, chronic pain is present in:

- 30.4 % of women aged 18-35
- 42.6 % of women aged 36-50
- 55 % of women aged 51-65
- 63.1 % of women aged >66

Tsang A et al. J Pain. 2008 Oct;9(10):883-91. doi: 10.1016/j.jpain.2008.05.005. Common chronic pain conditions in developed and developing countries: gender and age differences and comorbidity with depression-anxiety disorders.

Epidemiology / Men

In developed countries, chronic pain is present in:

- 20.9 % of men aged 18-35
- 31.5 % of men aged 36-50
- 42.5 % of men aged 51-65
- 47.2 % of men aged >66

Tsang A et al. J Pain. 2008 Oct;9(10):883-91. doi: 10.1016/j.jpain.2008.05.005. Common chronic pain conditions in developed and developing countries: gender and age differences and comorbidity with depression-anxiety disorders.

Chronic Pain Syndromes (ICD-11)

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

Pharmacologic Therapy

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

Efficacy

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

2-5

Opioids

- Routes of administration include IV, IM, oral, rectal, intranasal and sublingual
- Receptors, namely mu (μ), delta (δ), and kappa (κ)
- Agonists (e.g. morphine, hydromorphone)
- Antagonists (e.g. naloxone, naltrexone)
- Partial agonists (e.g. buprenorphine)

Opioids side effects

- Mood effects (e.g. euphoria)
- Sedation
- Nausea / vomiting
- Constipation
- Respiratory depression
- Miosis
- Antitussive effect

CNS-mediated effects

- **Tolerance**
- **Dependence**
- **Addiction**

1990s...



McCaffery M, Pasero CL. Pain ratings: the fifth vital sign. *Am J Nurs.* 1997;97(2):15-16

AHRQ 1992 Clinical Practice Guideline for Surgical Pain

“Half of all do not get adequate relief”

“Giving patients pain medicine only “as needed” can result in prolonged delays because patients may delay asking for help.”

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

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

AHRQ 1992 Clinical Practice Guideline for Surgical Pain

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

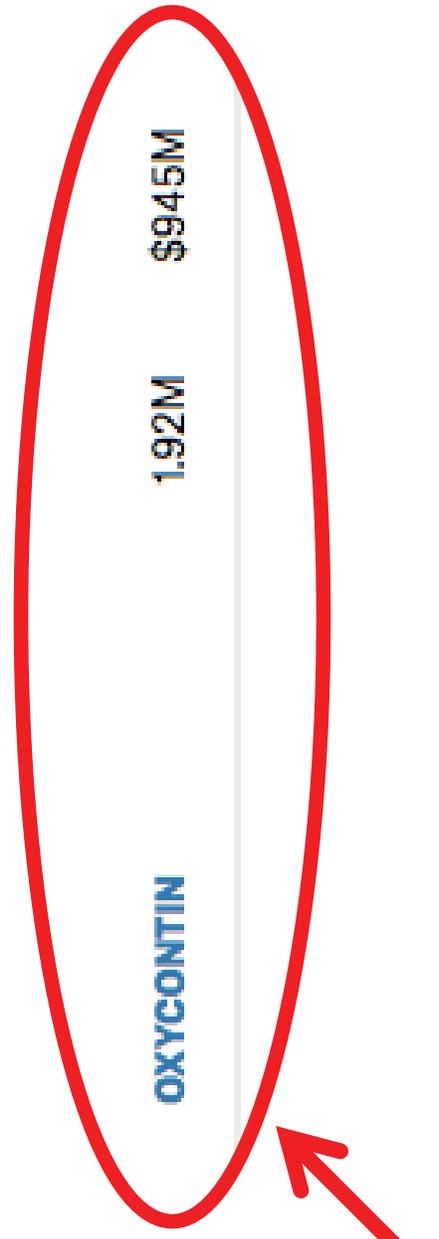
“Fears of postsurgical addiction to opioids are generally groundless.”

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

Medicare Part D: OxyContin® - Cost

Drug Name	Total Claims	Total Cost
NEXIUM	8.19M	\$2.53B
ADVAIR DISKUS	6.61M	\$2.26B
CRESTOR	9.07M	\$2.22B
ABILIFY	2.89M	\$2.11B
CYMBALTA	6.89M	\$1.96B
SPIRIVA	5.74M	\$1.96B
NAMENDA	6.88M	\$1.56B
JANUVIA	4.36M	\$1.46B
LANTUS SOLOSTAR	3.86M	\$1.37B
REVLIMID	154K	\$1.35B
LANTUS	4.6M	\$1.31B
DIOVAN	6.42M	\$1.23B
COPAXONE	224K	\$1.12B
LYRICA	4.11M	\$1.07B
ENBREL	354K	\$977M
HUMIRA	325K	\$955M
CELEBREX	3.63M	\$947M
OXYCONTIN	1.92M	\$945M

#18



Medicare Part D: Vicodin® - Prescriptions

Prescriptions by State **All Drugs**

State	Total Drug Cost	Drug Name	Total Claims	Total Cost
National	\$103.7B	LISINOPRIL	36.9M	\$307M
Alabama	\$1.89B	SIMVASTATIN	36.7M	\$434M
Alaska	\$95.4M	LEVOTHYROXINE SODIUM	35.2M	\$396M
Arizona	\$1.66B	HYDROCODONE-ACETAMINOPHEN	34.8M	\$568M
Arkansas	\$1000M			

#4

Hydrocodone

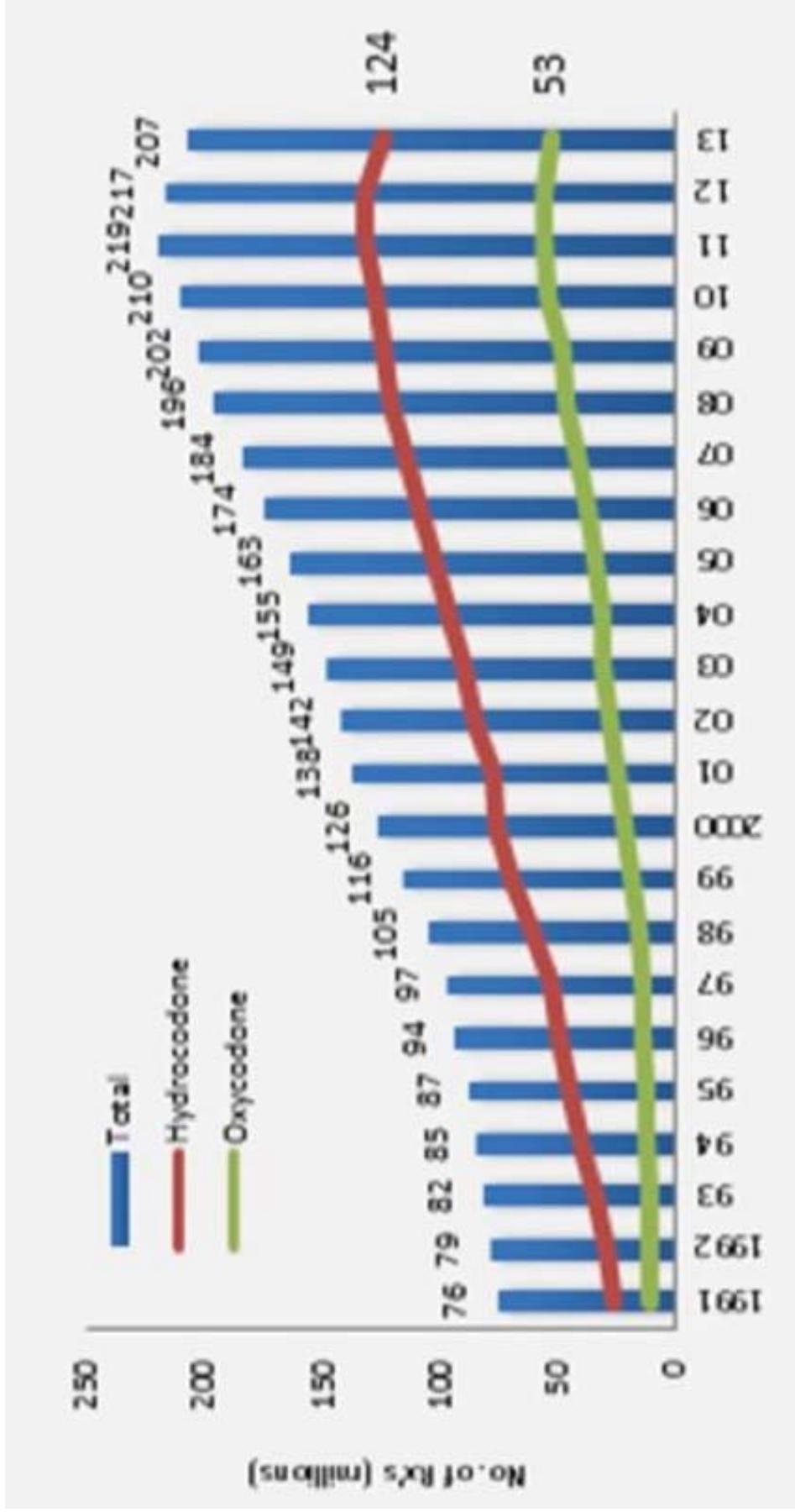
- On August 22, 2014, the Drug Enforcement Administration (DEA) published the final rule in the Federal Register to rescheduling **hydrocodone** combination products to **Schedule II** of the Controlled Substances Act
- Need to be converted into active metabolites (hydromorphone) via CYP2D6

Hydrocodone & Codeine Metabolism

- 5% to 10% of white people possess allelic variants of the CYP2D6 gene that are associated with reduced clearance
- 1% to 7% of white people carry CYP2D6 allelic variants associated with rapid metabolism
- African populations are highly variable in their (0%-34%) in regards to reduced clearance

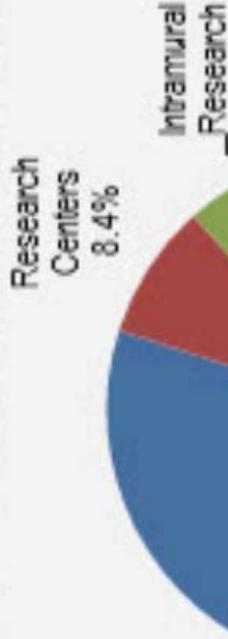
Bathum L, et al. Ultrarapid metabolism of sparteine: frequency of alleles with duplicated CYP2D6 genes in a Danish population as determined by restriction fragment length polymorphism and long polymerase chain reaction. *Pharmacogenetics* 1998;8(2):119-123 33.
Løvlie R, et al. Ultrarapid metabolizers of debrisoquine: characterization and PCR-based detection of alleles with duplication of the CYP2D6 gene. *FEBS Lett.* 1996;392(1):30-34

Cost



America's Addiction to Opioids: Heroin and Prescription Drug Abuse. May 14, 2014
 presented by Nora D. Volkow, M.D.; Senate Caucus on International Narcotics Control

FY 2016 NIH Budget
\$31.3 Billion – Estimated Percent Total by Mechanism



“The Annual direct costs from opioid pain relievers to insurance companies are more than double the total NIH budget or about 70x the annual NIDA budget”

8.1%

MAX BAUCUS, MONTANA, CHAIRMAN

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KENT CONRAD, NORTH DAKOTA
JEFF BINGAMAN, NEW MEXICO
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JOHN THUNE, SOUTH DAKOTA

RUSSELL SULLIVAN, STAFF DIRECTOR
CHRIS CAMPBELL, REPUBLICAN STAFF DIRECTOR

United States Senate

COMMITTEE ON FINANCE

WASHINGTON, DC 20510-6200

May 8, 2012

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

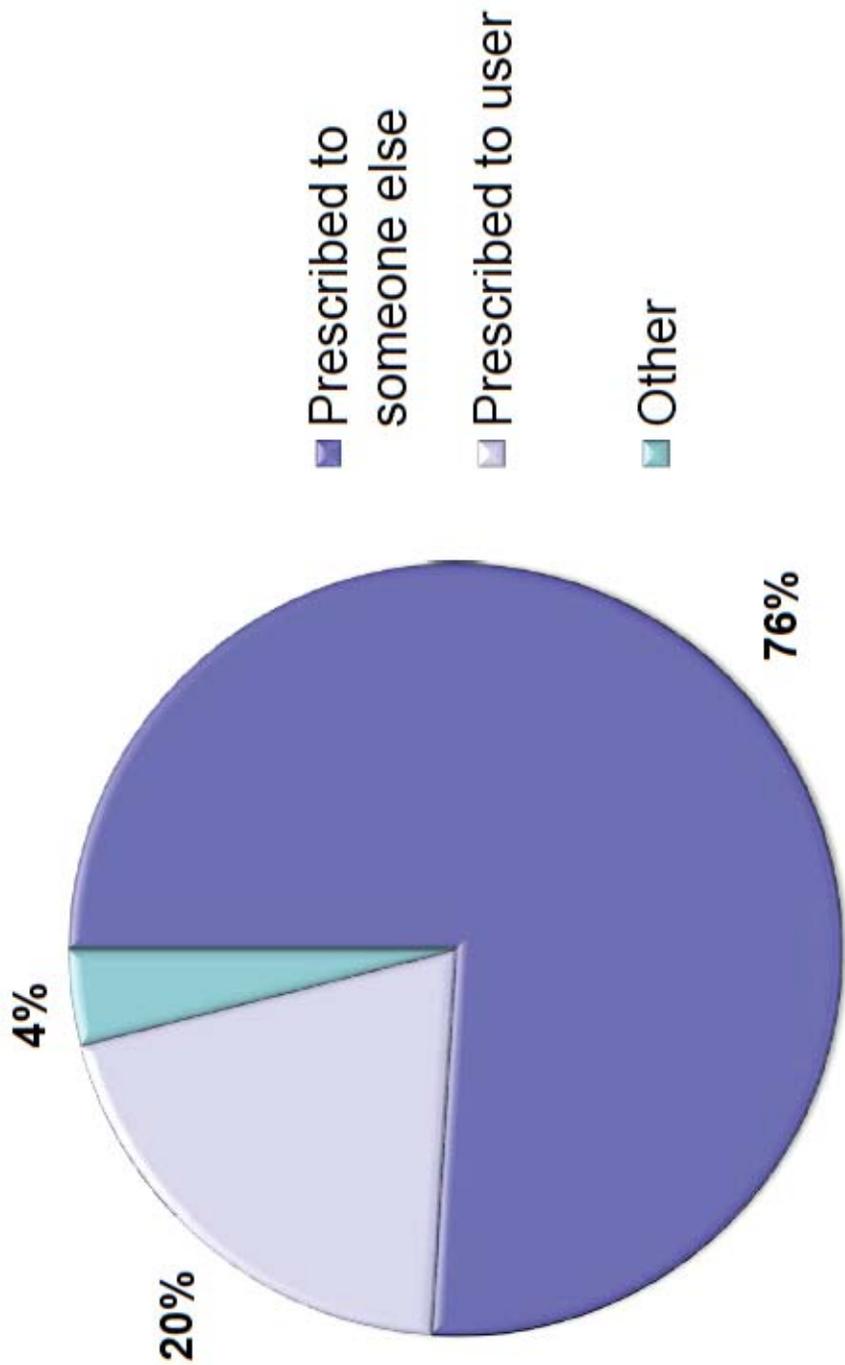
Dear Mr. Stewart:

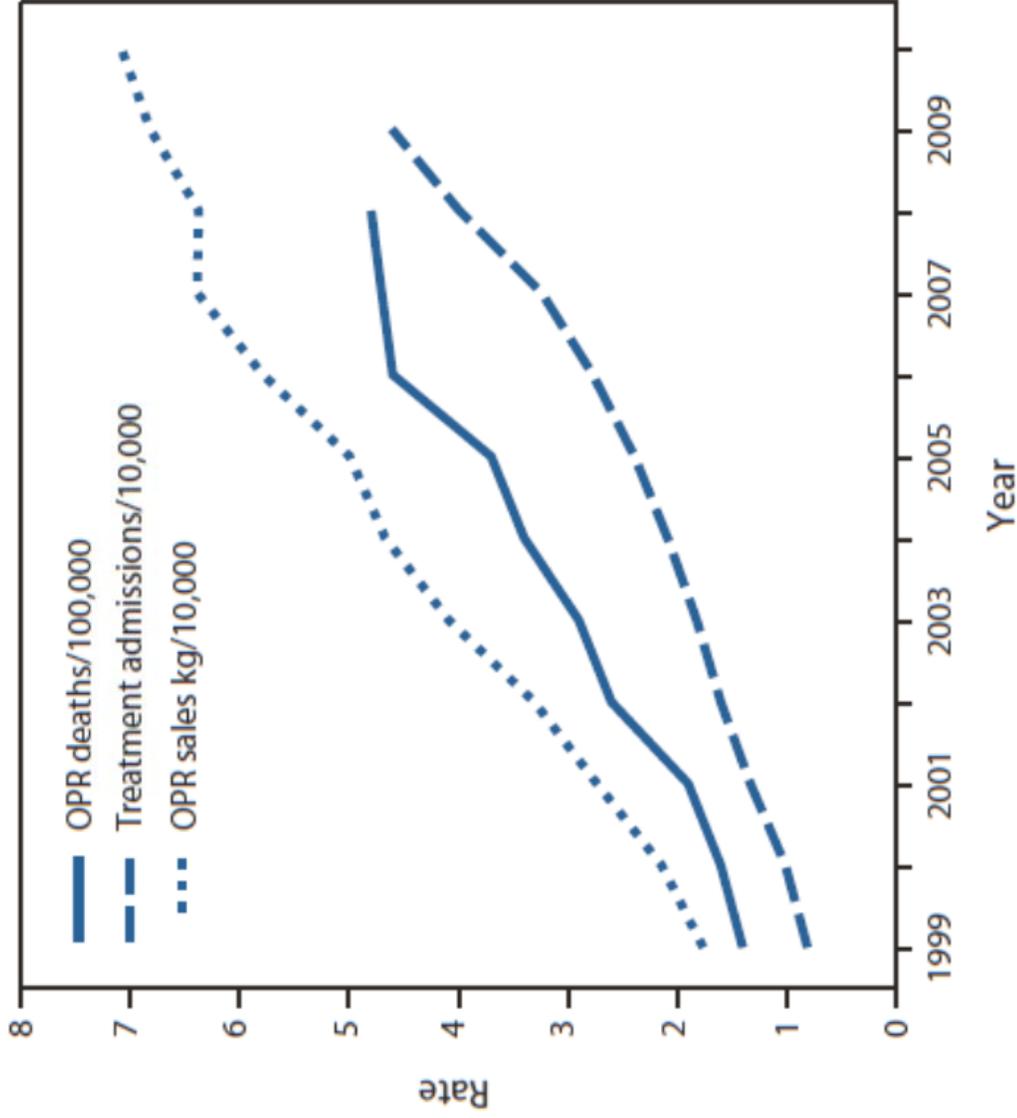
As Chairman and a senior member of the Senate Finance Committee, we have a responsibility to the more than 100 million Americans who receive health care under Medicare, Medicaid, and CHIP. As part of that responsibility, this Committee has investigated the



Photo of a typical death scene investigated by the Milwaukee County Medical Examiners Office. The office has finalized it statistics from 2015 and found a record-high 255 drug deaths compared to 251 in 2014.

By of the Milwaukee Journal Sentinel





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

Prescription Opioid Abuse – an “American Epidemic”

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

Prescription Opioid Abuse – an “American Epidemic”

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

Dart RC, Surratt HL, Cicero TJ, Parrino MW, Severtson SG, Bucher-Bartelson B, Green JL. Trends in Opioid Analgesic Abuse and Mortality in the United States. *N Engl J Med.* 2015;372(3):241-248.v
White AG, Birnbaum HG, Mareva MN, Daher M, Vallow S, Schein J, Katz N. Direct costs of opioid abuse in an insured population in the United States. *J Manag Care Pharm.* 2005;11(6):469-479.
Birnbaum HG, White AG, Schiller M, Waldman T, Cleveland JM, Roland CL. Societal costs of prescription opioid abuse, dependence, and misuse in the United States. *Pain Med.* 2011;12(4):657-667.



Department of Health Care Policy & Financing
1570 Grant Street
Denver, CO 80203

December 17, 2015

Morphine Equivalents Policy and PA Criteria

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

<https://www.colorado.gov/hcpf/pain-management-resources-and-opioid-use>



Gurman



RELATED CONTENT

Opioids linked with deaths other than overdoses, study says

As views shift on opioids, patients find

AMA seeks move toward opioid alternatives

By **Steven Ross Johnson** | June 15, 2016

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

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

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

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

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

<http://www.modernhealthcare.com/article/20160615/NEWS/160619941>



UNITED STATES SURGEON GENERAL

Vivek H. Murthy, M.D., M.B.A.

August 2016

Dear Colleague,

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

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

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

A 1980 letter on the risk of Opioid Addiction

TO THE EDITOR

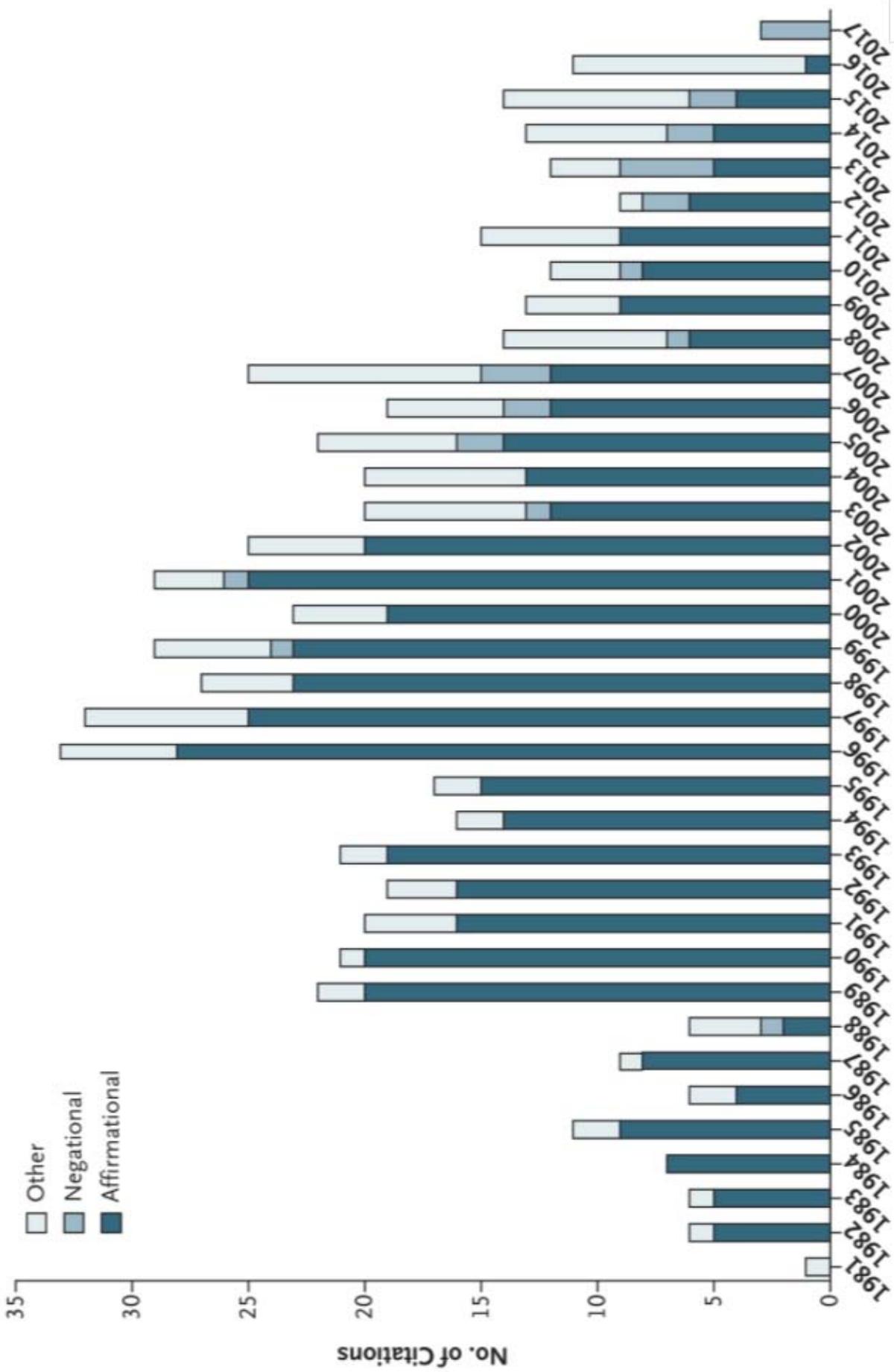
Recently, we examined our current files to determine the incidence of narcotic addiction in 39,946 hospitalized medical patients¹ who were monitored consecutively. Although there were 11,882 patients who received at least one narcotic preparation, there were only four cases of reasonably well documented addiction in patients who had no history of addiction. The addiction was considered major in only one instance. The drugs implicated were meperidine in two patients,² Percodan in one, and hydromorphone in one. We conclude that despite widespread use of narcotic drugs in hospitals, the development of addiction is rare in medical patients with no history of addiction.

Jane Porter

Hershel Jick, M.D.

Boston Collaborative Drug Surveillance Program Boston University Medical Center

N Engl J Med 1980; 302:123



N Engl J Med 2017; 376:2194-2195

Perceived impact of Incentives tied to formal patient satisfaction scores

*Preliminary data will be presented here
– not for public distribution*

Who is at risk for long-term (>90 days) opioid prescription after surgery?

39,140 opioid naïve geriatric patients in Canada:

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

Clarke H, Soneji N, Ko DT, Yun L, Wijeyesundera DN. Rates and risk factors for prolonged opioid use after major surgery: population based cohort study. *BMJ*. 2014;348:g1251

Risk Factors for long-term opioid prescribing after surgery

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

Alam A, Gomes T, Zheng H, Mamdani MM, Juurlink DN, Bell CM. Long-term analgesic use after low-risk surgery: a retrospective cohort study. *Arch Intern Med.* 2012;172(5):425-430.

Risk Factors for long-term opioid prescribing after surgery

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

Long-Term Opioid Use After Inpatient Surgery – A Retrospective Cohort Study

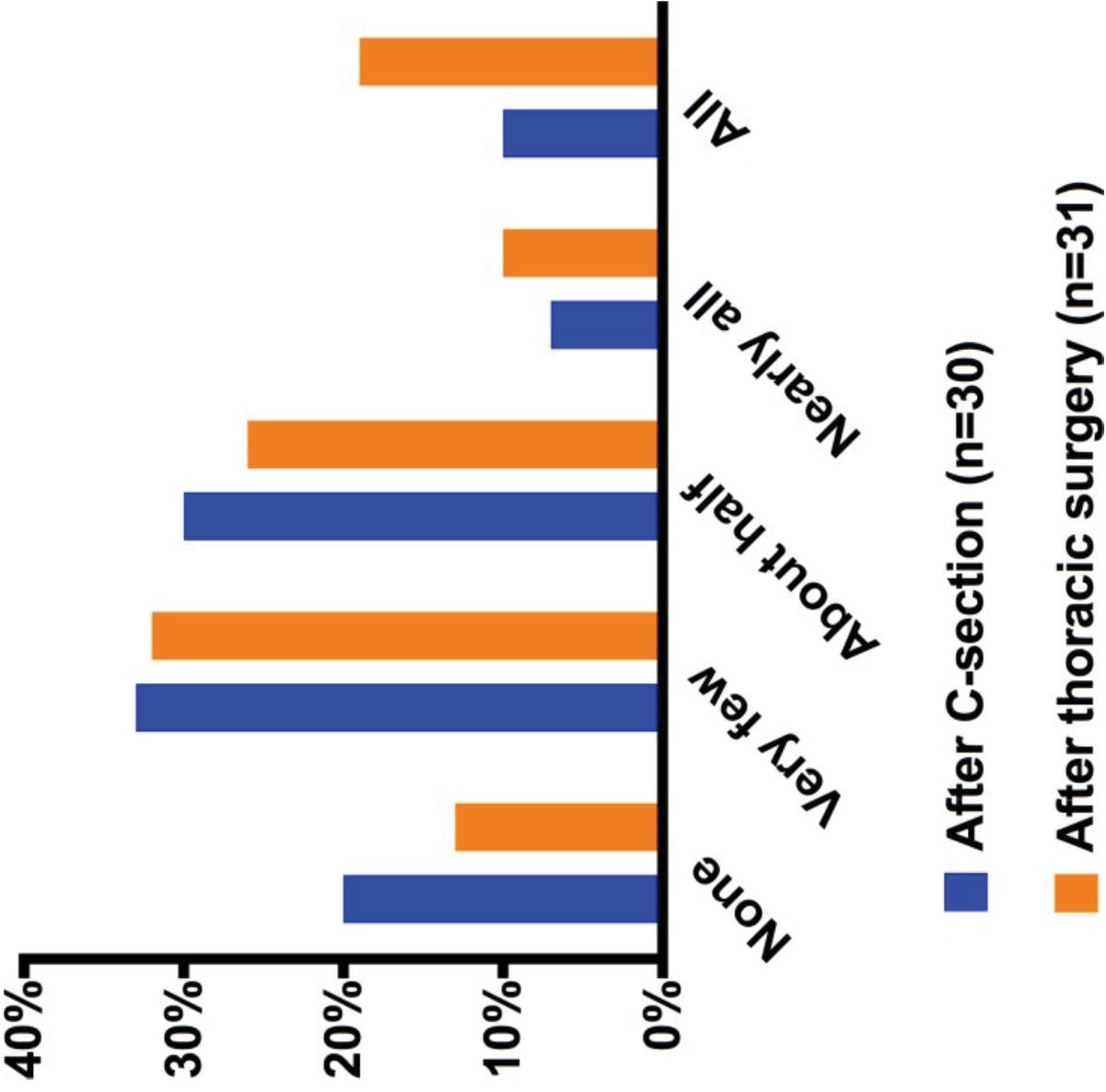
*Preliminary data will be presented here
– not for public distribution*

*Preliminary data will be presented here
– not for public distribution*

Active opioid ingredients in the post discharge
opioid prescriptions in a cohort of 652 patients
after Cesarean section.

*Preliminary data will be presented here
– not for public distribution*

Cumulative opioid dose in oral morphine equivalents (OME) prescribed to 652 patients upon hospital discharge after Cesarean section.



Bartels K et al.; Opioid Use and Storage Patterns by Patients after Hospital Discharge following Surgery. PLoSOne 2016

SundayReview

After Surgery in Germany, I Wanted Vicodin, Not Herbal Tea

By FIROOZEH DUMAS JAN. 27, 2018



Rosalie Stroesser

Thank you!

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

Myron Yaster, MD

Professor,
Department of Anesthesiology
myron.yaster@childrenscolorado.org



Disclosure

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

Objectives

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

“The world is full of obvious things which nobody by any chance ever observes.”

Sherlock Holmes -*The Hound of the Baskervilles*
Sir Arthur Conan Doyle



It all started with an observation



An Analysis of 34,218 Pediatric Outpatient Controlled Substance Prescriptions

Jessica A. George, MD,* Paul S. Park, BS,* Joanne Hunsberger, MD,* Joanne E. Shay, MD,* Christoph U. Lehmann, MD,†‡ Elizabeth D. White, RN,* Benjamin H. Lee, MD, MPH,* and Myron Yaster, MD*§

Anesthesia and Analgesia. 2016;122(3):807-813

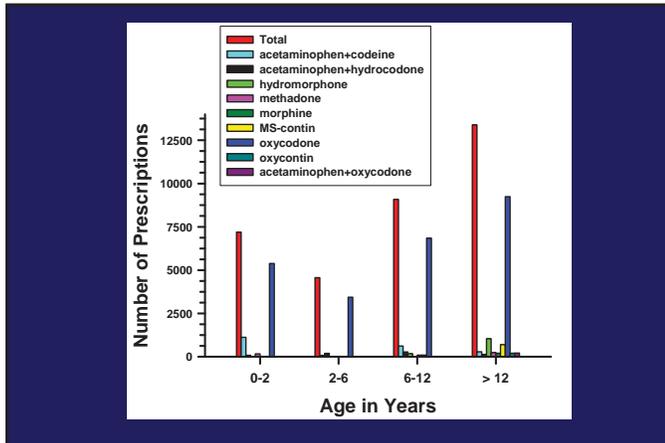
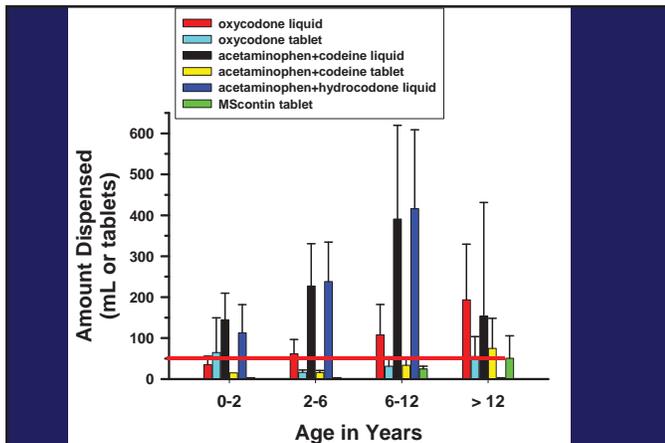


Table 2. Codeine Prescriptions by Year and How Dispensed

Year	Total	Liquid	Tablet
2007	377	306	71
2008	342	280	62
2009	584	497	87
2010	606	545	61
2011	327	289	38
2012	237	210	27
2013	29	22	7
2014	3	2	1



Analysis of Controlled Substance Prescriptions: Summary of Results

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

Another Observation... Which Led to More Questions...

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

Research Study Questions:

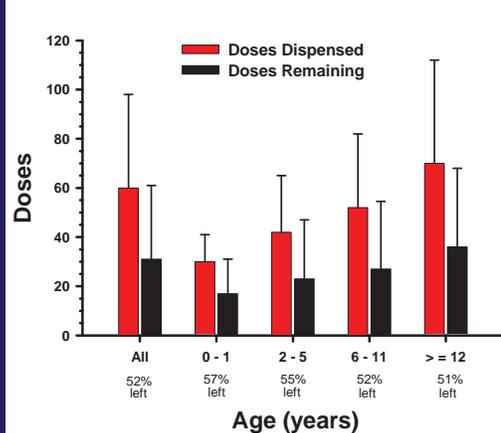
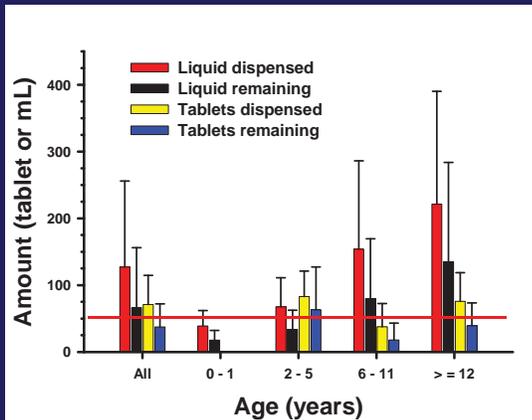
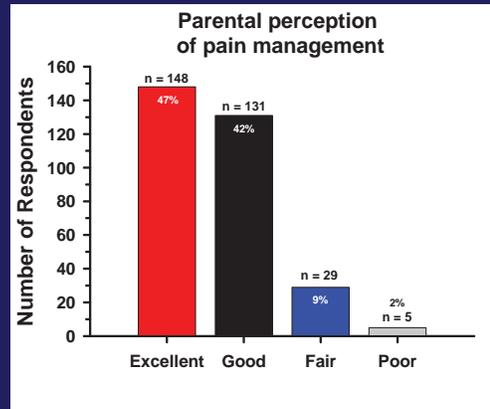
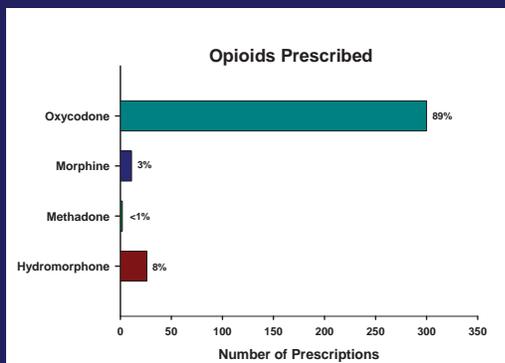
- Were they given instructions on how to dispose of leftover meds?
- Who informed them (physician, nurse, pharmacist)?
- Did they disposed of unused meds?
- Are there at-risk individuals in the home? (Adolescents and risk of NMUPO; young children and risk of accidental ingestion.)

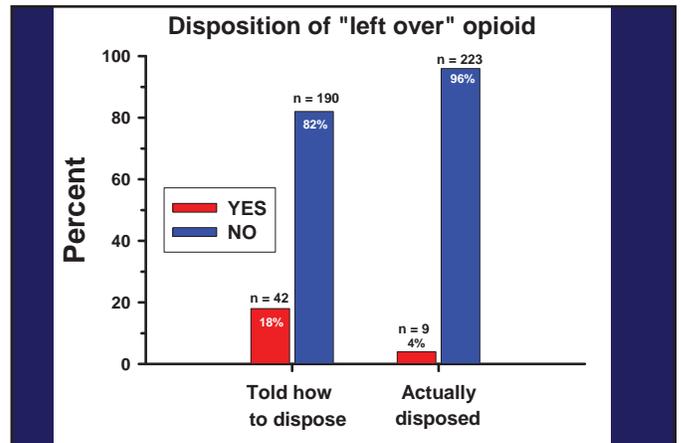
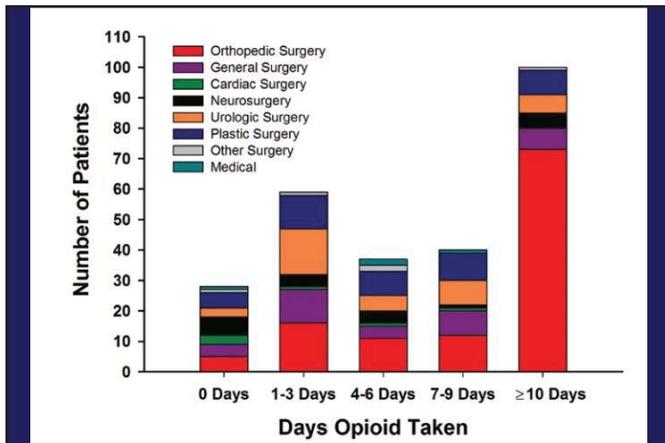
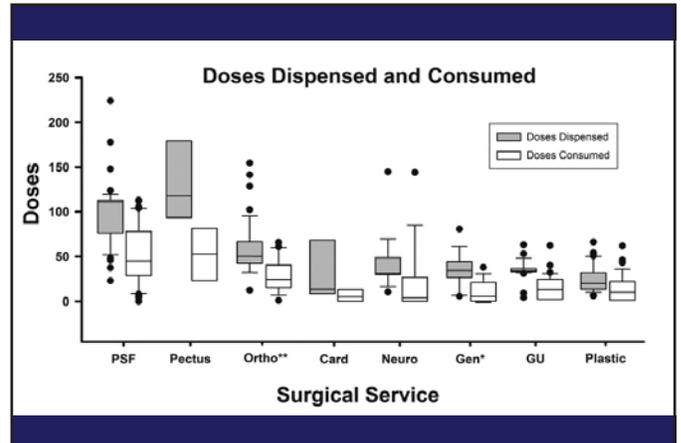
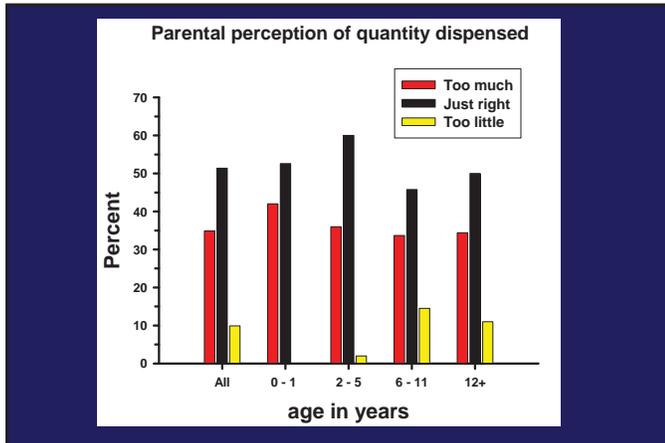


Opioid Prescribing for the Treatment of Acute Pain in Children on Hospital Discharge

Constance L. Monitto, MD,* Aaron Hsu, MHS,* Shuna Gao, BA,* Paul T. Vozzo, BA,* Paul S. Park, BS,* Deborah Roter, DrPh,† Gayane Yenokyan, MD, MPH, PhD,‡ Elizabeth D. White, RN,* Deepa Kattail, MD, MHS,* Amy E. Edgeworth, RN, MSN, CRNP,* Kelly J. Vasquez, RN, MSN, CPNP* Sara E. Atwater, RN, MSN, CPNP,* Joanne E. Shay, MD, MBA,* Jessica A. George, MD, MEd,* Barbara A. Vickers, MD, MPH,* Sabine Kost-Byerly, MD,* Benjamin H. Lee, MD, MPH,* and Myron Yaster, MD*

Anesthesia and Analgesia. 2017;125: 2013-22





Storage and Disposal of Morphine at the End of Treatment

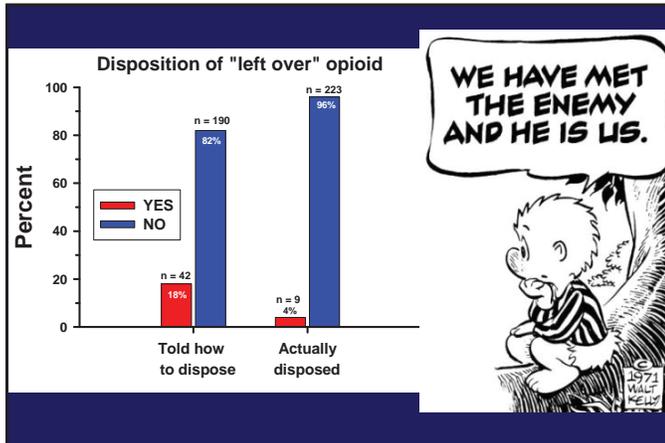
Storage, n (%)	
Room	
Kitchen	115 (65)
Bathroom	27 (15)
Parent's bedroom	18 (10)
Child's bedroom	9 (5)
Other	8 (5)
Open or closed space	
Open	76 (44)
Closed	96 (56)
Disposal of morphine at the end of treatment, n (%)	
Return to pharmacy	93 (55)
Throw away	45 (27)
Keep at home	16 (9)
Do not know	16 (9)

Abou-Karam M, et al. Parental Report of Morphine Use at Home after Pediatric Surgery. J Pediatr 2015; 167: 599-604

NMUPO and Adolescents

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

2012 Partnership Attitude Tracking Study (PATS)-MeLife Foundation



Opioids, Pain, and Surgery

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

If the only tool you have is a hammer, **you tend to see every problem as a nail**
 Abraham Maslow

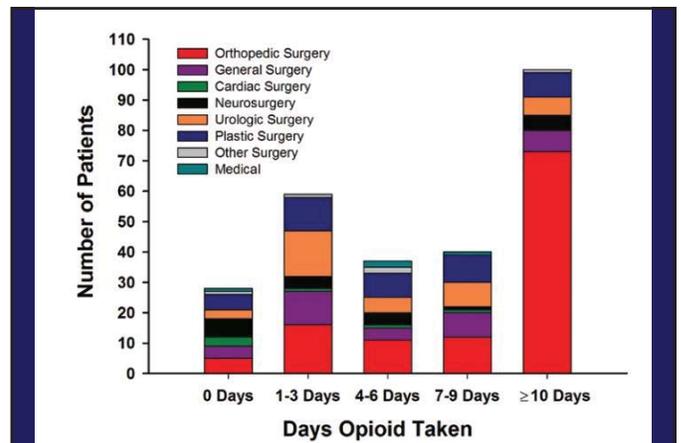
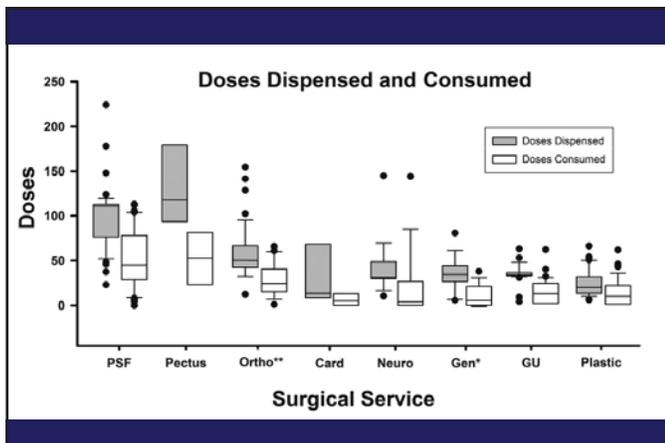
"Duh!"

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

Haven't we seen this before?

Pain is the 5th vital sign

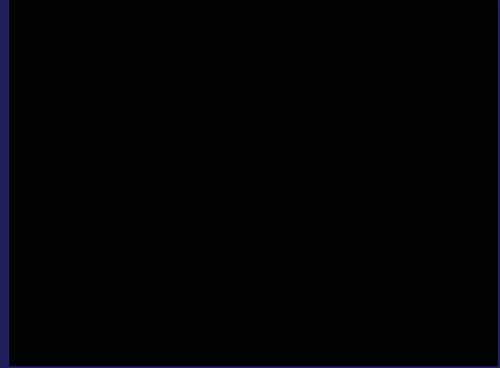
Opioidphobia



We need DATA!

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

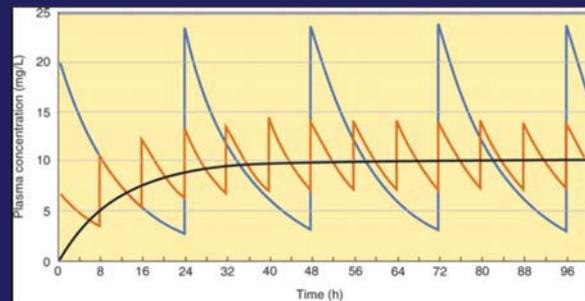
Strategies to limit opioid use after surgery



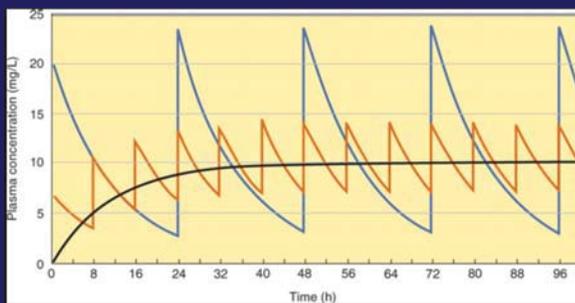
The “Usual Suspects”

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

PK it's not just for exams



Acetaminophen AND Ibuprofen



After Surgery in Germany, I Wanted Vicodin, Not Herbal Tea

By FIROOZEH DUMAS JAN. 27, 2018

- <https://www.nytimes.com/2018/01/27/opinion/sunday/surgery-germany-vicodin.html>



Basic/Translational Development of Forthcoming Opioid- and Nonopioid-Targeted Pain Therapeutics

Knezevic, Nebojsa Nick; Yekkirala, Ajay; Yaksh, Tony L.
Anesthesia & Analgesia 125(5):1714-1732, November 2017.

Current and Future Targets

- **NMDA Receptor Blockade**
 - Ketamine, Methadone, Dextromethorphan
- **Opioid Receptor**
 - Mu, Kappa, Delta, Neuropeptide nociception
 - Peripherally active agonists
 - Biased ligands
- **Alpha 2 agonists**
 - Clonidine, Tizanidine, Dexmedetomidine

Peripherally restricted opioids

- Reduced side effect profile and minimum abuse and drug seeking behavior
- **Kappa** peripherally restricted agonists are in phase 2 and 3 trials and are effective for acute, chronic, inflammatory and visceral pain as well as pruritus

Biased Ligand Opioids

- Combine a classic mu agonist with a beta arrestin molecule modulating opioid side effects. Specifically reducing:
 - Tolerance
 - Respiratory depression
 - Pruritus
- In phase 2 trials

Cannabinoids

- Cannabinoid receptors (CB1 and CB2) are G protein coupled receptors (like opioids).
- CB1 receptors are in spinal cord **neurons**, particularly dorsal root ganglia
- CB2 are in spinal cord **microglia**
- Psychotropic and abuse potential effects are CB1, analgesia are CB1 and CB2

Cannabinoids

- There is NO postoperative data
- There is A LOT of anecdotal data, particularly for opioid substitution
- There is evidence that it may be effective in neuropathic pain
- We NEED data but there are enormous hurdles in studying a Class 1 drug

Conclusions Future Directions

- Need to identify reasons for overprescribing of these meds and mitigate risk to patient by behavior change and data-driven practices
 - Develop new methods of disposal
- BUT**
- We can't forget the need for humane pain management which for moderate to severe pain almost always requires opioids

A Journey of Discovery



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

Myron Yaster, MD

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Department of Anesthesiology
myron.yaster@childrenscolorado.org



The Opioid Crisis: Addiction and Anesthesia

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

Conflicts

- None

Addiction

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

Pseudoaddiction?

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

Evaluation of Patient for OUD

CAGE-AID (Adapted to Include Drugs):

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

DSM-5 Diagnosis of Opioid Use Disorder (OUD)

2 or more of the following within 12 months:

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

Evaluation of Patient with OUD

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

Sen S, Arulkumar S, Cornett EM, Gayle JA, Flower RR, Fox CJ, et al. New Pain Management Options for the Surgical Patient on Methadone and Buprenorphine. Curr Pain Headache Rep. 2016;20(3):16.

Factors for Opioid Addiction or Abuse

- Risk Factors among adults on ≥ 90 days of COT
 - Not being married (population of veterans)
 - Younger age
 - Current Mental Health Disorder
 - Current painful physical disorder
 - High level of pain if receiving >4 rx's
 - Chronic pain dx in patients on methadone therapy
 - Back pain
 - Headache
 - High levels of health care visits or "poor health"
 - History of opioid abuse
 - Current non-opioid use disorder
 - Having an rx for >211-day supply in 12 months
 - High doses of opioid (esp >120mg MED)
 - Treatment with short-acting opioid
 - Having an rx for sedatives or hypnotics
- Additional Risk Factors
 - Genetics
 - Certain mutations in genes for the μ-, κ-, or δ-opioid receptors
- Protective Factors
 - Positive well-being
 - Being employed
 - Having health insurance
 - Among adults on ≥ 90 days of COT:
 - Long-acting opioid only
 - Lower prescribed dosage
 - Smaller prescribed supply

Identifying Who Is at Risk

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

SOAPP-1.0 SF (Short Form)

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

Opioid Risk Tool

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

Mark each box that applies	Female	Male
Family history of substance abuse		
Alcohol	1	3
Illegal drugs	2	3
Rx drugs	4	4
Personal history of substance abuse		
Alcohol	3	3
Illegal drugs	4	4
Rx drugs	5	5
Age between 16–45 years		
History of preadolescent sexual abuse	3	0
Psychological disease		
ADD, OCD, bipolar, schizophrenia	2	2
Depression	1	1
Scoring totals		

Importance of Perioperative Pain Management

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

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

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

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

- **Regarding Acute Pain:**
 - “a greater amount of early opioid exposure is associated with greater risk for long-term use (KQ5).”
 - “limiting days of opioids prescribed also should minimize the need to taper”
 - “each day of unnecessary opioid use increases likelihood of physical dependence without adding benefit”
 - “when opioids are needed for acute pain, clinicians should prescribe opioids at the lowest effective dose and for no longer than the expected duration of pain severe enough to require opioids”
 - “in most cases of acute pain **not related to surgery or trauma**, a ≤3 days’ supply of opioids will be sufficient.”
 - “Acute pain can often be managed without opioids.”
 - “Given longer half-lives and longer duration of effects (e.g., respiratory depression) with ER/LA opioids, clinicians should not prescribe ER/LA opioids for the treatment of acute pain.”

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

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 - “**Acute pain can often be managed without opioids.**”
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Opioid Crisis: Role of Prescription Opioids

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

Reducing Long-Term Use

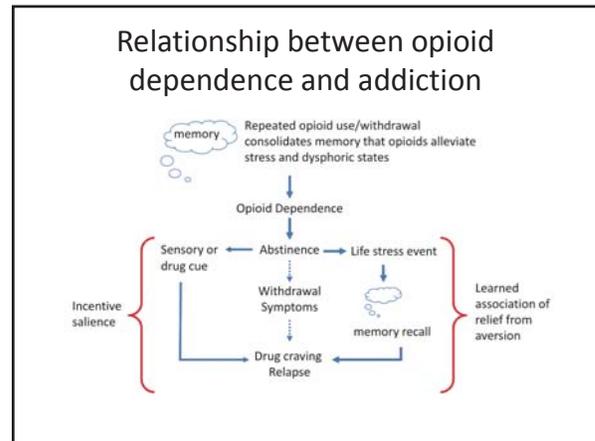
- Use of opioid for acute pain associated with long-term use
- Higher initial exposure (dose, duration/days supplied) also associated with long-term use
- Not all acute pain requires treatment with opioids!
- Why do we care what our patients do for pain long-term?

Risk Factors for OUD

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

Do Chronic Pain and Opioid Use Disorder Coexist?

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



Opioids Change the Brain!

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

Opioids Change the Brain!

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Non-Pharmacologic Interventions for Pain

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

Non-Pharmacologic Interventions for Pain

- TENS
 - 80-150 Hz
 - Meta-analysis found TENS reduced opioid consumption vs placebo at 12, 24 and 48-hours after TKA
 - Associated with lower VAS at all 3 time points
 - Minimal side effects
- Acupuncture
 - May increase time until first opioid dose after TKA and reduce pain
 - No impact on post-operative opioid dose
 - May reduce pain in first 2 days after TKA and THA

Non-Pharmacologic Interventions for Pain

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

Figure 3: Average pain score as a function of procedure-time interval for each group

The Impact of Intra-Operative Opioids

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

A. Ipsilateral hindpaw von Frey SNAP Surgery to only 10mg/kg s.c. morphine

Hyperalgesia

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

Hyperalgesia

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

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

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

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

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

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

- Local Anesthetic Techniques

Lack of Association Between the Use of Nerve Blockade and the Risk of Postoperative Chronic Opioid Use Among Patients Undergoing Shoulder Arthroplasty: Evidence From the MarketScan Database

Kathryn G. Mueller,* Stavros G. Memtsoudis, MD, PhD,† Edward R. Mariano, MD, MAS,‡§ Laurence C. Baker, PhD,||¶ Sean Mackey, MD, PhD,‡ and Eric C. Sun, MD, PhD†

- Unfortunately, 2 recent database reviews suggests that use of regional anesthetic techniques for TKA and Shoulder Arthroplasty is not associated with lower risk of chronic post-surgical opioid use

Management of Patient with OUD

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

Sen S, Arulkumar S, Cornett EM, Gayle JA, Flower RR, Fox CJ, et al. New Pain Management Options for the Surgical Patient on Methadone and Buprenorphine. Curr Pain Headache Rep. 2016;20(3):16.

Management of Patient with OUD

- Has not been studied in opioid-tolerant patients
 - Still WIDELY recommended to use a multi-modal approach in such patients where opioids may be ineffective (tolerance, OIH, etc.)
 - regional anesthesia
 - NSAIDs or COX-2 Inhibitors
 - acetaminophen
 - NMDA antagonists
 - α_2 agonists
 - anti-convulsants

Sen S, Arulkumar S, Cornett EM, Gayle JA, Flower RR, Fox CJ, et al. New Pain Management Options for the Surgical Patient on Methadone and Buprenorphine. Curr Pain Headache Rep. 2016;20(3):16.



Kyle Marshall, MD
University of Colorado
CRASH 2018

Ultrasound Guided Regional Anesthesia Workshop

SCHOOL OF MEDICINE
Department of Anesthesiology
UNIVERSITY OF COLORADO ANSCHUTZ MEDICAL CAMPUS

Disclosures

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



uchealth

Basic Physics



- Ultrasound machines produce sound waves
- They listen for what returns and create image
- Denser tissues reflect more waves
 - tissues are more "hyperechoic" or white
- Less Dense tissues allow them to pass through
 - Tissues which are "hypoechoic" reflect waves poorly or not at all

Basic Physics, cont.

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




Basic Physics, cont.

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



Preferred Ultrasound Machine

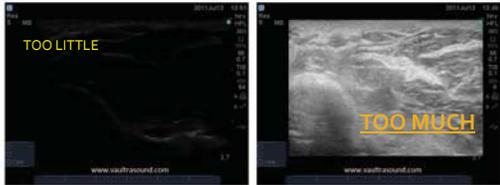
- High Frequency: 10MHz –15MHz
- Depth 1-6 cm (for linear probe)
- Needle finding technology
- Color capability for vascular structures
- Time Gain Compensation
- Wireless capability for Medical Record upload
- As few buttons as possible/necessary

Ultrasound Basics

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

Ultrasound basics

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



How to use a Probe

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

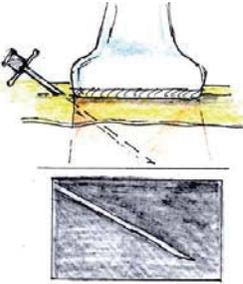


- **Anisotropy:**
 - small changes in tilt of probe can vastly improve picture

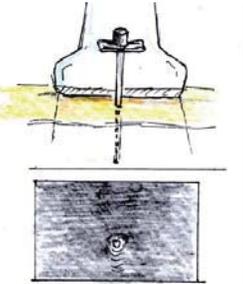
How to use a Probe & Needle

- Find your favorite view, and stick with it!
- Only small changes in anisotropy
- Don't chase your needle!
 - Finding it in "no man's land" does not help
 - Improve needle placement
 - So that changes in anisotropy will make it visible
 - Look at your hands, before the screen
 - Practice!

Ultrasound and Needle



IN PLANE



OUT OF PLANE

Principles of UGRA

- Before the Block:
 - Know how to manage Local Anesthetic Toxicity!
 - Practice hand/eye coordination
 - Know your anatomy
 - Be patient and optimize picture (depth/gain)
 - Position your patient to optimize view and ergonomics
- Block Time!
 - Use in-plane view when possible
 - Don't advance needle if unsure of position
 - Do not penetrate nerve
 - Paresthesia, pain or difficult injection? Pull back, re-direct
 - Ensure good local anesthetic spread
 - Use less local anesthetic if block looks good

New Format for CRASH 2018

- Two Nights!
- Beginner

- Advanced

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

CRASH 2018 Faculty

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



Thank you to our Vendors!

- Mindray: Darryl Wilson
- Philips: Aaron Rhoades
- Sonosite: Kristi Howe

Wednesday

PACU Management of the Obese Patient

Jay B. Brodsky, MD
 Professor (Anesthesiology)
 Stanford University Medical Center
 Stanford, California
 jbrodsky@stanford.edu

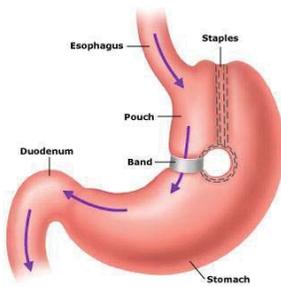
Feb 28, 2018

Goals and Objectives: Following the lecture, the audience should:

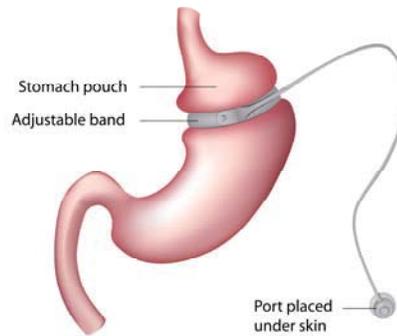
PACU Management of the Obese Patient

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

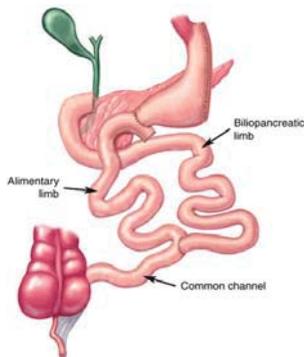
Vertical Banded Gastroplasty



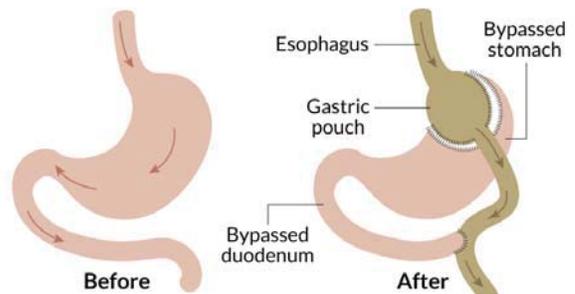
Adjustable Gastric Banding

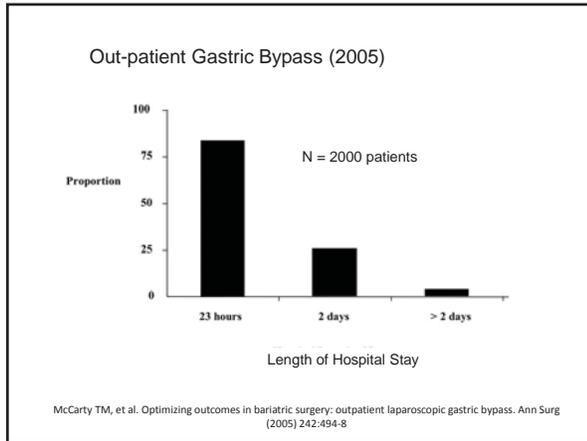


BilioPancreatic Diversion/Duodenal Switch



Roux-en-Y Gastric Bypass





PACU: Anastomotic Leak – Gastric Bypass

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

Byrne: Surg Clin N Am (2001) 81:1181-93

“Bariatric Leak Syndrome”

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

Anastomotic Leak

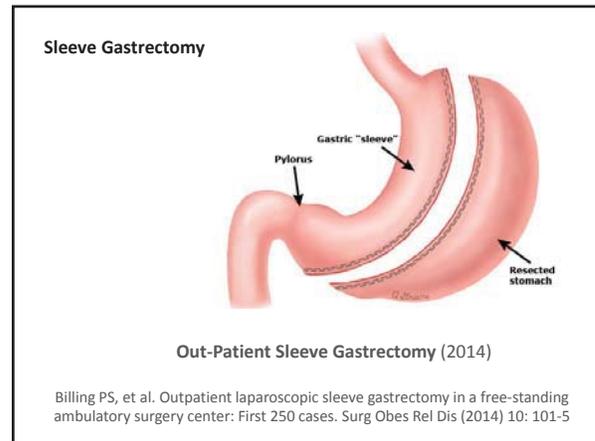
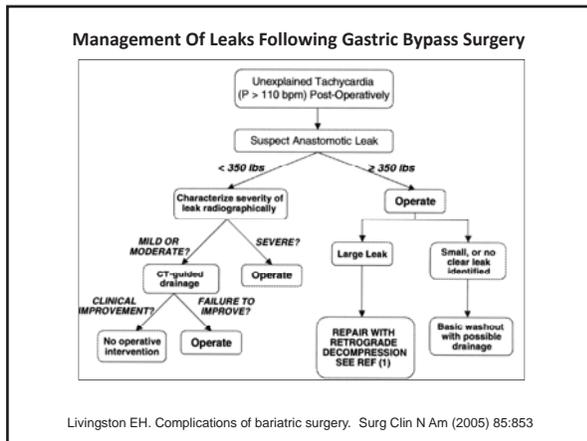
- Failure to improve
- Abdominal pain
- Increased iv fluid requirements
- Hiccups
- Progresses rapidly to overwhelming sepsis, necrotizing soft tissue infection, multi-system organ failure, and death
- Pulmonary dysfunction (symptoms may be confused with PE)

Thromboembolism - DVT/PE Risk in Obesity

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

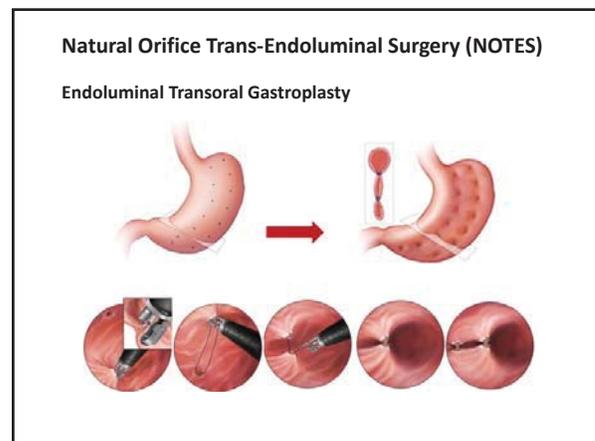
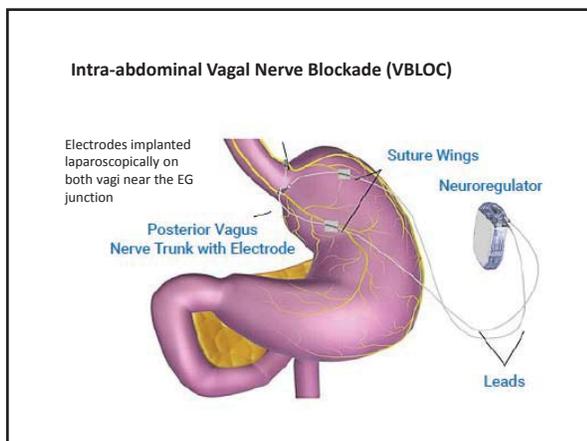
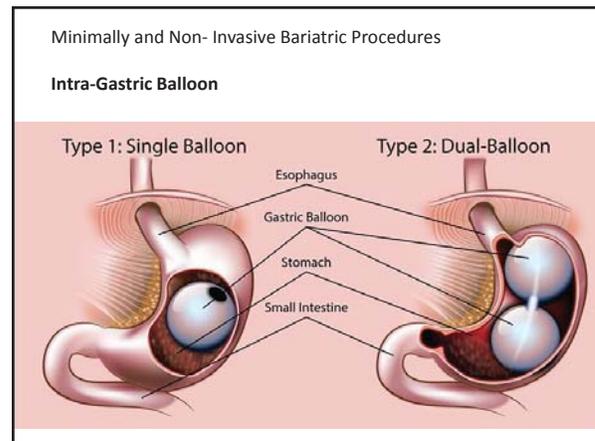
- PE (1-2%)
- Most common cause of perioperative death (1/3 fatal)
- Symptomatic DVT < 1 %
- DVT prophylaxis with compression boots and SQ Heparin
- Early ambulation
- Prophylactic IVC filter (???)

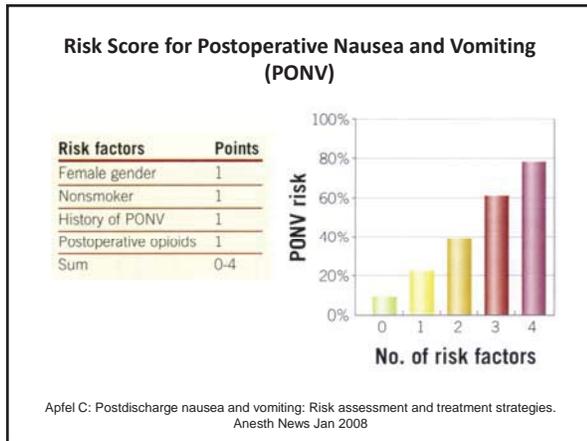
- Differential diagnosis in PACU is anastomotic leak



Bariatric Procedures – United States

	2011	2012	2013	2014	2015
Total	158,000	173,000	179,000	193,000	196,000
RNY	36.7%	37.5%	34.2%	26.8%	23.1%
Band	35.4%	20.2%	14%	9.5%	5.7%
Sleeve	17.8%	33%	42.1%	51.7%	53.8%
BPD/DS	0.9%	1%	1%	0.4%	0.6%
Revisions	6%	6%	6%	11.5%	13.6%
Other	3.2%	2.3%	2.7%	0.1%	3.2%
Balloons					~700 cases
V-Bloc					18 cases





PACU: Obesity and PONV - calculated risk

Postoperative vomiting (PV)
Postoperative nausea (PN)
Nausea and vomiting (PONV)

Mean BMI, risk profile for PONV and calculated risk for inhalational anaesthesia without antiemetic prophylaxis according to Apfel et al. Values are number (%) or mean (95% CI).

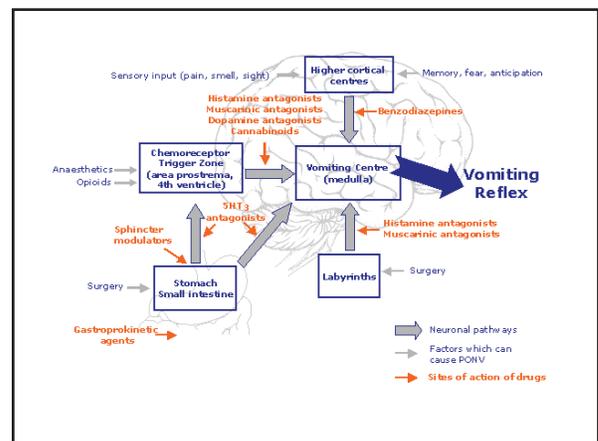
	Underweight n=72	Normal weight n=343	Overweight n=113	Obesity n=59
BMI	18.7 (18.5; 18.9)	22.9 (22.8; 23.1)	27.8 (27.6; 28.0)	34.4 (33.1; 35.7)
Female gender	64 (88.9)	237 (69.1)	72 (63.7)	39 (66.1)
Motion sickness or previous PONV	38 (52.8)	181 (52.8)	67 (59.3)	28 (47.5)
Nonsmoker	41 (56.9)	234 (68.2)	74 (65.5)	47 (79.7)
Postoperative opioids	13 (18.1)	105 (31.0)	35 (30.1)	16 (27.1)
Calculated risk	43.4 (39.5; 47.3)	44.7 (42.8; 46.6)	44.5 (41.1; 47.8)	44.6 (39.9; 49.3)

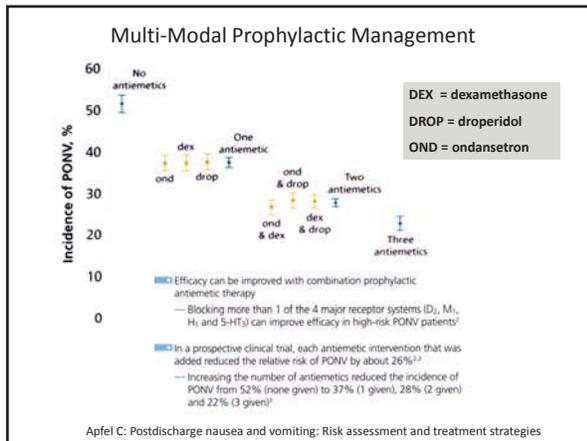
Kranke P, et al. An increased body mass index is no risk factor for postoperative nausea and vomiting. Acta Anaesthesiol Scand (2001) 45:160

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

	Underweight n=72	Normal weight n=343	Overweight n=113	Obesity n=59
PV 0-2 h	15.3 (6.8; 23.8)	17.8 (13.7; 21.8)	27.4 (19.1; 35.8)	20.3 (9.8; 30.9)
PN 0-2 h	29.2 (18.4; 39.9)	29.2 (24.3; 34.0)	33.6 (24.8; 42.5)	28.8 (16.9; 40.7)
PONV 0-2 h	34.7 (23.5; 46.0)	32.1 (27.1; 37.0)	39.8 (30.7; 49.0)	32.2 (19.9; 44.5)
PV 2-24 h	9.7 (2.7; 16.7)	14.0 (10.3; 17.7)	15.9 (9.1; 22.8)	13.6 (4.6; 22.6)
PN 2-24 h	26.4 (16.0; 36.8)	23.0 (18.6; 27.5)	20.4 (12.8; 27.9)	32.2 (19.9; 44.5)
PONV 2-24 h	29.2 (18.4; 39.9)	27.1 (22.4; 31.8)	25.7 (17.5; 33.8)	32.2 (19.9; 44.5)
PV 0-24 h	22.2 (12.4; 32.1)	24.2 (19.6; 28.8)	31.9 (23.1; 40.6)	23.7 (12.6; 34.9)
PN 0-24 h	45.8 (31.3; 54.8)	43.1 (33.0; 43.4)	40.7 (31.5; 49.9)	44.1 (31.0; 57.1)
PONV 0-24 h	45.8 (34.0-57.6)	43.1 (36.5; 46.9)	47.8 (38.4; 57.1)	44.1 (31.0; 57.1)

Kranke P, et al. An increased body mass index is no risk factor for postoperative nausea and vomiting. Acta Anaesthesiol Scand (2001) 45:160





Agent	Receptor	Location
Droperidol Metoclopramide Prochlorperazine Promethazine hydrochloride	Dopamine type 2 (D ₂)	Stomach, nuclei tractus solitarii (NTS) and chemoreceptor trigger zone (CTZ)
Dolasetron mesylate Granisetron Ondansetron	Serotonin type 3 (5-HT ₃)	Stomach and small intestine, CTZ, area postrema and NTS
Promethazine hydrochloride Scopolamine Dimenhydrinate Diphenhydramine hydrochloride	Histamine type 1 (H ₁)	NTS, CTZ and vestibular system
Promethazine hydrochloride Scopolamine Dimenhydrinate Diphenhydramine hydrochloride	Muscarinic cholinergic type 1 (M ₁)	NTS, CTZ and vestibular system
Dexamethasone	Unknown	Believed to antagonize prostaglandin or release endorphins

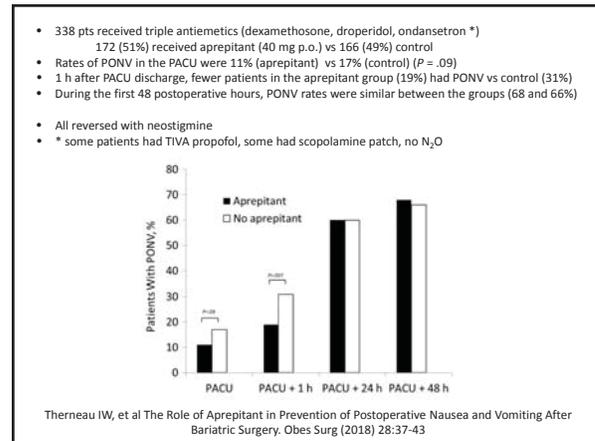
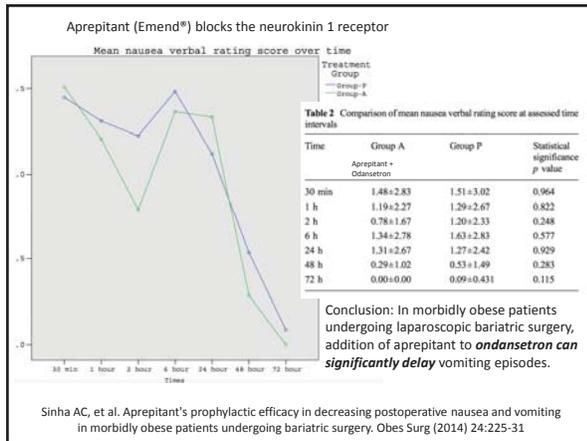


Table 3: Number of patients who received postoperative rescue antiemetics in various time periods after surgery

Timing of administration and type of antiemetic	Patients (N = 338)	
	Aprepitant (n = 172)	No aprepitant (n = 166)
In PACU	19 (11)	29 (17)
Droperidol	19	26
Promethazine	0	2
Granisetron	0	1
First hour after PACU	7 (4)	11 (7)
Droperidol	3	5
Ondansetron	5	6
1-24 h after PACU	78 (45)	61 (37)
Droperidol	20	23
Ondansetron	73	54
Metoclopramide	1	0
Prochlorperazine	8	6
Promethazine	4	8
25-48 h after PACU	56 (33)	40 (24)
Droperidol	8	9
Ondansetron	57	39
Prochlorperazine	7	3
Promethazine	4	3

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

Emend (Merck) average cost \$102/pill

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

PONV PACU - N (%)

	Group R	Group A	Group F
No nausea or vomiting	14/70.0*	12/80.0	19/86.36
Nausea	5/25.0*	3/20.0	3/13.64
Vomiting	1/5.0*	0/0	0/0

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

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

Sugammadex (S) vs Neostigmine (N)

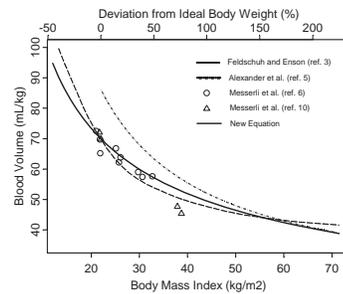
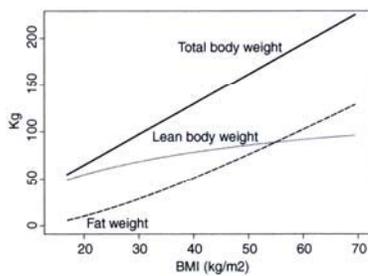
Table 2 Incidence and severity of PONV and antiemetic and analgesic treatment in groups.

	Group N n=48	Group S n=50	p
PONV at PACU			
No	35 (73%)	46 (92%)	0.016
Yes	13 (27%)	4 (8%)	
PONV at PACU			
0	35 (73%)	46 (92%)	NS
1	9 (19%)	3 (6%)	
2	3 (6%)	1 (2%)	
3	1 (2%)	0	
1-6 hours			
0	43 (90%)	48 (96%)	NS
1	4 (8%)	2 (4%)	
2	1 (2%)	0	
6-12 hours			
0	45 (94%)	50 (100%)	NS
1	3 (6%)	0	
2	0	0	
Antiemetic treatment (n) (Ondansetron)	16 (33%)	6 (12%)	0.011

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

Yagan O, et al. Comparison of the effects of sugammadex and neostigmine on postoperative nausea and vomiting. *Braz J Anesthesiol* (2017) 67:147-152

Fluid Management in Morbid Obesity

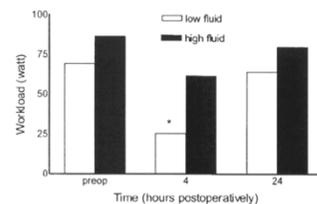


Lemmens HJM, et al: Estimating blood volume in obese and morbidly obese patients. *Obes Surg* (2006) 16:773-6

Intraoperative administration of **40 mL/kg** vs **15 mL/kg** LR improved postoperative organ functions and recovery and shortened hospital stay after laparoscopic cholecystectomy

Holte, et al. Liberal Versus Restrictive Fluid Administration to Improve Recovery After Laparoscopic Cholecystectomy: A Randomized, Double-Blind Study. *Ann Surg* (2004) 240:892-9

• Improved exercise capacity



- Less orthostatic hypotension
- Earlier ambulation
- Less PONV

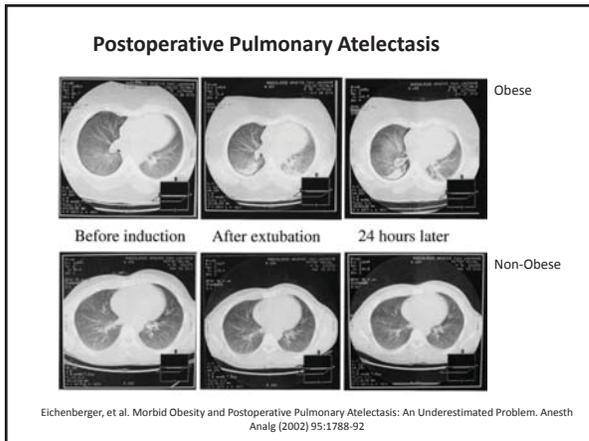
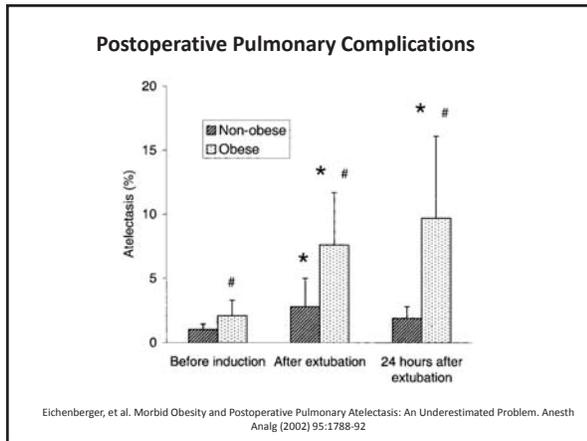
Holte, et al. Liberal Versus Restrictive Fluid Administration to Improve Recovery After Laparoscopic Cholecystectomy: A Randomized, Double-Blind Study. *Ann Surg* (2004) 240:892-89

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

Function	Status
Intraoperative urine output	Decreased
Intraoperative hormonal changes	
Antidiuretic hormone	Increased
Aldosterone	Increased
Plasma renin activity	Increased
Postoperative renal function	
Blood urea nitrogen	Decreased
Creatinine	Decreased
Creatinine clearance	Unchanged

Nguyen et al. The physiologic effects of pneumoperitoneum in the morbidly obese. Ann Surg (2005) 241:219

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



Supine Position

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

Obstructive Sleep Apnea

Does CPAP cause gas distension in bypassed stomach pouch leading to staple disruption and gastric leak syndrome?



CPAP after RYGB **does not** result in increased the morbidity

Ramirez A, et al. Continuous positive airway pressure in immediate postoperative period after laparoscopic Roux-en-Y gastric bypass: is it safe? Surg Obes Relat Dis (2009) 5 :544-6.

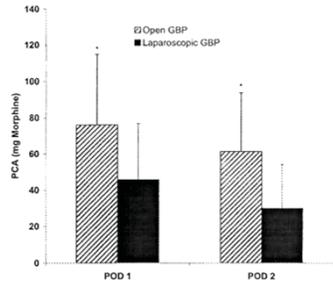
- CPAP did not increase transmural gastric pouch pressure in laparoscopic bariatric patients
- CPAP following RYGB *did not* pose a risk for pouch distension

Characteristic	Arrival	5 min	30 min	Discharge	P value ^a
Gastric pouch pressure, cm H ₂ O					
CPAP (n=19)	21.2±1.5	22.4±1.6	22.7±1.7	22.4±1.8	0.451
No CPAP (n=9)	22.8±2.4	22.5±2.7	21.4±2.8	20.3±2.3	0.200
Bladder pressure, cm H ₂ O					
CPAP (n=19)	12.0±1.9	12.1±1.1	12.1±1.2	12.6±1.1	0.336
No CPAP (n=9)	14.5±2.0	11.7±2.0	13.1±2.1	13.8±1.7	0.147
Transmural pressure, cm H ₂ O					
CPAP (n=19)	9.2±2.9	10.3±1.9	10.6±2.2	9.8±2.3	0.628
No CPAP (n=9)	8.4±2.6	10.9±3.0	8.3±3.6	6.5±2.9	0.053

Weingarten TN, et al. Effects of CPAP on gastric pouch pressure after bariatric surgery. Obes Surg (2011) 21:1900-5

Pain after Laparoscopy

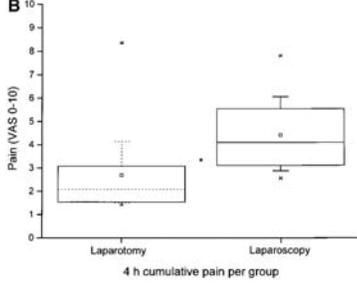
Morphine requirements 24 hrs after laparoscopic vs laparotomy gastric bypass



Time Point	Open GBP (mg)	Laparoscopic GBP (mg)
POD 1	~75	~45
POD 2	~60	~30

Nguyen, et al. Comparison of pulmonary function and postoperative pain after laparoscopic versus open gastric bypass: A randomized trial. J Am Coll Surg (2001) 192:469-77

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



Ekstein P, et al. Laparoscopic Surgery May Be Associated With Severe Pain and High Analgesia Requirements in the Immediate Postoperative Period. Ann Surg (2006) 243:41-6

PACU pain following Laparoscopy: somatic + visceral

Peritoneal irritation:

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

Heated CO₂ Insufflation - PAIN

postoperative pain intensity (VAS)

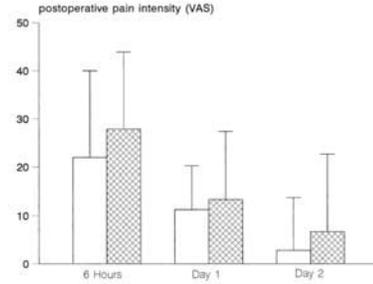
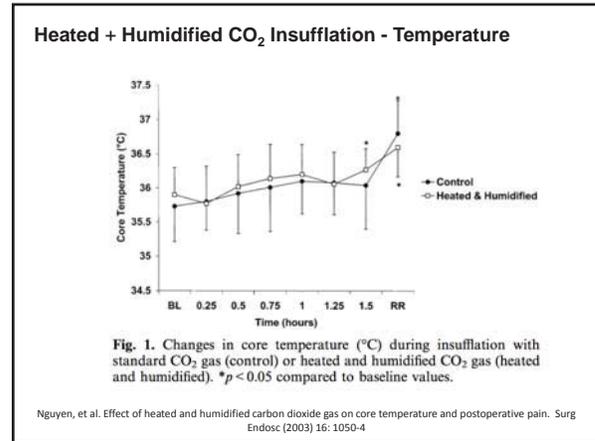
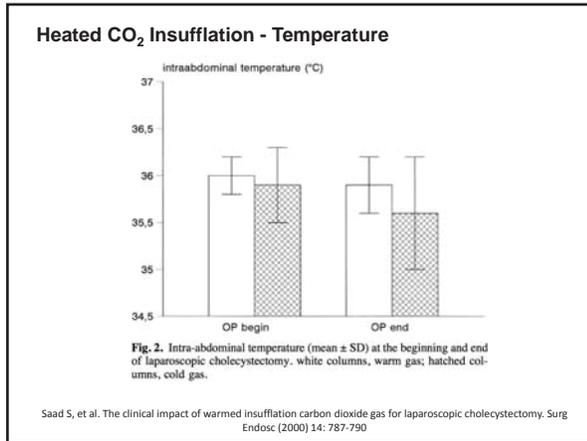


Fig. 3. Pain intensity (mean ± SD) at 6 h, day 1 and day 2 after laparoscopic cholecystectomy. white columns, warm gas; hatched columns, cold gas.

Saad S, et al. The clinical impact of warmed insufflation carbon dioxide gas for laparoscopic cholecystectomy. Surg Endosc (2000) 14: 787-790



Intraoperative intranasal nicotine as an analgesic

	N	Nicotine (N=42)	N	Placebo (N=47)	P value
Recovery room stay, min	42	94 [63, 110]	47	92 [75, 107]	0.711
Intravenous morphine equivalents, mg	42	5.2 [0, 10.0]	47	5.2 [0, 12.7]	0.829*
Numeric pain score					
On admission	40	0 [0, 6]	45	3 [0, 6]	0.354
30 min	40	5 [0.5, 6]	47	5 [0, 7]	0.492
60 min	34	4 [2, 6]	40	4 [3, 5]	0.809
At discharge	39	3 [2, 4]	44	3 [2, 4]	0.381
Use of rescue antiemetics	42	24 (57.1)	47	12 (25.5)	0.002

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

Weingarten TN, et al. Intranasal nicotine increases postoperative nausea and is ineffective in reducing pain following laparoscopic bariatric surgery in tobacco-naïve females: a randomized, double blind trial. *Obes Surg* (2015) 25:506-13

PAIN in PACU – TIVA ANESTHESIA

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

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

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

110 Bariatric Patients

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

	Experimental Group	Control Group	p
Pain (VAS: mm)	13.3 ± 10.9	21.7 ± 14.5	0.002
Morphine needs	4 (3.6 %)	12 (21.8 %)	0.01
Nauseas/vomits	9 (16.4 %)	2 (3.6 %)	0.056
Oral intake of fluids 6 h after surgery	42 (76.4 %)	19 (34.5 %)	0.001
Early mobilization ability (6 h after surgery)	40 (72.7 %)	18 (32.7 %)	0.001

Ruiz-Tovar J, et al. Intraoperative Ropivacaine Irrigation in Patients Undergoing Bariatric Surgery: a Prospective Randomized Clinical Trial. *Obes Surg* (2016) 26:2616-2621.

Sugammadex vs Neostigmine - laparoscopic bariatric surgery

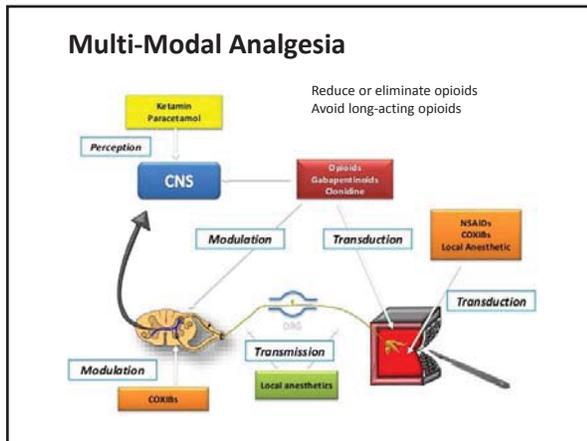
- Sugammadex
 - Less PONV
 - Less postoperative pain
 - Reduced rescue opioids
 - Shorter PACU stay

TABLE 3. Pain Evaluation Data

Evaluation Moment	SUG Group (n = 44)				NEO Group (n = 44)			
	PACU Arrival	30 min PACU	60 min PACU	PACU Discharge	PACU Arrival	30 min PACU	60 min PACU	PACU Discharge
VAS pain score:								
≤3	36	34	42	44	32	18	27*	43
4-7	8	8	2	0	10	19*	15*	1
≥8	0	2	0	0	2	7*	2	0

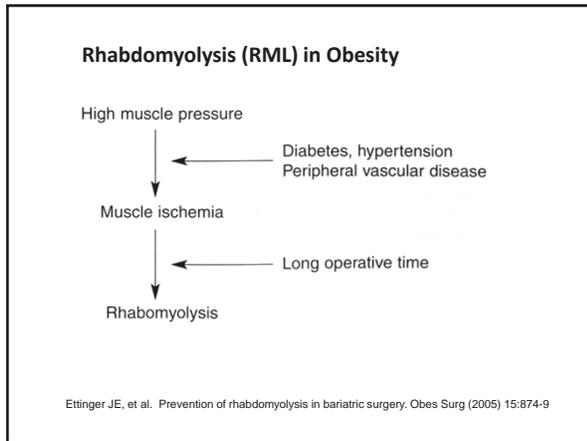
Values are number of cases.
**P* < 0.05 compared with the SUG group.
NEO indicates neostigmine; PACU, postanesthesia care unit; SUG, sugammadex; VAS, visual analogue scale.

Castro DS, et al. Sugammadex reduces postoperative pain after laparoscopic bariatric surgery: a randomized trial. *Surg Laparosc Endosc Percutan Tech* (2014) 24:420-3



Rhabdomyolysis (RML)

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



Case Reports RML and Bariatric Surgery

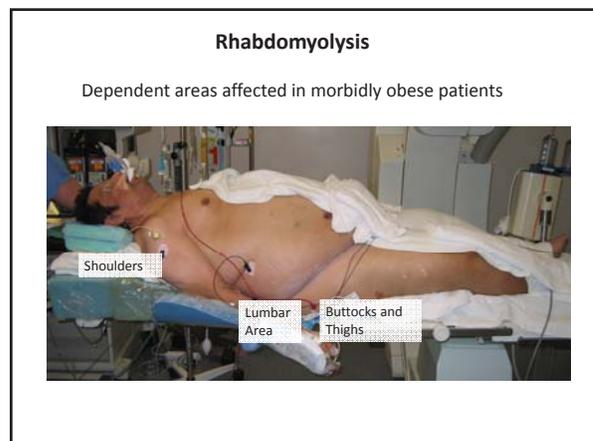
Study	Number	Gender	BMI (kg/m ²)	Age (years)	Type of surgery	Surgical time (min)	CPK	Symptoms and signs	Complications and outcome
Collins et al. [19]	1	W	88.0	43	RNYGBP	300	41,000	Gluteal pain	Death
Torres-Vidal et al. [20]	3	F/M/W	51.0	22	RNYGBP	225	10,600	Lumbar and gluteal pain	None
Burgelman et al. [14]	6	3F/3M	74.0	32	RNYGBP	360	13,176	Gluteal pain	Pressure ulcers
Wolke et al. [21]	1	M	66.0	46	RNYGBP	360	13,500	Lumbar pain	Renal failure
Dahlman et al. [22]	1	M	52.3	40	RNYGBP	420	8,000	Lumbar and gluteal pain	Renal failure
Rhodes et al. [23]	5	M	56.0	43	Sleeve	136	19,680	Lumbar pain	None
Fisher et al. [24]	1	W	11.0	20	RNYGBP	420	36,700	Lumbar and gluteal pain	None
Frank et al. [25]	1	W	48.0	46	Gastric banding	85	>15,000	Gluteal and hip pain	Renal failure
Stroh et al. [26]	1	W	52.0	44	Sleeve	205	7	Gluteal and shoulder pain	Death
Vincent et al. [27]	1	M	N/A	39	N/A	300	70,000	Gluteal pain	Severe encephalopathy
Alford et al. [17]	1	M	42.0	39	RNYGBP	510	35,236	Gluteal and lumbar pain	Polyneuropathy
Benedict et al. [28]	1	M	43.0	42	Sleeve	210	11,900	Gluteal and lumbar pain	Renal failure
Petro et al. [17]	1	W	54.3	34	RNYGBP	N/A	18,395	Gluteal pain	Renal failure

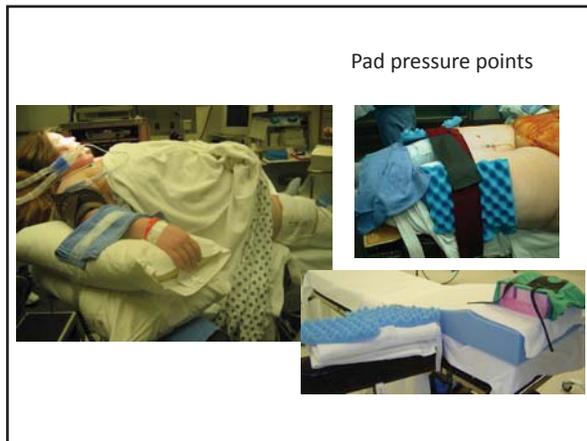
De Oliveira LD, et al. Rhabdomyolysis after bariatric surgery by Roux-en-Y gastric bypass: A prospective study. *Obes Surg* (2008) 19:1102-7

Case Series RML and Bariatric Surgery

Study	Type	BMI (no. of patients)	Age (years)	Sex (M/F)	BMI (kg/m ²)	Procedure	Operating time (min)	CK (U/L)	Muscle pain	AKI	Death
Vincent et al. [12]	Prospective	100	32	4/3	65	Open RNYGB	246	6,817	1	0	0
Wood et al. [13]	Prospective	36	21.3	3/1	51	Lap RNYGB	251	347	0	0	0
Wolke et al. [21]	Prospective	3	44.3	1/2	54	Lap RNYGB	—	2,629	0	0	0
Compagno et al. [14]	Prospective	30	30.5	—	44	—	—	—	—	—	—
Al-Obeidi et al. [15]	Prospective	1177	54	49	51.0	Open RNYGB	269	8,251	10	0	0
Compagno et al. [16]	Prospective	59	34	—	47	—	199	365	—	—	—
Compagno et al. [17]	Prospective	1120	58	62	50	DS-RNYGB	272	1,586	10	0	0
Carvalho et al. [18]	Prospective	58	50.7	—	49	LAPGB	193	228	—	—	—
Compagno et al. [19]	Prospective	21	38	19/18	45	Open RNYGB	234	1,699	0	0	0
Compagno et al. [20]	Prospective	41	37	16/15	42	—	205	697	—	—	—
Alford et al. [17]	Prospective	1	39	—	—	LAPGB	—	—	4	0	0
Compagno et al. [21]	Prospective	31	40	—	49	FXGB	—	—	—	—	—
Bohner et al. [22]	Prospective	7	40	—	49	Open and Lap RNYGB	221	1,736	9	1	0
Compagno et al. [23]	Prospective	107	41	—	—	—	179	339	—	—	—
Compagno et al. [24]	Prospective	89	40	6/10	37	Open RNYGB	234	1,075	5	3	0
Haidich et al. [25]	Prospective	308	—	—	—	—	—	—	—	—	—
Compagno et al. [26]	Prospective	100	—	—	—	—	—	—	—	—	—
Compagno et al. [27]	Prospective	100	—	—	—	—	—	—	—	—	—
Compagno et al. [28]	Prospective	100	—	—	—	—	—	—	—	—	—
Compagno et al. [29]	Prospective	100	—	—	—	—	—	—	—	—	—
Compagno et al. [30]	Prospective	100	—	—	—	—	—	—	—	—	—
Compagno et al. [31]	Prospective	100	—	—	—	—	—	—	—	—	—
Compagno et al. [32]	Prospective	100	—	—	—	—	—	—	—	—	—
Compagno et al. [33]	Prospective	100	—	—	—	—	—	—	—	—	—
Compagno et al. [34]	Prospective	100	—	—	—	—	—	—	—	—	—

Chakravarty S, et al. Rhabdomyolysis in bariatric surgery: a systematic review. *Obes Surg* (2013) 23:1333-40



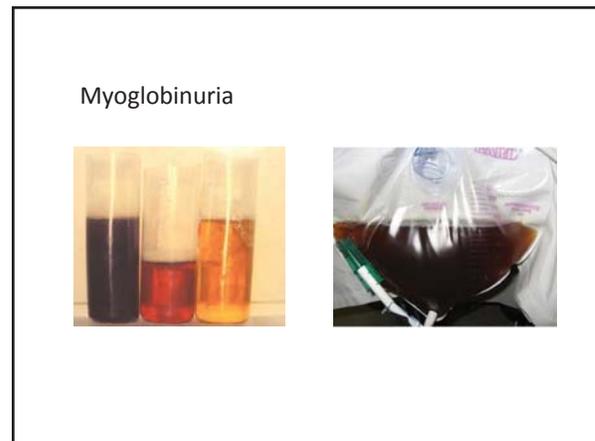


RML – Clinical Features

- **Muscle pain and tenderness**
- Swelling
- Bruising
- Weakness

RML - CLINICAL FEATURES

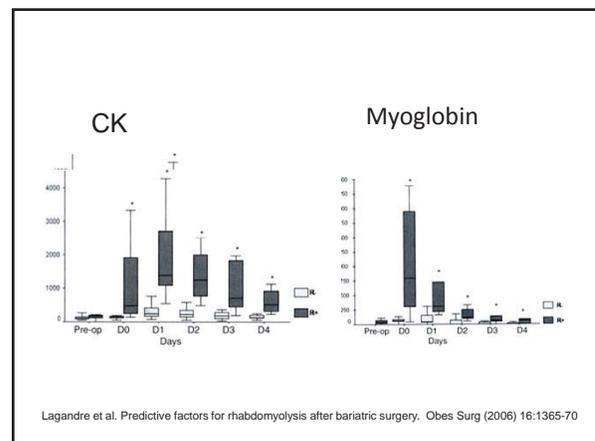
Dark Urine (brown, tea color)
 Anuria
 Fever, Malaise
 Nausea/Vomiting
 Agitation/Confusion/Delirium



RML Diagnosis

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

CK = 1,000 IU = RML
 (serum level 5x normal)



Electrolyte Disturbances (early)

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

RML: Late complications

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

Prevention

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

Ettinger JE, et al. Prevention of rhabdomyolysis in bariatric surgery. *Obes Surg* (2005) 15:874

RML – Intraoperative prevention

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

Ettinger JE, et al. Prevention of rhabdomyolysis in bariatric surgery. *Obes Surg* (2005) 15:874-9

Intravenous Fluid	15 ml/kg/TBW Group A (n=47)	40 ml/kg/TBW Group B (n=53)
Age (years)	44 (34–50)	39 (32–48)
Gender	7 males, 40 females	14 males, 39 females
Body mass index (kg/m ²)	45 (41–50)	44 (41–53)
IV Fluid (ml)	1,900 (1,600–2,154)	5,000 (4,495–5,515)
Operative Time (minutes)	147 (129–165)	149 (124–186)

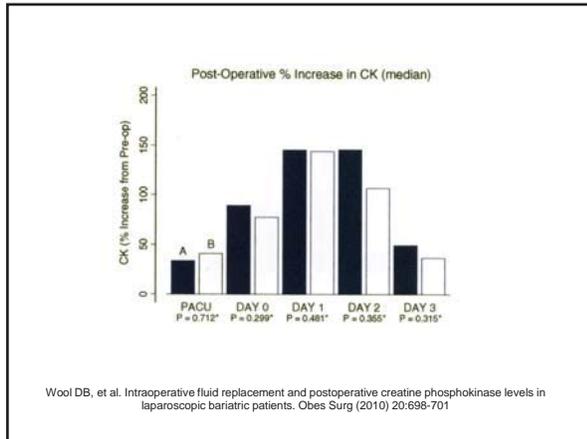
Wool DB, et al. Intraoperative Fluid Replacement and Postoperative Creatine Phosphokinase Levels in Laparoscopic Bariatric Patients. *Obes Surg* (2010) 20:698-701

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

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

Group	CK (IU/L)	Sex	Age (years)	BMI (kg/m ²)	Co-morbidities
A	3,161	Female	45	65	Hypertension Diabetes Congestive heart failure
A	2,602	Female	58	50	Hypertension Diabetes Congestive heart failure
A	1,602	Female	61	40	Hypertension Diabetes
A	6,244	Female	54	54	Hypertension Diabetes
B	1,080	Female	24	57	Hypertension
B	2,330	Female	41	61	Hypertension Coronary artery disease Hyperlipidemia
B	1,453	Male	31	50	Hypertension

Wool DB, et al. Intraoperative fluid replacement and postoperative creatine phosphokinase levels in laparoscopic bariatric patients. *Obes Surg* (2010) 20:698-701



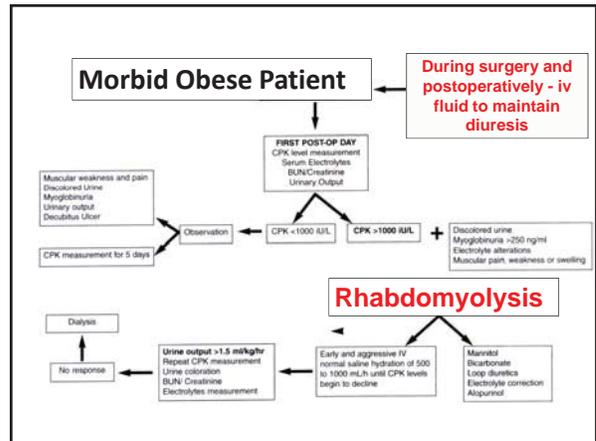
Compartment Syndrome

Large volumes of intravascular fluid (up to 12 liters) leaves circulation and enters injured muscle
 → Hypovolemia
 → Hemodynamic instability
 → Shock (further compromise of renal function)

Compartment Syndrome Requiring Fasciotomy

Fasciotomy procedure

Incision in skin and fascia to release pressure



Anesthesia for Total Joint Replacement Surgery

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

Disclosures

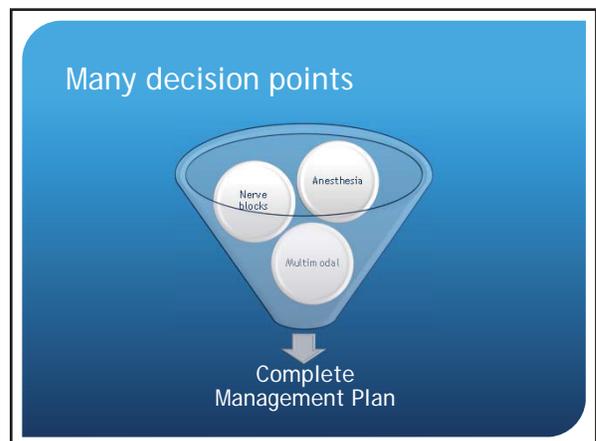
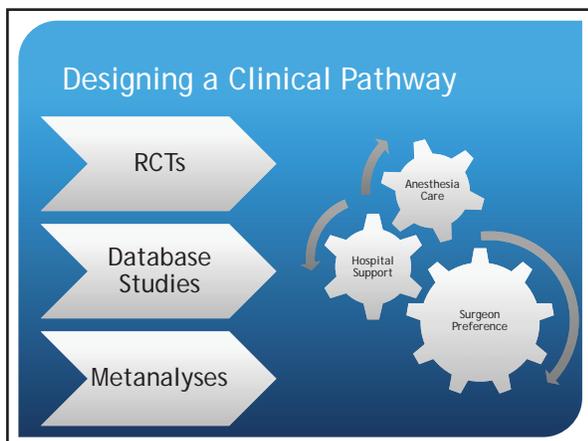
- No financial disclosures
- Will discuss several off-label uses of medications

Objectives

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

Goals of a Clinical Pathway

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



Choice of anesthesia

Large database TKA study: SA vs. GA

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Differences in Short-Term Complications Between Spinal and General Anesthesia for Primary Total Knee Arthroplasty

Andrew J. Pugely, MD, Christopher T. Martin, MD, Yubo Gao, PhD, Sergio Mendoza-Lattes, MD, and John J. Callaghan, MD
Investigation performed at the University of Iowa Hospitals and Clinics, Iowa City, Iowa

Background: Spinal anesthesia has been associated with lower postoperative rates of deepvein thrombosis, a shorter operative time, and less blood loss when compared with general anesthesia. The purpose of the present study was to identify differences in thirty-day perioperative morbidity and mortality between anesthesia choices among patients undergoing total knee arthroplasty.

Methods: The American College of Surgeons National Surgical Quality Improvement Program (ACS NSQIP) database was searched to identify patients who underwent primary total knee arthroplasty between 2005 and 2010. Complications that occurred within thirty days after the procedure in patients who had been managed with either general or spinal anesthesia

Large database TKA study: SA vs. GA

Pugely, et al.

Results (unadjusted, all p <0.01)

- Complication rate SA 10.72% vs GA 12.34%
- Superficial wound infection SA 0.68% vs GA 0.92%
- Blood transfusion SA 5.02% vs GA 6.07%
- Duration of hospital stay SA 3.45d vs GA 3.77d

Results (adjusted):

Independent risk factors for complications (all p < 0.05):

- Age 70-79y: OR 1.531
- Age > 80y: OR 2.173
- Female vs male sex: OR 1.176
- Black vs white race: OR 1.678
- Serum creatinine > 1.2 mg/dL: OR 1.474
- ASA class 3 or 4: OR 1.204
- General vs spinal anesthesia: OR 1.129

Large database THA study: RA vs. GA

Effects of Regional Versus General Anesthesia on Outcomes After Total Hip Arthroplasty

A Retrospective Propensity-Matched Cohort Study

Mohammad A. Helwani, MD, Michael S. Avidan, MBBCh, Arbi Ben Abdallah, PhD, Dagmar J. Kaiser, MD, John C. Clohiesy, MD, Bruce L. Hall, MD, and Heiko A. Kaiser, MD
Investigation performed at the Washington University in St. Louis School of Medicine, St. Louis, Missouri

Background: Many orthopaedic surgical procedures can be performed with either regional or general anesthesia. We hypothesized that total hip arthroplasty with regional anesthesia is associated with less postoperative morbidity and mortality than total hip arthroplasty with general anesthesia.

Methods: This retrospective propensity-matched cohort study utilizing the American College of Surgeons National Surgical Quality Improvement Program (ACS NSQIP) database included patients who had undergone total hip arthroplasty from 2007 through 2011. After matching, logistic regression was used to determine the association between the type of anesthesia and deep surgical site infections, hospital length of stay, thirty-day mortality, and cardiovascular and pulmonary complications.

Results: Of 12,929 surgical procedures, 5103 (39.5%) were performed with regional anesthesia. The adjusted odds for

Large database THA study: RA vs. GA

Helwani, et al.

Results (after matching with controls): RA vs GA

- 30-day mortality: 0.29% vs 0.37% OR 0.78 (CI 0.4 to 1.4) - NOT statistically significant
 Assoc. factors: Revision THA, age > 70y, ASA class 3 or 4, IDDM
- Deep Infection: OR 0.38 (CI 0.20 to 0.72, p < 0.01)
 Assoc. factors: Revision THA, age > 70y & IDDM
- Average hospital LOS: 3.2 vs 3.4 days
- Prolonged hospital LOS: 5% vs 6.6% OR 0.75 (CI 0.64 to 0.89, p < 0.01)
- CV complic: OR 0.61 (CI 0.44 to 0.85, p < 0.01)
- Pulm. complic: OR 0.51 (CI 0.3 to 0.8, p < 0.01)

Systematic review: TKA & THA pts

REVIEW ARTICLES

Neuraxial vs general anaesthesia for total hip and total knee arthroplasty: a systematic review of comparative-effectiveness research

R. L. Johnson*, S. L. Kopp, C. M. Burkle, C. M. Duncan, A. K. Jacob, P. J. Erwin, M. H. Murad and C. B. Mantilla

College of Medicine, Mayo Clinic, 200 First Street, SW, Rochester, MN 55905, USA
 *Corresponding author. E-mail: johnson.robica@mayo.edu

Abstract

Background: This systematic review evaluated the evidence comparing patient important outcomes in spinal or epidural vs general anaesthesia for total hip and total knee arthroplasty.

Methods: MEDLINE, Ovid EMBASE, EMBOD CINAH, Thomson Reuters Web of Science, and the Cochrane Central Register of Controlled Trials from inception until March 2013 were searched. Eligible randomized controlled trials or prospective comparative studies investigating mortality, major morbidity, and patient experience outcomes directly comparing neuraxial (spinal or epidural) with general anaesthesia for total hip arthroplasty, total knee arthroplasty, or both were included. Independent reviewers working in duplicate extracted study characteristics, validity, and outcomes data. Meta-analysis was conducted using the random-effects model.

Systematic review: TKA & THA pts

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

RCT of TKA protocol: TIVA vs SA

British Journal of Anaesthesia 111 (3): 391-9 (2013)
Advance Access publication 11 April 2013 - doi:10.1093/bja/aet104

BJA

Recovery after total intravenous general anaesthesia or spinal anaesthesia for total knee arthroplasty: a randomized trial¹

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²Lundbeck Centre for Fast-track Hip and Knee Arthroplasty, Rigshospitalet, Denmark
³Department of Surgical Pathophysiology, Rigshospitalet, Copenhagen University, Blegdamesvej 9, DK-2100 Rigshospitalet, Denmark
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Editor's key points

- Regional anaesthesia is often recommended for total knee arthroplasty (TKA).

Background. This study was undertaken to compare the effects of general anaesthesia (GA) and spinal anaesthesia (SA) on the need for postoperative hospitalization and early postoperative comfort in patients undergoing fast-track total knee arthroplasty (TKA).

Methods. One hundred and twenty subjects were randomly allocated to receive either intrathecal bupivacaine (SA group) or GA with target-controlled infusion of propofol and remifentanyl (GA group). Primary outcome was length of hospital stay (LOS) defined as

Choice of anesthesia - TKA

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

RCT of TKA protocol: TIVA vs SA

- Preop meds: celecoxib 400mg PO, APAP 1g PO
- Intraop:
 - No tourniquet or drains
 - Tranexamic acid 1g IV; abx prophylaxis; 2L LR over first 24h
 - Randomized to two groups:
 - SA: Bupivacaine 0.5% 3mL intrathecal at L4-5; propofol gtt for light sedation with 2L NC O2
 - GA: Propofol target-controlled infusion (TCI) 10mg/mL plus remifentanyl 40mcg/mL
 - Rocuronium 0.6mg/kg for intubation
 - Neostigmine 2.5mg plus glycopyrrolate 0.5mg for NMB reversal
 - Oxycodone 10mg IV 20 min before end of surgery
 - High-volume LIA: Ropiv 0.2% 150mL w epi 10mcg/mL
 - Posterior capsule, periarticular, and anterior peri-incisional subcutaneous tissues
- Postop:
 - Celecoxib 400mg PO q 12h, APAP 1g PO q6h
 - IV PCA morphine for 24h at 20mcg/kg 10 min lockout
 - After 24h, oxySR 10mg q12h and oxylR 10mg prn
 - O3h bladder scans with bladder catheterization protocol

RCT of TKA protocol: TIVA vs SA

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

Harsten, A., et al. (2013). "Recovery after total intravenous general anaesthesia or spinal anaesthesia for total knee arthroplasty: a randomized trial." *Br J Anaesth* 111(3): 391-399.

RCT of THA protocol: TIVA vs SA

Total intravenous general anaesthesia vs. spinal anaesthesia for total hip arthroplasty: a randomised, controlled trial

A. Harsten¹, H. Kehlet^{2,3}, P. Ljung⁴ and S. Toksvig-Larsen⁴

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²Lundbeck Centre for Fast-track Hip and Knee Arthroplasty, Copenhagen University, Denmark
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E-mail: andreas.harsten@skane.se

Conflicts of interest

Background: The choice of anaesthetic technique for patients undergoing joint arthroplasty is debatable. The hypothesis of this study was that general anaesthesia would generate a more favourable recovery profile than spinal anaesthesia.

Methods: We randomly allocated 120 patients to either intrathecal bupivacaine or general anaesthesia with target-controlled infusion

RCT of THA protocol: TIVA vs SA

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

Systematic Review: Cognitive Dysfunction

SYMPOSIUM: PERIOPERATIVE PAIN MANAGEMENT IN ORTHOPAEDIC SURGERY

The Influence of Anesthesia and Pain Management on Cognitive Dysfunction After Joint Arthroplasty

A Systematic Review

Michael G. Zywił MD, Atul Prabhū MD, Anthony V. Perruccio PhD, Rajiv Gandhi MSc, MD

Published online: 2 November 2013
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Abstract
Background Despite the overall success of total joint arthroplasty, patients undergoing this procedure remain susceptible to cognitive decline and/or delirium, collec-
Questions/purposes We systematically reviewed the English-language literature to assess the influence of the following anesthetic and/or pain management strategies on the risk for postoperative cognitive dysfunction in patients

Systematic Review: Cognitive Dysfunction

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

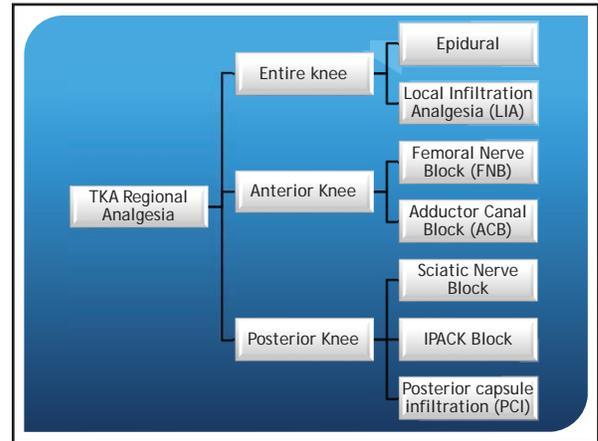
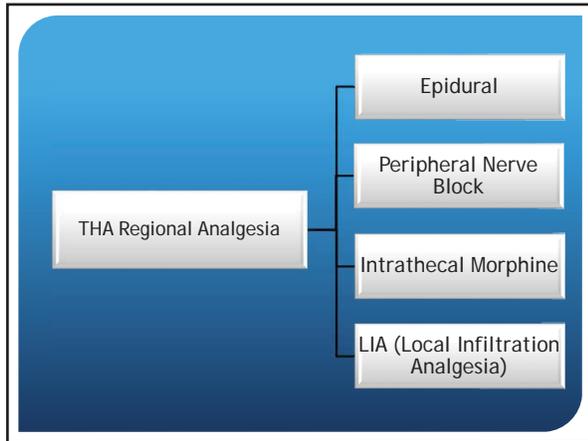
Summary: Choice of anesthesia

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

Choice of analgesia

Multimodal analgesia

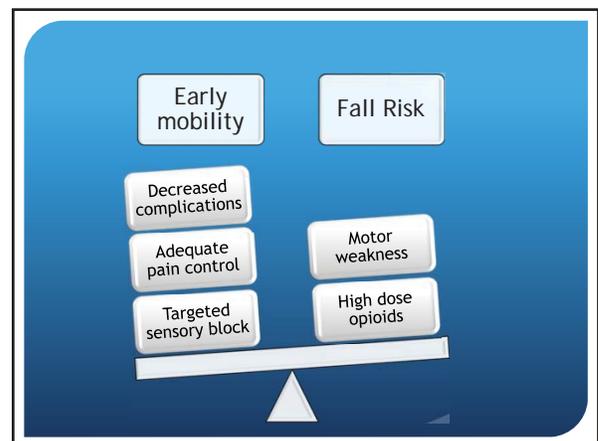
- NSAIDs
- APAP
- Ketamine
- Gabapentinoids
- Local anesthetics
- Opioids



IPACK Block

- ### Local Infiltration Analgesia (LIA)
- Sample recipe (aseptic preparation):
 - 200mg ropivacaine
 - 30mg ketorolac
 - 0.5mg epinephrine
 - Dilute with isotonic saline to 100-150mL
 - Adjuncts
 - Liposomal bupivacaine
 - Catheter in-situ
 - THA infiltration sites
 1. Acetabular capsule, adductor mm, gluteus medius m
 2. External rotators
 - TKA infiltration sites
 1. Posterior capsule structures
 2. Periprosthetic structures
 3. Fascia and subcutaneous tissues

Enhanced Recovery Pathways after Total Joint Surgery



Changes in practice

- Shorter stays – “Fast-Track”
- More aggressive rehabilitation programs
- Partnerships between Acute Pain Medicine specialists and Orthopedic surgeons
- Emphasis on function over “no pain”
- Decreased use of opioids

Le-Wendling

Other elements of ERAS

- Decreased number of drains & tubes
- Temperature management
- Glucose control
- PONV
- Urinary retention
- Infection risk
- Blood loss
- DVT prophylaxis

Summary

- Changes in practice toward early recovery programs has shifted priorities in care
 - Function over no pain
 - Decreased reliance on opioids
- Evidence-based choices for anesthesia especially in high risk populations
 - Neuraxial anesthesia
 - Multimodal analgesics
 - Regional anesthesia that works for your institution & practice model

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CRASH 2018

The Relationship Between Wellness, Resilience and Quality
Alison Brainard MD, Norah Janosy MD, Gina Whitney MD
February, 2018

Objectives

- Understand the connection between provider wellness, quality and safety culture
- Understand burnout – risk factors, signs and symptoms
- Experience resilience techniques that are shown to decrease burnout and increase resilience
- Investigate the national and regional available resources surrounding quality improvement and wellness

Overview

Acknowledgments



Jenny Reese, MD



Abbie Beacham, PhD



Resilience Program



Vesna Jevtic-Todorovic, MD, PhD, MBA

How do you **define** burnout?



“Burnout is the sum total of hundreds of tiny betrayals of purpose, each one so minute that it hardly attracts notice.”

– Richard Gunderman, MD, PhD

Burnout

Broader consequences of working in a stressful environment

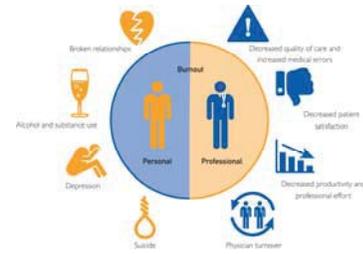
Emotional Exhaustion Depersonalization Reduced sense of accomplishment and achievement

Maslach et al. *Maslach Burnout Inventory Manual*, 3rd edn. Palo Alto, CA: Consulting Psychologists Press 1996

Impact of Burnout in Health Care

- Medical Error and Mortality¹⁻³
- Impaired professionalism^{5,6}
- Reduced patient satisfaction⁷
- Staff turnover and reduced hours^{8,12}
- Depression and Suicidal Ideation^{9,10}
- Motor vehicle crashes and near misses¹¹

¹JAMA 296:1071, ²JAMA 304:1173, ³JAMA 302:1294, ⁴Annals IM 136:358, ⁵Annals Surg 251:995, ⁶JAMA 306:952, ⁷Health Psych 12:93, ⁸JACS 212:421, ⁹Annals IM 148:334, ¹⁰Arch Surg 146:54, ¹¹Mayo ClinProc 2012, ¹²Mayo ClinProc 2016



Shanafelt et al. *Mayo Clin Proc*. January 2017;92(1):129-146

Prevalence

54% of Physicians report at least one symptom of burnout¹

50% of nurses are emotionally exhausted²



2 in 3 have difficulty sleeping 1 in 4 are clinically depressed

1. Shanafelt et al. *Mayo Clin Proc*. 2015
2. Sexton et al. *Palliative Care*. 2009

Key Drivers of Burnout and Engagement

Executive Leadership and Physician Well-being: Nine Organizational Strategies to Promote Engagement and Reduce Burnout.



Shanafelt et al. *Mayo Clin Proc*. January 2017;92(1):129-146

What is a “second victim”?

- First described by Albert Wu in 2000
- “... although patients are the first and obvious victims of medical mistakes, doctors are wounded by the same errors: they are the second victims.”

Formal definition:

- “A health-care provider involved in an unanticipated adverse patient event, medical error and/or a patient-related injury who becomes victimized in the sense that the provider is traumatized by the event.”

(Scott et al., 2009)

Quality Improvement

- “Quality improvement (QI) consists of systematic and continuous actions that lead to measurable improvement in health care services and the health status of targeted patient groups. The Institute of Medicine (IOM), which is a recognized leader and advisor on improving the Nation’s health care, defines quality in health care as a direct correlation between the level of improved health services and the desired health outcomes of individuals and populations.”

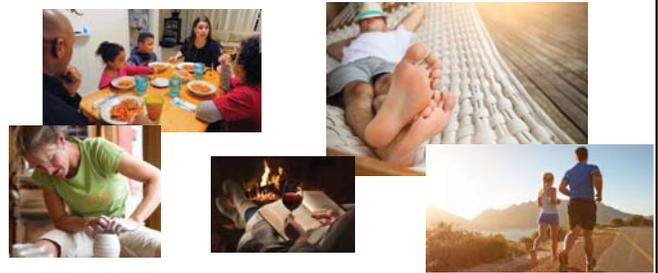
Safety Culture

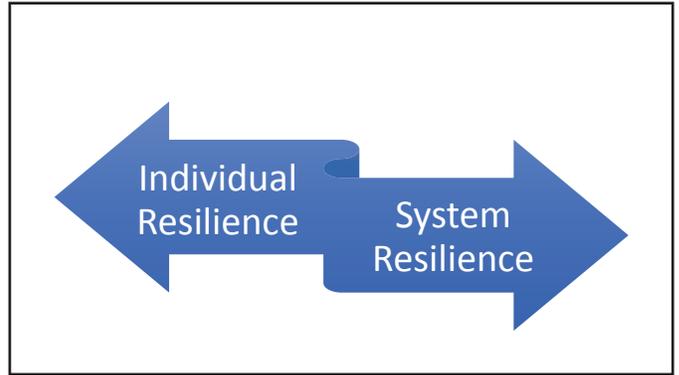
- “A culture of safety can be defined as an integrated pattern of individual and organizational behavior based upon shared beliefs and values, that continuously seeks to minimize patient harm that may result from processes of care delivery.”

Just Culture

- “A strategy to develop a just culture employs two complementary ideas. First, it creates a system that encourages reporting of injuries and near misses and keeps individuals safe from blame, shame, and retaliation. Next, the value imparted by open reporting promotes the creation of reliable care processes, which goes beyond vigilance.”

What does it mean to be well?





What is Resilience?

Four images illustrating resilience: a cartoon tiger, a person bending a tree, a person at a sunrise, and a flower in cracked earth.

Resilience

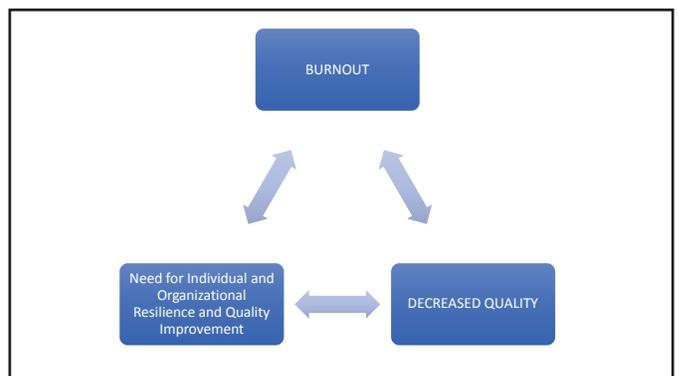
- Resilience is the process of negotiating, managing and adapting to significant sources of stress or trauma.
- Assets and resources within the **individual**, their life and **environment** facilitate this capacity for adaptation and “bouncing back” in the face of adversity.
- Across the life course, the experience of resilience will vary.

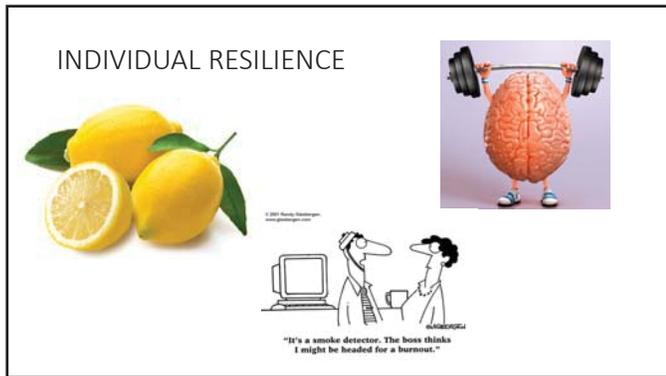
• Windle et al. A methodological review of resilience measurement scales. *Health and Quality of Life Outcomes* 2011, 9:8.

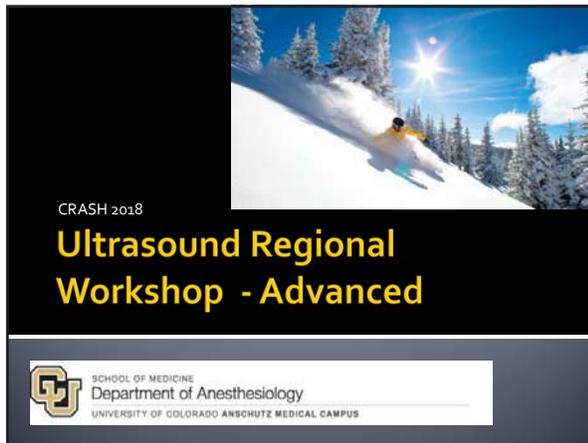
Have you ever?

A 3x3 grid of blue boxes containing questions about resilience:

- Worked Tired?
- Not given your patient on the table your full attention?
- Worked when under family stress?
- Worked Sick?
- Had a near miss and done the next case?
- Told yourself you were okay and really were not?
- Taken call when sick?
- Had a death in the OR and done the next case?
- You are in good company we all have....but should we???







Disclosures

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

New Format for CRASH 2018

- GOAL: increase hands-on Ultrasound usage
 - Increase exposure to Faculty
- 5 blocks
 - Advanced: ICV, SAP, PVB, PECs, QL/ESP
- 8 stations/models
- Blue Phantom/needle station for practice!
- Ask the Faculty anything, at anytime

CRASH 2018 Faculty

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

Thank you to our Vendors!

- Mindray: Darryl Wilson
- Philips: Aaron Rhoades
- Sonosite: Kristi Howe

Thursday



Post-operative Delirium

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




Disclosures

- IP for monitoring technology licensed to Medtronic




Set up audience participation

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




which of the following features define delirium (single best)?



- Depressed level of consciousness or cognition
- Auditory or visual hallucinations
- Fluctuating level of consciousness or cognition
- Grandiose or paranoid ideations
- Combativeness and agitation

Start the presentation to see live content. Still no live content? Install the app or get help at PollEv.com/app




Delirium Definitions

- DSM
 - Altered level of consciousness
 - Impaired cognition
 - Acute onset, fluctuating course
 - Direct consequence of general medical condition
- CAM
 - Fluctuating course
 - Inattention
 - Disorganized thinking
 - Altered level of consciousness



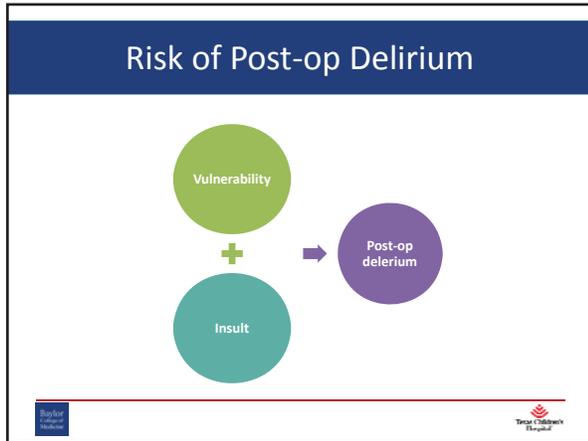

Incidence of Delirium

- Occurs in 15-55% of hospitalized patients, and in the ICU from 40-80%, depending on patient population (Inouye NEJM 2006)

Surgery	Incidence of delirium (%)
Abdominal aortic aneurysm (infrarenal)	33-54
Abdominal	5-51
Cataract	4
Coronary artery bypass graft surgery	37-52
Elective orthopedic	9-15
Head and neck (major)	17
Hip fracture	35-65
Peripheral vascular	30-48
Urologic	4-7

Anesth Analg 2011;112:1202-11



Patient Vulnerability

Non-Cardiac Risk Factors

- Age
- Baseline cognitive impairment
- Multiple co-morbidities
- Poor functional status
- Alcohol use
- Electrolyte abnormalities

Cardiac Risk Factors

- MMSE,
- Depression,
- Albumin,
- Stroke history

# Risk Factors	Incidence of Delirium
0	18%
1	43%
2	60%
3	87%

Marramonte et al. JAMA. 1994
Rodolph et al. Circulation. 2009



An 85 year old presents for cataract surgery

- He was previously unable to lie still for a "no anesthesia" cataract excision.
- PMH: 3V CABG; CHF NYHA II; ex-smoker
- Enalapril, metoprolol, ASA, Lasix
- Na 134 Meq/L; glucose 95 mg/dL; Albumin 2.6; Cr 2.8 mg/dL
- HR 64; 143/92; 94%
- Affable; Oriented to person and place-confused about the date; Poor hearing and vision; daughter is holding his glasses, hearing aid and walker.

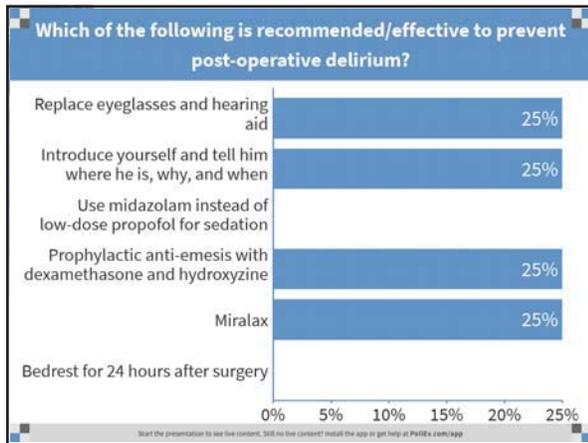
What risk factors for post-op delirium did you find in this history?

Top

Start the presentation to see live content. SRS.No live content? Install the app to get help at PASEX.com/app

An 85 year old presents for cataract surgery

- He was **previously unable to lie still** for a "no anesthesia" cataract excision.
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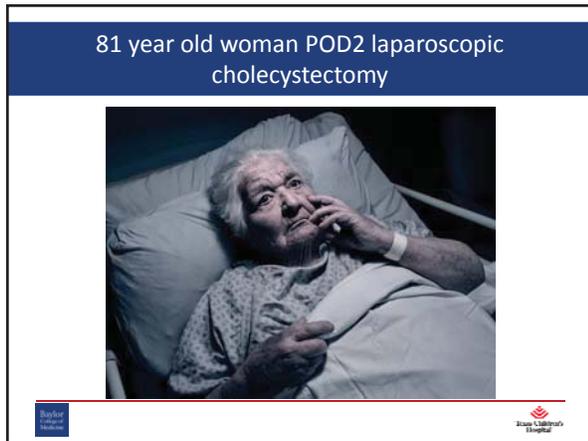
Pathophysiology

- Neurotransmitters
 - Acetylcholine deficiency
 - Dopamine excess
- Neuroinflammation
- Metabolic disorders
- Cerebrovascular
- Drugs
- Physiologic stressors
 - Cortisol
 - Ischemia/hypoxia
- Baseline vulnerability
 - Genetic
 - Cognitive reserve

	Type of data available	Review published
Neurotransmitters		
Acetylcholine	Experimental and observational	Yes
Dopamine	Experimental and observational	Yes
γ-aminobutyric acid	Experimental and observational	No
Nitric oxide	Experimental	Yes
Tryptophan or serotonin	Observational	No
GABAergic	Observational	No
Epinephrine or norepinephrine	Hypothetical	No
Psychopharmacology mediators		
Midazolam or benzodiazepines	Experimental	No
Midazolam	Observational	Yes
Midazolam B	Observational	Yes
Midazolam D	Observational	No
Tumour necrosis factor-α	Hypothetical	Yes
Midazolam D2	Hypothetical	Yes
Midazolam D1	Hypothetical	Yes
Physiological stressors		
Cortisol	Observational	No
SDSB	Observational	No
Neopterin	Observational	No
Myeloperoxidase	Observational	No
Metabolic disorders		
Lactic acidosis	Experimental and observational	No
Hyperglycaemia or hypoglycaemia	Observational	No
KPI	Observational	Yes
Hypomagnesaemia	Observational	Yes
Endocrine disorders		
Insulin resistance	Experimental and observational	No
Genetic factors		
Apolipoprotein E	Observational	Yes
Glucocorticoid receptor	Observational	No
Dopamine transporter receptor	Observational	Yes
Toll-like receptor 4	Hypothetical	No

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Inouye et al Lancet 2013



Which of these is true?

- Psychomotor agitation is the prominent feature of delirium
- Psychomotor slowing is the prominent feature of delirium
- This is a trick question

Start the presentation to see live content. Still no live content? Install the app or get help at PassEx.com/app

Delirium Subtypes

- Hyperactive
 - Easy to diagnose
 - Combative/agitated
- Hypoactive
 - Easy to miss
 - Psychomotor slowing

Start the presentation to see live content. Still no live content? Install the app or get help at PassEx.com/app

Symptoms Associated with Delirium

1. Change in level of arousal: **drowsiness or decreased arousal*** or increased arousal with hypervigilance
2. **Delayed awakening from anesthesia***
3. Abrupt change in cognitive function (worsening confusion over hours or days), including problems with attention, difficulty concentrating, new memory problems, new disorientation
4. Difficulty tracking conversations and following instructions
5. **Thinking and speech that is more disorganized, difficult to follow, slow,* or rapid**
6. Quick-changing emotions, easy irritability, tearfulness, uncharacteristic refusals to engage with postoperative care
7. Expression of new paranoid thoughts or delusions (ie, fixed false beliefs)
8. New perceptual disturbances (eg, illusions, hallucinations)
9. Motor changes such as **slowed or decreased movements,*** purposeless fidgeting or restlessness, **new difficulties in maintaining posture such as sitting or standing***
10. **Sleep/wake cycle changes such as sleeping during the day* and/or awake and active at night**
11. **Decreased appetite***
12. **New incontinence of urine or stool***
13. Fluctuating symptoms and/or level of arousal over the course of minutes to hours

BayCare Logo
Tampa Children's Hospital Logo

Octogenarian for Hip Replacement



- An 83 year old woman with daughter for pre-op consultation.
- Mild memory loss
- HTN- HCTZ
- Unable to self care due to hip pain
- Will this surgery cause cognitive decline?

BayCare Logo
Tampa Children's Hospital Logo

Which is true regarding the risk of cognitive decline

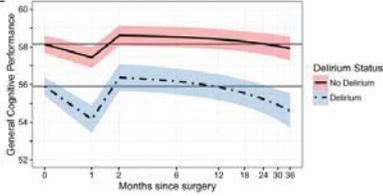


- This patient is at risk for preventable delirium, not cognitive decline which is not preventable
- The use of regional anesthesia is shown to decrease the risk of cognitive decline
- The use of deep anesthesia has been shown to increase the risk of cognitive decline
- Prophylactic seroquel is an option to consider

Start the presentation to see full content. Get the full content! Install the app or get help at [PACEX.com/app](#)

BayCare Logo
Tampa Children's Hospital Logo

Delirium and Cognitive Decline



Cognitive decline accelerates after post-operative delirium

BayCare Logo
Tampa Children's Hospital Logo

Regional Anesthesia

Regional should help:

- Pain control
- Less GA

Regional Anesthesia has not been shown to reduce the risk of post-operative delirium.

A. Neuraxial Anesthesia vs. General Anesthesia

Study	Relative Risk	95% CI	Weight (%)
Brugha 1997	1.00	0.91 - 1.10	34.02
Waters 2006	1.27	0.45 - 3.60	12.58
Waters 2009	0.42	0.15 - 1.12	32.75
Nguyen 2005	1.06	0.24 - 4.70	8.70
Overall (I-squared=0.0%, P=0.98)	0.94	0.76 - 1.16	68.06

B. Spinal Anesthesia vs. Intravenous Anesthesia

Study	Relative Risk	95% CI	Weight (%)
Waters 2006	0.87	0.46 - 1.66	11.03
Waters 2009	1.38	0.46 - 4.26	8.51
Nguyen 2005	0.88	0.44 - 1.80	8.08
Overall (I-squared=1.0%, P=0.93)	0.88	0.61 - 1.45	27.62

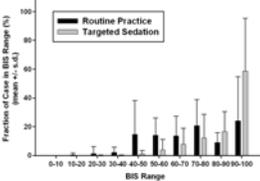
Postoperative Delirium (Relative Risk) vs. General Anesthesia

Postoperative Delirium (Relative Risk) vs. Intravenous Anesthesia

Zhang et al. Critical Care Medicine 2013

BayCare Logo
Tampa Children's Hospital Logo

Does regional mean less general?



Without monitoring, many "sedated" patients are receiving general anesthesia.

BayCare Logo
Tampa Children's Hospital Logo

Best Practice Statement from the American Geriatrics Society

“A health care professional trained in regional anesthetic injection may consider providing regional anesthetic at the time of surgery and postoperatively to improve pain control and prevent delirium in older adults.”

Journal of the American College of Surgeons 2015

Cochrane Database Review

“There is moderate-quality evidence that Bispectral Index (BIS)-guided anesthesia reduces the incidence of delirium compared to BIS-blinded anaesthesia or clinical judgement (RR 0.71, 95% CI 0.60 to 0.85; two studies; 2057 participants).”



Interventions for preventing delirium in hospitalised non-ICU patients (Review)
Siddiqi M, Harrison M, Clapp E, Todd VA, Young J, Dapkin G

Prophylactic antipsychotics

Negative Studies	Positive Studies
Haldol 0.5mg tid in elderly hip surgery Kalisvaart et al. JAGS 2005	Haldol in non-cardiac surgery (23 vs. 15%) Wang et al. Crit Care Med 2012
MINDS trial: Haldol or Zyprexa in mixed ICU Girard et al. Crit Care Med 2010	Haldol 1mg tid in high risk ICU patients reduced delirium from 75% to 65% van den Boogard et al. Crit Care 2013)
	Risperidone (1mg SL) reduced delirium from 32% to 11%. Prakanrattana et al. Anaesth Int Care 2007

Journal of the American College of Surgeons 2015

Best Practice Statement from the American Geriatrics Society

“There is insufficient evidence to recommend for or against the use of antipsychotic medications prophylactically in older surgical patients to prevent delirium.”

Journal of the American College of Surgeons 2015

Depth of Anesthesia

RCCT: Light vs. Deep or Routine (BIS-guided)	Result
F.E. Sieber, K.J. Zakriya, A. Gottschalk, et al. Sedation depth during spinal anesthesia and the development of postoperative delirium in elderly patients undergoing hip fracture repair Mayo Clin Proc, 85 (2010), pp. 18-26	Deeper sedation: more delirium
M.T. Chan, B.C. Cheng, T.M. Lee, et al. BIS-guided anesthesia decreases postoperative delirium and cognitive decline J Neurosurg Anesthesiol, 25 (2013), pp. 33-42	BIS guided: less delirium
F.M. Radtke, M. Franck, J. Lendner, et al. Monitoring depth of anaesthesia in a randomized trial decreases the rate of postoperative delirium but not postoperative cognitive dysfunction Br J Anaesth, 110 (2013), pp. 198-205	BIS guided: less delirium

Journal of the American College of Surgeons 2015

Best Practice Statement from the American Geriatrics Society

“The anesthesia practitioner may use processed electroencephalographic monitors of anesthetic depth during intravenous sedation or general anesthesia of older patients to reduce postoperative delirium.”

Journal of the American College of Surgeons 2015

In your opinion, which is more important for the risk of post-op delirium? (no right answer)

Depth of anesthesia

Choice of anesthetic agent

Both

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Comparing Agents: no difference

Study	Surgery	Intervention	Result
Nishikawa 2004	Abdominal	Propofol vs. Sevo (all with epidural)	No difference (delirium)
Hudetz 2009	Cardiac	Additional ketamine (0.5 mg /kg)	3.4% vs. 31% (delirium)
Royse 2011	Cardiac	Propofol vs. Des	No difference (POCD)
Leung 2006	Non-cardiac	Additional nitrous	No difference (delirium & POCD)

Nishikawa Acta Anaesth Scand 2004
Hudetz J Card Vasc Anesth 2009
Royse Anaesthesia 2011
Leung BJA 2006

Dexmedetomidine

Days after surgery	Placebo group (n)	Dexmedetomidine group (n)
1	320	300
2	349	349
3	346	342
4	341	330
5	323	307
6	330	286
7	290	267

- Dexmedetomidine has been extensively studied as a post-operative sedative to reduce delirium.

Su x et al, Lancet 2016

Following uneventful hip replacement with regional and light sedation, the patient is awake, conversant and comfortable.

Which is true?

The patient is at ongoing risk of developing post-op delirium

Delirium presents in the immediate post-op period

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On post-op day 1:

It is time to assess for physical therapy and ambulation to prevent delirium

short-acting opiate PCA with demand-only administration facilitates ambulation and prevents delirium

Care pathways with a geriatric specialist are more effective than general medical care to prevent delirium

The first line of therapy for acute confusion and agitation is a newer generation anti-psychotic

Start the presentation to see live content. Still no live content? Install the app to get help at Pallix.com/app

Pain and post-op delirium

Oral opioids vs IVPCA: (OR, 0.4; 95% CI 0.2 to 0.7)

Pain Severity	Risk of Delirium
Moderate	OR 2.2 (1.2 – 4)
Severe	OR 3.7 (1.5 – 9)

Vaurio, L.E et al, Anesthesia and Analgesia 2006

Geriatrician consult

- Marcantonio et al
 - 126 patients > 65 y/o admitted for emergent surgical repair of a hip fracture
 - Geriatrician vs. usual care
- Result: Improved rates of delirium in the intervention arm (32% vs. 50%; $p=0.04$)

Marcantonio et al J Am Geriatr Soc. 2001



Most effective prevention: non-pharmacologic

1. **Sensory enhancement** (glasses, hearing aids)
2. **Mobility enhancement** (ambulating)
3. **Cognitive orientation** and therapeutic activities
4. **Pain control**
5. **Cognitive stimulation**
6. **Communication standards** to prevent the escalation of behaviors
7. **Nutrition and fluid repletion**
8. **Sleep enhancement** (nonpharmacologic)
9. **Medication review**
10. Daily rounding by an interdisciplinary team to reinforce the interventions

Postoperative Delirium in Older Adults: Best Practice Statement from the American Geriatrics Society
Inouye, Sharon K, et al.
Journal of the American College of Surgeons, Volume 220, Issue 2, 136 - 148.e1



In the event of acute delirium:

1. First line: Non-pharmacologic interventions
2. When pt is not agitated, medications are not indicated.
3. Agitated self harming pts failing non-pharmacologic interventions
 - Lowest effective dose antipsychotic
 - Lowest effective dose benzo if antipsychotic fails



Take-home

- Delirium: common
- Delirium: harmful
- Delirium: preventable

Thank You!



Update on Governmental and Other Regulations Affecting Anesthesiology

Randall M. Clark, M.D.
 Department of Anesthesiology
 University of Colorado School of Medicine
 Board of Directors, American Society of Anesthesiologists
 Chair – ASA Section on Professional Standards



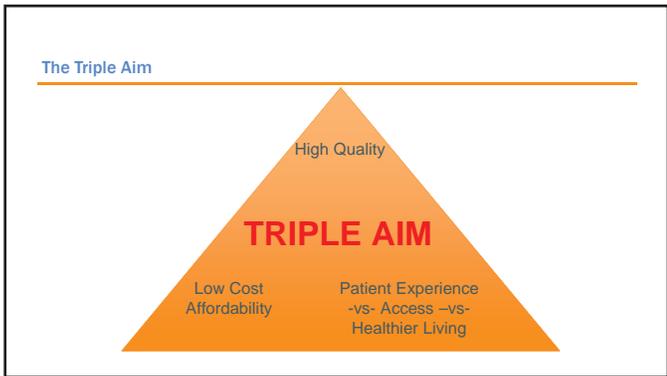
Disclosures

- No financial conflicts of interest to disclose
- The opinions expressed are my own and not necessarily those of the University of Colorado or the American Society of Anesthesiologists

Objectives

- Provide updates on governmental action at the federal level affecting health care delivery and payment for anesthesia services
- Understand how the American Society of Anesthesiologists is responding to the challenges created by health care reform
- Learn what you can do at the group, department, and individual level to prepare for MACRA and MIPS

The Imperative: Improving Value in Health Care Delivery



Progress Towards Achieving Better Care, Smarter Spending, Healthier People

Jan 26, 2015
By: Sylvia Mathews Burwell, HHS Secretary

Since my very first days as Secretary, you've heard me talk about improving our nation's health delivery system to better meet the needs and expectations of the people of America.

Whether you happen to be a patient, a provider, a business, a health plan or a taxpayer, it's in our common interest to build a health care delivery system that's better, smarter and healthier – a system that delivers better care; a system that spends health care dollars more wisely; and a system that makes our communities healthier.

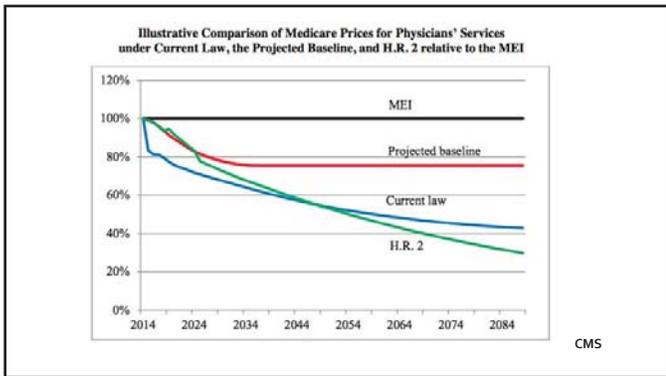
Our first goal is for 30% of all Medicare provider payments to be in alternative payment models that are tied to how well providers care for their patients, instead of how much care they provide – and to do it by 2016. Our goal would then be to get to 50% by 2018.

The new administration and new Congress will accelerate these efforts.

SGR Repeal and Medicare Provider Payment Modernization Act of 2015 (MACRA)

- SGR Repealed
- 2015 Updates
 - July – December - 0.5%
- Further Updates
 - 2016 through 2019: 0.5%
 - 2020 through 2025: 0.0%
 - 2026 - forward: 0.5%
- APM 2026 – forward: 1%
- PQRS, VBM, EHR MU Consolidated

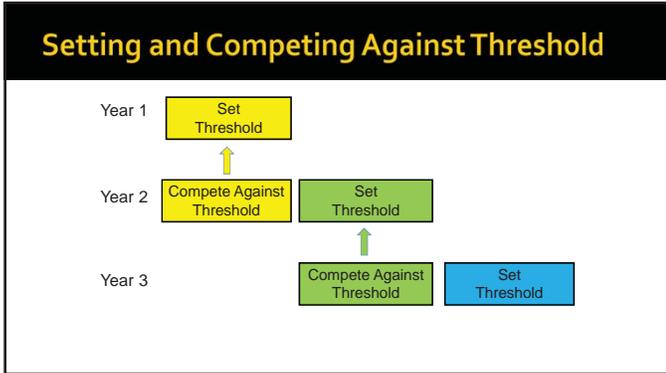
2% sequestration in effect through 2024



MIPS Adjustments

- Losers – Negative Adjustments
 - 2019: Up to -4.0%
 - 2020: Up to -5.0%
 - 2021: Up to -7.0%
 - 2022: Up to -9.0%
- Winners – Positive Adjustments
- Based on funds available from losers i.e. lots of losers means larger adjustments for winners, fewer losers means smaller adjustments for winners.

** Worst case under current PQRS, VBM, MU scenarios is approximately - 11%*



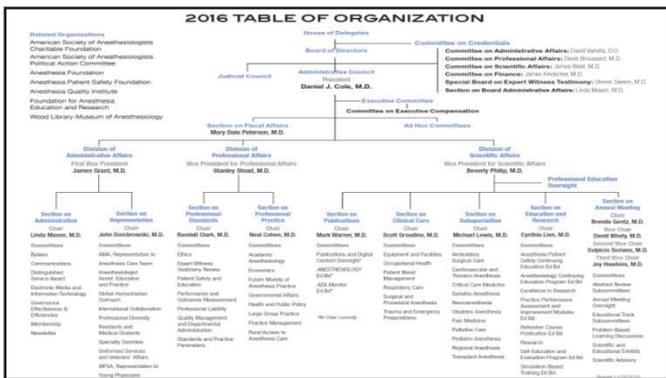
Anesthesia Quality Institute – National Anesthesia Clinical Outcomes Registry

- Received designation as a Qualified Clinical Data Registry in 2014
- Allows AQI to specify the outcomes to be measured without complicated NQF process
- Easily incorporated into other AQI reporting

The AQI 2.0

- \$10 million since start in 2008
- \$1.6 million in 2015 redesign (in order to move from startup to mature organization)
- Currently receiving \$1.4 million per year in fees
- Contract signed in October 2015 with ArborMetrix
- Data delivery is now standardized
- Data integrity is much improved
- Now with ability to scale to much larger programs

Improving Value: How is ASA Responding?



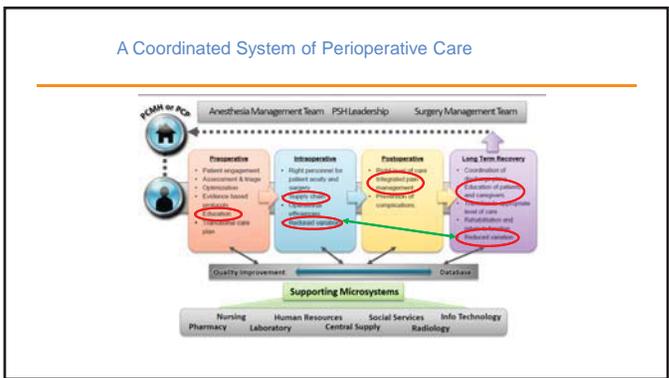
Improving Value

- Perioperative Surgical Home*
- Health Policy Analysis and Research
- Practice Management
- Anesthesia Quality Institute & NACOR: QCDR*
- Measure Development
- Exploring and Promoting Alternative Payment Models*
- Population Health*

What is the Perioperative Surgical Home?

- The PSH model is a **physician-led, patient-centric**, team-based system of **coordinated care** that guides patients through the entire surgical experience, from the decision to undergo surgery to discharge and beyond, with the goal of providing **cost-effective, high quality** perioperative care and **exceptional patient experiences**.
- Achieved through shared decision-making and seamless continuity of care for surgical patients

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PSH 2.0 Members – 59 Organizations

39 in the Core Collaborative and 20 in the Advanced Cohort

PSH Learning Collaborative 2.0 Timeline

Two-year timeline provides time to collaborate, transform, and measure performance to demonstrate success

- April 1, 2016 – Launch date
- Spring 2016 – First in-person all-member meeting
- Summer 2016 – First Advanced Cohort PI sprint
- Fall 2016 – Second in-person all-member meeting
- Winter 2017 – Second Advanced Cohort PI sprint
- Spring 2017 – Third in-person all-member meeting
- Summer 2017 – Third Advanced Cohort PI sprint
- Fall 2017 – Fourth in-person all-member meeting
- Winter 2018 – Fourth Advanced Cohort PI sprint
- March 31, 2018 – PSH 2.0 end date

Key benefits of participation include:

- Peer-to-peer networking and shared learning opportunities
- Access to subject matter experts on a variety of topics
- Tools and resources to support successful implementation and performance optimization

Ongoing Outreach Efforts

More Information

- ASA White Paper on Perioperative Surgical Home
- 2014 - 2017 Practice Management Conferences
- 3rd ASA PSH Meeting
- 2nd ASA Quality Meeting
- ASA Website: <https://www.asahq.org/psb>
- Special thanks to Zeev Kain, MD (UC Irvine), Stan Stead, MD (ASA VP Professional Affairs), and Mike Schweitzer, MD (now managing Population Health for Premiere, Inc.)

Alternative Payment Models

Payment Reform Accelerating New Models

Source: PriceWaterhouseCoopers

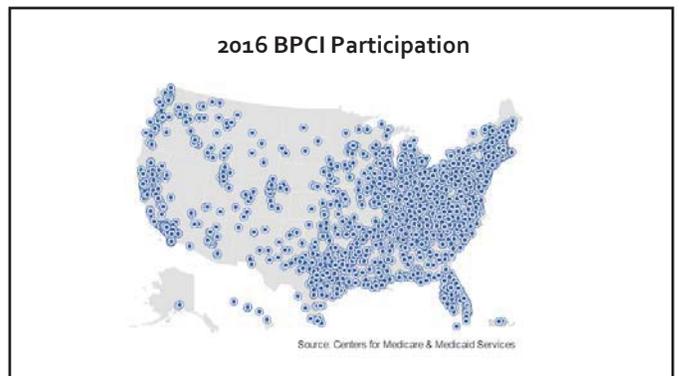
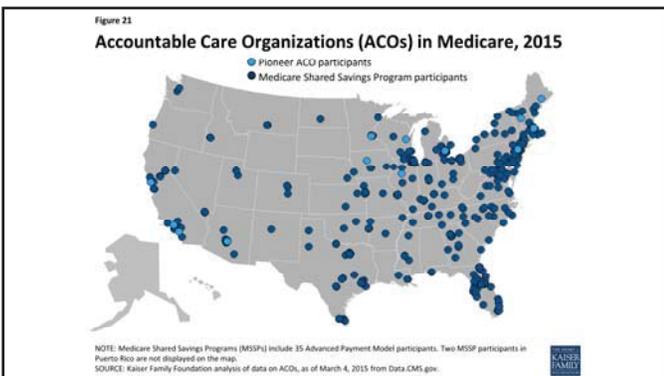
CMS Innovation (2016)

- 8.9 million seniors in Medicare shared savings, Pioneer or Next Generation ACOs representing \$85 billion in spending
- 415 hospitals, 305 physician groups, and 723 skilled nursing facilities in BPCI accounting for \$10 billion in spending
- CJR program to add another \$3 billion
- 30% target met in March 2016

EXHIBIT 1
Bundled Payments for Care Improvement Initiative Model Characteristics

Model	Episode	Conditions	Episode initiators	Medicare discount
1	Inpatient stay (hospital services only)	All diagnosis-related groups (DRGs)	Acute care hospitals	Year 1 (0-6 months) = 0.0% Year 2 (7-12 months) = 0.5% Year 3 = 1.0% Year 3+ = 2.0%
2	Inpatient stay plus 30, 60, or 90 days (participant's choice) of postacute care	One or more of 48 episodes based on families of DRGs (participant's choice)	Acute care hospitals or physician group practices	3% for episodes 30 or 60 days in length 2% for episodes 90 days in length
3	30, 60, or 90 days (participant's choice) of postacute care following a hospital stay	One or more of 48 episodes based on families of DRGs (participant's choice)	Postacute care provider (skilled nursing facility, inpatient rehabilitation facility, long-term care hospital, or home health agency) or physician group practice	3% for all episodes (regardless of length)
4	Inpatient stay (including physician services)	One or more of 48 episodes based on families of DRGs (participant's choice)	Acute care hospitals	3% for most episodes (3.25% for cardiac and orthopedic episodes included in the acute care episode demonstration)

SOURCE: Author's analysis.



THE RESULTS

\$2.3 MILLION (15%) SAVED IN THE FIRST YEAR	10% REDUCTION IN READMISSIONS	20% REDUCTION IN SKILLED NURSING UTILIZATION	22% REDUCTION IN INPATIENT REHAB UTILIZATION
--	---	---	---

Baptist Health System 2016 BPCI Report



2017 ASA Conference on Practice Management

- MACRA/MIPS Update
- Understanding Alternative Payment Models:

https://education.asahq.org/totara/pluginfile.php/147276/mod_page/content/44/Alt%20Payment%20Models%20and%20PSH_Stead.pdf

Understanding the Evolution to Population Health

Definition

- The population health approach is positioned as a unifying force for the entire spectrum of health system interventions -- from prevention and promotion to health protection, diagnosis, treatment and care -- and integrates and balances action between them.
- This will be the framework for all future action in government funded health care, and soon thereafter, all American health care.

Key Pillars of Population Health Management

QUALITY, SAFETY, AND EFFECTIVENESS

Business Model	Payment Model	Clinical Integration	Technology
Business vision, population definition, policies, modeling, financials, contracts, procedures, market analysis, and value proposition	Risk, incentives, payment management, shared savings	Workflows, role changes, people, care coaches, wellness program development, health risk assessment process, population engagement	Integration and interoperability including HIE, patient portal, analytics, coaching tools and health risk assessment

HIMSS 15

ASA Committee on Future Models of Anesthesia Practice

- Oversaw initial roll-out of Perioperative Surgical Home
- Now studying the role of the anesthesiologist in population health management
- Recognizes the unique role of anesthesiology – the unifying factor in the care of all surgical patients
- Publishing a white paper and action plan for ASA leadership, Board of Directors, and House of Delegates

References

- http://journals.lww.com/anesthesia-analgia/Abstract/2016/07000/A_Primer_on_Population_Health_Management_and_Its_10.aspx
- Intersection of Population Health and Anesthesiology
 - Email me at randall.clark@childrenscolorado.org
 - Currently preparing upcoming publication in A&A
- http://journals.lww.com/anesthesia-analgia/Fulltext/2016/09000/The_Periooperative_Surgical_Home_More_Than_Smoke.2.aspx

Population Health Action Plan

- Educate yourself on PSH and Population Health
- Understand what your institutions (surgical specialties, hospital, health system, academic medical center) are planning in the realm of population health
- Appoint a lead coordinator to facilitate communication with the external entities
- Participate in any discussion on how the financial pillar will be handled and how it will affect anesthesiology

randall.clark@childrenscolorado.org





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Anesthesia Demographics Past, Present and Future?

Steven J Zeichner, MD
Assistant professor of Anesthesiology
University of Colorado School of Medicine

Objectives:

- Understand the changing demographic of anesthesia practice in the US
- Anticipate positioning your practice for the future
- Understanding the cultural history of anesthesia practices and planning for the necessary changes the future will bring
- Strategic planning for anesthesia group practice future



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Conflicts of interest:

- I have no disclaimers



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Data Sources

- ASA
 - From surveys of graduating residents
- MGMA
 - Surveys of members
- CU Resident Graduates
 - Recently obtained
 - Preliminary study
 - unpublished



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Background:

- I spent the first 27 years of my professional career in private practice in South Florida
- I am presently (for the past three and one half years) endeavoring to be an academic anesthesiologist at the University of Colorado School of medicine in Denver Colorado



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Currently-

- As of April of 2017 eight entities employed more than 22 percent of all anesthesia providers in the US

- Greenfield, MD and Locke, MA; ABA Communique, Volume 22, Issue 3



• Evolution

- One person (man) individual practices that coordinated to cover facility sites and call.
- Encouraged (read coerced) by hospitals to form group practices
 - Facilitates negotiations on behalf of hospitals

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Evolution

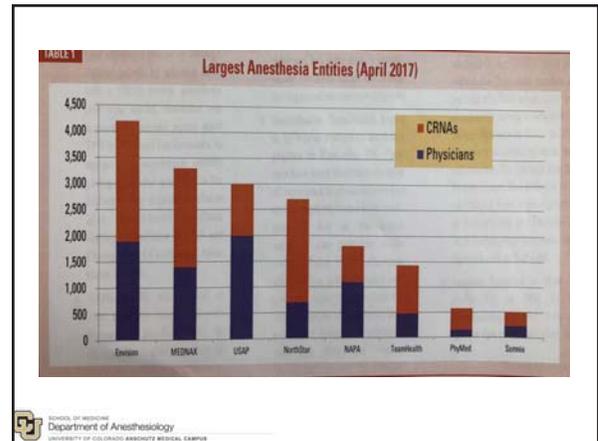
- Culturally the tradition of individuality persists
- **Tension:**
- Individuals make *clinical* decisions
- Group makes *practice* decisions

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Traditionally anesthesia groups:

- Owned by MD providers
- Niche Market, i.e. local
 - One or more hospitals
 - Ambulatory centers
 - Physician offices
- Lean overhead
 - Billing expenses
 - Malpractice insurance
- Primary objective
 - Job security
 - Preservation of income and lifestyle
 - Maintenance of status quo

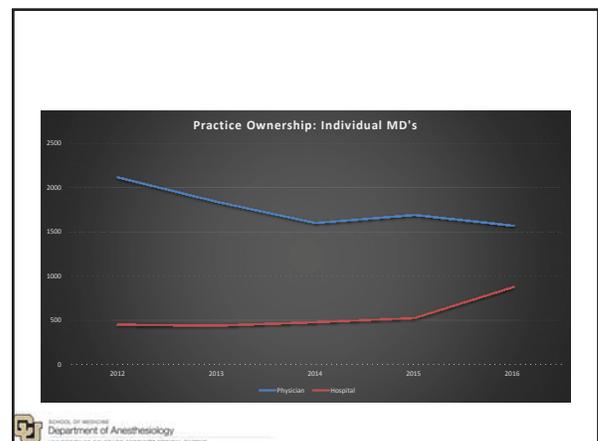
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**Group Ownership:
Physician vs. Hospital**

	Physician Gp	Physician #	Hospital Gp	Hospital #
2012	92	2119	41	455
2013	94	1845	49	445
2014	72	1609	44	482
2015	72	1699	42	528
2016	53	1578	65	870

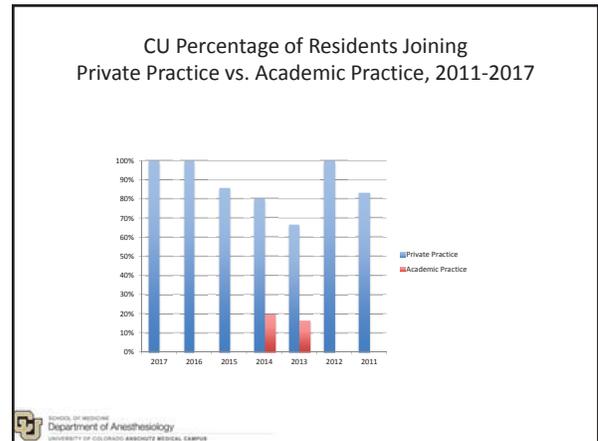
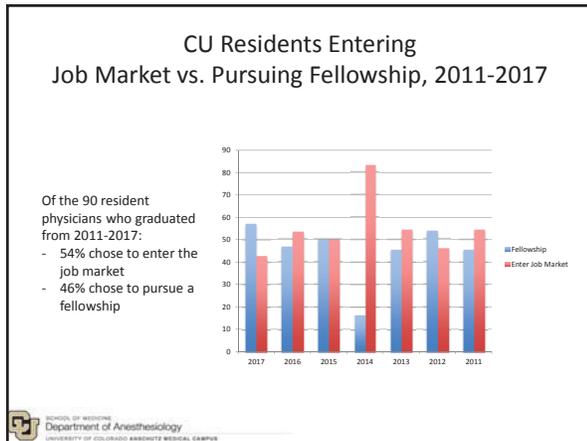
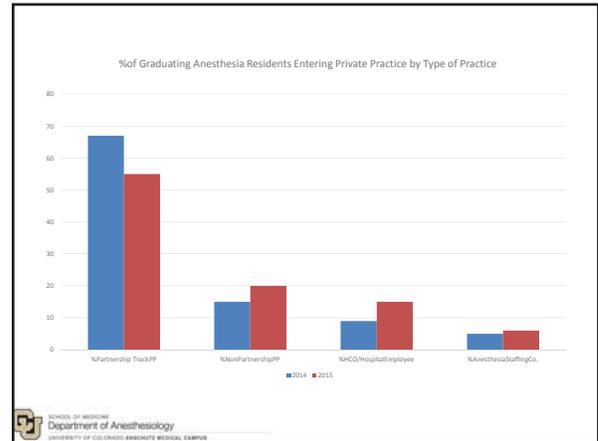
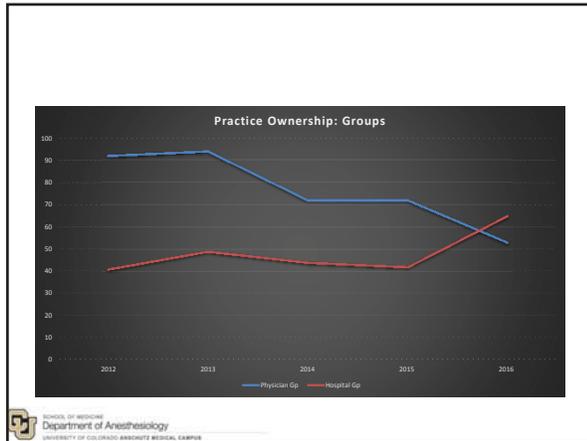
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Slide 9

ZS1

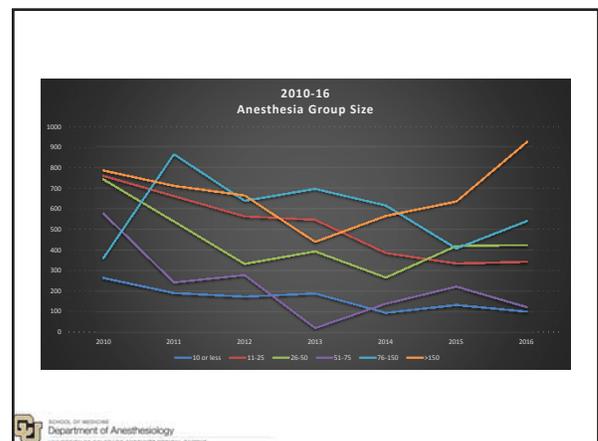
Zeichner, Steven, 2/10/2018



MGMA: Anesthesia groups by size 2010-2016

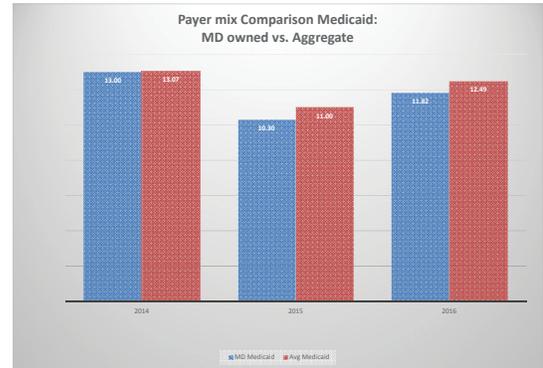
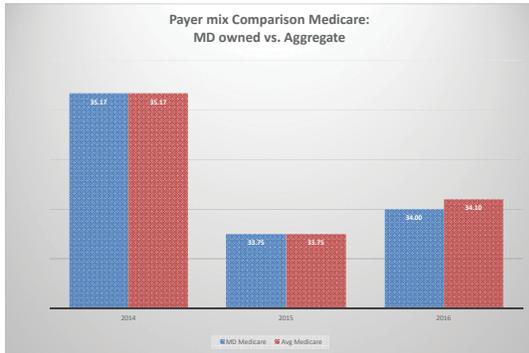
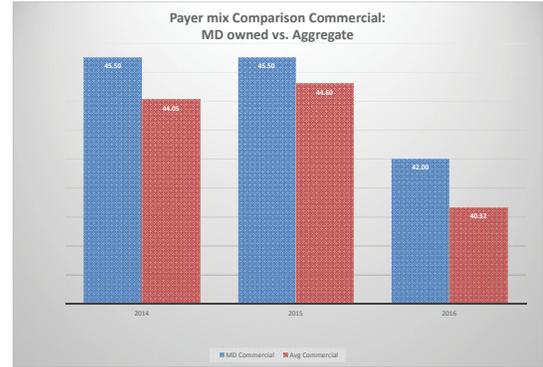
	10 or less	51-75	>150	
2010		266	579	787
2011		193	244	713
2012		175	280	666
2013		191	23	441
2014		97	141	567
2015		135	224	637
2016		102	124	926

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Is BIG better ?

- Better contracts with insurance provider
- More leverage in negotiations with facilities
- Cost of billing and compliance
- More health care facilities are part of large networks
- Greater security due to size and scope
- Greater Flexibility



Strategy



The market for anesthesia services in the US has been traditionally bound by regional "cultural" differences

- The anesthesia care team model were more common in the South and East, much less so in the West.
- Anesthesia groups in the Mid-Atlantic region actively pursued opportunities to provide services endoscopic for endoscopy and endoscopic centers. Practices in the west, particularly California, avoided.

Growth

- Challenges the fundamental nature of anesthesia groups-
- Anesthesia practices traditionally were professional associations with limited business and professional management
- Managing a practice of 100+ providers is drastically different from 10-20 (old mom & pop shop)

Professional Management

- Size does not guarantee success
- Goal no longer income and lifestyle
- Security and Predictability (long term goals) prioritized

Strategic Planning

- Anesthesia could, in the past, be summarized as the service of safely managing patients during surgery
- Quality was defined as safely and comfortably getting the patient through surgery

Strategic Planning

- Moving into the future we should be engaging ourselves as strategic partners with our hospitals and health systems
- Leveraging our greatest attributes:
- The ability to keep the patient comfortable and secure throughout the surgical experience
- Anesthesiology has the greatest potential to positively influence the patients experience

Strategic Partnership

- Hospitals: "We will provide you with work"
- Anesthesiologists: "We can provide optimized quality experience for your patients and facilitate your opportunities to attract more patients-increase your market share"

What hospitals think of us-

- Over-paid
 - Make a lot of \$\$
- "Carpetbaggers"
 - We don't have to go out and solicit business, just comes to us (through them)
- Lazy
 - All we do is sit there, surgeon does all the work

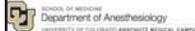
Strategic Partnership

- We must seek to offer Value in our relationships with hospitals and health care institutions
- We must make sure these same hospitals and health care institutions are aware of our contributions



Strategic Partners

- Anesthesia groups should have a thorough understanding and command of data relative to our sites of service
 - Including, but not limited to OR's, L&D suites, endoscopy, CVCU, Radiology suites and any other non traditional places we provide service
- Anesthesia must share this data with the hospitals and health care systems we partner with to optimally prove our value .



Leverage Anesthesia group brings to hospital:

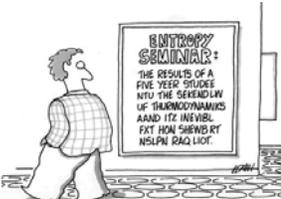
- Data
 - Manage Data Base
 - Run OR's and off OR sites efficiently
 - Work 1:1 with surgeons
 - Improve efficiency
- Customer Satisfaction
- Quality
 - No longer anecdotal
 - Must be empirical and measurable



- Historically we have focused on what we do in the OR
- We must shift our focus to include what is happening outside the OR as well
- What happens outside the OR increasingly has more to do with the success of our practices



The second law of thermodynamics=US Health Care




RESOURCES:
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 Stein EJ, Mesrobian JR, Abouleish AE. The 2014 job market for graduating anesthesiology residents. ASA Newsletter 2015;79(6)54-47
 Stein EJ, Mesrobian JR, Abouleish AE. The 2013 job market for graduating anesthesiology residents. ASA Newsletter 2014;78(4)44-47
 Greenfield, MD and Locke, MA. Strategy and Adaptability in a Competitive Market: Lessons from the nation's largest anesthesia organizations. ABA Communique, Volume 22, Issue 3
 MGMA (Medical Group Management Association): Databank 2018




FROM GETTING ALONG TO WORKING TOGETHER:
TIPS AND TECHNIQUES FOR PHYSICIAN-HOSPITAL RELATIONS

Brian M. Davidson, MD, MBA, CPE
 President
 St. Mary's Medical Center – SCL Health
 Grand Junction, Colorado

Learning Objectives

1. Understand the operational and financial drivers in the perioperative arena that are important to hospital leaders.
2. Review common pitfalls and successful techniques related to negotiations with hospitals.
3. Demonstrate the changing landscape of physician and physician leadership in the healthcare marketplace.

Disclosures

Employed by SCL Health System
 Broomfield, CO



The Situation

“An increasing number of physicians are embarking on a pathway from clinical practice to senior leadership positions that historically have been held by nonmedical or allied health professionals”

John Henson, MD, FACHE -Chief of Cardiology
 Piedmont Healthcare, Atlanta, GA

Physicians also called upon to lead in mixed roles:

- Medical Director
- Department Chair
- Chief Medical Officer
- Medical Societies
- Industry

Why Should I Care?

“Caring is a business, with revenues and expenses, not just a calling.”

“Healing is an art, medicine is a profession, and healthcare is a business.”

“Lead or be led, the only other option is fruitless resistance.”

LEADERSHIP

Why The Best Hospitals Are Managed by Doctors

by James K. Stoller, Amanda Goodall, and Agnes Baker
 DECEMBER 21, 2014

Harvard Business Review

“Doctors were once viewed as ill-prepared for leadership roles because their selection and training led them to become ‘heroic lone healers’ ”

USNWR 2011: Quality scores ≈ 25% higher in physician-run hospitals

Largest positive correlation → “proportion of leaders with clinical degrees”

Reasoning:

- “credibility...peer-peer credibility”
- “signaled to important external stakeholders – patients, employees..”
- “Having a boss who is an expert in the core business is associated with high levels of employee job satisfaction and low intentions of quitting.”

Why The Best Hospitals Are Managed by Doctors
 Harvard Business Review
 by James K. Stoller, Amanda Goodall, and Agnes Baker
 DECEMBER 27, 2014

...and how can training make them better ones.

"social skills...physicians are not taught to be team players."

Trained in "command and control" and "heroic lone healer" culture

"Conspires against great leadership....clear need to train physicians more systematically."

How?

- Formal leadership training programs
- Core curriculum → "Emotional intelligence"
- "Teambuilding, conflict resolution, situational leadership."

Wild Ride: My Own Leadership Journey
 July 2014

From: Univ. of Colorado as Vice Chair, Anesthesiology & Assoc. Medical Director of perioperative services

To: Chief Medical Officer at St. Mary's Medical Center in Grand Junction, CO

September 2015

- Become Interim President, SMMC
- Dual roles for seven months

May 2016

- Selected as permanent president after national search



St. Mary's Medical Center

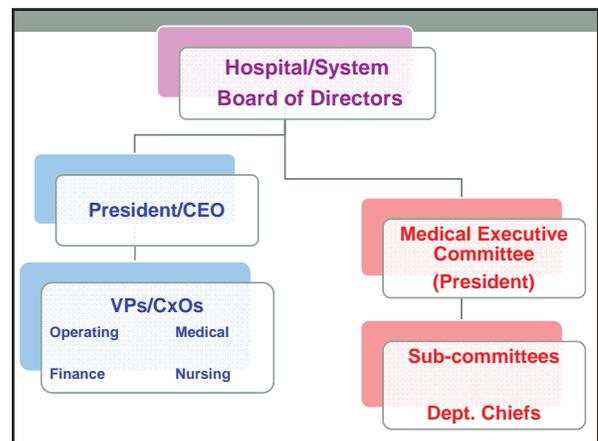
- 346-Bed, \$430M
- 12 ORs + 4 ASC
- 10,500 surgeries
- Level II Trauma
- Cardiac Surgery
- NICU Level III
- Blood Bank
- 44k ED visits
- 100+ mile area
- Aeromedical

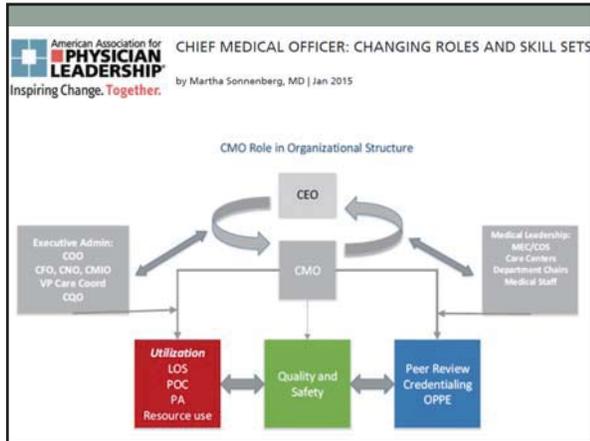
- 2,200+ Associates
- 380+ Medical Staff
- 500+ Volunteers

Why The Physician Executive Route?

- Broader healthcare system interests
- Too few physicians at the table
- Physician-hospital alignment
- Increasingly complicated environment
- Administrators ≠ Clinical experience

A yellow thinking face emoji with question marks above it.





How did you prepare?

Formal Education/Practice:

- Administrative Fellowship (2 yrs.) – UC Health University
- MBA in Healthcare Administration – U. of CO Denver
- Graduate Certificate, Quality/Safety – Regis Univ.
- Certified Physician Executive – Amer. Assoc. Physician Executives

Organizational/Community Leadership Opportunities:

- Associate Medical Director Perioperative Svcs.
- Vice Chair, Quality/Safety/Improvement, Anesthesiology
- Medical Board, UC Health University
- Board of Directors, Univ. Physicians Inc.
- CO State Dental Board, public member
- State-wide public office candidate

Models For Physician Leadership

<p>Dyads</p> <ul style="list-style-type: none"> • Physician & administrator • Different job descriptions • Partner for results • Mutual respect • Complimentary skills • Variable training • Develop with experience 	<p>Cross Train</p> <ul style="list-style-type: none"> • Physician as administrator • Adopts job description • Responsible for results • Identity challenges • Awareness of weaknesses • Significant training • Prior experience required
--	--

Competencies

<p>Technical</p> <ul style="list-style-type: none"> Finance & economics Operations science Human resources Informatics/technology Healthcare/business law Change management 	<p>Interpersonal</p> <p>Emotional Intelligence</p> <ul style="list-style-type: none"> • Awareness of self & others • Emotional control Relationship management Diplomacy Organization-over-self Time management
--	---

Five Ideas for the Development of Successful Physician Leaders
John W. Henson, MD, FACHE, chief of medical services, Piedmont Healthcare, Atlanta, Georgia
JOURNAL OF HEALTHCARE MANAGEMENT 61:3 MAY/JUNE 2016

Leadership Competencies

CLINICAL CONCEPTS AND COMMENTARY

Developing Leaders in Anesthesiology
A Practical Framework
Patricia H. Sommers, M.D., M.B.A., Jeffrey W. Hull, Ph.D.

Traditional View

- Hierarchy-based
- Personal traits (charisma)
- Innate in a few
- “Touchy feely”

Updated View

- Relationship-based
- Action & accountability
- Facilitation
- Developed, not innate
- Expected from everyone
- Studied scientifically

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We Need Leaders

Anesthesiology & Leadership *The 48th Annual Roventine Lecture*
Peter J. Pronovost, M.D., Ph.D.
Anesthesiology 2010; 112:779-85

“Leadership is helping people address problems that will make the world better...focusing on a goal and inviting everyone to help achieve it.”

“It is not about individualism; it is about teamwork”

“The patient should be the focus, not the clinician”

“We barely spend a penny on researching healthcare delivery for every dollar we spend on basic and clinical research”

“Now is the time for anesthesiologists to take on leadership roles within their hospitals...be perioperative directors, chief medical officers, chief quality officers, chief executive officers, and deans”

Physician as Customer?

Employment increasing

- Predictability
- Physician financial risk

Single source contracting

- Predictability
- Increase hospital monopsony
- Reduce physician monopoly

Compensation subsidies

- Moving toward goal alignment
- Value, quality, efficiency

Total Physicians vs. Truly Independent¹ - Projected Change, 2000-2013 (000s)

Year	Total Physicians	Truly Independent Physicians	% Truly Independent
2000	683	~320	47%
2005	723	~280	39%
2009	757	~240	32%
2013	793	~200	25%

1. Estimated Sources: Accenture Analysis, MGMA, American Medical Association

Hospital – Physician Economy

Buyer (customer)

- ✓ Hospitals → Physicians

Seller (firm)

- ✓ Physicians → Hospitals

Customers

↓

Partners

Autonomy → Alignment

Autonomy	Alignment
Autocratic	Collaborative leadership
Medical profession	Other sectors
4 T's:	4 E's:
<ul style="list-style-type: none"> • Time (when) • Team (who) • Task (what) • Technique (how) 	<ul style="list-style-type: none"> • Equity • Efficiency • Evidence-based • Engagement
Financial Success	Financial Success
<ul style="list-style-type: none"> • Volume + payer mix • Subjective "quality" • \$ Accounting • Stay put • Status quo 	<ul style="list-style-type: none"> • Value (quality / cost) • Objective quality • Accountability • Throughput • Maneuverability

Inconvenient Truths

<p>Shared pressure</p> <ul style="list-style-type: none"> ✓ Payment reduction ✓ Regulation ✓ Quality expectation ✓ Public reporting ✓ Cultural transition ✓ Consolidation 	<p>Hospital pressure</p> <ul style="list-style-type: none"> ✓ Labor risk expense ✓ Physician specialization ✓ Ambulatory competition <p>Physician pressure</p> <ul style="list-style-type: none"> ✓ Specialization ✓ Substitution ✓ Education loans ✓ Life style expectations
---	--

Learn to Negotiate

Separate people from problem

- ✓ Good people
- ✓ Two interests
- ✓ Techniques (disassociation)

Focus on interests, not positions

- ✓ Positioning = One interest
- ✓ Identify / empathize
- ✓ Befriend opposed positions

The negotiation problem

- ✓ Positions = *bargaining*
- ✓ Principled = *negotiation*

Learn to Negotiate

Invent options for mutual gain

- ✓ Understand counterparty needs
- ✓ Realize own capabilities

Use objective criteria

- ✓ Fair standards & metrics
- ✓ Reason → be open to reason
- ✓ Yield to principle, not pressure

Yes, BUT they...

- ✓ Have more power → BATNA
- ✓ Won't play
- ✓ Use dirty tricks

Hospital Desires

- Reduced total cost...period
 - Safe patient care
 - Reduced variation
 - Efficient use of capital/personnel
 - Per unit of service cost reduction
- Improved quality
 - Real: published metrics
 - Perceived: satisfaction scores (HCAHPS)
 - Raise your own expectations
- Recruitment & Retention
 - Positive environment
 - Physician & staff



Success: My Own

Keep it professional. Respect is power!

Beware of claiming “higher quality” unless you can prove it

If you don’t want to be treated like a commodity, don’t represent yourself as one

Negotiating is better than bargaining

Overt lobbying is rarely useful

Beware playing politics with politicians

Professional Development

Inspired Physician Leadership

Creating influence and impact
By Charles B. Sisson and Jason S. Stroup



1. Today: The Case for Physician Leadership
2. Transitions: The Nature & Challenge of Clinical/Leader Interplay
3. Tone: The Significance of the Interpersonal Factor
4. Dialogue: Communicating for Understanding and Influence
5. Teamwork: The Foundations of Collective Synergy
6. Conflict: The Power of Respectful Conflict Encounters
7. Negotiations: Influence and Principled Outcomes
8. Motivation: Building Performance through People
9. Change: A Future of Opportunity
10. Tomorrow: A Case for Possibility

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We Need Leaders

The 48th Annual Rovenstine Lecture

Peter J. Pronovost, M.D., Ph.D.*

Anesthesiology 2010; 112:779-85

Five Ideas for the Development of Successful Physician Leaders

John W. Howell, MD, FRCPC, Chief of medical services, Piedmont Healthcare, Atlanta, Georgia
Journal of Hospital and Medicine 81:3 May/June 2014

Grooming M.D. Leaders

CEOs need to target and develop physicians to play leading roles in health care transformation

Carson F. Dye, FACHE



Inspiring Change. Together.

A Systematic Review of Physician Leadership and Emotional Intelligence

Journal of Graduate Medical Education, March 2014



Thank You!



Winner: 2016 Associate Photo Contest, Lucas Cahalan

 **CRASH Vail, Colorado 2018**
 Colorado Review of Anesthesia for ~~SurgiCenters and Hospitals~~
 and Ski Holiday!

 **Anesthetic considerations in Adults with Congenital Heart Disease**

 **Dr. Mark Twite** MA MB BChF FRCP
 Director of Congenital Cardiac Anesthesiology
 Associate Professor
 Department of Anesthesiology
 University of Colorado, Anschutz Medical Campus &
 Children's Hospital Colorado

 University of Colorado
 Health | Colorado Springs | Denver | Fort Collins | Boulder

CRASH Vail, Colorado 2018
 Colorado Review of Anesthesia for SurgiCenters and Hospitals

 **No Financial Disclosures**

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 Health | Colorado Springs | Denver | Fort Collins | Boulder

Ameristar Casino, Blackhawk, CO

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Objectives

Understand and Discuss the:

1. Changing epidemiology of congenital heart disease (CHD)
2. Current outcomes for patients with CHD
3. Perioperative anesthetic approach to adults with CHD undergoing non-cardiac surgery

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Case

- 37yr old female in Atrial Flutter presents for TEE, EP study and ablation
- Tricuspid Atresia s/p Fontan
 - Non-alcoholic cirrhosis (elevated LFTs and low albumin)
 - Protein losing enteropathy
 - Hypoxia. Baseline Sats 75-85% in air. Polycythemia Hct 65
 - Pacemaker Dual Chamber DDD at 70bpm
- Medications
 - Apixaban, Aspirin
 - L-Arginine
 - Digoxin, Quinapril, Sotalol
 - Furosemide, Spironolactone
 - Melatonin, Valium, Ambien, Tramadol

  University of Colorado
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Case

- 37yr old female in Atrial Flutter presents for TEE, EP study and ablation
- Echocardiogram 9/2016 TTE
 1. History of Tricuspid atresia, status post initial class (RA to PA)Fontan, with subsequent Fontan conversion to intra-cardiac lateral tunnel Fontan through the RA body
 2. Subjectively there remains normal LV systolic function.
 3. Dilated IVC without respiratory collapse. Low velocity flow within IVC suggests IVC pressure is greater than 15 mm Hg.
 4. The Glenn anastomosis is not well visualized, though there is normal respiratory variation in SVC flow suggestive of no obstruction within the Fontan pathway.
 5. Trivial mitral regurgitation, mild mitral stenosis (mean gradient 5.6 mmHg).
 6. Mildly dilated left ventricle with subjectively normal function. Hypoplastic right ventricle is not well seen.
 7. No pericardial effusion.

  University of Colorado
 Health | Colorado Springs | Denver | Fort Collins | Boulder

Case

- 37yr old female in Atrial Flutter presents for TEE, EP study and ablation
- Cardiac Cath
 - CATH (Denver, 2010) no fenestration, unobstructed PA's, Fontan 11-12 mmHg, no change with volume challenge, small angiographic right to left shunt seen likely from the suture line of the lateral tunnel.
 - CATH (Denver, 2013) Fontan pressures 18 mmHg, PCWP 14 mmHg, small venovenous collaterals off left innominate embolized, 100% FiO2 and improved Fontan pressure to 11 mmHg
 - CATH (Denver, 2016) hepatic wedge 19 mmHg, hepatic vein 15 mmHg (transhepatic gradient 4 mmHg), Fontan 13, RPA 11, LPA 12, PCWP 9, Fick CO 5.06, S/P 10ml/kg bolus PA increased to 17, PCWP to 14, Fick CO 5.74. With 100% O2, PA pressure decreased to 13, PCWP to 12, Fick CO 5.69, with 40 ppm iNO PA pressure 14, PCWP 13, CO 5.64

Page 4

Page 7

Congenital Heart Disease

- Most common congenital disorder of newborns
 - 1% of live births
 - Leading cause of infant deaths in the USA
 - Accounts for more than half of all deaths from congenital anomalies worldwide
- Estimated 1.5 million adults living in USA with CHD
- NIH funded CHD research from 2005 – 2015
 - 663 CHD research projects for a total cost of \$991 million
 - 70% Basic science (Cardiac developmental biology most common)
 - 27% Clinical
 - 3% Both

Van der Bom *Nat Rev Cardiol* 2011
Burns *Pediatr Cardiol* 2017

Page 8

Changing Epidemiology: Adults and Children in Quebec

Year	Median Age (yrs)
1985	11
2000	17
2010	25

Marelli *Circulation* 2007 & 2014

Page 9

Changing Epidemiology: Mortality

Distribution of Age at Death in Patients With Congenital Heart Disease in 1987 to 1988 and 2004 to 2005. Histogram bars depict the proportion of all deaths (x-axis) according to age at death (y-axis). Bold black curves with diamonds represent the corresponding age at death distribution in the general Quebec population

Khairy *J Am Coll Cardiol* 2010

Page 10

Classification of CHD Complexity

	Simple	Moderate	Severe
Atrial septal defect		Anomalous pulmonary venous drainage	Single ventricle palliation
Ventricular septal defect		Atrioventricular canal defect	Transposition of the great arteries
Patent ductus arteriosus		Coarctation of the aorta	Truncus arteriosus
		Tetralogy of Fallot	Tricuspid atresia
			Pulmonary atresia
			Eisenmenger syndrome

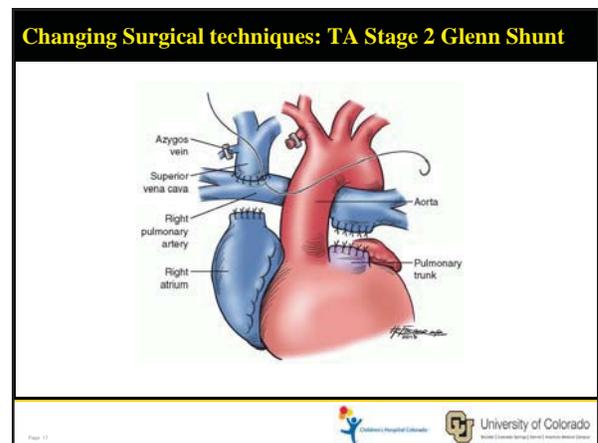
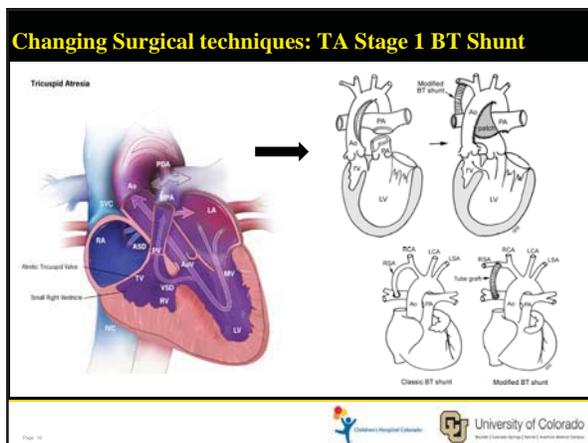
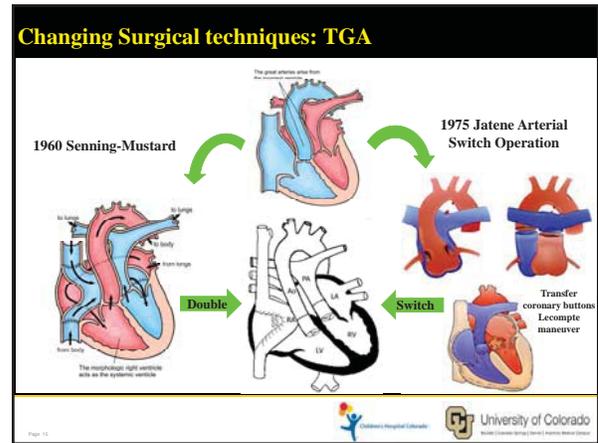
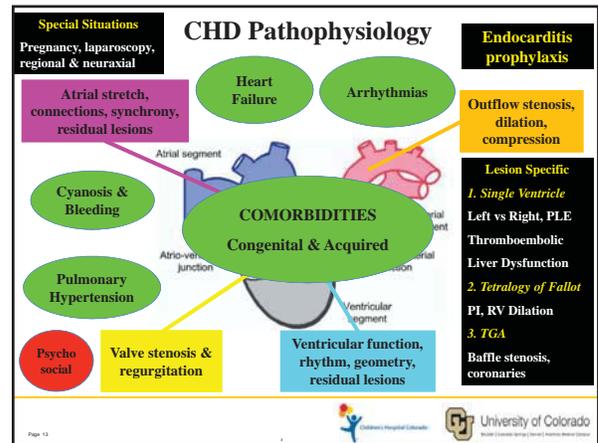
Simple defects have a favorable natural history unless they are unrepaired with a significant L to R shunt which may then develop Eisenmenger syndrome

Page 11

Long term Survival by complexity of CHD

	95%	90%	80%
	Simple	Moderate	Severe
Atrial septal defect		Anomalous pulmonary venous drainage	Single ventricle palliation
Ventricular septal defect		Atrioventricular canal defect	Transposition of the great arteries
Patent ductus arteriosus		Coarctation of the aorta	Truncus arteriosus
		Tetralogy of Fallot	Tricuspid atresia
			Pulmonary atresia
			Eisenmenger syndrome

Long term survival > 20 years Warnes J Am Coll Cardiol 2008



Changing Surgical techniques: TA Stage 3 Fontan

AtrioPulmonary Lateral Tunnel Extracardiac

Page 13

Effects of anesthetic agents

	Contractility	MAP	SVR	PAP	PVR	HR
Halothane	↓↓	↓↓	↓↓	↓	↓	↓↓
Isoflurane	→	↓	↓↓	↓	↓	↑
Sevoflurane	↓	↓	↓	↓	↓	↑
Desflurane	→	↓	↓	↓	↓	↑
Propofol	↓	↓↓	↓↓	↓	↓	↓
Ketamine	→*	→	↑	↑→	↑→	↑
Etomidate	→	→	→	↑	↑	→
Dexmedetomidine	→	↑	↑	→	→	↓↓
Opioids	→	→	→	→	→	↓
Benzodiazepines	→	→	→	→	→	→

*Ketamine can depress contractility *in vitro* and in catecholamine depleted patients.
 †Dexmedetomidine can increase MAP during loading dose administration.

Friesen SCVA 2017

Page 14

Consensus Statements

AHA SCIENTIFIC STATEMENT Circulation, October 2017

Diagnosis and Management of Noncardiac Complications in Adults With Congenital Heart Disease

AHA SCIENTIFIC STATEMENT Circulation, January 2017

Management of Pregnancy in Patients With Complex Congenital Heart Disease

A Scientific Statement for Healthcare Professionals From the American Heart Association

Page 20

Time-series analysis: referral to specialized ACHD centers and ACHD patient mortality

Page 21

Atrial Arrhythmias

JOURNAL OF THE AMERICAN COLLEGE OF CARDIOLOGY VOL. 59, NO. 7, 2012

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PERMISSION TO REPRODUCE DOI: 10.1016/j.jacc.2012.05.014

Increasing Prevalence of Atrial Fibrillation and Permanent Atrial Arrhythmias in Congenital Heart Disease

Fabien Labombarda, MD,¹ Robert Hamilton, MD,² Azadeh Shohouli, PhD,¹ Jamil Abouhoun, MD,¹ Craig S. Blumberg, MD,¹ Marie A. Chata, MD,¹ Scott Cohen, MD,¹ Stephen Cook, MD,¹ Annie Dore, MD,¹ Susan M. Fernandes, PhD, PA-C,¹ Anne Fournier, MD,¹ Joseph Kay, MD,¹ Laurent Macle, MD,¹ Blandine Mondesert, MD,¹ François-Pierre Mongon, MD, SM,¹ Alexander R. Optonowky, MD, MMS,¹ Anna Proietti, RN,¹ Lena Rivard, MD,¹ Jennifer Ting, MD,¹ Bernard Thibault, MD,¹ Ali Zaidi, MD,¹ Paul Khairy, MB, PhD,¹ on behalf of the AACC

Studied 482 adults with CHD from 12 centers in the USA

- Most common presenting arrhythmia:
 - Intra-atrial re-entrant tachycardia (IART) 61.6% (increased with CHD complexity)
 - Atrial fibrillation (AF) 28.8% increased with age to surpass IART at 50yrs of age
 - Focal atrial tachycardia 9.5%

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Circulation
Arrhythmia and Electrophysiology

American Heart Association

Natural History and Clinical Predictors of Atrial Tachycardia in Adults With Congenital Heart Disease

Pablo Ávila, José María Oliver, Pastora Gallego, Ana González-García, María José Rodríguez-Puras, Esther Cambrero, José Ruiz-Castador, Ana Campos, Rafael Peinado, Raquel Prieto, Fernando Samago, Raquel Yotti and Francisco Fernández-Avilés

Circ Arrhythm Electrophysiol. 2017;10:

Risk factors for developing atrial arrhythmias:

- single ventricle
- previous intracardiac repair
- systemic right ventricle
- pulmonary hypertension

Page 23

International Journal of Cardiology 248 (2017) 153–154

Contents lists available at ScienceDirect
International Journal of Cardiology
 journal homepage: www.elsevier.com/locate/ijcard

Short communication
Impact of atrial arrhythmias on outcome in adults with congenital heart disease

H. Yang^{a,b,1}, J.M. Kuijpers^{a,b,1}, J.R. de Groot^{a,1}, T.C. Konings^{c,1}, A. van Dijk^{d,1}, G.T.J. Sieswerda^{c,1}, M.C. Post^{c,1}, B.J.M. Mulder^{a,b,1}, B.J. Bouma^{a,c,2,1}

Adults with CHD and atrial arrhythmias:
 • x 4 increase of heart failure
 • x 2 increase in death

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International Journal of Cardiology 248 (2017) 164–168

Contents lists available at ScienceDirect
International Journal of Cardiology
 journal homepage: www.elsevier.com/locate/ijcard

Incidence and clinical characteristics of sudden cardiac death in adult congenital heart disease

Benjamin Moore^{a,1}, Christopher Yu^{b,1}, Irina Kotchetkova^{c,1}, Rachael Cordina^{a,1}, David S. Celermajer^{a,b,1}

Atrial arrhythmias frequent cause of sudden cardiac death (43%)
 Increasing incidence with complexity of CHD
 - Eisenmenger
 - Transposition of great arteries (atrial switch)
 - Single ventricles lesions palliated to Fontan circulation

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ORIGINAL ARTICLE

WILEY **Congenital Heart Disease**

Sudden cardiac death and late arrhythmias after the Fontan operation

Kavitha N. Pundi, MD¹ | Krishna N. Pundi, MD² | Jonathan N. Johnson, MD^{1,3} | Joseph A. Dearani, MD⁴ | Zhuo Li, BS⁵ | David J. Driscoll, MD¹ | Philip L. Wackel, MD¹ | Christopher J. McLeod, MD, PhD³ | Frank Cetta, MD^{1,3} | Bryan C. Cannon, MD^{1,3}

Congenital Heart Disease 2017 (12) 17-23

Single Center study in USA of Fontan patients
 • 10, 20 and 30 year freedom from arrhythmias of 71%, 42% and 24%
 • SCD 52 of 1052 Fontan patients (5%) with 65% due to arrhythmias

Page 26

Factors leading to arrhythmias in CHD

A Pre-operative
 B Post-operative

Escudero Can J Cardiol 2013

Page 27

Risk estimates for arrhythmias across CHD

Complexity of CHD	Type of CHD	Prevalence (in CHD population)	Atrial Arrhythmias			Ventricular Arrhythmias		Other Pacing Needs	
			AV	AF	Other	SVD	AV block	Bradyarrhythmias, Heart Failure	
Simple	Pulmonary stenosis	0.4%							
	Pulmonary atresia	0.4%							
	Ventricular septal defect	10.1%							
	Secundum atrial septal defect	8.10%							
Moderate	Aortic coarctation	0.7%							
	Anteriorly positioned aortic valve	0.2-1.3%							
	Anteroseptal septal defect	3.5%							
	Aortic regurgitation	2.4%							
	Ebstein anomaly	0.1-1.1%							
Severe	Transposition of the large arteries	8.10%							
	Primary atrial septal defect	2.3%							
	Tricuspid atresia	1.3-2%							
	Pulmonary atresia	2.2-3%							
	Double outlet right ventricle	1.3-2%							
	D-transposition of the great arteries	0.7%							
Other	L-transposition of the great arteries	1.2%							
	Hypoplastic left heart syndrome	0.4%							
	Other (bicuspid, other single ventricle)	1.0%							

PACES/ HRS Expert Consensus Statement on the Recognition and Management of Arrhythmias in ACHD *Heart Rhythm* 2014

Page 28

Implantable Cardioverter-Defibrillator

Circulation
 Arrhythmia and Electrophysiology

American Heart Association

Prevention of Sudden Cardiac Death in Adults With Congenital Heart Disease: Do the Guidelines Fall Short?

Jim T. Vehmeijer, Zeliha Koyak, Werner Budts, Louise Harris, Candice K. Silversides, Erwin N. Oechslin, Berto J. Bouma, Acilko H. Zwinderman, Barbara J.M. Mulder and Joris R. de Groot

Circ Arrhythm Electrophysiol. 2017;10:

Majority of SCD victims unrecognized with an area under the curve of 0.6 for the discriminative ability of current guidelines
 Critical clinical reasoning essential when deciding on ICD placement in adult CHD patients

Page 29

ACHD Heart Failure

Diagnosis:
 ● Single ventricle
 ▲ Tetralogy of Fallot
 ○ TGA (Mustard)
 ▽ Left-to-right shunt
 ▹ Valve disease
 ▸ Coarctation

Single Ventricle palliated to Fontan
 Single ventricle has both the systemic and pulmonary resistances in series

Tetralogy of Fallot
 Pulmonary regurgitation causes RV dilation and dysfunction, abnormal septal configuration, altered RV-LV interaction and LV dysfunction

Subsystemic RV
 1. D-TGA palliated with a Mustard/Senning atrial switch
 2. ccTGA

Coronary Artery Disease – focus on prevention

Norval. Am J Cardiol 2006
 DiNardo. Sem Cardiothoracic Vasc Anes 2012
 Stefanescu. Curr Treat Options Cardio Med 2014

Heart Liver Transplant

Contemporary Outcomes of Combined Heart-Liver Transplant in Patients With Congenital Heart Disease

Roosevelt Bryant 3rd, MD,^{1,2} Raheel Rizwan, MD,^{1,2} Farhan Zafar, MD,^{1,2} Shimul A. Shah, MD,³ Clifford Chin, MD,^{2,4} James S. Tweeddale, MD,^{1,2} and David L. Morales, MD^{1,2}
 Transplantation February 2018 Volume 102 Number 2

Isolated heart transplant and combined heart-liver transplant in adult congenital heart disease patients: Insights from the united network of organ sharing☆

Elisa A Bradley ^{Ab,1}, Krong-on Pinyoluksana ^{Ab,1}, Melissa Moore-Clingenpeel ^{b,1}, Yongjie Miao ^{b,1}, Curt Daniels ^{Ab,1}
 International Journal of Cardiology 228 (2017) 796-795

Heart Liver Transplant

UNOS Database 1987 – 2015

- 61437 Heart Tx
 - 190 CHLT
 - 41 had CHD
 - 30 day, 1 and 5 year survival 95%, 86% and 83%
 - CHLT with and without CHD comparable
 - Trend towards better survival for CHLT compared with isolated Heart Tx for CHD

CHD Pathophysiology

Special Situations
 Pregnancy, laparoscopy, regional & neuraxial

Endocarditis prophylaxis

Outflow stenosis, dilation, compression

Lesion Specific
 1. Single Ventricle
 Left vs Right, PLE
 Thromboembolic Liver Dysfunction
 2. Tetralogy of Fallot
 PI, RV Dilation
 3. TGA
 Baffle stenosis, coronaries

COMORBIDITIES
 Congenital & Acquired

Other conditions:
 Atrial stretch, connections, synchrony, residual lesions
 Heart Failure
 Arrhythmias
 Cyanosis & Bleeding
 Pulmonary Hypertension
 Valve stenosis & regurgitation
 Ventricular function, rhythm, geometry, residual lesions
 Psycho-social

Mark.Twite@UCDenver.edu

Swan Song in Cardiac Surgery?

Wayne Soong, MD, FCCP

Disclosures

I have no relationships with or investments in pertinent commercial interests to disclose.

Objectives

- Quantify and characterize the risks of PAC use
- Determine patient populations appropriate for PAC use in cardiac surgery
- Characterize surgical considerations in deciding on PAC use
- Describe the implications of institutional setting on PAC use

Outline

- History of the PAC
- Patient selection
- Surgical considerations
 - OPCAB
 - CPB
- Setting
 - Institutional norm
 - Accuracy
 - Interpretation
 - Treatment

PAC in Cardiac Surgery

Percentage of Patients Monitored with PAC	CPB (%)	OPCAB (%)	Minimally Invasive CABG (%)	Minimally Invasive Valve (%)
100%	34.6	45.2	42.4	46.3
75%-99%	33.6	22.5	16.2	17.3
50%-74%	7.1	5.5	6.8	5.4
25%-49%	6.1	3.5	5.8	2.8
1%-24%	15.1	14.2	15.2	12.8
0%	3.5	9.2	13.6	15.3

Judge 2015

PAC in Cardiac Surgery

- CABG 60.3%
- Aortic or mitral valve replacement 74.1%
- CABG + valve replacement 75.5%
- Other 70.9%

STS Database 2015

History

Vol. 283 No. 9 FLOW-DIRECTED BALLOON-TIPPED CATHETER - SWAN ET AL. 447

CATHETERIZATION OF THE HEART IN MAN WITH USE OF A FLOW-DIRECTED BALLOON-TIPPED CATHETER*

H. J. C. SWAN, M.B., Ph.D., F.R.C.P., WILLIAM GANZ, M.D., C.Sc., JAMES FORRESTER, M.D., HAROLD MARCUS, M.D., GEORGE DIAMOND, M.D., AND DAVID CHONETTE

Abstract Pressures in the right side of the heart and pulmonary capillary wedge can be obtained by cardiac catheterization without the aid of fluoroscopy. A No. 5 Fr double-lumen catheter with a balloon just proximal to the tip is inserted into the right atrium under pressure monitoring. The balloon is then inflated with 0.6 ml of air. The balloon is carried by blood flow through the right side of the heart into the smaller radicles of the pulmonary artery. In this position when the balloon is inflated wedge pressure is obtained. The average time for passage of the catheter from the right atrium to the pulmonary artery was 35 seconds in the first 100 passages. The frequency of premature beats was minimal, and no other arrhythmias occurred.

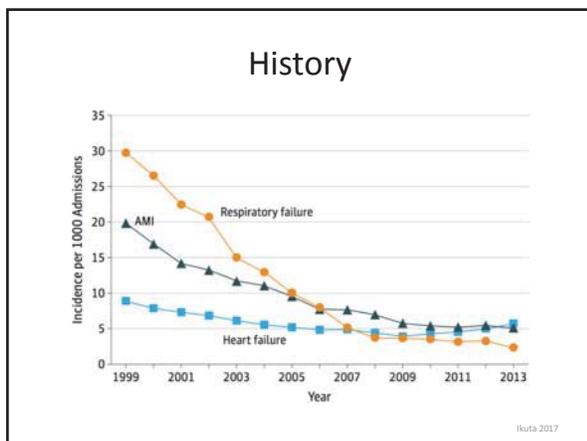
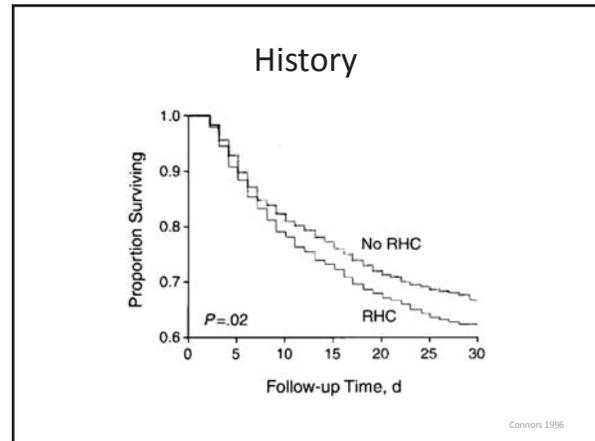
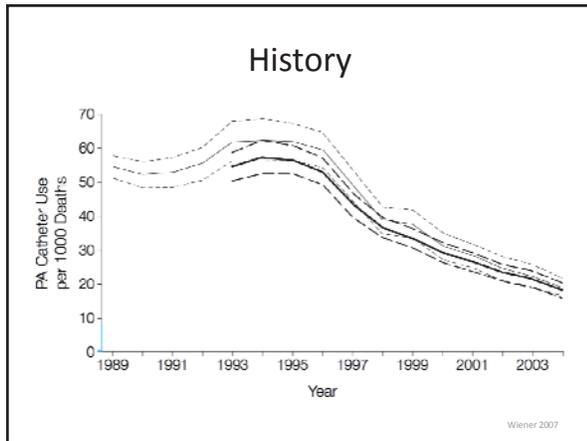
DIAGNOSTIC catheterization of the right and left sides of the heart with the use of semi-rigid cardiac catheters has been the routine method for the study of the central circulation in animals and in man. The use of such catheters requires fluoroscopic guidance and the development of marked technical skill in catheter manipulation.

the diagnostic cardiac laboratory and in the intensive-care, coronary-care and myocardial-infarction research units. This approach has proved to be effective and safe and has wide application in the study of the central circulation in man.

CATHETER CONSTRUCTION

Measured Parameters

- Central venous pressure
- Right ventricular pressure
- Pulmonary artery pressure
- Pulmonary artery occlusion pressure
- Spectrophotometric mixed venous oxygen saturation
- Thermodilution cardiac output



Should we use PACs in cardiac surgery?

In summary, there is conflicting evidence from controlled studies regarding the benefit that cardiac surgery patients receive from PA catheterization.

Roben 2003

Procedural Risk

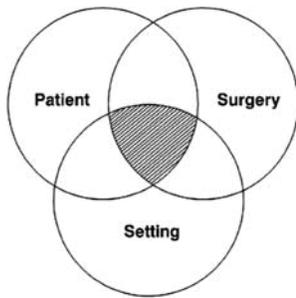
Complication	Reported Incidence (%)	References	Incidence in Meta-Analysis (%)
Central venous access			
Arterial puncture	0.1-1.3	97,98,103,104,106,205	≈3.6
Bleeding at cut-down site (phlebotomy)	5.3	206	
Postoperative neuropathy	0.3-1.1	97,99	
Pneumothorax	0.3-4.5	97,100,104-107,109,113,206	0.3-1.9
Air embolism	0.5	105	
Catheterization			
Minor dysrhythmias*	4.7-68.9	97-106,120,124,205-208	>20
Severe dysrhythmias (ventricular tachycardia or fibrillation)*	0.3-62.7	97,100,102,103,106,120,121,122,124,125,205,207,208	0.3-3.8
Minor increase in troponin* reoperation	17	129	
Right bundle-branch block*	0.1-4.3	98,104,126,128	
Complete heart block (in patients with prior left bundle-branch block)*	0-8.5	104,126-128	
Catheter residence			
Pulmonary artery rupture*	0.03-1.5	102,104,105,140,141,143,209	0.03-0.7
Positive catheter-tip cultures	1.4-34.8	98,102,146-152,154,155,210	≈19
Catheter-related sepsis	0.7-11.4	98,100,107,113,147,150,152,154,155,210,211	0.7-3.0
Thrombophlebitis	6.5	99	
Venous thrombosis	0.5-66.7	98-100,107,130	0.5-3
Pulmonary infarction*	0.1-6.6	97,98,102-104,131,205	0.1-2.8
Mural thrombus*	28-61	132,212	
Valvular/endoarterial vegetations or endocarditis*	2.3-100	98,104,105,133-136,146,212,213	2.3-7.1
Deaths attributed to pulmonary artery catheter*	0.02-1.5	100,104,105	

Roizen 2003

Cost

- Catheter
- Procedural time
- Anesthesiologist time
- Infrastructure
- Nursing care
- Cost effectiveness

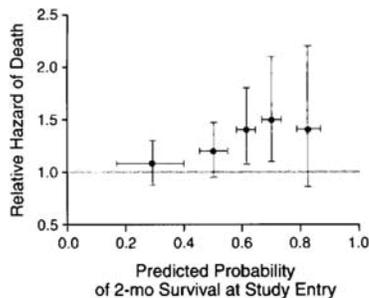
Should we use PACs in cardiac surgery?



Roizen 2003

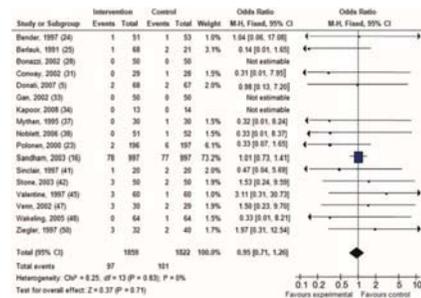
Patient

Patient Selection

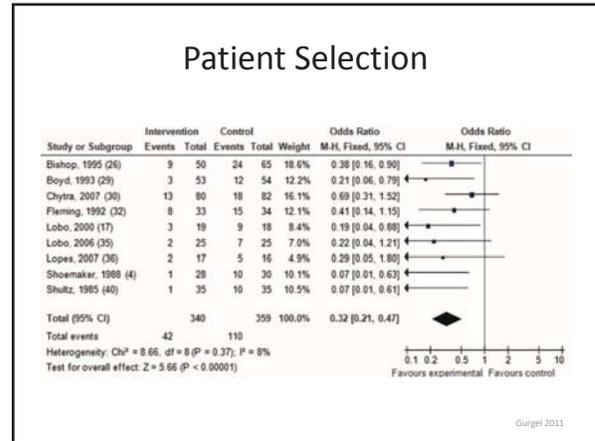
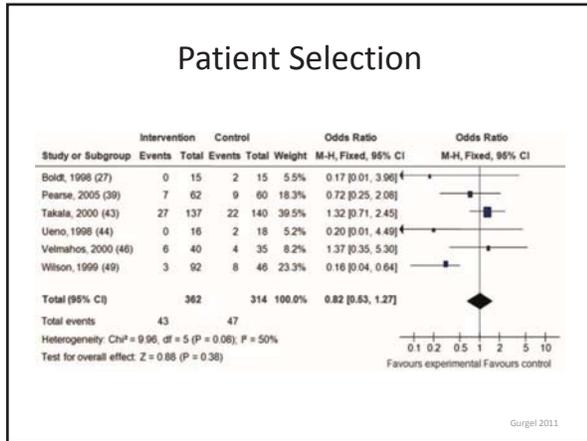


Connors 1996

Patient Selection



Gurgel 2011



Patient Selection

Patient Factor	Overall (%)	No PAC (%)	PAC (%)	p Value	Adjusted OR (95% CI)	p Value
Low-risk patients	1.3	1.2	1.3	0.846	1.12 (0.76-1.68)	0.571
High-risk patients	10.9	9.6	12.2	<0.001	1.30 (1.16-1.48)	<0.001
Patients aged > 80 years	7.7	7.0	8.5	0.016	1.24 (1.03-1.50)	0.024
Pulmonary hypertension	6.3	9.2	9.4	0.600	1.00 (0.60-1.73)	0.981
Multiple valve	12.2	12.1	12.3	0.871	0.98 (0.73-1.32)	0.889

Chiang 2015

- ### Patient Selection
- ASA 4 or 5
 - Age > 80
 - Ventricular dysfunction
 - Pulmonary arterial hypertension
 - Intracardiac shunt
 - Pulmonary edema

Surgery

Off Pump

Clinical Outcomes of Low-Risk Patients Undergoing Beating-Heart Surgery With or Without Pulmonary Artery Catheterization

Fernando G. Resano, MD,* Emmanouil I. Kapetanakis, MD,† Peter C. Hill, MD,‡ Elizabeth Haile, MS,§ and Paul J. Corso, MD†

Objective: For patients who undergo off-pump coronary artery bypass (OPCAB) surgery, pulmonary artery catheterization (PAC) has been proposed as a useful intraoperative monitoring tool. This study was designed to determine if the choice of PAC versus central venous pressure monitoring (CVP) had any effect on outcome after OPCAB. This study compared these 2 methods of hemodynamic monitoring in low-risk patients undergoing beating-heart surgery via a median sternotomy and evaluated their effect on morbidity and in-hospital mortality.

Design: Retrospective database and medical record review.

Setting: Tertiary care teaching hospital.

Participants: Low-risk patients who had coronary revascularization via a median sternotomy on the beating heart.

Interventions: None.

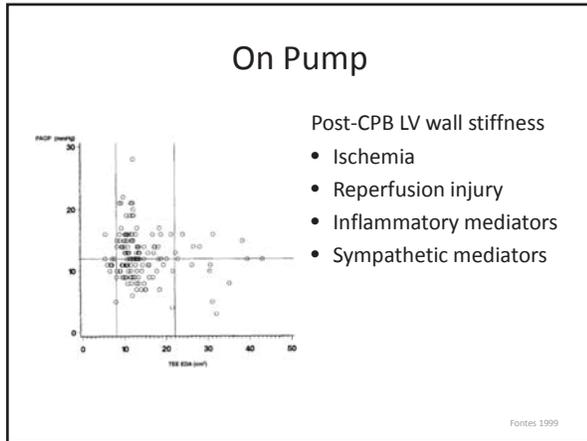
Measurements and Main Results: A population of 2,414 low-risk patients who had beating-heart coronary revascularization between January 2000 and December 2003 was reviewed. Most patients (1,871 or 69.2%) received a PAC, whereas 743 (30.8%) had CVP monitoring. Risk-adjusted logistic regression analyses were performed to investigate the effect of each technique on clinical outcomes. The groups were comparable in both baseline characteristics and Fanonetti's mortality risk (1.5 ± 0.3; p = 0.58). Univariate analysis failed to show a difference in operative mortality (p = 0.76), on-pump conversion rate for completion of aortocoronary bypasses (p = 0.85), postoperative low cardiac output (p = 0.16), or prolonged inotropic agent use (p = 0.22). Similarly, in the multivariate analysis, both groups had a similar rate of conversion to an on-pump procedure for completion of coronary artery grafting (p = 0.91), intraoperative intra-aortic balloon pump use (p = 0.89), low cardiac output state (p = 0.16), or in-hospital mortality (p = 0.31).

Conclusions: This single-institution, retrospective study suggests that in low-risk patients undergoing beating-heart surgery, CVP monitoring may be sufficient.

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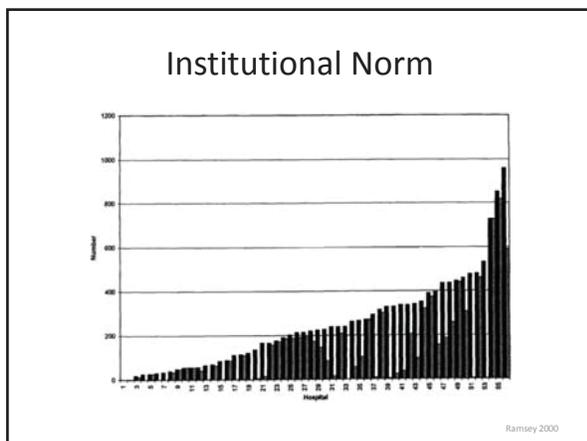
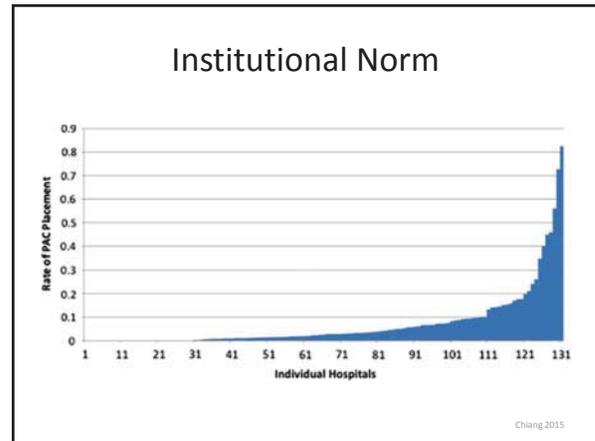
KEY WORDS: pulmonary artery catheterization, beating-heart surgery, morbidity, mortality, anesthesia techniques, OPCAB

Resano 2006



- ### Surgery
- Reoperation
 - Double- or triple-valve surgery
 - Assist device
 - Surgeon

Setting



Accuracy

Assessment of critical care nurses' knowledge of the pulmonary artery catheter

THOMAS J. IBERTI, MD, FCCM**†; ELAINE K. DALY, RN, BS, FAHA; ANDREW B. LEIBOWITZ, MD; CLYDE B. SCHETTER, MD, PhD; ELLEN P. FISCHER, PhD; JEFFREY H. SILVERSTEIN, MD; THE PULMONARY ARTERY CATHETER STUDY GROUP*

Objectives: To assess the knowledge and understanding of the use of the pulmonary artery catheter and interpretation of data derived from it in a group of nurses attending the American Association of Critical Care Nurses' National Teaching Institute conference.

Design: A 37-question multiple choice examination that tested knowledge regarding the use of the pulmonary artery catheter was administered to a group of nurses, attending a national conference, who preregistered for a hemodynamics workshop.

Setting: American Association of Critical Care Nurses' National Teaching Institute Conference, New Orleans, LA, May 1992.

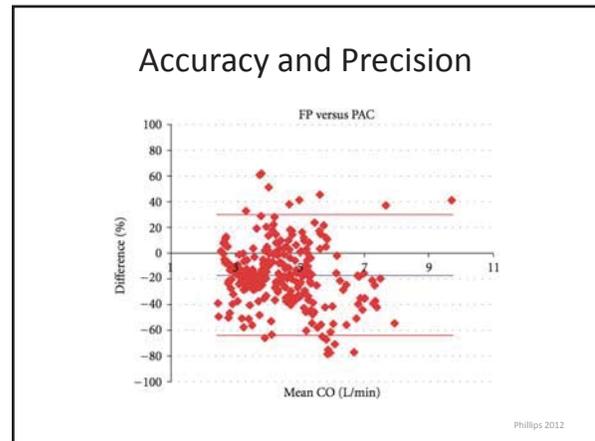
Measurements and Main Results: Two-hundred sixteen nurses completed the questionnaire. The mean test score was 16.5 ± 5.7 (80) (48.9%). Test scores were significantly associated with years of experience in critical care, critical care registered nurse certification, responsibility for repositioning and manipulating the catheter, frequency of use, and self-

* Address requests for reprints to: Andrew B. Leibowitz, MD.
 † Iberti 1994

Accuracy

Subtest Content	No. of Items	Score (mean ± SD)	%
Complications	3	1.9 ± 0.9	63.3
Waveforms	6	3.7 ± 1.5	52.2
Patient management	5	2.5 ± 1.3	50.5
Insertion technique	4	2.0 ± 1.1	49.9
Positioning	4	1.9 ± 1.2	47.2
Physiology	5	2.0 ± 1.2	40.9
Calculations	6	2.3 ± 1.4	38.6

Iberti 1994



Interpretation

A Multicenter Study of Physicians' Knowledge of the Pulmonary Artery Catheter

Thomas J. Iberti, MD, Ellen P. Fischer, PhD, Andrew B. Leibowitz, MD, Edward A. Panacek, MD, Jeffrey H. Silverstein, MD, Timothy E. Albertson, MD, PhD, and the Pulmonary Artery Catheter Study Group

We administered a 31-question multiple-choice examination to 496 physicians practicing in 13 medical facilities in the United States and Canada to assess their knowledge and understanding of the use of the pulmonary artery catheter and interpretation of data derived from it. The mean test score was 20.7 (67% correct), with an SD of 5.4 and a range of 6 to 31 (19% to 100%). Mean scores varied independently by training, frequency of use of pulmonary artery catheter data in patient treatment, frequency of inserting a pulmonary artery catheter, and whether the respondent's hospital was a primary medical school affiliate. Given the variability in physician understanding of the pulmonary artery catheter, we believe that credentialing policies should be reevaluated and that consideration should be given to restricting its use to individuals with documented competency.

JAMA. 1996;274:2928-2932

Iberti 1990

Interpretation

Subject Area	No. of Questions	Mean Score	% Correct	SD
Overall	31	20.7	66.8	5.4
Insertion & complications	6	3.9	65.0	1.4
Cardiac physiology	3	2.1	70.0	0.9
Interpretation*	14	9.1	65.0	2.7
Application of data	8	5.7	71.2	1.7

Iberti 1990

Treatment

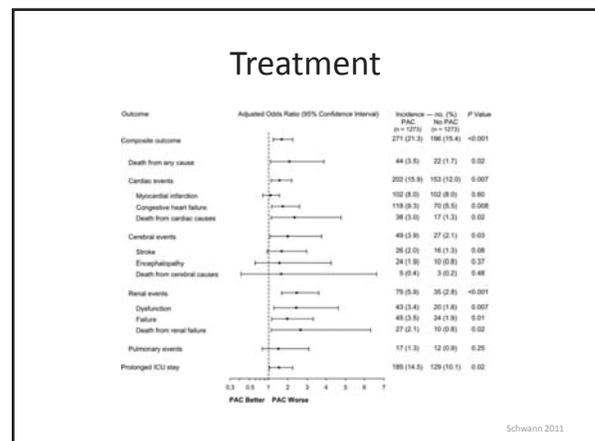
Lack of Effectiveness of the Pulmonary Artery Catheter in Cardiac Surgery

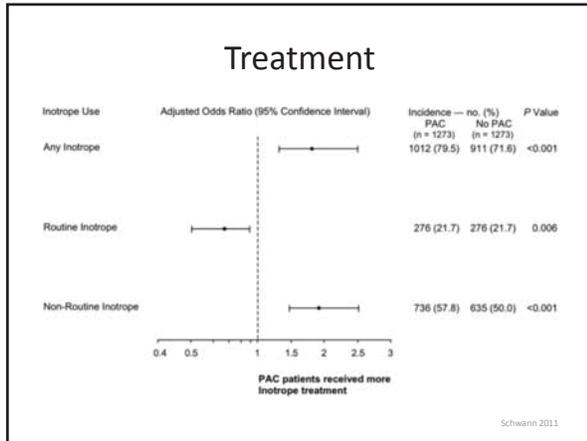
Nanette M. Schwann, MD,*† Zak Hilliel, PhD, MD,‡ Andreas Hoeft, MD,§ Paul Barash, MD,|| Patrick Möhnle, MD,¶ Yinghui Miao, MD, MPH,** and Dennis T. Mangano, PhD, MD††

BACKGROUND: The pulmonary artery catheter (PAC) continues to be used for monitoring of hemodynamics in patients undergoing coronary artery bypass graft (CABG) surgery despite concerns raised in other settings regarding both effectiveness and safety. Given the relative paucity of data regarding its use in CABG patients, and given entrenched practice patterns, we assessed the impact of PAC use on fatal and nonfatal CABG outcomes as practiced at a diverse set of medical centers.

METHODS: Using a formal prospective observational study design, 5065 CABG patients from 70 centers were enrolled between November 1996 and June 2000 using a systemic sampling protocol. Propensity score matched-pair analysis was used to adjust for differences in likelihood of PAC insertion. The predefined composite endpoint was the occurrence of any of the following: death (any cause), cardiac dysfunction (myocardial infarction or congestive heart failure), cerebral dysfunction (stroke or encephalopathy), renal dysfunction (dysfunction or failure), or pulmonary dysfunction (acute respiratory distress syndrome). Secondary variables included treatment indices (inotrope use, fluid administration), duration of postoperative intubation, and intensive care unit length of stay. After categorization based on PAC and transesophageal echocardiography use (both, neither, PAC only, transesophageal echocardiography only), we performed the primary analysis contrasting PAC only and neither (total, 3321 patients), from which propensity pairing yielded 1273 matched pairs.

Schwann 2011





Treatment

Variable	Entire cohort		Adjusted OR	95% CI	P Value	Propensity-matched cohort		P Value
	PAC N = 453	Non-PAC N = 908				PAC N = 424	Non-PAC N = 424	
Nitroglycerin	183(40.4)	326(35.9)	0.732	0.274-1.518	0.451	164(38.0)	148(35.0)	0.255
Dopamine	30(170.8)	413(45.4)	2.925	2.287-3.770	<0.001	30(72.8)	190(45.2)	<0.001
Epinephrine	26(7.7)	24(2.5)	2.766	1.623-3.816	<0.001	33(7.8)	13(3.0)	0.002
In-hospital death	6(1.3)	10(1.1)	0.636	0.170-2.384	0.502	6(1.4)	3(1.1)	0.792
Myocardial infarction	3(0.6)	4(0.4)	1.464	0.337-6.360	0.611	3(0.7)	2(0.4)	0.664
Atrial fibrillation	41(9.0)	78(7.8)	2.196	0.755-6.153	0.191	38(8.9)	33(7.7)	0.335
Cardiovascular accident	3(0.6)	4(0.4)	0.432	0.074-2.518	0.351	3(0.7)	3(0.7)	NA
Acute renal failure	10(2.2)	18(1.8)	1.894	0.625-5.741	0.259	9(2.1)	7(1.6)	0.814
Reoperation for bleeding	7(1.5)	11(1.1)	0.692	0.288-2.756	0.643	7(1.6)	6(1.4)	0.780
Infective complications	4(0.8)	7(0.7)	0.968	0.324-1.105	0.194	4(0.9)	3(0.7)	0.704

Xu 2015

Treatment

A Prospective, Randomized Study of Goal-Oriented Hemodynamic Therapy in Cardiac Surgical Patients

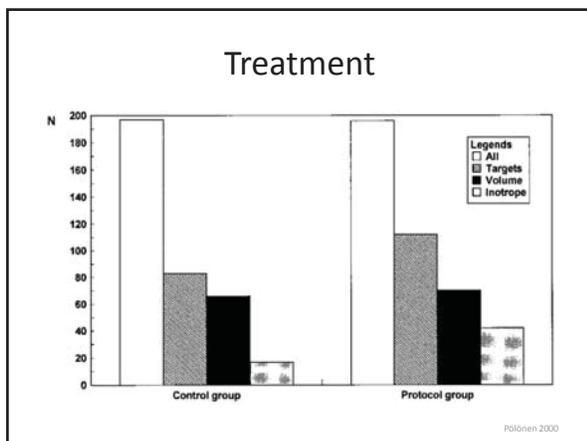
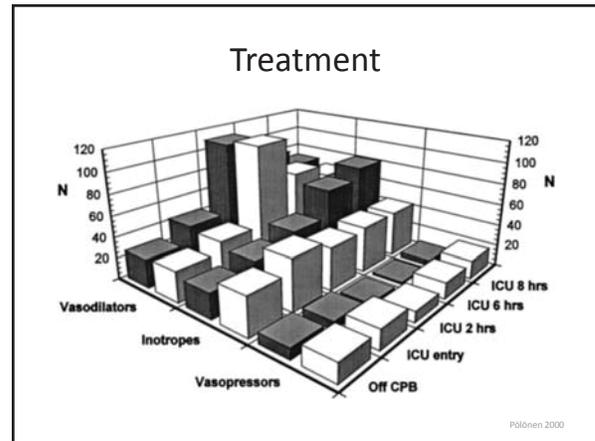
Pekka Pölonen, MD^a, Esko Ruokonen, MD, PhD^a, Mikko Hippeläinen, MD, PhD^a, Mikko Pöyhönen, MD, PhD^a, and Jukka Takala, MD, PhD^a

^aCritical Care Research Program, ^bDepartments of Anesthesia and Intensive Care, and ^cSurgery, Kuopio University Hospital, Kuopio, Finland

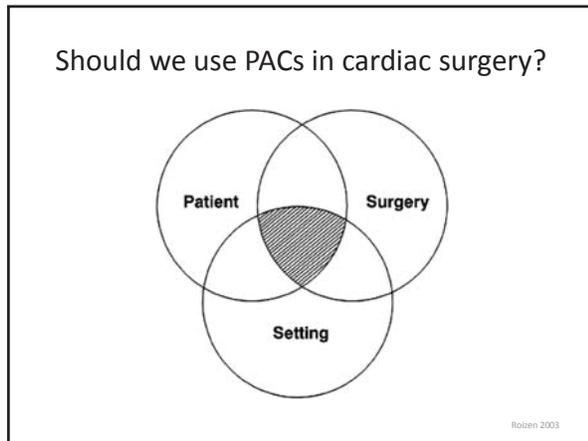
Organ dysfunction and multiple organ failure are the main causes of prolonged hospital stay after cardiac surgery, which increases resource use and health care costs. Increased levels of oxygen delivery and consumption are associated with improved outcome in different groups of postoperative patients. Cardiac surgical patients are at risk of inadequate perioperative oxygen delivery caused by extracorporeal circulation and limited cardiovascular reserves. The purpose of our study was to test whether increasing oxygen delivery immediately after cardiac surgery would shorten hospital and intensive care unit (ICU) stay. Four hun-

group were to maintain Svo₂ >70% and lactate concentration <2.0 mmol/L from admission to the ICU and up to 8 h thereafter. Hemodynamics, oxygen transport data, and organ dysfunctions were recorded. The median hospital stay was shorter in the protocol group (6 vs 7 days, P < 0.05), and patients were discharged faster from the hospital than those in the control group (P < 0.05). Discharge from the ICU was similar between groups (P = 0.8). Mortality was less frequent at the time of hospital discharge in the protocol group (1.1% vs 6.1%, P < 0.01). Increasing oxygen delivery to achieve normal Svo₂ values and lactate concentration during the immediate postoper-

Pölonen 2000



- ### Setting
- Institutional norm
 - Nursing familiarity
 - Physician interpretation
 - Appropriate treatment
 - Non-responders



CRASH 2018

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



I have no conflicts of interest or financial disclosures to report

Goals and Objectives

1. Review right ventricle anatomy and function
2. Discuss the pathophysiology of right ventricular failure
3. Review the echocardiographic evaluation of the right ventricle
4. Identify risk factors for RV failure
5. Discuss management strategies for RV failure

Right Ventricle Anatomy

- Complex shape
- Right Ventricle divided into 3 main anatomic areas
 - Smooth muscular inflow (body or sinus)
 - Trabecular apical region
 - Outflow area (infundibulum or conus)
- Blood supply
 - RCA mediated Acute Marginal branches
 - PDA may supply RV inferior free wall

Right Ventricle Normal Function

- Larger than the LV by EDV
- Lower ejection fraction than LV by 10-15%
 - Lower end of normal values ~ 45%
- Mass regresses as PVR drops at birth
 - Adult 1/6th the LV mass
- Better adapted to handle volume overload

RV Dysfunction

- INTERMACS definition:
 - CVP > 16 cmH₂O
 - Dilated IVC with absence of respiratory variation by TTE
 - Associated clinical features of venous congestion

RV Basics

- Refractory RV failure post cardiac surgery needing prolonged inotropic support or RVAD
 - 0.1% all comers
 - 2-3% Heart Transplants
 - 20-30% of patients with LVAD
- Survival Rates for post op RV failure ~ 25-30%
- RV systolic dysfunction or severe RV dilation
 - Present in almost ½ the patients with hemodynamic compromise¹

¹Costachescu 2002

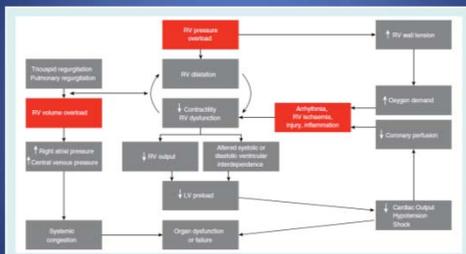
RV Basics

- Immediate survival Rates for post op RV failure ~ 25-30%
- RV systolic dysfunction or severe RV dilation
 - Present in almost ½ the patients with hemodynamic compromise¹
- 2 year all cause mortality²
 - RVEF <20% 16.7%
 - 20-30% 8.2%
 - >30% 4.1%

¹Costachescu 2002

² Bootsma et al. JCV 2017

Right Ventricle Pathophysiology



Langensletten Journal of Heart Failure (2015) 18:325-341
doi:10.1002/jhf.478

Pathophysiology

- Chronic volume overload
 - Progressive lengthening of base to apex and septum to free wall
 - D shaped LV in diastole
- Chronic pressure overload
 - D shaped LV short axis in systole

Perioperative RVD Risks

- Identify Patients at high risk
 - Long cardiopulmonary bypass runs (>150 min)
- Suboptimal Intraoperative myocardial protection
- Coronary Embolism or graft occlusion
- Lung Injury or mechanical ventilation induced lung injury
 - ARDS post cardiac surgery ~10%
- Heart Transplants
 - Donor heart ischemia or pre-op pulmonary vascular dysfunction

Right Ventricle Failure

- Need for inhaled vasodilator >48 hours
- Intravenous inotropes > 14 days
- Right ventricular assist device

Avoiding RV Failure

- Appropriate Timing of Surgery
- Optimizing myocardial protection
- Selective Use of Pulmonary Vasodilators
- Avoiding liberal transfusion strategies
 - Avoiding old blood products

Timing

- Things out of our control
 - Valvular Induced pre-op RV failure
 - Someone waited too long
- Acute RV infarction
 - 1 month wait to allow for RV recovery

Surgical Technique

- Choice and route of cardioplegia
- Choice of bypass graft targets
 - For long term revascularization
 - Improve myocardial protection
- Addition of tricuspid repair
- Atrial and ventricular wires



Cardioplegia

- Beware the RCA obstruction
- Retrograde cardioplegia caveats
 - Thebesian vessels
- Data on choice of plegia still to come

Pulmonary Vasodilation

- Nitric Oxide
- Inhaled Prostaglandins
- Other inhaled agents
- Timing of use

Nitric Oxide

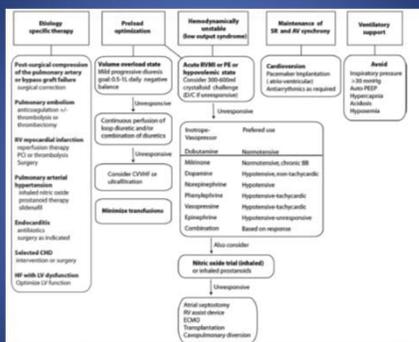
- Primary pulmonary vasodilator
 - No effect on systemic circulation
- V-Q matching
- Reduced RV afterload
- Negatives-
 - Methemoglobinemia
 - Cost
 - Weaning required

Inhaled Prostagladins

- Epoprostenol (prostaglandin I₂)
- Similar effects as NO
 - Longer half life
- Negative
 - Potential for impaired platelet aggregation

Inhaled Milrinone

- Phosphodiesterase type III inhibitor
- Inhaled has reduced effect on SVR and MAP
 - With maintaining increased CO, PAP, and PVR reduction
 - Limited studies



Haddad et al Anesth Analg 2009

AV Synchrony

- Sinus Rhythm maintenance
 - Cardioversion
 - Anti-arrhythmics
- Atrial pacing wires in high risk patients

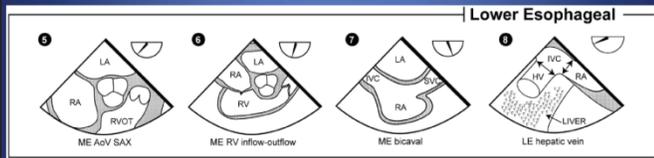
Inotropic Support

- Is there evidence for one inotropic agent?
- Pros/Cons
 - Dobutamine
 - Milrinone
 - Epinephrine
 - Vasopressin
 - Norepinephrine

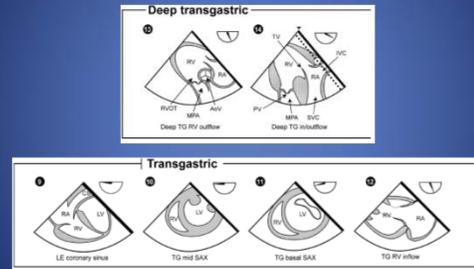
Echocardiography

- Evaluating the RV
 - Modified 4 chamber
 - RV inflow-outflow
 - Bicaval (for Tricuspid Jet doppler)
- Transgastric
 - Short and long axis
 - Modified view

Esophageal Views



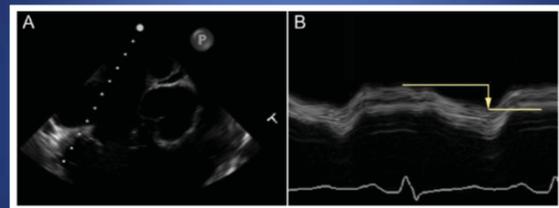
Transgastric Views



RV Assessment

- Tricuspid Annular Plane systolic excursion (TAPSE)
 - Modified deep transgastric long index
- RV Fractional Area Change (FAC)
- Tei index/ RV index of myocardial performance (RIMP)
 - Tissue doppler
- 3D TEE
- Speckle tracking and strain

TAPSE Image



Tei Index

- Image to be added

Echocardiography Caveats

- Imaging modality matters
- 2D vs 3D
 - Changes in RV long axis performance

Mechanical Support Options

- Impella
- RVAD
- ECMO

- Outcomes data

Summary

- RV failure is rare but can be catastrophic
- Beware of pre-operative RV dysfunction
- Many factors are under surgeon's control
- Intraoperative TEE will help guide your decision making
- Inotropes and vasopressors each have pros and cons

- There is no perfect solution!

Friday

The Changing Landscape of Opioid Analgesics: An FDA Perspective

Jeffrey L. Galinkin MD, FAAP
Professor of Anesthesiology and Pediatrics
University of Colorado, AMC

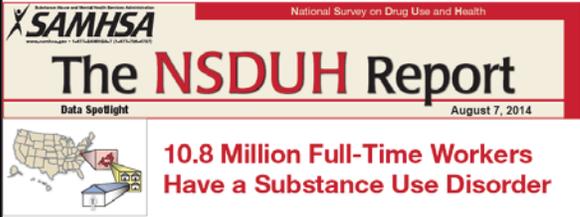
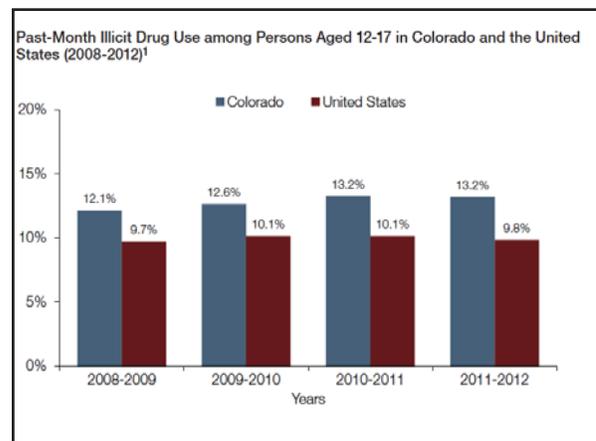
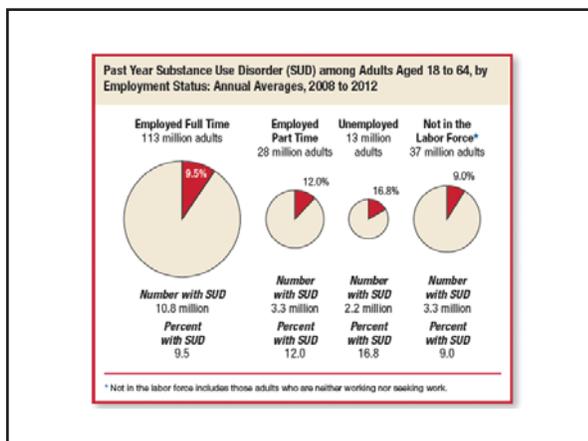


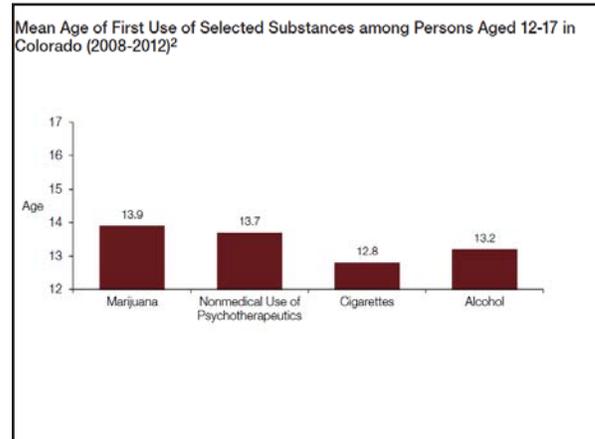
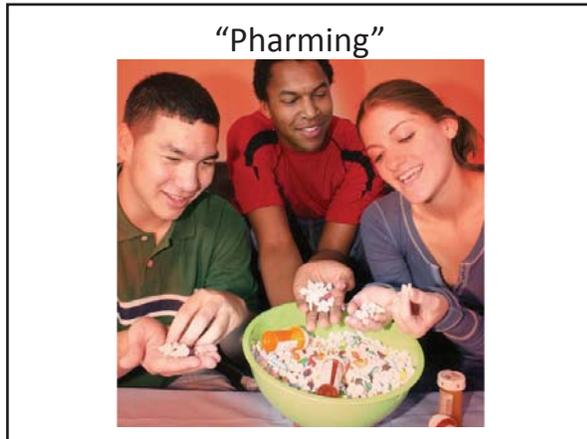

Disclosures

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

Objectives

1. Understand the need for new formulations of opioids.
2. Develop an understanding of new opioid anti-abuse technologies.
3. Understand what REMS are and why they are needed.
4. Understand the rationale for naloxone dosing.



Differentiation

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

Differentiation

- **Medical Misuse of Prescription Opioids**
 - Refers to engaging in behaviors not intended by the prescriber such as using too much to get high
- **Non-Medical Use of Prescription Opioids (NMUPO)**
 - Refers to the non-prescribed use of opioids
 - 7 out of 10 people who reported lifetime use of opioids intranasally screened positive for past year drug abuse.

Addiction behavior 2007, 32:562-5

How many drugs are out there?

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

Pain Physician: July Special Issue 2012

The US and Synthetic Opioids

- In 2007 the US constitutes 4.6% of the world population.
- In 2007 we consumed 83% of the worlds oxycodone and 99% of the worlds hydrocodone.

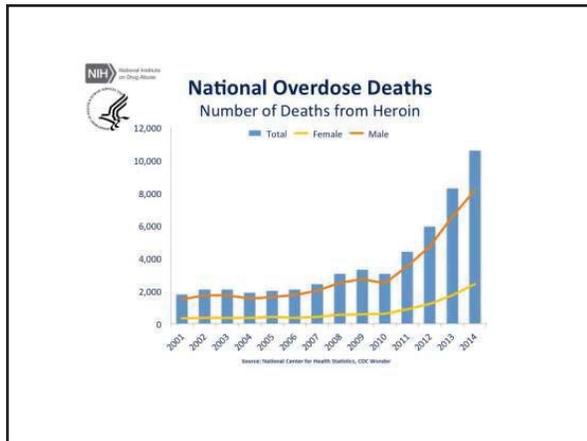
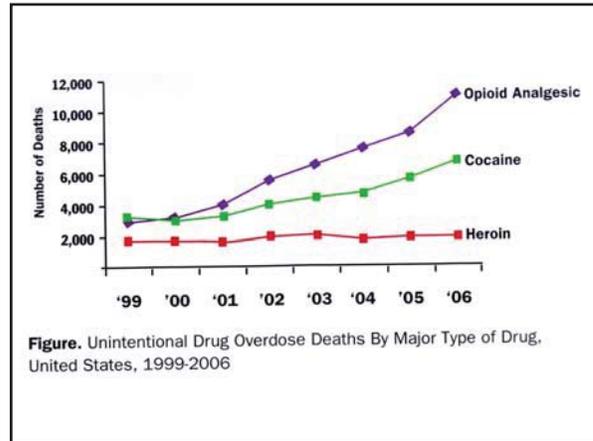
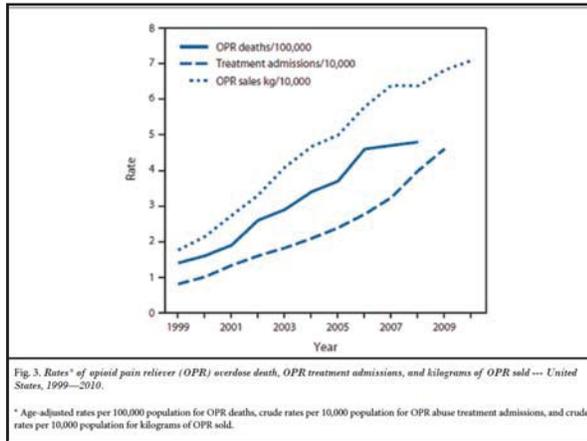


Table 1. Nonmedical Use of Prescription Pain Relievers in the Past Year among Persons Aged 12 or Older, by Quintile and State: 2010-2011

Quintile and State	Percent	95% Confidence Interval
States with Rates between 5.33 and 6.37		
Oregon	6.37%	5.25-7.71
Colorado	6.00%	4.96-7.24
Washington	5.75%	4.76-6.92
Idaho	5.73%	4.74-6.91
Indiana	5.68%	4.68-6.89
Arizona	5.66%	4.60-6.94
Nevada	5.62%	4.57-6.89
Delaware	5.61%	4.61-6.82
Arkansas	5.55%	4.60-6.68
New Mexico	5.45%	4.47-6.64

National Survey on drug use and health SAMHSA, Jan 2013

TABLE 15
Trends in Availability of Drugs as Perceived by 8th Graders

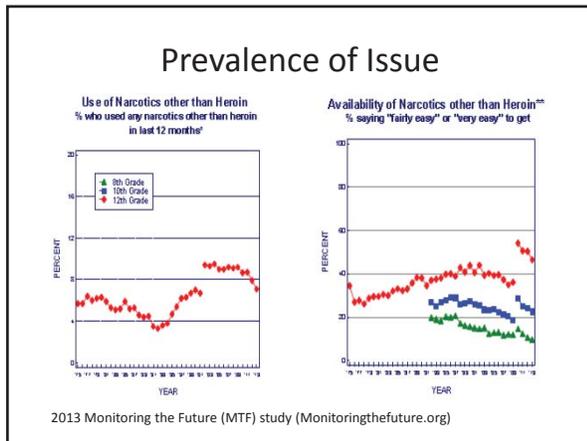
From: [http://www.ahrq.gov/research/publications/availability/availability.pdf](#)

Drug	1995	2000	2005	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
Aspirin	100	100	100	100	100	100	100	100	100	100	100	100	100	100
Acetaminophen	100	100	100	100	100	100	100	100	100	100	100	100	100	100
Codeine	100	100	100	100	100	100	100	100	100	100	100	100	100	100
Hydrocodone	100	100	100	100	100	100	100	100	100	100	100	100	100	100
Oxycodone	100	100	100	100	100	100	100	100	100	100	100	100	100	100
Tramadol	100	100	100	100	100	100	100	100	100	100	100	100	100	100
Propofol	100	100	100	100	100	100	100	100	100	100	100	100	100	100
Midazolam	100	100	100	100	100	100	100	100	100	100	100	100	100	100
Valium	100	100	100	100	100	100	100	100	100	100	100	100	100	100
Xanax	100	100	100	100	100	100	100	100	100	100	100	100	100	100
Alprazolam	100	100	100	100	100	100	100	100	100	100	100	100	100	100
Clonazepam	100	100	100	100	100	100	100	100	100	100	100	100	100	100
Lorazepam	100	100	100	100	100	100	100	100	100	100	100	100	100	100
Phenobarbital	100	100	100	100	100	100	100	100	100	100	100	100	100	100
Chloralhydrate	100	100	100	100	100	100	100	100	100	100	100	100	100	100
Propofol	100	100	100	100	100	100	100	100	100	100	100	100	100	100
Midazolam	100	100	100	100	100	100	100	100	100	100	100	100	100	100
Valium	100	100	100	100	100	100	100	100	100	100	100	100	100	100
Xanax	100	100	100	100	100	100	100	100	100	100	100	100	100	100
Alprazolam	100	100	100	100	100	100	100	100	100	100	100	100	100	100
Clonazepam	100	100	100	100	100	100	100	100	100	100	100	100	100	100
Lorazepam	100	100	100	100	100	100	100	100	100	100	100	100	100	100
Phenobarbital	100	100	100	100	100	100	100	100	100	100	100	100	100	100
Chloralhydrate	100	100	100	100	100	100	100	100	100	100	100	100	100	100

Trends in Availability of Drugs as Perceived by 12th Graders

From: [http://www.ahrq.gov/research/publications/availability/availability.pdf](#)

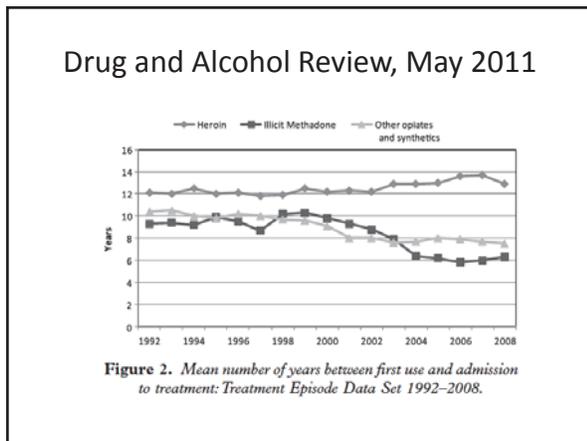
Drug	1995	2000	2005	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
Aspirin	100	100	100	100	100	100	100	100	100	100	100	100	100	100
Acetaminophen	100	100	100	100	100	100	100	100	100	100	100	100	100	100
Codeine	100	100	100	100	100	100	100	100	100	100	100	100	100	100
Hydrocodone	100	100	100	100	100	100	100	100	100	100	100	100	100	100
Oxycodone	100	100	100	100	100	100	100	100	100	100	100	100	100	100
Tramadol	100	100	100	100	100	100	100	100	100	100	100	100	100	100
Propofol	100	100	100	100	100	100	100	100	100	100	100	100	100	100
Midazolam	100	100	100	100	100	100	100	100	100	100	100	100	100	100
Valium	100	100	100	100	100	100	100	100	100	100	100	100	100	100
Xanax	100	100	100	100	100	100	100	100	100	100	100	100	100	100
Alprazolam	100	100	100	100	100	100	100	100	100	100	100	100	100	100
Clonazepam	100	100	100	100	100	100	100	100	100	100	100	100	100	100
Lorazepam	100	100	100	100	100	100	100	100	100	100	100	100	100	100
Phenobarbital	100	100	100	100	100	100	100	100	100	100	100	100	100	100
Chloralhydrate	100	100	100	100	100	100	100	100	100	100	100	100	100	100
Propofol	100	100	100	100	100	100	100	100	100	100	100	100	100	100
Midazolam	100	100	100	100	100	100	100	100	100	100	100	100	100	100
Valium	100	100	100	100	100	100	100	100	100	100	100	100	100	100
Xanax	100	100	100	100	100	100	100	100	100	100	100	100	100	100
Alprazolam	100	100	100	100	100	100	100	100	100	100	100	100	100	100
Clonazepam	100	100	100	100	100	100	100	100	100	100	100	100	100	100
Lorazepam	100	100	100	100	100	100	100	100	100	100	100	100	100	100
Phenobarbital	100	100	100	100	100	100	100	100	100	100	100	100	100	100
Chloralhydrate	100	100	100	100	100	100	100	100	100	100	100	100	100	100



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

	2010	2011	2012	2013
Try any narcotic other than heroin (codeine, Vicodin, OxyContin, Percocet, etc.) once or twice	40.4	39.9	38.4	43.1
Take any narcotic other than heroin occasionally	54.3	54.8	53.8	57.3
Take any narcotic other than heroin regularly	74.9	75.5	73.9	75.8

Monitoring the future report 2013



A Proactive Response to Prescription Opioid Abuse

Robert Califf et al, NEJM 374:15
April 14, 2016

Issue	FDA Response
Reducing individual need and societal risk. Patients responsible for the rise in opioid use must be protected from the effects of illicit drugs.	The FDA will consult with partners including the National Academy of Medicine to establish a framework for opioid use, approval, and monitoring that respects individual choice but also protects the public health consequences of opioid abuse and misuse.
Meeting the need for timely action. The evolving clinical of opioid abuse requires a flexible response approach until the full policy framework is developed.	The FDA Science Board will convene in March to advise on the role of pharmacovigilance in pain management, development of alternative pain medications, and post-marketing surveillance activities. Multiple other actions will be taken over the next several months, including an evaluation of the existing drug labeling and regulatory (DRUG) requirements for analgesic-release long-acting (ER/LA) opioids. The agency continues to evaluate the status and offer additional regulatory guidance regarding the scope and content of prescriptive information and to support the FDA program and risk prevention activities necessary to improve patient safety and public health.
Reducing health and promoting overall well-being. Patients, clinicians, and manufacturers are required to conduct post-marketing public surveillance and research studies, but these measures may need to be enhanced.	The FDA will continue to support adverse event reporting, reporting the requirements for drug companies to generate post-market risk assessment reports. The FDA will also continue to support the development of alternative pain medications and to provide guidance on the safety and abuse associated with long-acting oral and injectable opioids, and other important issues.
Phasing down delivery formulations and strengthening delivery formulations. The FDA will also continue to support the development of alternative pain medications and to provide guidance on the safety and abuse associated with long-acting oral and injectable opioids, and other important issues.	The FDA will continue to support adverse event reporting, reporting the requirements for drug companies to generate post-market risk assessment reports. The FDA will also continue to support the development of alternative pain medications and to provide guidance on the safety and abuse associated with long-acting oral and injectable opioids, and other important issues.
Addressing the lack of recognized alternatives for pain management. Although recognized alternatives for chronic pain have recently been approved for market, more alternatives are needed, including nonpharmacologic treatments.	The FDA is working closely with industry and the National Institutes of Health to develop the next generation of pain management approaches for pain treatment that are safe and effective.
Creating clear guidelines for opioid use. The current regulatory framework for opioids is complex and often inconsistent, making it difficult for clinicians and patients to understand the appropriate use and management.	The FDA is supporting the CDC's guidance for prescribing opioids for chronic pain. The FDA also supports the Drug Research and Innovation Act, which will provide guidance on the safety and abuse associated with long-acting oral and injectable opioids, and other important issues.
Managing pain in children. Use of opioid medications in children with severe and chronic pain conditions requires special considerations. The FDA will continue to evaluate the safety and effectiveness of these medications in children, and will continue to work with industry and the Pediatric Research Equity Act to ensure that children have access to safe and effective pain management options.	An FDA Pediatric Advisory Committee will address the use of opioid medications in children, including the development of high-quality evidence to guide treatment and provide guidance on the safety and abuse associated with long-acting oral and injectable opioids, and other important issues.
Developing a better evidence base. Opioid use in pregnancy is associated with a higher risk of stillbirth, and the use of long-term use, or substantially long.	Health and Human Services agencies and the FDA program for non-pharmaceutical approaches to pain management are developing a coordinated plan to conduct research that will provide evidence to guide clinical practice and the development of pain management approaches to pain prevention and management.

- ## The FDA will:
- Re-examine the risk-benefit paradigm for opioids and ensure that the agency considers their wider public health effects
 - Convene an expert advisory committee before approving any new drug application for an opioid that does not have abuse-deterrent properties;
 - Assemble and consult with the Pediatric Advisory Committee regarding a framework for pediatric opioid labeling before any new labeling is approved;
 - Develop changes to immediate-release opioid labeling, including additional warnings and safety information that incorporate elements similar to the extended-release/long-acting (ER/LA) opioid analgesics labeling that is currently required.
 - Support better pain management options, including alternative treatments.

The FDA will:

- Expand access to, and encourage the development of, abuse-deterrent formulations of opioid products;
- Update Risk Evaluation and Mitigation Strategy requirements for opioids after considering advisory committee recommendations and review of existing requirements;
- Improve access to naloxone and medication-assisted treatment options for patients with opioid use disorders; and

Making opioids safer

- “The development of abuse-deterrent opioid analgesics is a public health priority for the FDA,” Douglas Throckmorton, M.D., deputy director for regulatory programs CDER.

FDA news release April 16, 2013

How Do You Reformulate Opioids to be “Abuse Deterrent”?

General Principles for Evaluating the Abuse Deterrence of Generic Solid Oral Opioid Drug Products Guidance for Industry

Additional copies are available from:
Office of Communications, Division of Drug Information,
Center for Drug Evaluation and Research,
Food and Drug Administration,
10801 New Hampshire Ave., Bethesda, MD, 4th Floor,
Silver Spring, MD 20901-0002
Phone: 855-543-5734 or 301-796-1080; Fax: 301-431-0333
druginfo@fda.hhs.gov <http://www.fda.gov/Drugs/Guidance/ComplianceandRegulatoryInformation/Guidances/default.htm>

U.S. Department of Health and Human Services
Food and Drug Administration
Center for Drug Evaluation and Research (CDER)

November 2017
Generic

Routes of Abuse

- Injection: Can you manipulate a pill and make easy to inject?
- Insufflation: (snorting) Can you manipulate a pill and make it easy to insufflate?
- Smoking: Can a pill be inhaled/smoked in either an intact or manipulated form?
- Ingestion: Does manipulating a pill make it more bioavailable when orally taken?

Approach to Evaluation

- Tier-based approach
- Performance based evaluation of abuse deterrence
- Most effective manipulation
- Sample selection after physical manipulation
- Comparing abuse deterrent formulation to reference product in extraction studies
- Statistical comparison of new to old formulation

Approaches to Reformulation



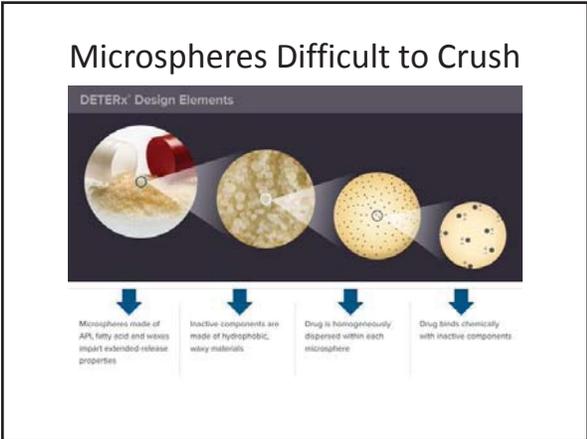
Big pill difficult to crush

“OXYCONTIN is formulated with inactive ingredients intended to make the tablet more difficult to manipulate for misuse and abuse.”

Oxycontin Package Insert

In vitro physical and chemical tablet manipulation studies were performed to evaluate the success of different extraction methods in defeating the extended-release formulation.

- Increase in the ability of OXYCONTIN to resist crushing, breaking, and dissolution using a variety of tools and solvents.
- When subjected to an aqueous environment, OXYCONTIN gradually forms a viscous hydrogel (i.e., a gelatinous mass) that resists passage through a needle.



Microspheres Difficult to Crush

- XTAMPZA ER capsules contain microspheres formulated with inactive ingredients intended to make the formulation more difficult to manipulate for misuse and abuse.
- Relative to immediate-release oxycodone tablets, XTAMPZA ER is less susceptible to the effects of grinding, crushing, and extraction using a variety of tools and solvents.
- XTAMPZA ER resisted attempts to pass the melted capsule contents or the microspheres suspended in water through a hypodermic needle.

Oxycodone ER: Reformulated

- “While both original and reformulated OxyContin are subject to abuse and misuse, the FDA has determined that reformulated OxyContin can be expected to make abuse by injection difficult and expected to reduce abuse by snorting compared to original OxyContin.”

Douglas Throckmorton, MD

FDA news release April 16, 2013

Oxymorphone ER (Opana)

“...Increased ability of the reformulated version of Opana ER to resist crushing relative to the original formulation.

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

FDA statement May 10, 2013

Roxybond

RoxyBond is the first and only FDA-approved immediate-release opioid medication with abuse-deterrent claims in its approved labeling language

SentryBond™is formulated with inactive ingredients that make the tablet more difficult to manipulate for misuse and abuse, even if subjected to physical manipulation and/or chemical extraction.

Other Crush resistant formulations

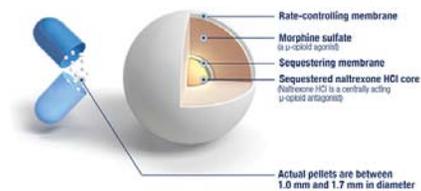
- Morphabond ER (Morphine)
- Arymo ER (Morphine)
- Vantrela ER (12 hour Hydrocodone)
- Hysingla ER (24 hour Hydrocodone)

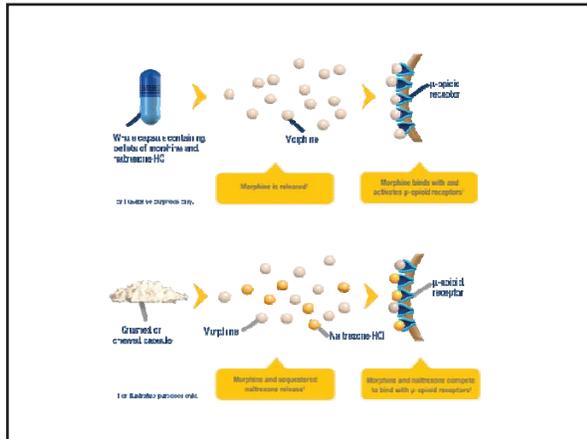
<https://www.fda.gov/Drugs/DrugSafety/InformationbyDrugClass/ucm337066.htm>

Combining an Opioid and Antagonist

Morphine/naltrexone (Embeda)

- Embda approved on November 4, 2013





Other products?

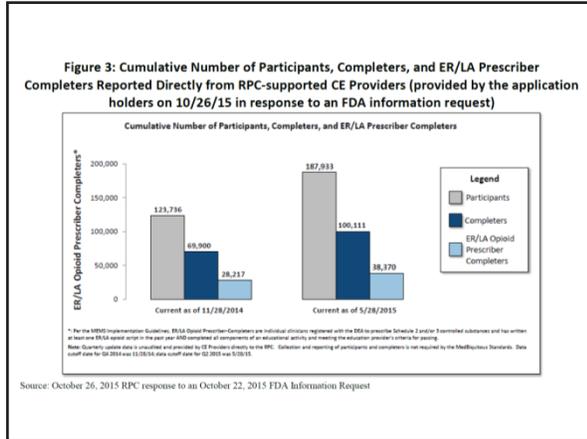
- Troxyca ER (Oxycodone/Naltrexone) and Targiniq (Oxycodone/Naloxone) have both been discontinued for now.

Other products?

- KemPharm tried to re-engineer hydrocodone to impart abuse-deterrent properties at a molecular level.
- Benzhydrocodone: Bonded hydrocodone to benzoic acid, a widely used food preservative.
- Benzhydrocodone was not pharmacologically active, but had to be metabolized into hydrocodone by enzymes in the intestinal tract to deliver its pharmacologic effects.

FDA website

FDA Briefing Document
 Joint Meeting of the Drug Safety and Risk Management (DSaRM) Advisory Committee and the Anesthetic and Analgesic Drug Products Advisory Committee (AADPAC)
 May 3-4, 2016
 Extended-release and Long-acting (ER/LA) Opioid Analgesics Risk Evaluation and Mitigation Strategy (REMS)



FDA’s Opioid Analgesic REMS Education Blueprint for Health Care Providers Involved in the Treatment and Monitoring of Patients with Pain (January 2018)

Opioid REMS

- To include both ER/LA products and IR products
- Intended to support other national efforts underway to address the misuse and abuse of prescription opioid analgesics

As part of the Opioid Analgesic REMS, all opioid analgesic companies must provide the following:

- Education for healthcare providers (HCPs) who participate in the treatment and monitoring of pain.
 - Education will be offered through accredited continuing education (CE) activities via unrestricted educational grants from opioid analgesic companies.
- Information for HCPs to use when counseling patients about the risks of ER, LA, and IR opioid analgesic use.

Too Tall a Task?

- The fundamental concepts of pain management, including definitions and mechanisms of pain
- How to assess patients in pain, identifying risk factors for abuse and addiction
- The range of therapeutic options for managing pain, including nonpharmacologic approaches and pharmacologic (non-opioid and opioid analgesics) therapies
- How to integrate opioid analgesics into a pain treatment plan individualized to the needs of the patient
- How to safely and effectively manage patients on opioid analgesics in the acute and chronic pain settings, including initiating therapy, titrating, and discontinuing use of opioid analgesics
- How to counsel patients and caregivers about the safe use of opioid analgesics, including proper storage and disposal
- How to counsel patients and caregivers about the use of naloxone for opioid overdose
- When referral to a pain specialist is appropriate
- The fundamental elements of addiction medicine
- How to identify and manage patients with opioid use disorder

Result of REMS Trial

- Respondents were knowledgeable about management and counseling requirements for patients being considered for treatment or currently being treated with ER/LA opioid analgesics.
- Respondents were less knowledgeable about assessment of patients, initiation and modification of treatment, and general and product specific information for ER/LA opioid analgesics.
- Since participating in a REMS-compliant activity, respondents reported more often conducting appropriate prescriber behaviors

Result of REMS Trial

- Half of respondents reported no changes in opioid prescribing behaviors since participating in the CE activity.
- 22% reported writing prescriptions for ER/LA opioid analgesics less often.
- 19% reported writing more ER/LA opioid analgesics prescriptions.
- 38% of respondents reported prescribing more non-opioid medications.
- 23% reported limiting which ER/LA opioid analgesics they prescribe.
- 32% of respondents reported no changes in the types of medications prescribed.



Clinical and Regulatory Perspectives on Naloxone Products Intended for Use in the Community

Joint Meeting of the Anesthetic and Analgesic Drug Products Advisory Committee and the Drug Safety and Risk Management Advisory Committee
October 5, 2016

Jennifer Nadel, MD
Medical Officer
FDA/CDER/OND

Division of Anesthesia, Analgesia, and Addiction Products

Inside the FDA meeting

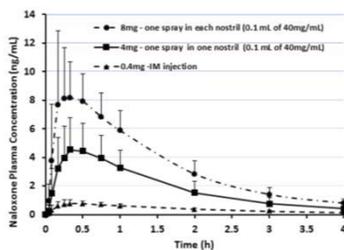
- New concerns over high potency illicit opioids requiring higher doses of naloxone
- We now have companies approaching us about different dosing regimens for these products
- FDA is seeking advice on how to approach these new questions
 - Is our minimum standard high enough?
 - Is there a place for products of different doses/strengths?
 - How would we label a product so a prescriber would know which to choose?

FDA Website

Regulatory Path Forward

- Infeasible to study minimal effective dose, or conduct efficacy trial
 - Life-threatening nature of opioid overdose
 - Ethical and logistical issue
- Reliance on Agency's previous findings for approved Naloxone Injection
- To establish a scientific bridge via relative bioavailability study between new product and the reference

Concentration-time Profiles



- Similar T_{max}
- Higher C_{max} and AUC (~5-fold) for 4 mg Nasal Spray

www.fda.gov

12

Questions for the Committee

The current pharmacokinetic standard for the approval of naloxone products for use in the community requires demonstration of comparable or greater naloxone levels compared to a minimum dose of 0.4 mg of approved naloxone injection administered by one of the labeled routes of administration.

- a. If you support a different pharmacokinetic standard, describe the rationale for this approach.
- b. Discuss whether this minimum standard for approval is sufficient to address the management of the variety of opioid overdose situations arising in the community or if there is a role for more than one standard for different anticipated situations.

Questions for the Committee

Different sponsors have proposed different strength doses for their naloxone products intended for use in the community and some have proposed marketing more than one dose strength. Discuss whether there are factors that support different dosing strengths, and how that can be reflected in labeling to assist clinicians in product selection.

Questions for the Committee

Both children and adults may be at risk for opioid overdose in the home. The current approach has been to require that naloxone products for community use are appropriate for both adult and pediatric use to minimize the risk of product confusion when treating an overdose in the home. Strictly following the pediatric dosing recommendations from the American Academy of Pediatrics (AAP) would require a minimum dose of 2 mg, higher than the current standard for adult products.

- a. Discuss whether there should be products specifically targeting naloxone dosing for children based on the AAP recommendations.
- b. Discuss whether the standard for approval of naloxone products for use in the community should reflect pediatric dose requirements, and comment on the implications for use of these products in adults.
- c. Discuss whether it is acceptable to have different adult and pediatric products available in the home, and how to weigh the risk for product confusion.

Results

- High degree of controversy over whether dose increase is necessary
- Overall the committee recommended increasing the standard dose.

Conclusions

- The FDA does have a plan to combat opioid diversion.
- The plan is limited in scope.
- REMS programs are going to become much more prevalent for all prescribers of opioids.
- We as anesthesiologists will have a duty to educate other providers as experts.



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CRASH 2018

Update in Cardiothoracic Anesthesiology and Perioperative Care

Karsten Bartels, MD



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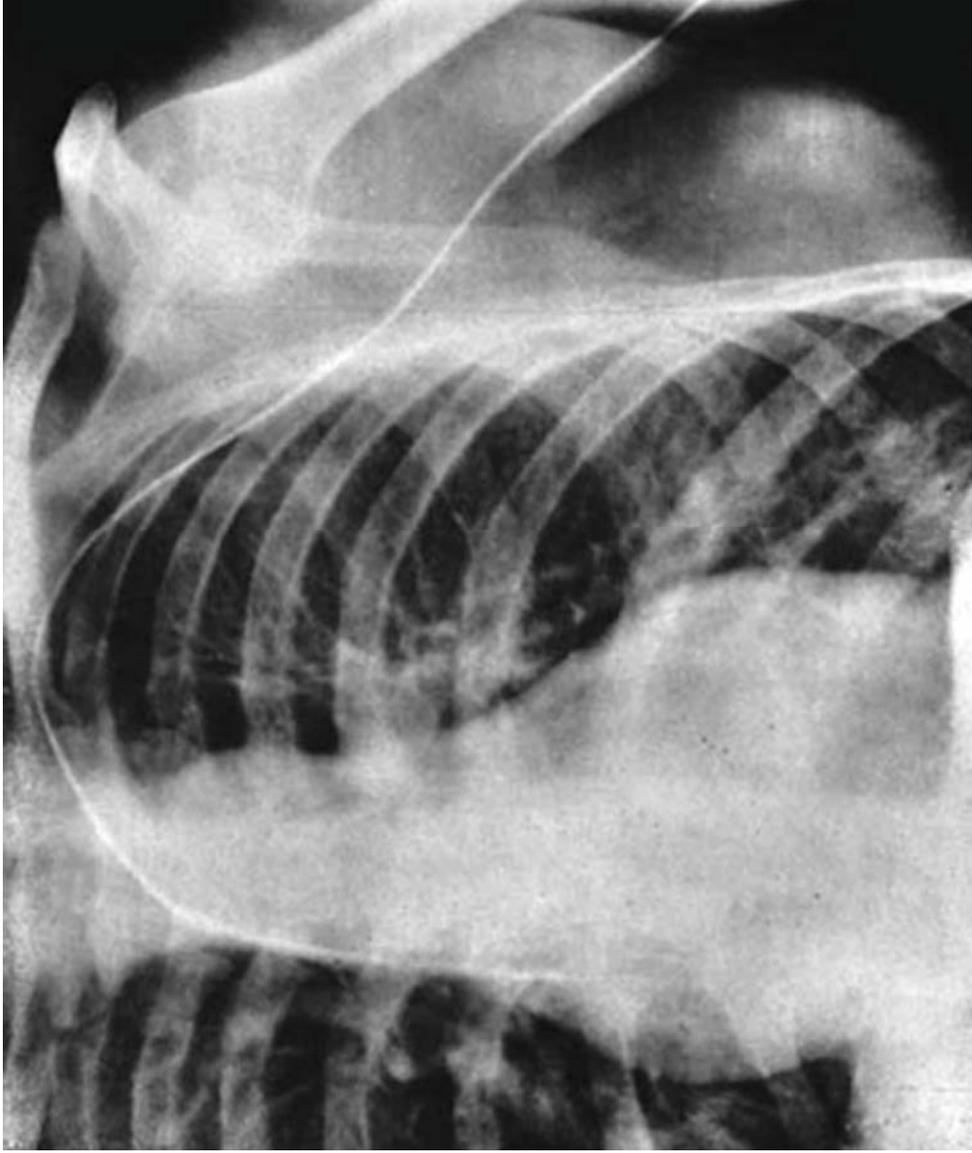
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Disclosures



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Forßmann W (1929) Die Sondierung des Rechten Herzens. Klin Wochenschr 8(45):2085–2087



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The PAC Debate

- Sandham et. al. N Engl J Med 348: 5, 2003 (1994 patients)
 - RCT of “high-risk” scheduled for urgent or elective major surgery, followed by a stay in an ICU. No mortality difference. More PEs in the PAC group. (p=0.004). **Goals for CI and DO₂ were met by 79% and 63% of patients, respectively, after surgery.**
- Warszawski J et. al. JAMA 290: 2713, 2003 (676 patients)
 - RCT of patients who fulfilled the criteria for shock, ARDS, or both conducted in 36 French ICUs. Patients randomly assigned to PAC (n = 335) or not (n = 341). **Treatment was left to the discretion of each individual physician.** No significant differences in mortality at any time point.
- Harvey S et. al. Lancet 366: 472, 2005 (1041 patients)
 - RCT from 65 UK ICUs, assigned to management with (n=519) or without (n=522) a PAC. **“Clinical management after randomization was at the discretion of the treating clinician.”** No difference in mortality. 46 complications associated with insertion of a PAC, none of which was fatal.

All of these trials either failed to achieve the structured hemodynamic goals in the treatment group (Sandham), or worse, did not provide any guidance for the clinician in terms of how to actually use the device.



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Central Thermodilution

- In Animals: Primarily compared using regression-based statistical methods

Thermodilution versus...	Direct Fick $\dot{Q} = \dot{V}O_2 / (CaO_2 - CvO_2)$	Electromagnetic Flowmeter	Transit Time Flow Probes
Correlation Coefficient (number of independent measurements)	0.96 (48) 0.96 (32) 0.94 (80) 0.97 (130) 0.95 (6) 0.94 (52)	0.98 (87) 0.97 (120) 0.95 (128) 0.98 (82) 0.92 (75) 0.96 (62) 0.85 (75) 0.79 (210) 0.87 (72) 0.97 (39) 0.84 (45) 0.88 (128)	0.90 (70) 0.90 (95) 0.93 (366)



Central Thermodilution

- In Humans: Primarily compared using regression-based statistical methods

Thermodilution versus...	Direct Fick	EMF	TT Flow Probe	
Correlation Coefficient (and number of independent measurements)	0.90 (11) 0.70 (77) 0.91 (23) 0.91 (26) 0.83 (50) 0.86 (57) 0.98 (43) 0.92 (32) 0.86 (237) 0.95 (50) 0.94 (42) 0.83 (72)	0.96 (99) 0.68 (50) 0.81 (73) 0.94 (180) 0.85 (51) 0.85 (136) 0.84 (48) 0.84 (22) 0.84 (42) 0.84 (15) 0.84 (30)	0.80 (46)	0.55 (170)



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Central Thermodilution

- Conclusions
 - Large number of studies in both animals models and humans
 - More than any other available technology
 - Across a range of hemodynamic conditions not possible in human volunteer studies
 - Extremely accurate when compared to invasive gold-standards
 - ***Accuracy ≠ utility***



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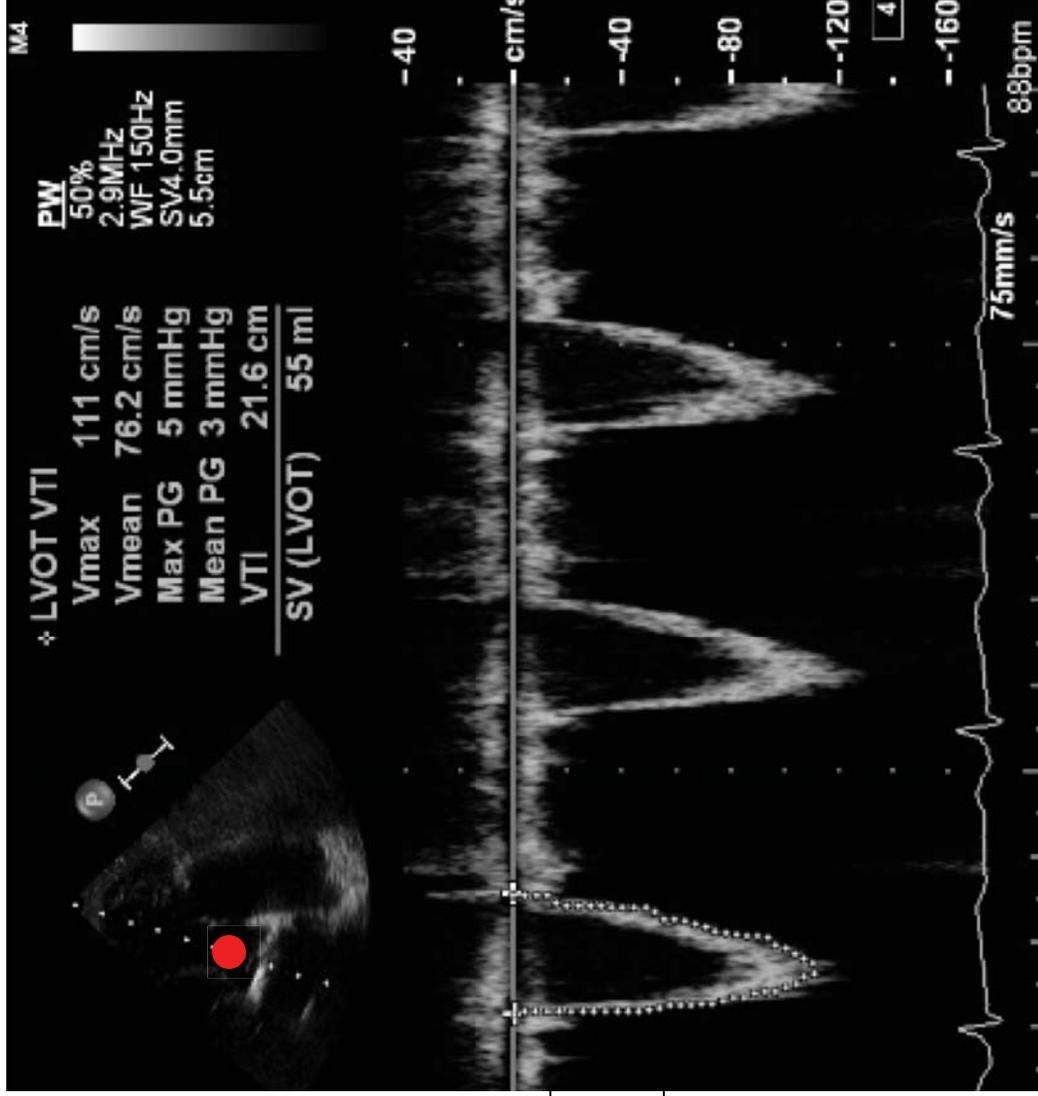
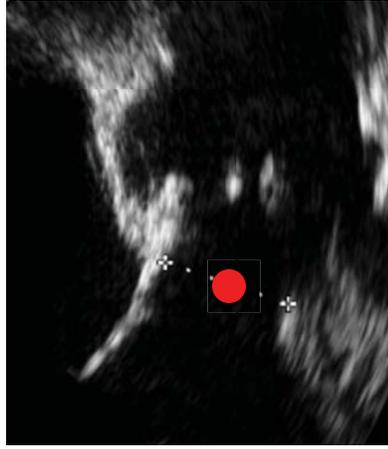
Doppler





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$$SV = VTI * CSA$$

SV= Stroke Volume

VTI = Velocity Time Integral

CSA = Cross Sectional Area



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Doppler in Humans

Doppler versus...	Direct Fick		Thermodilution	
	Surface Doppler	0.83 (11) 0.98 (33) 0.78 (28) 0.89 (85) 0.76 (12) 0.85 (14) 0.86 (52)	0.81 (42) 0.91 (20) 0.94 (22) 0.90 (73) 0.89 (46) 0.96 (20)	0.44 (18) 0.94 (110) 0.51 (416) 0.84 (52) 0.94 (53) 0.97 (10) 0.94 (12) 0.84 (17)
Esophageal Doppler	0.89 (67) 0.76 (12) 0.89 (46)		0.95 (136) 0.81 (40) 0.80 (96) 0.99 (96)	



TABLE 1. Simultaneous Comparisons of Thermodilution and Doppler to Reference Standards

Study/Author	Subjects	n	Doppler	n	TDCO
Fick					
Welch (31)	Pigs	28	0.88	28	0.91
Christie (65)	Humans	42	0.81	42	0.94
Gola (55)	Humans	73	0.9	73	0.81
Electromagnetic flow meter					
Gregoretti (34)	Pigs	128	0.87	128	0.95
Segal (39)	Sheep	341	0.89	81	0.85
Heerdt (41)	Humans	46	0.64	46	0.8
Segal (269)	Humans	44	0.82	44	0.85
Transit time flow meter					
Wong (81) ^a	Dogs	95	0.74	95	0.9
AadahI (44)	Pigs	70	0.73	70	0.9
Dicorte (46)	Humans	170	0.49	170	0.55
Bajorat (45)	Pigs	366	0.84	366	0.93
Mean-weighted averages					
			0.80		0.85

^aComparisons between changes in cardiac output, not absolute values. Boldface values are the larger values between Doppler and TDCO in the respective rows.



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Bioimpedance & Bioelectance



<http://www.cheetah-medical.com>



ECOM <http://www.cardiacengineering.com>



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Bioimpedance & Bioreactance

Bioimpedance versus...	Fick	Thermodilution	
Bioimpedance	<p>0.70 (15)</p> <p>0.84 (42)</p> <p>0.90 (25)</p> <p>0.84 (40)</p> <p>0.84 (10)</p> <p>0.61 (416)</p> <p>0.73 (94)</p> <p>0.80 (metaanalysis)</p>	<p>0.61 (411)</p> <p>0.78 (111)</p> <p>0.87 (14)</p> <p>0.87 (19)</p> <p>0.63 (120)</p> <p>0.43 (58)</p> <p>0.86 (201)</p> <p>0.87 (27)</p> <p>0.84 (400)</p> <p>0.86 (842)</p> <p>0.89 (256)</p>	<p>0.08 (24)</p> <p>0.85 (2192)</p> <p>0.28 (109)</p> <p>0.83 (20)</p> <p>0.46 (33)</p> <p>0.35 (11)</p> <p>0.41 (7)</p> <p>0.86 (129)</p> <p>0.49 (160)</p> <p>0.83 (metaanalysis)</p>
Bioreactance		<p>0.90 (27)</p> <p>0.79 (67)</p> <p>0.77 (33)</p>	



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Partial Rebreathing





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<http://www.healthcare.philips.com>

Partial Rebreathing

- Noninvasive
- Shunt fraction is estimated
- Long response time



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Partial Rebreathing

Partial Rebreathing versus... (Humans)	Thermodilution
Partial Rebreathing	<p> 0.78 (20) Suzuki, 2005 0.80 (112) Kotake, 2003 0.62 (36) Racco, 2004 0.63-0.7 (225) Tachibana, 2002 0.34-0.75 (150) Tachibana, 2005 0.42 (140) Allerdant-S., 2009 0.47-0.52 (294) Valiatti, 2004 0.83 (111) Levy, 2004 0.69 (42) van Heerden, 2000 </p>



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Arterial pressure waive form analysis

- Uncalibrated (Flotrac)
- Calibrated (LIDCOPlus), PiCCO



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Arterial Waveform

Arterial Pressure Analysis (Humans)	Thermodilution
LIDCO	0.89 (44) Linton 1993 0.88 (151) Costa 2008 0.82 (220) Mora, 2011
PICCO	0.85 (216) Goedje 1999 0.86 (186) Della Rocca 2002 0.68 (400) Hamzaoui, 2008 0.88 (36) Buhre, 1999 0.73 (375) Gust 1998
FloTrac / Vigileo	0.12 (24) Opdam, 2007 0.66 (166) Cannesson, 2007 0.51 (112) Eleftheriadis, 2009 0.53 (120) Sander, 2006



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Photoplethysmography

- A finger bladder is inflated to maintain the artery in an “unstretched” state
- Finger blood pressure is the monitored continuously
- Pulse contour analysis principles are then applied to determine CO



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Photoplethysmographic BP measurement

Characteristic	Nexfin / ClearSight™	CNAP®
Number of fingers used	1-2	2
Algorithm to account for changes in vasomotor tone	“Physiocal”	“VERIFI”
Algorithm for stroke volume estimation	Pulse contour analysis and biometric calibration	Pulse contour analysis using CNCO®-algorithm and biometric or manual calibration



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When things get ugly...*

- Meng et al.
 - Vigileo-Flotrac vs. esophageal Doppler following hemodynamic manipulation
 - Phenyphrine (afterload)
 - Ephedrine (afterload, contractility)
 - Trendelenberg (preload)

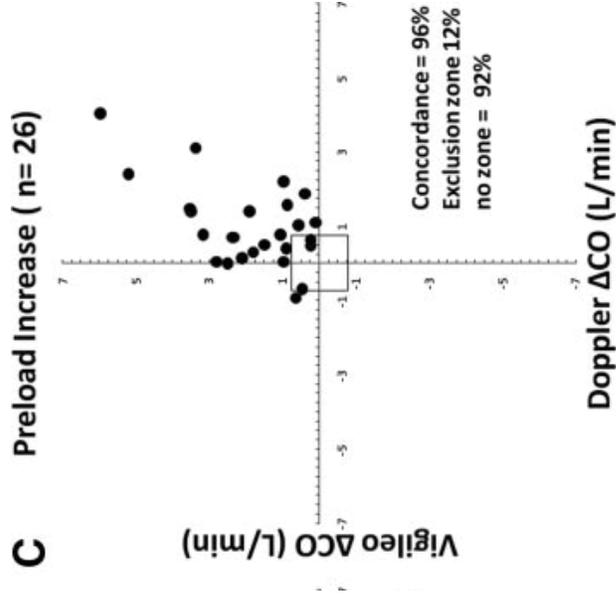
***With special thanks to Bob Thiele, UVA**



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When things get ugly...



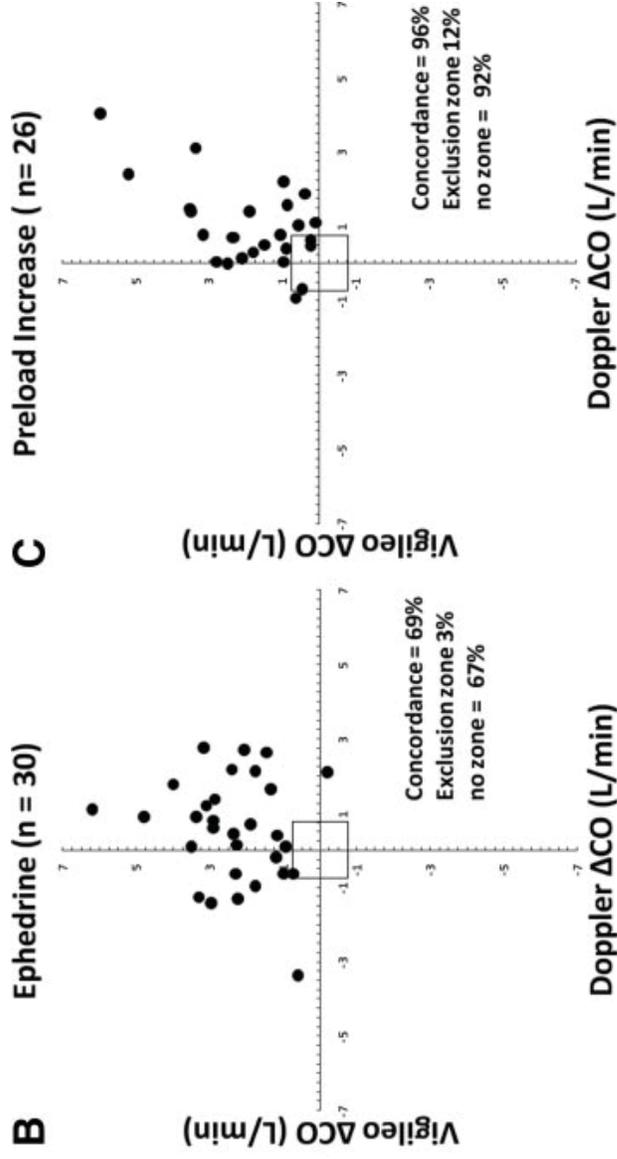
concordance analysis. Δ CO = change in cardiac



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When things get ugly...



inst esophageal Doppler based on 4-quadrant concordance analysis. Δ CO = change in cardiac output).



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When things get ugly...

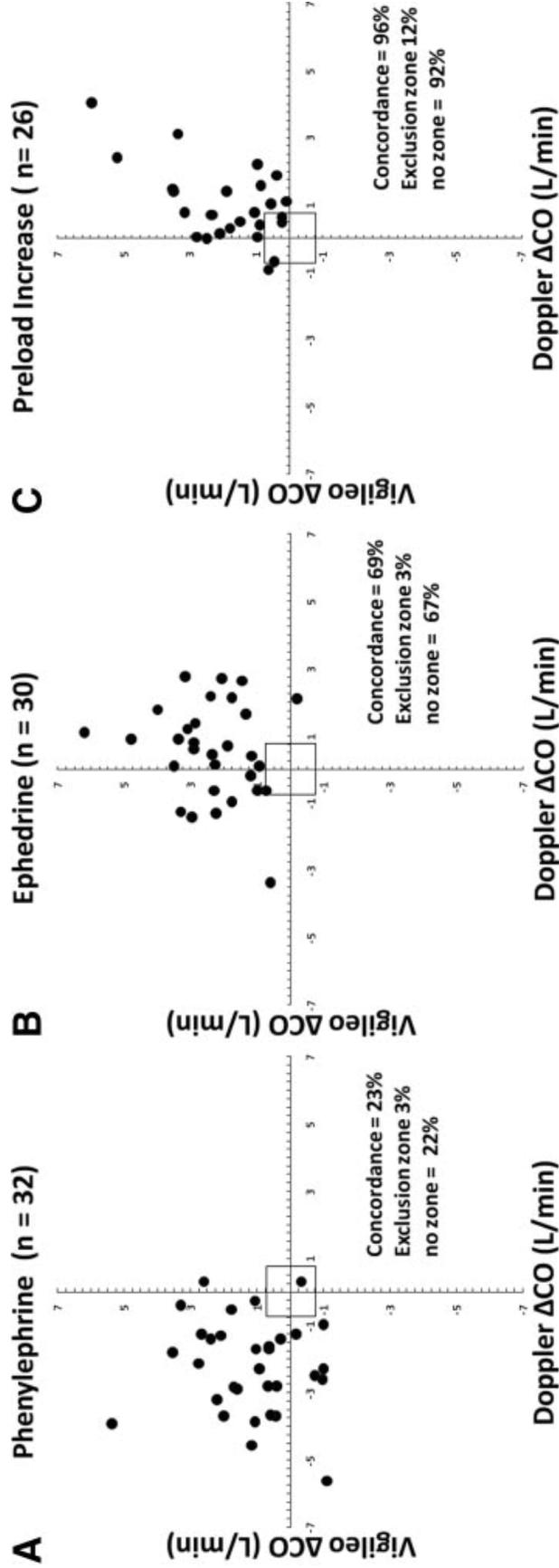


Figure 3. Trending ability of Vigileo-FloTrac against esophageal Doppler based on 4-quadrant concordance analysis. Δ CO = change in cardiac output (postintervention minus preintervention).



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When things get ugly...

- Cooper and Muir
 - PulseCO (uncalibrated) vs. LiDCO (calibrated)
 - Twelve adult dogs
 - Hemorrhagic shock (MAP 30-40 mm Hg for 60 min)
 - Resuscitation with lactated Ringer's solution (MAP 60-70 mm Hg)





When things get ugly...

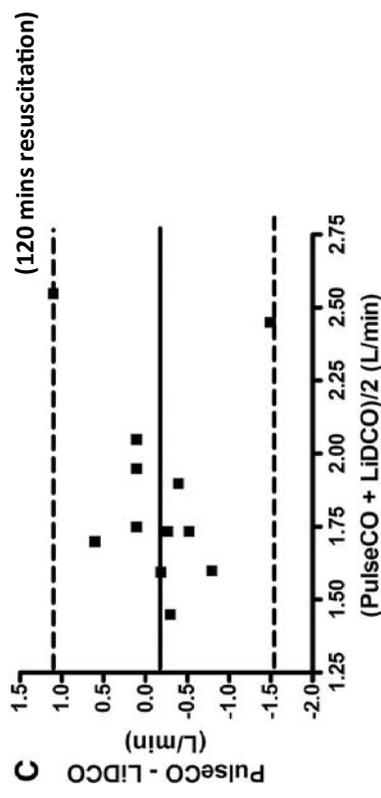
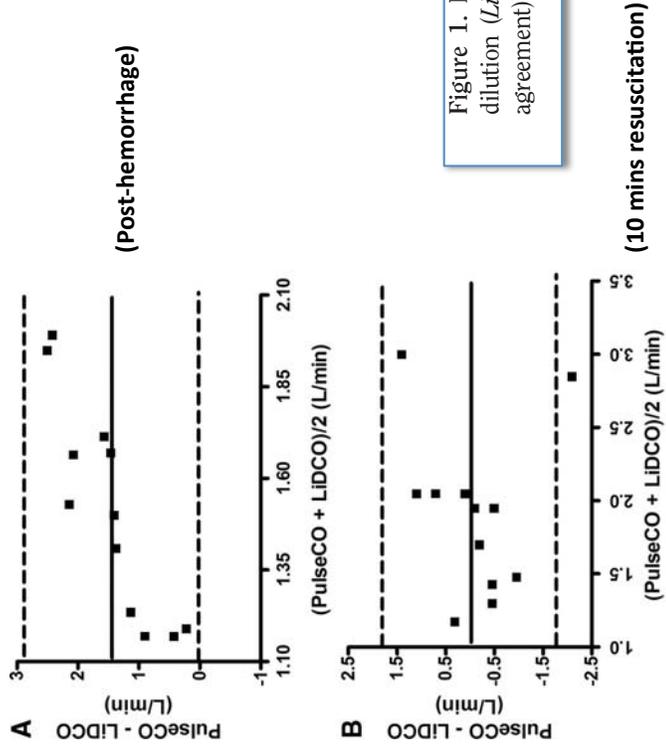


Figure 1. Bland-Altman plot of arterial pressure waveform analysis (PulseCO) and lithium indicator dilution (LiDCO) at various time points. Solid line indicates mean bias, dashed lines ± 2 SD (limits of agreement). Top, posthemorrhage; middle, 10 mins postresuscitation; bottom, 120 mins postresuscitation.



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When things get ugly...

- Johansson and Chew
 - PiCCO (uncalibrated) vs. PiCCO (calibrated)
 - 15 pigs
 - Septic shock (endotoxemia)
 - CO measured before and after re-calibration (thermodilution)



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When things get ugly...

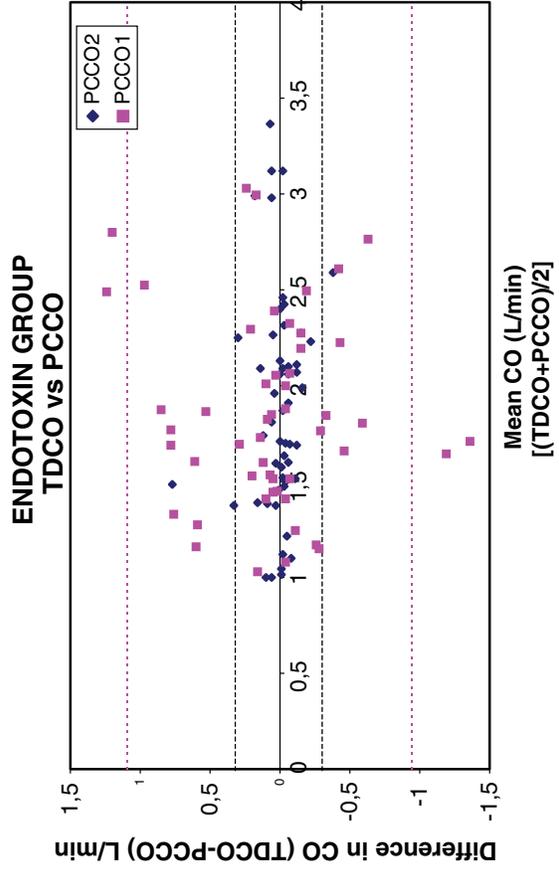
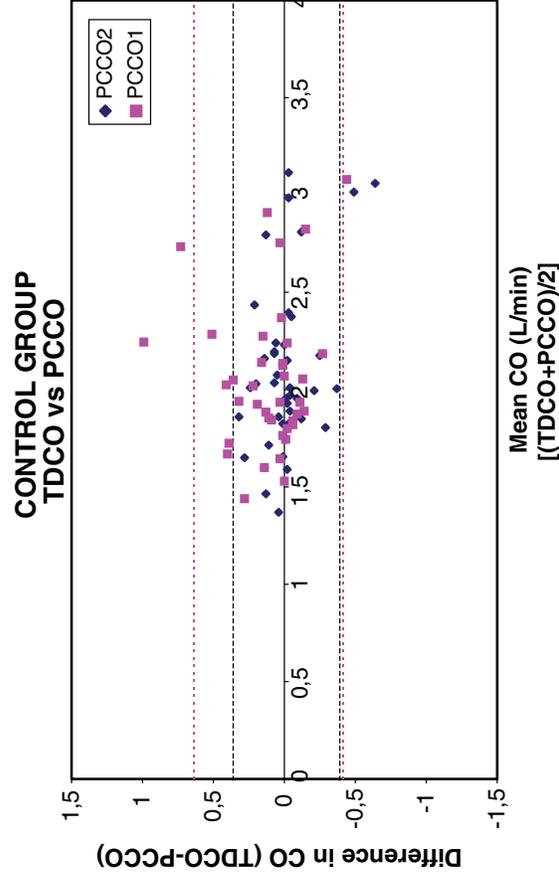


Fig. 2. Bland Altman plots for the differences between TDCO and PCCO pre-calibration (PCCO₁) and post-calibration (PCCO₂), for control and endotoxin groups.



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Invasiveness

- Doppler
- Bioimpedance / Bioreactance
- Calibrated Pulse Contour
- Uncalibrated Pulse Contour
- Partial Rebreathing
- Photoplethysmography
- Thermodilution



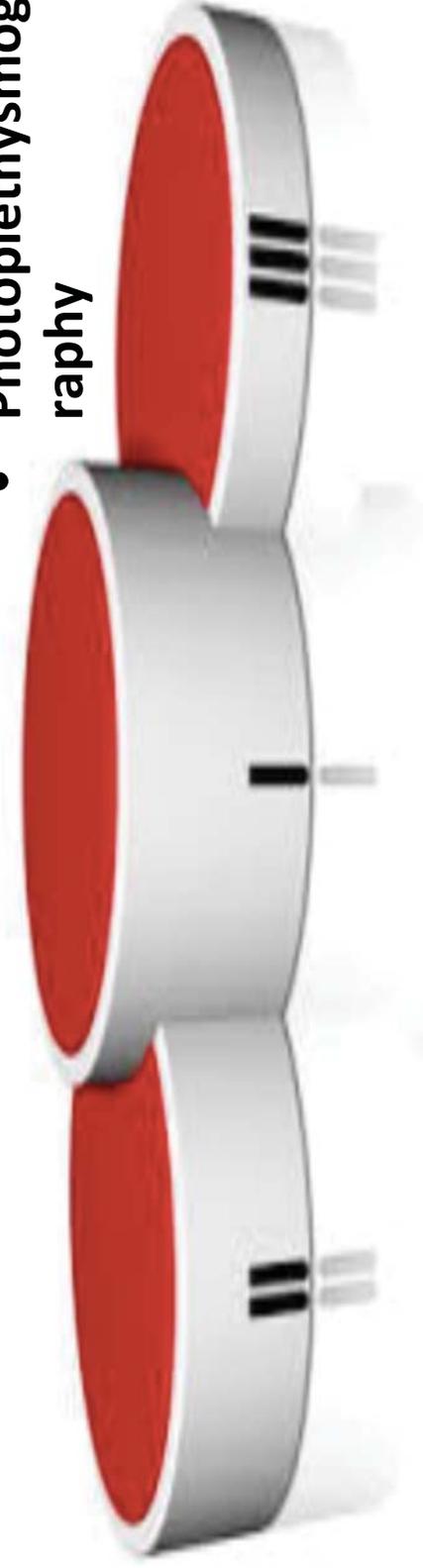


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Accuracy

- Doppler
- Calibrated Pulse Contour
- Thermodilution
- Uncalibrated Pulse Contour
- Bioimpedance / Bioreactance
- Partial Rebreathing
- Photoplethysmography





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Response Time

- **Doppler**
- **Calibrated Pulse Contour**
- **Uncalibrated Pulse Contour**
- **Thermodilution**
- **Bioimpedance / Bioreactance**
- **Photoplethysmography**
- **Partial Rebreathing**





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Features

- Doppler
- Calibrated Pulse Contour
- Thermodilution
- Uncalibrated Pulse Contour
- Photoplethysmography
- Bioreactance/Bioimpedance
- Partial Rebreathing





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Convenience

- **Uncalibrated Pulse Contour**
- **Photoplethysmography**
- **Doppler**
- **Calibrated Pulse Contour**
- **Bioreactance/Bioimpedance**
- **Partial Rebreathing**
- **Thermodilution**





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— Dr. William Harvey (1628)

De Motu Cordis



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Case

- A 56 year-old woman was intubated in the ER, an arterial and a central line was placed, and she received a 1 liter fluid bolus, prior to transfer to your ICU
- She had an ablation procedure for Afib 4 days ago at an OSH
- Increasing SOB and drowsiness over the last 24 hours



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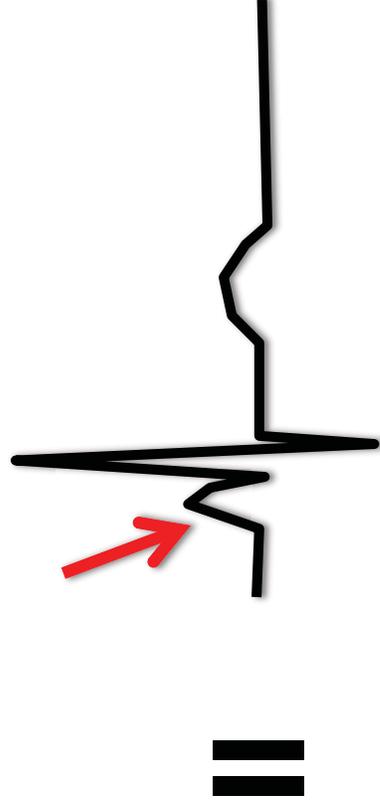
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- VS: BP 90/40, HR 110, CVP 18, SaO₂ 97% on
PCV 20/5, RR 16, TV 480ml
- HCO₃ 18 mEq/L, Hgb 9 g/dL

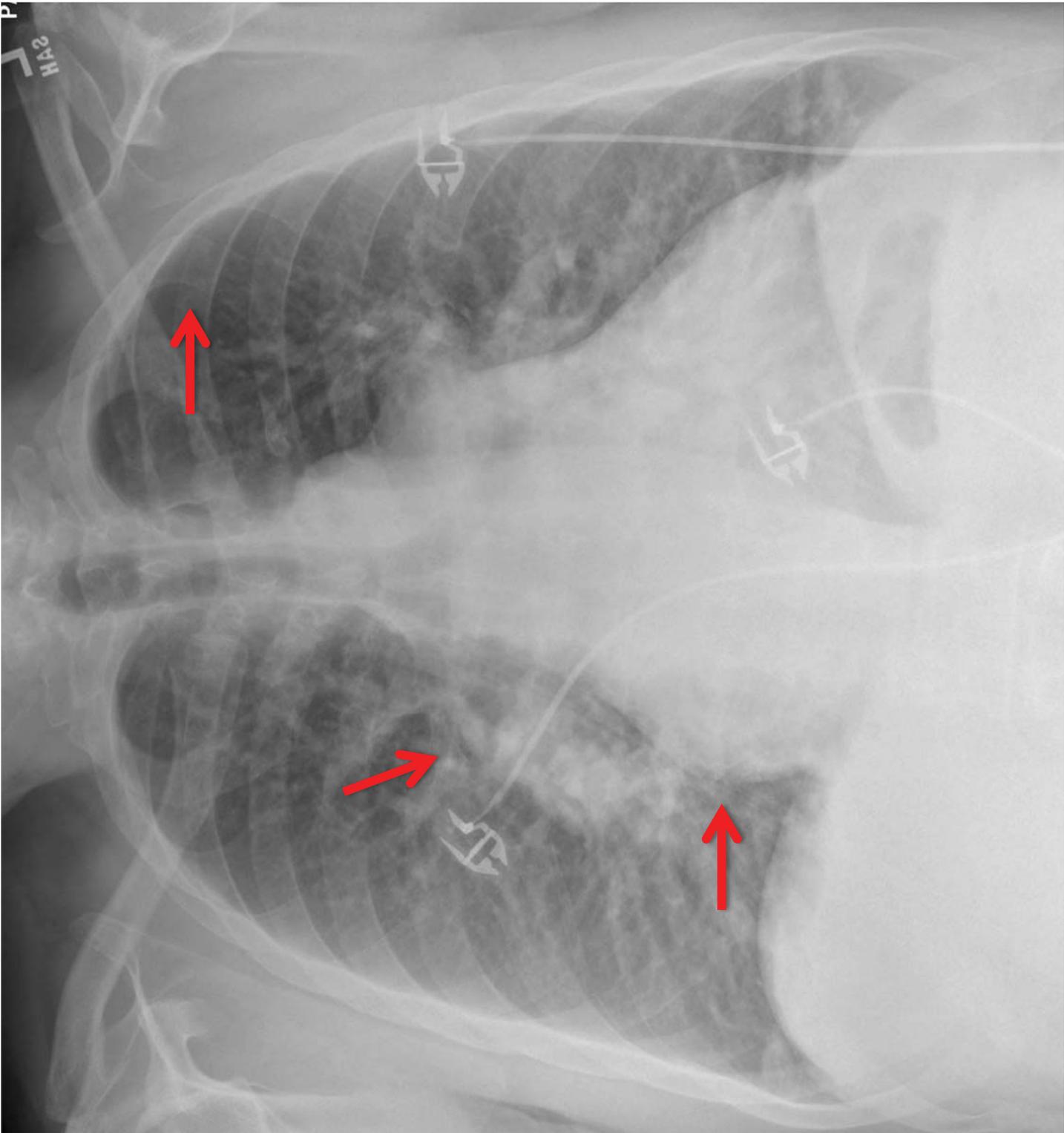


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- R/S ratio >1 in V1
- Persistent deep S waves in precordial leads



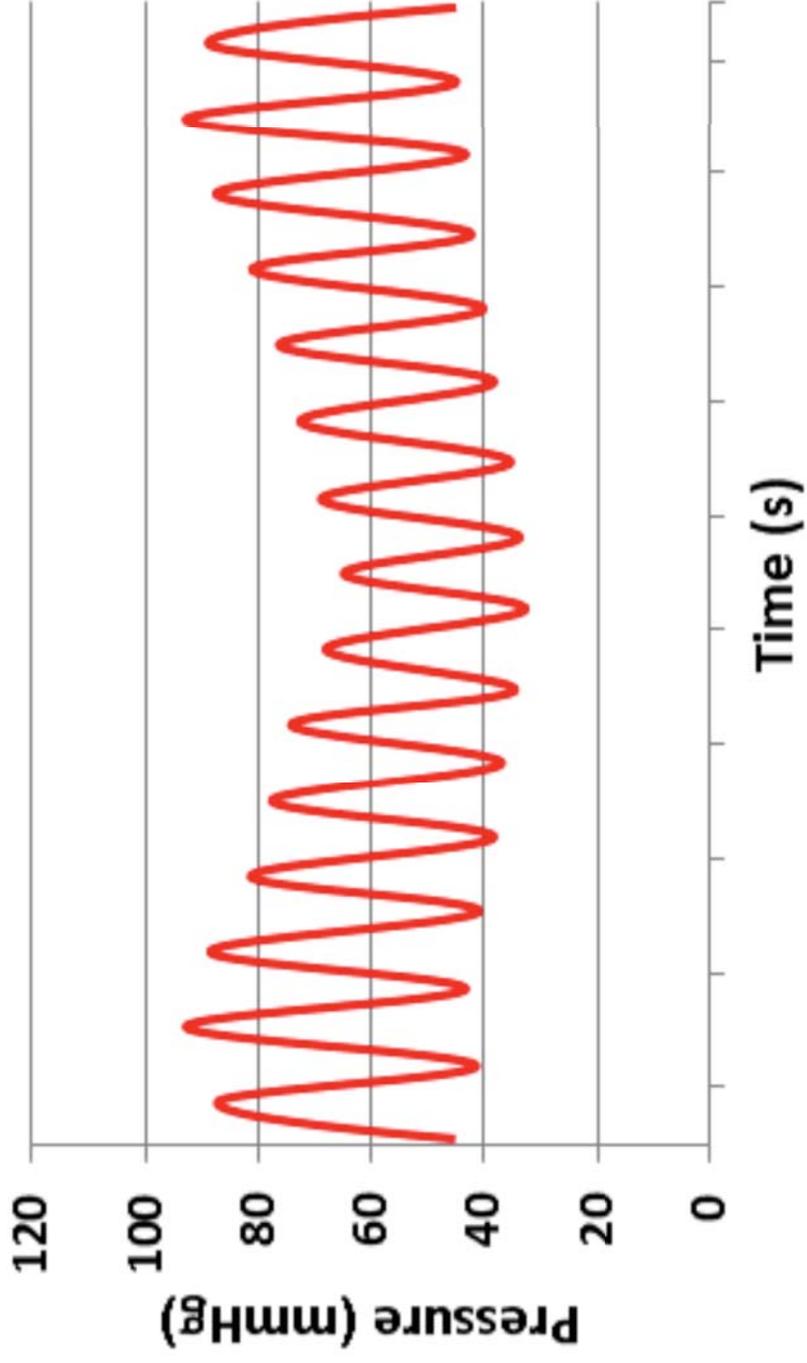


- Prominent pulmonary artery
- RV enlargement
- Peripheral hypovascularity



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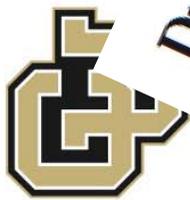


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What is your next step?

- A Give 500ml LR
- B Start iNO
- C Start epinephrine
- D Something else



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ANIRVITZ MEDICAL CAMPUS

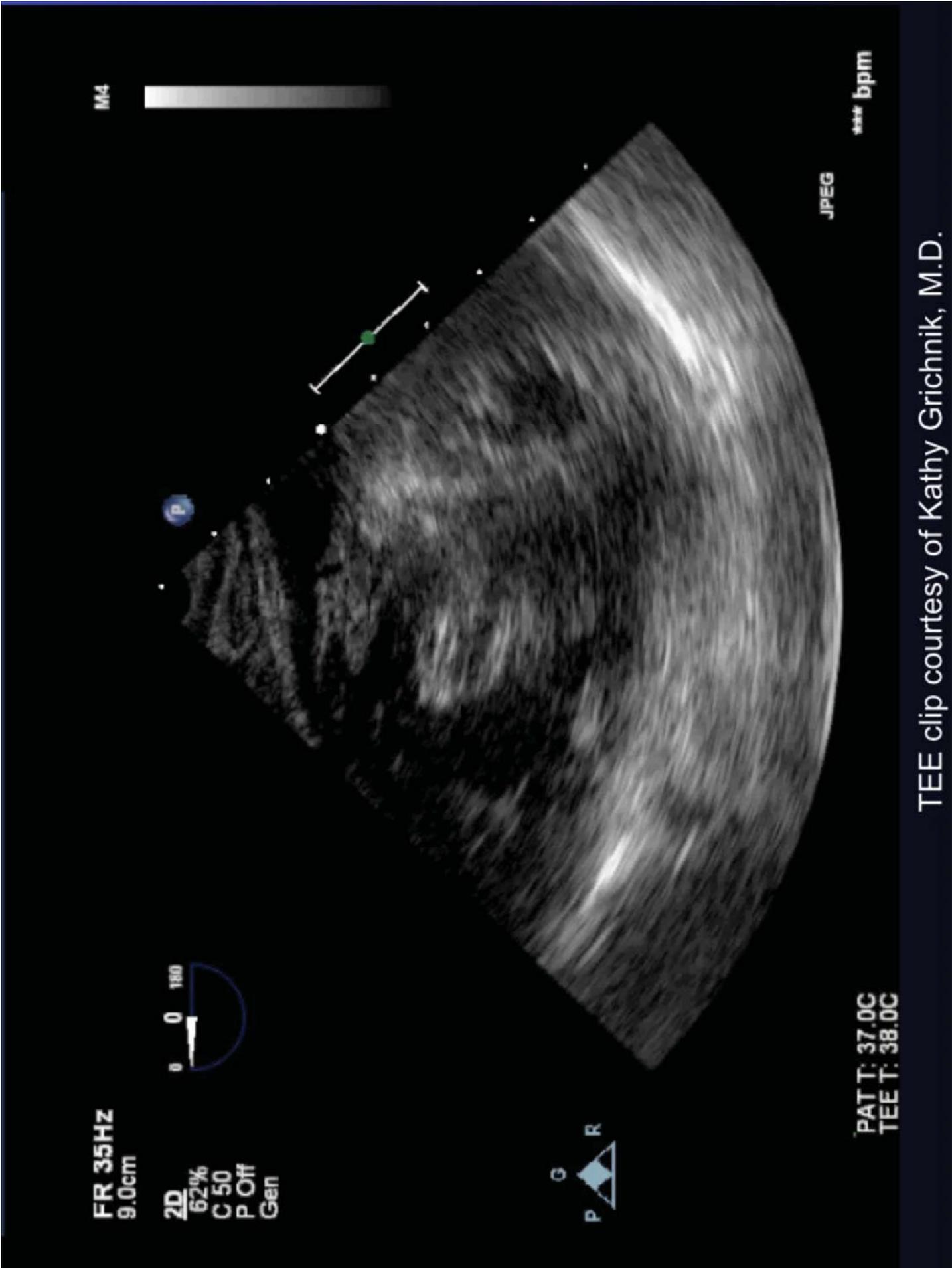
*Dynamic changes in arterial
responsiveness in
review of HL*

Special Feature

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

Robert H. Thiele, MD, Douglas A. Colquhoun, MB ChB, MSc, Franziska E. Blum, MD, and Marcel E. Durieux, MD, PhD

A Systematic Review of Seven Meta-analyses of Seven Markers of Systemic Hemodynamic Variability
Paul E. Marik, MD, FRCPC, FICM; Amyn Hirani, MD



FR 35HZ
9.0cm

2D
62%
C 50
P Off
Gen

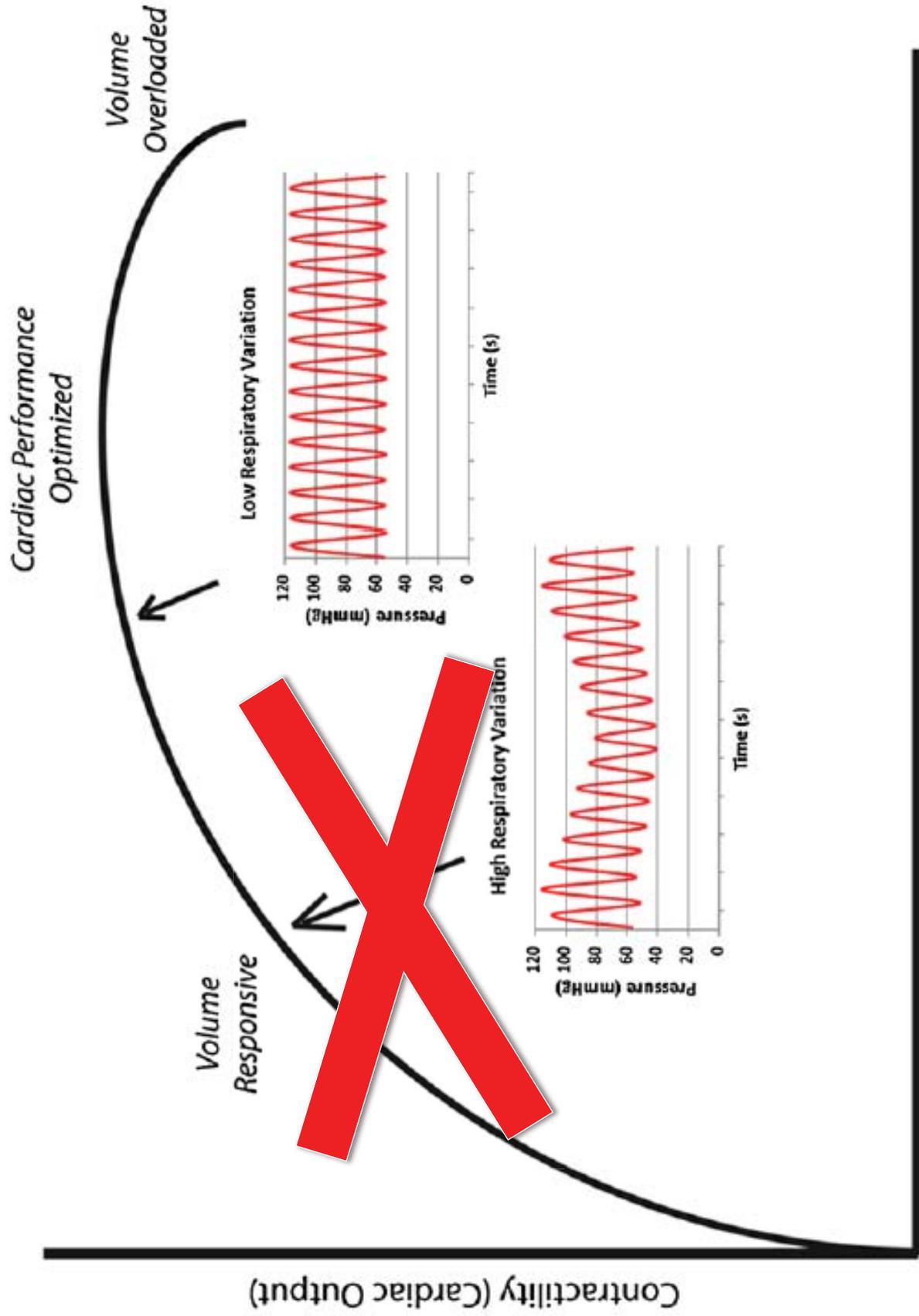


PAT T: 37.0C
TEE T: 38.0C

JPEG

bpm

TEE clip courtesy of Kathy Grichnik, M.D.



Preload (Left Ventricular End Diastolic Volume)

Thiele RH, Bartels K, Gan TJ. Can J Anaesth. 2015 Feb;62(2):169-81.

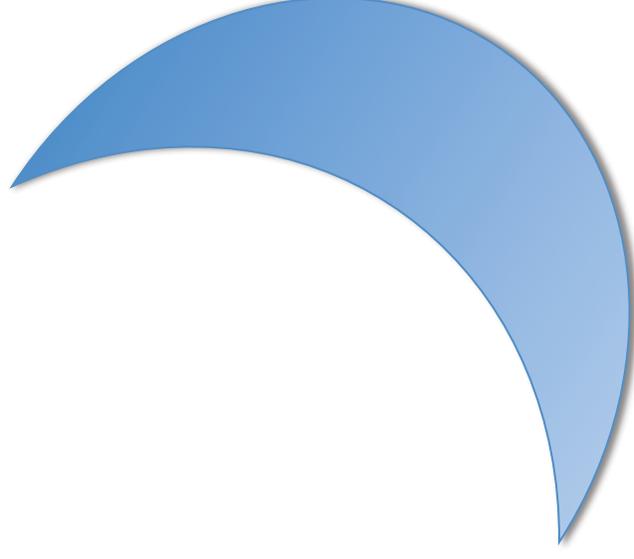


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The Right Ventricle

(...) it is crescent shaped...



From: Miller's Anesthesia, 6th edition



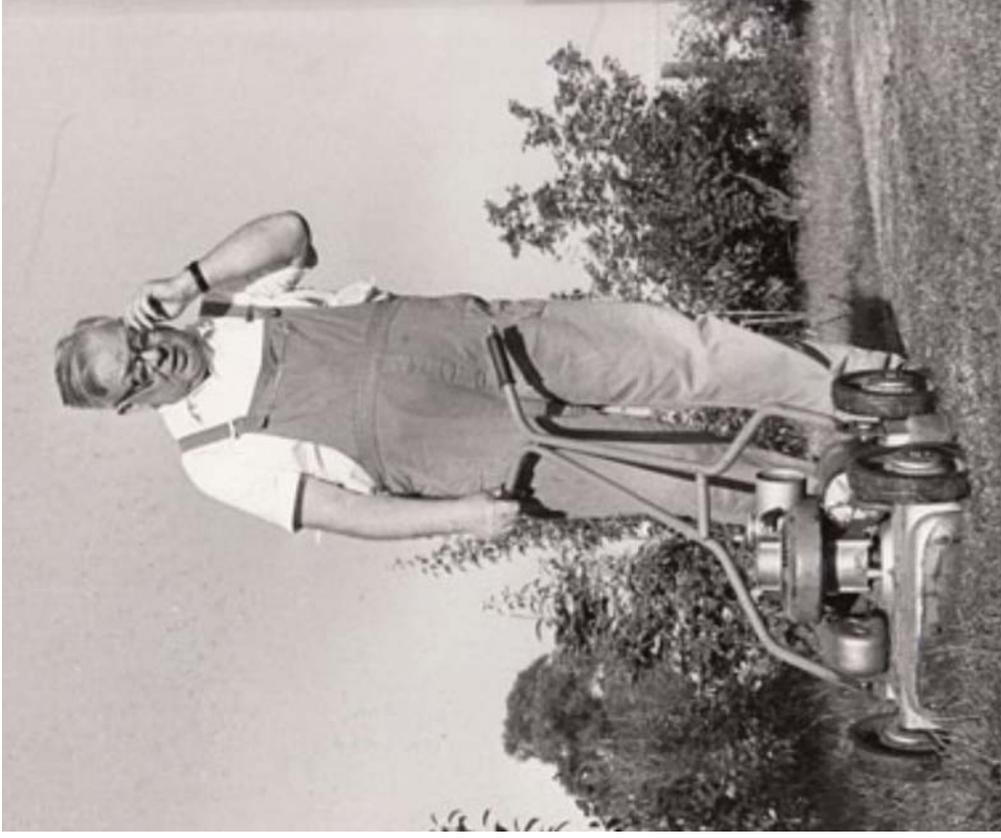


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**Werner Forßmann
(1904–1979)**

**1956 Nobel Prize laureate
Physiology and Medicine**





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