CRASH 2022 SYLLABUS

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Wednesday, March 2

Thursday, March 3

University of Colorado
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DISCLOSURE

of Relevant Financial Relationships to Learners

CRASH

Colorado Review of Anesthesia for Hospitals and Surgicenters

February 27 – March 3, 2022

Internet Live Course

All of the planners, faculty, and individuals in control of content for this educational activity have no relevant financial relationship(s) to disclose with ineligible companies.

Definitions

An **ineligible company** is any entity whose primary business is producing, marketing, selling, re-selling, or distributing healthcare products used by or on patients.

Relevant financial relationships are financial relationships of any amount occurring in the past 24 months with ineligible companies if the educational content an individual can control is related to the business lines or products of the ineligible company.

2/22/2022-CJW

Sunday, February 27th

Decision-making in Airway Management: The Difficult Airway

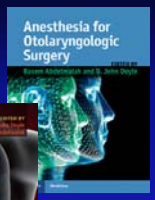
Basem Abdelmalak, MD, FASA, SAMBA-F
Professor of Anesthesiology
Director, Anesthesia for Bronchoscopic Surgery
Director, Center for Procedural Sedation
Anesthesiology Institute, Cleveland Clinic

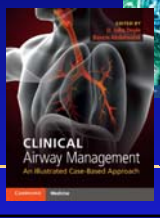
Past President, Society For Ambulatory Anesthesia
Past president, Society For Head and Neck Anesthesia

@basemcc

Conflict Of Interest Disclosure

- No active industry grants
- Co-editor, text books on "Anesthesia for Otolaryngology" and "Clinical Airway Management: an Illustrated Case Based Approach"
- Consultant and speaker:
  - Acacia Pharma
  - Medtronic Inc.





Disclaimer

- I present to you only my own understanding of and reflections on the 2022 ASA Practice Guidelines for the Management of The Difficult Airway,
- I do not speak on behalf of the task force, or the ASA or any of the societies that co-sponsored, or endorsed these practice guidelines

Objectives

At the end of this presentation , the participant will be able to discuss:

- Updates in the ASA DA Guidelines
- Decision making in airway management
- Awake intubation
- Management steps for the un-anticipated difficult airway
- Extubation of the difficult airway

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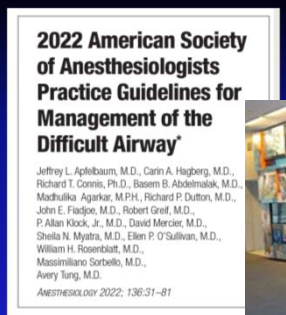

2022 American Society of Anesthesiologists Practice Guidelines for Management of the Difficult Airway*

Jeffrey L. Apfelbaum, M.D., Carin A. Hagberg, M.D., Richard T. Connis, Ph.D., Basem B. Abdelmalak, M.D., Madhulika Agarkar, M.P.H., Richard P. Dutton, M.D., John E. Fiadjoe, M.D., Robert Greif, M.D., P. Allan Klock, Jr., M.D., David Mercier, M.D., Sheila N. Myatra, M.D., Ellen P. O'Sullivan, M.D., William H. Rosenblatt, M.D., Massimiliano Sorbello, M.D., Avery Tung, M.D.

Anesthesiology 2022; 136:31–81

Co-Chairs

J. Apfelbaum, MD

C. Hagberg, MD

Methodologists

R. Connis, PhD

M. Agarkar, MPH

The Task Force Members

Collaborating Societies

- **The American Society of Anesthesiologists (ASA)**
- All India Difficult Airway Association (AIDAA)
- European Airway Management Society (EAMS)
- European Society of Anaesthesiology and Intensive Care (ESAIC)
- Italian Society of Anesthesiology, Analgesia, Resuscitation and Intensive Care
- Learning, Teaching and Investigation Difficult Airway Group
- Society for Airway Management (SAM)
- Society for Ambulatory Anesthesia (SAMBA)
- Society for Head and Neck Anesthesia (SHANA)
- Society for Pediatric Anesthesia (SPA)
- Society of Critical Care Anesthesiologists (SOCCA)
- The Trauma Anesthesiology Society

ASA DA Guidelines:

- May be adopted, modified, or rejected according to clinical needs and constraints, and are not intended to replace local institutional policies
- Are not intended as standards or absolute requirements
- Cannot guarantee any specific outcome
- Are subject to revision as warranted by the evolution of medical knowledge, technology, and practice
- Provide basic recommendations that are supported by a synthesis and analysis of the current literature, expert and practitioner opinion, open forum commentary, and clinical feasibility data

Apfelbaum JL, Hagberg CA, Connis RT, Abdelmalak BB, Agarkar M, Dutton RP, Fiadjoe JE, Greif R, Klock PA, Jr., Mercier D, Myatra SN, O'Sullivan EP, Rosenblatt WH, Sorbello M, Avery A.2022 American Society of Anesthesiologists Practice Guidelines for Management of the Difficult Airway. Anesthesiology. 2022 Jan 1;136(1):31-81

What's New in the 2022 Guidelines

- International 15 members task force
- 12 national and international societies
- More inclusive of clinicians, and settings
- Decision tool
- Emphasis on the number of attempts
- Emphasis on the passage of time: earlier invasive airway

Apfelbaum JL, Hagberg CA, Connis RT, Abdelmalak BB, Agarkar M, Dutton RP, Fiadjoe JE, Greif R, Klock PA, Jr., Mercier D, Myatra SN, O'Sullivan EP, Rosenblatt WH, Sorbello M, Avery A.2022 American Society of Anesthesiologists Practice Guidelines for Management of the Difficult Airway. Anesthesiology. 2022 Jan 1;136(1):31-81

What's New in the 2022 Guidelines

- Infographics
- Pediatric algorithm and infographic
- Emphasis on O_2 throughout, including extubation
- More robust recommendation for the extubation of the difficult airway
- Human factors in DA management
- New list of suggested items to have at standard anesthetizing location

Apfelbaum JL, Hagberg CA, Connis RT, Abdelmalak BB, Agarkar M, Dutton RP, Fiadjoe JE, Greif R, Klock PA, Jr., Mercier D, Myatra SN, O'Sullivan EP, Rosenblatt WH, Sorbello M, Avery A.2022 American Society of Anesthesiologists Practice Guidelines for Management of the Difficult Airway. Anesthesiology. 2022 Jan 1;136(1):31-81

2022 Guidelines Focus

The management of the difficult airway encountered during:

- Procedures requiring general anesthesia, deep sedation, moderate sedation or regional anesthesia
- Elective airway management without a procedure
- Procedures include diagnostic, elective, and emergency procedures and invasive airway access
- Adult and pediatric patients
- Obstetric anesthesia

Apfelbaum JL, Hagberg CA, Connis RT, Abdelmalak BB, Agarkar M, Dutton RP, Fiadjoe JE, Greif R, Klock PA, Jr., Mercier D, Myatra SN, O'Sullivan EP, Rosenblatt WH, Sorbello M, Avery A.2022 American Society of Anesthesiologists Practice Guidelines for Management of the Difficult Airway. Anesthesiology. 2022 Jan 1;136(1):31-81

Application

- Everybody who perform anesthesia care and airway management
- Inpatients and outpatients
- NORA, ASCs, OBA,
- EDs, and ICUs

Apfelbaum JL, Hagberg CA, Connis RT, Abdelmalak BB, Agarkar M, Dutton RP, Fiadjoe JE, Greif R, Klock PA, Jr., Mercier D, Myatra SN, O'Sullivan EP, Rosenblatt WH, Sorbello M, Avery A.2022 American Society of Anesthesiologists Practice Guidelines for Management of the Difficult Airway. Anesthesiology. 2022 Jan 1;136(1):31-81

What is Not Covered in the 2022 Guidelines

- Airway management during CPR
- Physiologically Difficult Airway
- Patients at High Risk of aspiration without anatomically DA
- Airway management education, training and certification
- Not all manifestations of DA, and/or all possible approaches
- Pre-hospital airway management

Apfelbaum JL, Hagberg CA, Connis RT, Abdelmalak BB, Agarkar M, Dutton RP, Fiadjoe JE, Greif R, Klock PA, Jr., Mercier D, Myatra SN, O'Sullivan EP, Rosenblatt WH, Sorbello M, Avery A.2022 American Society of Anesthesiologists Practice Guidelines for Management of the Difficult Airway. Anesthesiology. 2022 Jan 1;136(1):31-81

Table 1. Airway Management Items for Anesthetizing Locations

Self-inflating resuscitation bag
Suction tubing, Yankauers, suction catheters, and appropriate connectors
Various sizes of face masks
Various sizes of oral and nasal airways
Various sizes and types of laryngoscope blades and handles
Various sizes and types of tracheal tubes
Tracheal tube introducer (bougie) for adult patients
Tracheal tube stylets (malleable and rigid)
Equipment for emergency invasive airway management
Various sizes of supraglottic airways
Water-soluble medical lubricant
Nasal cannula and oxygen face masks
Video laryngoscope with appropriate stylets
Standard ASA monitors
Anesthetic induction, maintenance, and rescue medications

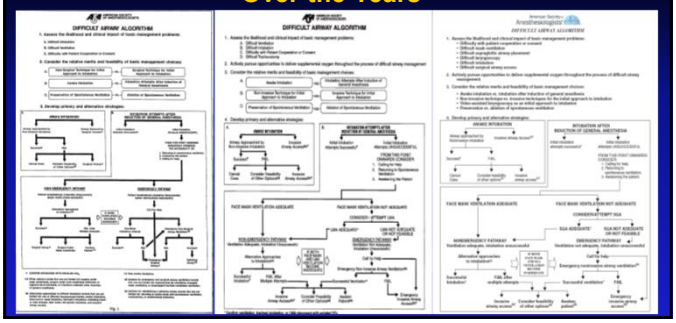
Table 2. Portable Storage Unit Items for Difficult Airway Management

Category*	Item†‡
Alternative/rescue ventilation equipment	Oral and nasal airways of assorted sizes
	Supraglottic airways of assorted sizes/cuffed pharyngeal sealer
	Nasal cannula
Alternative intubation equipment	Tracheal tubes of assorted sizes (including microlaryngeal tubes)
	Rigid blades of alternate design and size for intubation
	Tracheal tube guides. Examples include (but are not limited to) semirigid stylets, lighted stylets, forceps designed to manipulate the distal portion of the tracheal tube
	Intubating supraglottic airway
	Videolaryngoscope with appropriate stylet
	Optical laryngoscope
	Intubating video stylet
	Flexible intubating bronchoscope along with topical anesthetic and equipment, and airway/bite block
	Aintree catheter
Emergency airway equipment	Equipment for emergency invasive airway management
	Jet ventilation equipment
Miscellaneous	Airway exchange catheters of assorted sizes
	Multiple exhaled carbon dioxide detectors
	A laminated version of a local accepted difficult airway algorithm/cognitive aid/checklist
	Defogger

Human Factors in DA Management

- Practitioner factors
  - Before
    - Practitioner knowledge and training
    - Possible alternate outcomes (plan B)
    - Preoperative assessment
    - Complacency
  - During
    - Internal and external stressors (fatigue, illness, production pressure)
    - Decision-making (perseveration, judgment, situational awareness, interpretation of data)
    - Team dynamics (leadership, role assignment, empowerment, sterile cockpit)
    - Calling for assistance
  - After
    - Strategic debriefing
- External factors
  - Patient factors
    - Anatomical/physiological airway difficulty risk, aspiration risk, infection risk, exposure risk, urgency, comorbidities
  - Environment factors
    - Airway equipment
    - Monitoring
    - Personal protective equipment
  - Institutional factors
    - Culture, staffing, shift duration
    - Protocols, reporting
    - Supervision/support, training

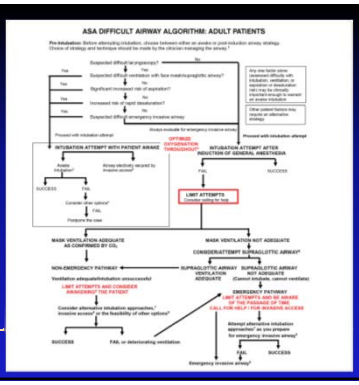
Over the Years



History of the ASA Difficult Airway Guidelines

1993 SGA → 2003 Video-laryngoscopy → 2013 Have we overcome the DA challenge?

2022 Adult DA Algorithm



ANESTHESIOLOGY

Management of Difficult Tracheal Intubation

A Closed Claims Analysis

Aaron M. Joffe, D.O., Michael F. Aziz, M.D., Karen L. Posner, Ph.D., Laura V. Duggan, M.D., F.R.C.P.C., Shawn L. Mincer, M.S.W., Karen B. Domino, M.D., M.P.H.

Anesthesiology 2019; 131:818–29

higher proportion of death in 2000 to 2012 claims (73%; n = 74 of 102 *vs.* 42%; n = 39 of 93 in 1993 to 1999 claims; $P < 0.001$ adjusted for multiple testing). In 2000 to 2012 claims, preoperative predictors of difficult tracheal intubation were present in 76% (78 of 102). In the 97 claims with sufficient information for assessment, inappropriate airway management occurred in 73% (71 of 97; $\kappa = 0.44$ to 0.66). A "can't intubate, can't oxygenate" emergency occurred in 80 claims with delayed surgical airway in more than one third (39%; n = 31 of 80).

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ANESTHESIOLOGY

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Aaron M. Joffe, D.O., Michael F. Aziz, M.D., Karen L. Posner, Ph.D., Laura V. Duggan, M.D., F.R.C.P.C., Shawn L. Mincer, M.S.W., Karen B. Domino, M.D., M.P.H.

Anesthesiology 2019; 131:818–29

Conclusions: Outcomes remained poor in recent malpractice claims related to difficult tracheal intubation. Inadequate airway planning and judgment errors were contributors to patient harm. Our results emphasize the need to improve both practitioner skills and systems response when difficult or failed tracheal intubation is encountered.

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Success of Intubation Rescue Techniques after Failed Direct Laryngoscopy in Adults

A Retrospective Comparative Analysis from the Multicenter Perioperative Outcomes Group

Michael F. Aziz, M.D., Ansgar M. Brambrink, M.D., Ph.D., David W. Healy, M.D., M.R.C.P., F.R.C.A., Amy Wen Willett, M.D., Amy Shanks, Ph.D., Tyler Tremper, B.S., Leslie Jameson, M.D.,

[Anesthesiology 2016; 125:656-66]

- 1.5K cases/ 347K had failed DL
- 28 % of failed DL had ≥ 2 predictors of DI
- Pharyngeal injury was reported in 12/1122 rescue, all associated with VL
- Dental injury was reported in 4 cases

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Success of Intubation Rescue Techniques after Failed Direct Laryngoscopy in Adults

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[Anesthesiology 2016; 125:656-66]

Table 1. Airway Rescue Techniques and Comparative Success Rates of the Common Rescue Strategies

Rescue Technique (Total n = 1,511)	Success, n (%) (95% CI)	Failure, n (%) (95% CI)	*P* Values
Video laryngoscopy (n = 1,122)	1,032 (92) (90–93)	90 (8) (7–10)	Reference group
SGA conduit (n = 82)	64 (78) (68–86)	18 (22) (14–32)	0.0001
Flexible fiberoptic (n = 170)	132 (78) (71–83)	38 (22) (17–29)	0.0001
Lighted stylet (n = 128)	98 (77) (69–83)	30 (23) (17–31)	0.0001
Optical stylet (n = 9)	6 (67) (35–88)	3 (33)	0.031

SGA = supraglottic airway.

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EDITORIALS

Airway management: judgment and communication more than gadgets

François Donati, MD, PhD

be a disappointment for those who like simple recipes. In spite of, and probably because of, the multiplicity of new tools and approaches, safe airway management is not simpler than it was in the past. Paradoxically, the emphasis is no longer on tools and devices but rather on good planning and communication. In terms of specific

The third point to emphasize is that video laryngoscopy is not presented as an all-encompassing solution to airway problems. Although many studies suggest that the

2022: Pre-operative Airway Assessment

- Before the initiation of anesthetic care or airway management,
- Ensure that an airway risk assessment is performed by the person(s) responsible for airway management
- When available in the patient's medical records, evaluate demographic information, clinical conditions, diagnostic test findings, patient/family interviews, and questionnaire responses
- Assess multiple airway features to determine a patient's potential for a difficult airway or aspiration

Apfelbaum JL, Hagberg CA, Connis RT, Abdelmalak BB, Agarkar M, Dutton RP, Fiadjoe JE, Greif R, Klock PA, Jr., Mercier D, Myatra SN, O'Sullivan EP, Rosenblatt WH , Sorbello M, Avery A.2022 American Society of Anesthesiologists Practice Guidelines for Management of the Difficult Airway. Anesthesiology. 2022 Jan 1;136(1):31-81

Decision Making in 1993,03 and 13 Guidelines

1993

1. Assess the likelihood and clinical impact of basic management problems:
   - A. Difficult Intubation
   - B. Difficult Ventilation
   - C. Difficulty with Patient Cooperation or Consent

OF ANESTHESIOLOGISTS

DIFFICULT AIRWAY ALGORITHM

2003

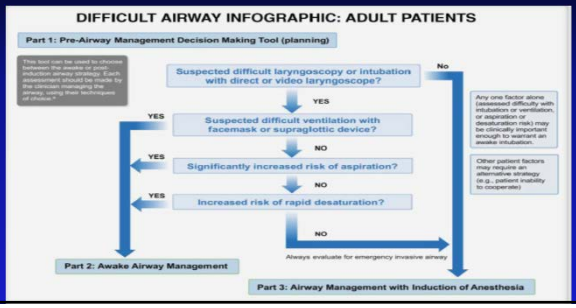
1. Assess the likelihood and clinical impact of basic management problems:
   - A. Difficult Ventilation
   - B. Difficult Intubation
   - C. Difficulty with Patient Cooperation or Consent
   - D. Difficult Tracheostomy

DIFFICULT AIRWAY ALGORITHM

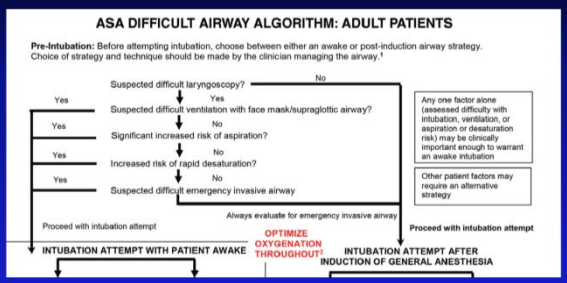
2013

1. Assess the likelihood and clinical impact of basic management problems:
   - Difficulty with patient cooperation or consent
   - Difficult mask ventilation
   - Difficult supraglottic airway placement
   - Difficult laryngoscopy
   - Difficult intubation
   - Difficult surgical airway access

2022 ASA Guidelines: Part 1



2022 ASA Guidelines: Part 1 Decision Tool



Does VL Ever Fail ?

- Reports of being able to see the larynx, but cannot intubate[1]
  - Poor mandibular advancement[2]
  - Other predictors of failure:[3]
    - Neck radiation
    - Masses
    - Surgical alterations (Flaps)
  - Intubator's experience??

1. Platts-Mills et al, comparison of glidescope videolaryngoscopyvs direct laryngosopy intubation in the ED . Acad emerg med 2009: 16:866-71
2. Tremblay MH, Williams S et al. Poor visualization during DL and high upper lip bite score . . Anesth Analg. 2008;106(5):1495-1500
3. Aziz , Healy, et al Routine Clinical Practice Effectivness of the GlideScope... Anesthesiology 2011;114(1):34-41

ANESTHESIOLOGY

Pulmonary Aspiration of Gastric Contents: A Closed Claims Analysis

Mark A. Warner, M.D., Karen L. Meyerhoff, M.D., M.P.H., Mary E. Warner, M.D., Karen L. Posner, Ph.D., Linda Stephens, Ph.D., Karen B. Domino, M.D.

ANESTHESIOLOGY 2021; 135:284–91

What This Article Tells Us That Is New

- In a closed claims analysis of 115 cases of pulmonary aspiration, death occurred in 57% of the claims and severe permanent injury in another 14%
- Sixty-one percent of the patients in the claims had either gastrointestinal obstruction or another intraabdominal process
- Anesthetic practice was judged to be substandard in 59% of the 115 claims

Anaesthesia 2020, 75, 323-330 doi:10.1111/anae.14915

Original Article

Reliability of gastric suctioning compared with ultrasound assessment of residual gastric volume: a prospective multicentre cohort study

L. Bouvet,[1,2] L. Zieleskiewicz,[3] E. Loubradou,[1] A. Alain,[3] J. Morel,[4] L. Argaud,[5] D. Chassard,[6,7]

fourth ultrasound was performed 90 min after the third. Sixty (98%) patients had a qualitatively assessed full stomach at first ultrasound examination vs. 52 (85%) after gastric suctioning (p = 0.016). The calculated gastric volume significantly decreased after gastric suctioning, without a significant decrease in the number of patients with volume ≥ 250 ml. Four of the nine patients with calculated gastric volume ≥ 250 ml had vomiting within the last 24 h (p = 0.013). The antral cross-sectional area significantly decreased between the third and the fourth ultrasound examination (p = 0.015). Erythromycin infusion did not make a significant difference to gastric volume (n = 10). Our results demonstrate that gastric suctioning is not a reliable tool for monitoring residual gastric volume. Gastric ultrasound is a feasible and promising tool for gastric volume monitoring in clinical practice.

The Cricoid Force Necessary to Occlude the Esophageal Entrance: Is There a Gender Difference?

Ahed M. Zeidan, MD,*† M. Ramez Salem, MD,‡§ Munir Bamadhaj, MD,‖ Jean-Xavier Mazoit, MD, PhD,¶

CONCLUSIONS: The current study provides evidence that the median force necessary to occlude the esophageal entrance to prevent regurgitation is less in women compared with men. Applying the appropriate cricoid force in women should also decrease airway-related problems that tend to occur with the use of excessive forces. The findings of the current study may only be applicable to patients with normal body habitus. (Anesth Analg 2017;XXX:00–00)

JAMA Surgery | Original Investigation

Effect of Cricoid Pressure Compared With a Sham Procedure in the Rapid Sequence Induction of Anesthesia
The IRIS Randomized Clinical Trial

Aurélie Birenbaum, MD; David Hajage, MD, PhD; Sabine Roche, MD; Alexandre Ntouba, MD; Mathilde Eurin, MD;

CONCLUSIONS AND RELEVANCE This large randomized clinical trial performed in patients undergoing anesthesia with RSI failed to demonstrate the noninferiority of the sham procedure in preventing pulmonary aspiration. Further studies are required in pregnant women and outside the operating room.

JAMA Surg. 2019;154(1):9-17.

Editorial

JOHNA Journal of Head & Neck Anesthesia

OPEN

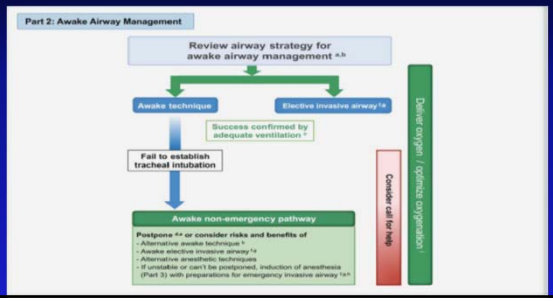
The case against preoperative endoscopic airway examination (PEAE) in the "ENT airway"

Basem Abdelmalak, MD, FASA*

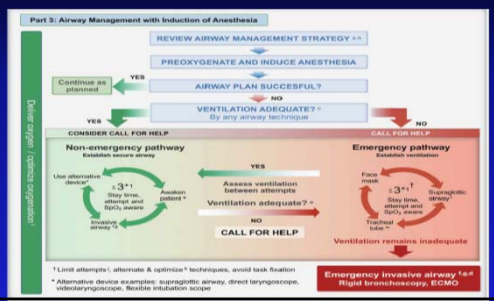
questioned[12], and the aspiration rate as a complication of intubation is reported to be 0.04%[9]. Protective reflexes against aspiration include the glottic closure reflex[13], which is only diminished and not abolished by topicalization[14], and the cough reflex mediated by the rapidly adapting receptors (pulmonary irritant receptors) abundantly available in extra, and (mainly) intrapulmonary airways including the trachea and the main bronchi[15]. In the author's experience and that of other

Editorial. JOHNA (2019) 3:e22

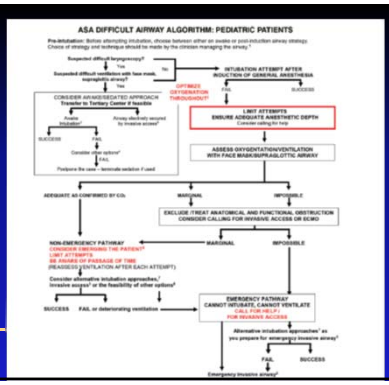
2022 ASA Guidelines: Part 2

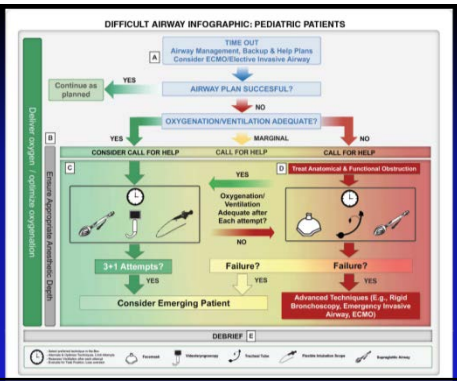


2022 ASA Guidelines: Part 3



2022 Pediatric DA Algorithm





Recommendation for Confirmation of Tracheal Intubation

- Confirm tracheal intubation using capnography or end-tidal carbon dioxide monitoring.
- When uncertain about the location of the tracheal tube, determine whether to either remove it and attempt ventilation or use additional techniques to confirm positioning of the tracheal tube

Apfelbaum JL, Hagberg CA, Connis RT, Abdelmalak BB, Agarkar M, Dutton RP, Fiadjoe JE, Greif R, Klock PA, Jr., Mercier D, Myatra SN, O'Sullivan EP, Rosenblatt WH, Sorbello M, Avery A.2022 American Society of Anesthesiologists Practice Guidelines for Management of the Difficult Airway. Anesthesiology. 2022 Jan 1;136(1):31-81

Extubation of the Difficult Airway

US Closed Claims:
- Death and severe brain damage were more often associated with extubation or the recovery period

UK NAP4:
- 39% of the events followed head & neck surgery.
- Approximately 30% of these reports were associated with obstructive lesions within the airway
- Reports indicated evidence of poor anticipation and planning for management of extubation.

Peterson GN, Domino KB, Caplan RA, Posner KL, Lee LA, Cheney FW. Management of the difficult airway: a closed claims analysis. *Anesthesiology* 2005; 103: 33– 9
Cook TM, Woodhall N, Frerk C, on behalf of the Fourth National Audit Project. 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. Part 1: Anaesthesia. *British Journal of Anaesthesia* 2011; 106: 617– 31

Extubation is an Elective Procedure!

You decide on:
- Time
- Place
- Equipment
- Assistants
- Strategy/plan

Extubation of the Difficult Airway

- Have a pre-formulated strategy for extubation and subsequent airway management.
- Assess patient readiness for extubation.
- Assure that a skilled individual is present to assist with extubation when feasible.
- Select an appropriate time and location for extubation when possible.

2022 American Society of Anesthesiologists Practice Guidelines for Management of the Difficult Airway*

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Extubation of the Difficult airway

- short-term use of an airway exchange catheter? and/or SGA ? that can serve as a guide for expedited reintubation.
- Evaluate the risks and benefits of elective surgical tracheostomy.
- Evaluate the risks and benefits of awake extubation *versus* extubation before the return to consciousness.
- When feasible, use supplemental oxygen throughout the extubation process.
- Assess the clinical factors that may produce an adverse impact on ventilation after the patient has been extubated.

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Continuous Airway Access for the Difficult Extubation: The Efficacy of the Airway Exchange Catheter

Thomas C. Mort, MD BACKGROUND: The American Society of Anesthesiologists Task Force on the Man-

- Prospective. 354 patients. Mostly ICU
- Mean 4 hours. Range 5 min-72 hs
- 47/51 successful re-intubation , 21 within 2 hours
- 3 inadvertently removed during re-intubation, and 1 failure to pass the tube
- 11 and 14 F 7% discomfort .19 F 50 % discomfort

(Anesth Analg 2007;105:1357–62)

What Could Go Wrong With AECs?

- Tracheo laryngeal trauma
- Kincking/esophageal migration on re-intubation
- Aspiration
- Accidental extubation of the exchange catheter
- Barotrauma with jetting through the AEC
- Stomach rupture

Duggan L, Law A, Murphy MBrief review: Supplementing oxygen through an airway exchange catheter: efficacy, complications, and recommendations Can J Anaesth 2011 Jun;58(6):560-8

Anesthesiology 2006; 104:1111–2

Unforeseen Esophageal Misplacement of Airway Exchange Catheter Leading to Gastric Perforation

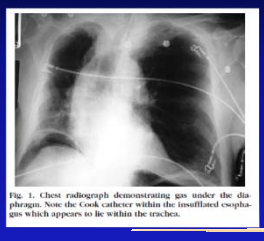


Fig. 1. Chest radiograph demonstrating gas under the diaphragm. Note the Cook catheter within the insufflated esophagus which appears to lie within the trachea.

Fig. 2. Abdominal radiograph demonstrating gastric distension from oxygen insufflation.

Follow Up Post A DA Encounter

- Use post-extubation steroids and/or racemic epinephrine when appropriate.
- Inform the patient (or responsible person) of the airway difficulty
- Document the presence and nature of the airway difficulty in the medical record to guide and facilitate the delivery of future care.
- Instruct the patient to register with an emergency notification service when appropriate and feasible.

2022 American Society of Anesthesiologists Practice Guidelines for Management of the Difficult Airway*

Apfelbaum JL, Hagberg CA, Connis RT, Abdelmalak BB, Agarkar M, Dutton RP, Fiadjoe JE, Greif R, Klock PA, Jr., Mercier D, Myatra SN, O'Sullivan EP, Rosenblatt WH, Sorbello M, Avery A.2022 American Society of Anesthesiologists Practice Guidelines for Management of the Difficult Airway. Anesthesiology. 2022 Jan 1;136(1):31-81

Summary

- Pre-op airway evaluation and decision making are a must
- Awake intubation is a patient safety issue
- Preparation is a key to success
- Consider situational and human factors when feasible
- Be ware of time, and number of attempts, awakening the pat. Is an option so as emergency invasive airway.
- Get acquainted with the DA algorithm now, during the emergency is not the right time to look at for the first time

49

Society for Head and Neck Anesthesia

SHANA

Society for Head and Neck Anesthesia
WWW.SHANAHQ.COM

eHealthcare Leadership Awards 2014 WINNER

Cleveland Clinic

Every life deserves world class care.

Thank you for your attention
Basem Abdelmalak, MD, FASA, SAMBA-F
abdelmb@ccf.org
@basemcc

COVID-19
What Have We Learned?

Jason C. Brainard, MD, FCCM
Section Chief, Critical Care Medicine
Department of Anesthesiology
University of Colorado School of Medicine

1

Goals and Objectives

- Discuss successes and failures associated with COVID-19 response
- Discuss applications of COVID-19 learned lessons to Anesthesiology

2

Disclosures

- None
- But, Open to Offers ☺

3

Dr. Wes Ely

Intensivist

Vanderbilt University

- "As I was standing at the foot of his bed, something hit me that I'd rarely been conscious of in 25 years as an ICU physician: raw fear. I could sense an uncomfortable degree of fear in my head, heart and the pit of my stomach. Fear from general dread of a new deadly disease with so many unknowns. Fear of repeated exposures for my colleagues, who could become sick and die. And fear that the virus, which was invisibly present throughout the room, would infect my lungs, blood and brain despite my best efforts. Fear can be healthy or unhealthy. This fear was unhealthy — like a barrier keeping me from the man I was there to try to help."

4

5

Fear

- Fear of not doing enough to keep our patients alive
- Fear of exposing our colleagues and ourselves to the virus

6

Notes From Emergency COVID-19 Conference with ICU Leadership from Italy and China March 11, 2020

- Invasive Ventilation – "very good response to prone ventilation, delayed weaning is best due to recurrent hypoxemia, keep deeply sedated for first 7 days"
- Non-Invasive Ventilation – "NIV questionable, patients evolve and crash quickly, if SpO2 < 95% on FiO2 60%, intubate immediately"
- Hemodynamics – "myocardial dysfunction is common"
- Co-Infection – "co-infection with other viruses like influenza or RSV is < 2%, if you have a post-test for another virus, you don't need to test for COVID, very few concurrent bacterial infections"
- Steroids and Antivirals – "remdesivir if available, possible other antiviral cocktails (lopinavir/ritonavir), ribavirin, and chloroquine, no corticosteroids"

7

University of Colorado COVID-19 ICU Guidelines

1. Oxygen Delivery
   a. Heated High Flow Nasal Cannula (HHFNC): *Use cautiously*
      i. Data suggests caution as patients deteriorate rapidly (hours), particularly in the setting of ARDS.
      ii. HHFNC should only be applied in a negative pressure room and on an ICU service
   b. NIPPV (BiPAP/CPAP): ***Not recommended***
      i. Risk of treatment failure is high. Not recommended for COVID related hypoxia or ARDS
      ii. For ARDS in particular, data (and experience) suggests role for early intubation
      iii. Exhalation port on BiPAP/CPAP mask may increase aerosolization
      iv. Consider only for patients with diagnosis responsive to NIPPV (COPD/CHF) or pre-existing need (OSA/OHS)

8

University of Colorado COVID-19 ICU Guidelines

1. Intubation
   a. Intubation is extremely high risk for aerosolization
      i. Perform early with ARDS
      ii. Most experienced provider should perform this procedure. Minimize proceduralists and bedside providers as possible – consider 1 MD and 1 assistant in room with additional MD donned in PPE outside the room
      iii. Preferentially perform all intubations in a negative pressure room
      iv. Utilize RSI and paralysis in all patients (minimize BVM, coughing, maximize success)
      v. Utilize video laryngoscope for improved 1st pass success
      vi. Consult Anesthesiology if concern for difficult airway or based on provider skill and experience

9

University of Colorado COVID-19 ICU Guidelines

Antiviral therapy may be considered*, ID Consultation required:

- **Lopinavir/ritonavir (LPV/r)[1-4] 400mg/100mg PO BID ± Ribavirin** (dosing on Page 2) x 5 days (up to 14 days)
  - LPV/r pregnancy category C, human data does not show increased teratogenic risk
  - Ribavirin pregnancy category X
  - Significant drug interaction potential with LPV/r (Overview Page 3-6)
  - Monitor for QTc prolongation, liver impairment, cytopenias, and diarrhea
  - PO ribavirin preferred, PO solution available
  - Inhaled ribavirin discouraged, consideration with ID and ID pharmacy
- **Hydroxychloroquine[3-4] 400mg PO BID for one day then 200mg PO BID, OR Chloroquine 500mg PO BID x 5 days (up to 14 days)**
  - Pregnancy category C, human data in malaria does not show increased risk
  - Caution in liver disease
  - Low drug interaction potential
  - Monitor for visual changes, neuropathy, QTc prolongation, and cytopenias
- **Nitazoxanide[5] 1,000mg PO BID x 5 days (up to 14 days)**

Start with Antiviral therapy*, ID Consultation Required:
+
Contact ID Pharmacy *Immediately* for coordination of compassionate use Remdesivir[5]

*Agents are not approved for CoV infections, and limited evidence supports possible benefit in COVID-19 infection, weigh risks and benefits prior to initiation

10

Version 1.0 3/17/2020 4:00PM

MASSACHUSETTS GENERAL HOSPITAL

Massachusetts General Hospital COVID-19 Treatment Guidance

- This document was developed by members of the ID division at MGH in conjunction with pharmacy, radiology, and other medicine divisions to provide guidance to frontline clinicians caring for patients with COVID-19.
- This document covers potential off-label and/or experimental use of medications and immunosuppression management for transplant patients as well as a suggested laboratory work up. It does NOT cover recommendations for infection control, PPE, management of hypoxemia or other complications in patients with COVID-19.
- This is a living document that will be updated in real time as more data emerge.

Table 1: Laboratories for diagnosis, prognosis / risk stratification, and/or safety of agents Suggested for all hospitalized patients with confirmed or suspected COVID-19

Recommended daily labs: • CBC with diff (trend total lymphocyte count) • Complete metabolic panel[1] • CPK (creatine kinase)	Viral serologies[2] • HBV serologies (sAb, cAb, and sAg) • HCV antibody, unless positive in past • HIV 1/2 Ab/Ag
For risk stratification (may be repeated q2-3 days if abnormal or with clinical deterioration): • D-dimer • Ferritin / CRP / ESR • LDH • Troponin[3] • Baseline ECG[4]	If clinically indicated: • Routine blood cultures (2 sets) • For acute kidney injury (i.e. serum creatinine >0.3 above baseline), send urinalysis and spot urine protein creatinine • Procalcitonin • IL-6 See below for criteria
Radiology:	Following up-to-date infection control

11

NIH COVID-19 Treatment Guidelines

COVID-19 Resources

COVID-19 is an emerging, rapidly evolving situation.
Get the latest public health information from CDC: https://www.coronavirus.gov
Get the latest research information from NIH: https://www.nih.gov/coronavirus

NIH COVID-19 Treatment Guidelines

Coronavirus Disease 2019 (COVID-19) Treatment Guidelines

VIEW GUIDELINES

Society of Critical Care Medicine

https://covid19treatmentguidelines.nih.gov/

12

Fear Driving Deviation from Best Practice

- Early Intubation
- Avoidance of HHFNC and NIV
- Deep Sedation / Paralysis
- Experimental Therapies

- **Return to 1990s Critical Care**

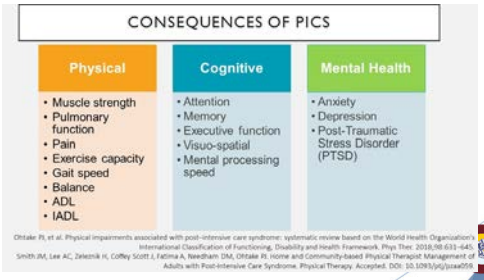
13

Fear Driving Worse Clinical Outcomes

- Prolonged ICU and Hospital LOS
- Post-Intensive Care Syndrome (PICS)
  - Physical Disability
  - Cognitive Disability
  - Mental Heath Disorders

14

Post-Intensive Care Syndrome (PICS)



15

Dr. Elisabeth Riviello

Intensivist

Beth Israel

- "The risk of PICS is less dramatic, and further away, so we give in to immediate fears and keep patients sedated too long"

16

COVID-19
What have we learned?

17

Get Back to Best Practice

- No Silver Bullet for COVID-19
- No Silver Bullet in Critical Care

18

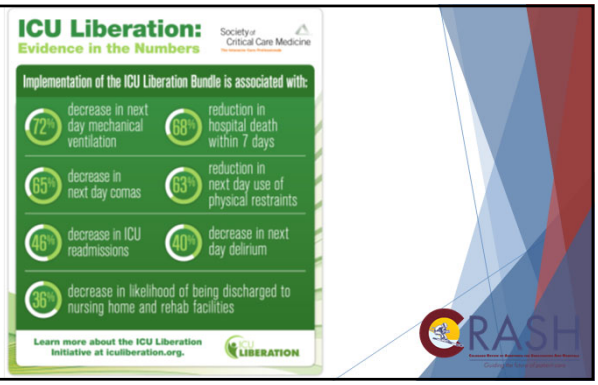
Get Back to Best Practice

- ICU Liberation
- A2F Bundle
- PADIS Guidelines

- ARDSNet (2000): Low vs. Traditional TV in ARDS
- FACTT (2006): Fluid Management in ARDS
- PROSEVA (2013): Prone Ventilation in ARDS
- ROSE (2019): Neuromuscular Blockade in ARDS

19

20



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Lessons Learned for Anesthesiology?

22

"Best Practice" Must Be Driven By Data

23

Lessons Learned - Hip Surgery

ORIGINAL ARTICLE

Spinal Anesthesia or General Anesthesia for Hip Surgery in Older Adults

•Mark D. Neuman, M.D.,
•Rui Feng, Ph.D.,
•Jeffrey L. Carson, M.D.,
•Lakisha J. Gaskins, M.H.S.,
•Derek Dillane, M.D.,
•Daniel I. Sessler, M.D.,
•Frederick Sieber, M.D.,
•Jay Magaziner, Ph.D., M.S.Hyg.,
•Edward R. Marcantonio, M.D.,
•Samir Mehta, M.D.,
•Diane Menio, M.S.,
•Sabry Ayad, M.D.,
• for the REGAIN Investigators

24

Lessons Learned - Hip Surgery

- **Effect of Regional vs General Anesthesia on Incidence of Postoperative Delirium in Older Patients Undergoing Hip Fracture Surgery**The RAGA Randomized Trial
- Ting Li, PhD[1,2]; Jun Li, PhD[1]; Liyong Yuan, MD[3]; et alJinze Wu, MD[4]; Chenchen Jiang, MS[2]; Jane Daniels, PhD[5]; Rajnikant Laxmishanker Mehta, MS[6]; Mingcang Wang, MD[7]; Joyce Yeung, PhD[8,9]; Thomas Jackson, PhD[10]; Teresa Melody, RN[9]; Shengwei Jin, PhD[1]; Yinguang Yao, MD[11]; Ji min Wu, MD[12]; Junping Chen, MD[13]; Fang Gao Smith, PhD[1,9,10]; Qingquan Lian, PhD[1]; for the RAGA Study Investigators
- Author Affiliations
- *JAMA*. 2022;327(1):50-58. doi:10.1001/jama.2021.22647

25

Lessons Learned - Hip Surgery

- Day-of-Surgery Gabapentinoids and Prolonged Opioid Use: A Retrospective Cohort Study of Medicare Patients Using Electronic Health Records
- Young, Jessica C. PhD*,†; Dasgupta, Nabarun PhD‡; Chidgey, Brooke A. MD§; Stürmer, Til MD, PhD*; Pate, Virginia MS*; Hudgens, Michael PhD‖; Jonsson Funk, Michele PhD*
- Author InformationAnesthesia & Analgesia: November 2021 - Volume 133 - Issue 5 - p 1119-1128
- doi: 10.1213/ANE.0000000000005656

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Lessons Learned for Anesthesiology?

- TIVA vs. Inhaled Anesthetic
- Analgesic Adjuncts (Ketamine/Dex/Lido)
- Regional Nerve Blocks
- ERAS Pathways

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CRASH

Guiding the future of patient care

Thanks!

28

COVID-19 WHAT HAVE WE LEARNED?

THE WELLBEING PERSPECTIVE – WHAT CAN WE DO TO RECOVER, THRIVE AND FIND JOY ?

Anesthesiology
UNIVERSITY OF COLORADO
ANSCHUTZ MEDICAL CAMPUS

1

LEARNING OBJECTIVES

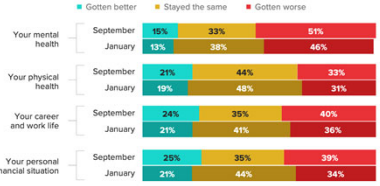
- Define moral injury and how it applies to our current work environment
- Describe individual vs organizational tools
- Peer to Peer Conversations as a solution

2

1 in 2 Health Care Workers Say Their Mental Health Has Suffered During the Pandemic

Career and finances have also taken a hit for many

Health care workers were asked how the following parts of their lives have changed during the COVID-19 pandemic:



MORNING CONSULT

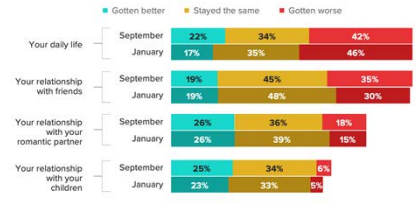
Polls conducted Jan. 4-9, 2021, and Sept. 2-8, 2021, among 1,000 U.S. health care workers each, with margins of error of +/-3%. "Don't know/No opinion" responses are not shown. Figures may not add up to 100% due to rounding.

3

More Than 1 in 3 Health Care Workers Say Their Friendships Have Gone Downhill During Pandemic

They're less likely to say relationships with partners or children have worsened

Health care workers were asked how the following parts of their lives have changed during the COVID-19 pandemic:



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4

Burnout

- Burn-out is defined in ICD-11 as follows:
- "Burn-out is a syndrome conceptualized as resulting from chronic workplace stress that has not been successfully managed. It is characterized by three dimensions:
  - feelings of energy depletion or exhaustion
  - increased mental distance from one's job, or feelings of negativism or cynicism related to one's job
  - reduced professional efficacy

Management pretending they don't see how burnt out we are:

https://www.who.int/news/item/28-05-2019-burn-out-an-occupational-phenomenon-international-classification-of-diseases

5

Moral Injury vs. Stress Injury

- "A deep sense of transgression including feelings of shame, grief, meaninglessness, and remorse from having violated core moral beliefs" (Brock and Lettini 2012)
- "A betrayal of what's right, by someone who holds legitimate authority, in a 'high-stakes situation'" (Shay 1994, 2014).
- "Any severe and persistent distress or loss of ability to function caused by damage to the brain, mind, or spirit after exposure to the overwhelming stressors of fatigue (burnout), trauma, loss, or moral injury." (Nash et al 2010)
- Stress Injury Literature comes from military research

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6

Artist unknown

7

Can we measure Moral Injury to know who is at risk?

- Researchers at Duke worked to validate a tool specific to moral injury in health care professionals (HCPs)
  - Moral Injury Symptom Scale-Health Professional version
- 10 dimensions of MI assessed by this measure are betrayal, guilt, shame, moral concerns, loss of trust, loss of meaning, difficulty forgiving, self-condemnation, religious struggle and loss of religious faith

Mantri, S., Lawson, J.M., Wang, Z. *et al.* Identifying Moral Injury in Healthcare Professionals: The Moral Injury Symptom Scale-HP. *J Relig Health* **59,** 2323-2340 (2020).

8

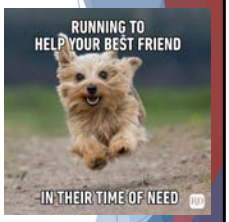
Consensual Factors cited for contributing to professional stress in anesthesiologists

- Time Constraints
- Work Overload
- Production measures
- Complexity of clinical tasks
- Huge Clinical Responsibilities
- Fear of Harming a patient
- Workplace atmosphere
- Communication difficulties
- Lack of job control
- Mixing family life with professional duties
- Fatigue

Saadat, Haleh, Kain, Zeev N. Wellness Interventions for Anesthesiologists, Current Opinion in Anaesthesiology: June 2018-Volume 31 – Issue 3 – p 375-381

9

What can we do?



10

Intervene with Stress First Aid

Ready	Reacting	Injured	Ill
Definition	**Definition**	**Definition**	**Definition**
• Adaptive coping • Effective functioning • Well-being	• Responding to multiple stressors at work and home • Mild and transient distress or loss of function	• Responding to strong or multiple stressors ◦ Trauma ◦ Loss ◦ Moral Injury ◦ Wear and tear • More severe or persistent distress or loss of function	• Unhealed orange zone stress • Additional stress or risk factors • Clinical mental disorders (PTSD, anxiety, depression, substance use disorders)
Features	**Features**	**Features**	**Features**
• In control • Calm and steady • Getting the job done • Motivated • Maintaining humor • Sleeping enough • Ethical and moral behavior	• Changes in mood (worrying, anxious, sad, irritable, angry) • Loss of motivation • Loss of focus • Physical changes (poor sleep, aches and pains) • Social changes (isolation, hyperactive, loud, numb)	• Loss of control of mood, social, or physical reactions (panic, rage, guilt, shame, social numbing or isolation, can't sleep, moral compass affected) • No longer feeling like normal self	• Symptoms persist and worsen for more than 30 days • Severe distress • Functional impairment

https://edhub.ama-assn.org/steps-forward/module/2779767

11

	Description	Techniques
Observe	Actively observe behaviors and look for patterns.	Ask yourself about your colleagues—are they more sullen, withdrawn, frustrated, or irritable than usual?
State observations	State the behaviors. Summarize just the facts without interpretations or judgments.	"I have noticed over the past few days that you seem [lost in thought/quiet/frustrated/irritated]."
Clarify role	State why you are concerned about the behaviors. Validate why you are addressing the issue.	"As a [coworker/friend/supervisor], [Colleague], I am concerned."
Ask why	Seek clarification; try to understand the other person's perception of their behaviors.	"Help me understand what's going on. I would like to help if I can."
Respond	Clarify concern if indicated. Discuss desired behaviors. State options in behavioral terms.	"Thank you for trusting me enough to share that [issue]. I really do want for you to be comfortable working together. I respect your privacy and that you have a lot going on. If not me, would you be willing to talk with [names of two trusted resources]."

12

How do we energize in healthcare?

- Highly resilient people
  - Prevail because setbacks are interpreted as "temporary, local, changeable."
  - Don't sit still – make changes to make the circumstances different
- Can we use Job Crafting to reinvigorate?

13

Job Crafting Definition

- Coined by Amy Wrzesniewski and Jane Dutton in 2001 "the physical and cognitive changes individuals make in the task or relational boundaries of their work"
- Job Crafting Theory (JCT) posits that people who engage in crafting activities increase the meaningfulness of their work and people will further engage in job crafting activities to:
  - satisfy their need for control
  - to maintain a good self-image
  - to connect with others
- Most of us do this intuitively

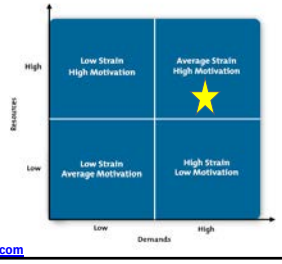
14

Types of Job Crafting

- **Task Crafting**: refers to the changes employees make to either the type or amount of work they do.
  - Choosing the optimal time of day to do most complex tasks – writing, research etc
  - Choosing the task that gets completed at that moment
  - Choosing the method of completing task
- **Relational Crafting**: refers to the control employees have over the people at work they interact with
  - Deciding the amount of time spent with an overly negative colleague vs overly positive
  - Deciding energy expenditure on creating social network with colleagues
  - Deciding on degree of letting work overlap with personal life
- **Cognitive Crafting**: refers to the way an employee makes changes to their perception about their job to attach more meaning to their work
  - Changing the way one thinks about work to align with personal values
  - Choosing the boundaries of the work day – allowing variance to align with current vision of balance (finishing a presentation well into the night)

15

JD-R theory – all aspects of work are either job demands or resources



Source: Mindtools.com

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Motivating Potential Score (MPS)

"The overall degree to which a job is objectively designed in a way that maximizes the possibility for internal motivation pn the part of the people who perform it."

$$MPS = \frac{\text{Skill Variety} + \text{Task Identity} + \text{Task Significance}}{3} \times \text{Autonomy} \times \text{Feedback}$$

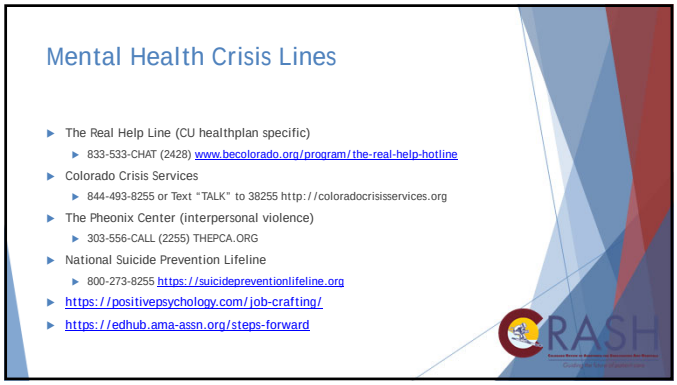
Hackman JR, Oldham GR. *Work Redesign*. Addison Wesley; 1980.

17

Protective Domains include:

- World view
  - Death is part of life. Acceptance doesn't mean understanding
- Social network
  - Strong role models. Trusted Mentors
- Cognititive Flexibility
  - Optimism, positive reframing
- Self-care and balance
  - Physical, emotional spiritual health, rituals

18


Mental Health Crisis Lines
The Real Help Line (CU healthplan specific)
833-533-CHAT (2428) www.becolorado.org/program/the-real-help-hotline
Colorado Crisis Services
844-493-8255 or Text "TALK" to 38255 http://coloradocrisisservices.org
The Pheonix Center (interpersonal violence)
303-556-CALL (2255) THEPCA.ORG
National Suicide Prevention Lifeline
800-273-8255 https://suicidepreventionlifeline.org
https://positivepsychology.com/job-crafting/
https://edhub.ama-assn.org/steps-forward
CRASH

19

COVID and Pregnancy: Safety on Labor and Delivery

Cristina Wood, MD MS

Associate Professor Anesthesiology, University of Colorado School of Medicine

Medical Director Anesthesiology Colorado Fetal Care Center

Program Director Obstetric Anesthesiology Fellowship

No Financial Disclosures

Learning Objectives

- Review epidemiology of COVID infection and in pregnant patients
- Discuss COVID screening and testing on labor and delivery units
- Understand safety considerations for COVID positive in maternal patients
- Recommendations for treatments and vaccinations

Background

- Incidence
  - International: 10%, wide geographical variation
    - 54% asymptomatic versus 41% in general population
  - Parturients more likely to develop more severe disease (13%)
    - Hypercoagulable
    - Immunocompromised
      - Decreased Th1:Th2 immunity
  - Increased risk of developing pre-eclampsia
  - Possible increased duration of symptoms, needs more data

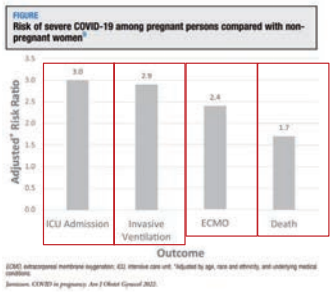
Pregnant Women with COVID-19, United States, January 22, 2020 - February 14, 2022

TOTAL CASES	TOTAL DEATHS
173,508	274

- In a global systematic review: COVID negative pregnant patients
  - Increases in the stillbirths and maternal deaths
  - Declines in maternal mental health
  - Increased rate of ruptured ectopic pregnancies

Outcomes

- 4% require ICU admission
- Increased need for invasive ventilation
  - OK to prone and LLD may be just as helpful (SMFM 10/2021)
- Increased need for ECMO
- Increased mortality
  - Compared to symptomatic non-parturients: OR 1.7
  - Compared to COVID negative parturients: OR 2.85
- Risk factors:
  - Non-white ethnicity
  - Chronic hypertension
  - Pre-existing diabetes
  - Advanced maternal age (>35)
  - Elevated body mass index



Testing

- Routine testing for all admissions
  - PCR is recommended over rapid antigen test
  - 95% versus 60-75%
- Routine testing for all surgical procedures
- Antepartum testing
  - Dependent on local infection rates
  - Dependent on symptoms
  - Some centers doing this weekly
  - Does it change your management, staffing and PPE

- COVID positive test should not alone dictate mode or timing of delivery

OB Visitation/Support Person Scenarios

Pregnant patients and patients in active labor are allowed 1 visitor, also known as a support person. A doula or other similar birth care attendant, may be allowed in addition to the 1 support person.* No children under the age of 16 are allowed to visit hospitalized patients.

To provide some guidance, the table below details the common scenarios seen in the OB and women's care settings. The support person/doula/birth care attendant must wear appropriate PPE at all times.

Pregnant Patient Scenario	Allowance	Precautions
Asymptomatic and tests negative for COVID-19	Allowed 1 support person per 24 hrs. A doula or other similar birth care attendant may be allowed in addition to the 1 support person.	Universal Masking and Eye Protection, N95 During 2nd Stage of Labor (in addition to any other precautions indicated)
Symptomatic and tests negative for COVID-19	Allowed 1 support person per 24 hrs. A doula or other similar birth care attendant may be allowed in addition to the 1 Support person.	Universal Masking and Eye Protection, N95 During 2nd Stage of Labor (in addition to any other precautions indicated)
Asymptomatic or Symptomatic and tests positive for COVID-19 during or after delivery	Allowed 1 support person per 24 hours.	Enhanced Precautions
COVID-19 positive prior to delivery and does not meet criteria for release from isolation.**	Allowed 1 support person per 24 hrs.	Enhanced Precautions
Declines COVID-19 Testing	Allowed 1 support person for 24 hrs.	Enhanced Precautions
Asymptomatic on Quarantine and tested negative for COVID-19 at admission	Allowed 1 support person per 24 hrs.	Enhanced Precautions

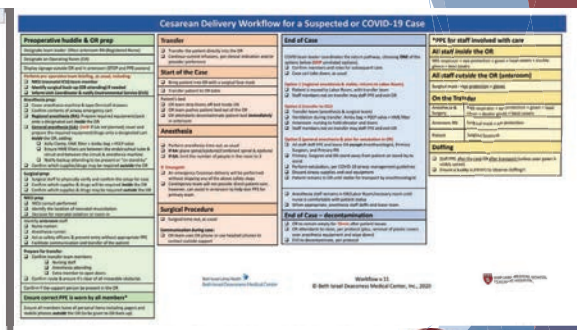
*Exceptions may be granted on a case by case basis by your AOC or house supervisor and should follow COVID positive or under quarantine visitor guidelines.
**Per CDC, the release from isolation requires the person to be at least 10 days post-symptom onset, fever free for 24 hours without the use of fever reducing medications, and symptoms improving. If no symptoms, patients should isolate for 10 days from the date of positive test. If the patient is immunocompromised or had severe illness requiring hospitalization, isolation should be extended to 20 days

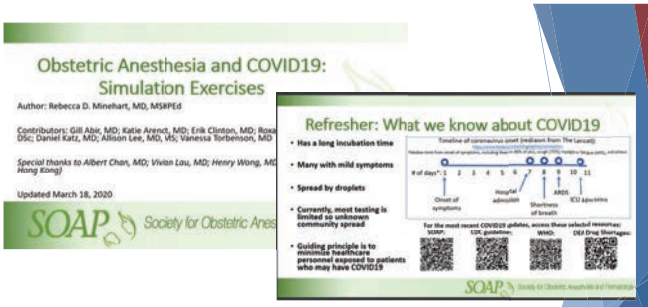
Preparedness on the Unit

- Negative Pressure Triage Room
  - Who does the testing
    - OB RN
  - What is the turn around time
    - Batching
    - Reagents
  - What to do if positive or negative
    - Location
    - Visitors
    - NICU/peds guidelines
- Negative Pressure Operating Room
  - Who secures the room
  - Understand airflow rates and clearance
  - Identify a "Runner" for individual teams (i.e. anesthesia, OB, NICU)

Preparedness in the Operating Room

- Anesthesia Machine
  - HEPA Filters
  - Covers
- Tackle box
  - Airway
  - Drugs
  - IV kits





Drill, drill, drill

COVID-19 Toolkit (memberclicks.net)

Labor analgesia and COVID

- Neuraxial
  - Recommend early epidural analgesia to reduce the need for general anesthesia for emergent cesarean delivery
    - Leave epidural cart outside of a PUI/COVID + room
  - COVID19 diagnosis itself is NOT considered a contraindication for neuraxial anesthesia
    - DO NOT delay for COVID test
  - Reduce number of potential interventions:
    - Combined Spinal Epidural
    - Programmed Intermittent Epidural Bolus
    - Patient Controlled Epidural Analgesia
  - Epidural Blood patch: case by case
    - PDPH can have significant comorbidity: Anesth Analg. 2019 Nov;129(5):1192.
- Nitrous oxide
  - COVID negative test
  - Filter with pore size <0.05um

To the OR….

- Avoid emergent cesarean deliveries: All about the communication
- Assign the most experienced anesthesia provider
- Wear appropriate PPE: Intubation may be needed at any time.
- Consider Double gloving
- HEPA filter at the patient side of the circuit
- Extubation is equally aerosolizing
  - Minimize personnel, utilize airborne (N95/PAPR) precautions.
- Extubate in the OR or transfer and extubate in a negative pressure room

ASA and APSF Joint Statement on Elective Surgery and Anesthesia for Patients after COVID-19 Infection

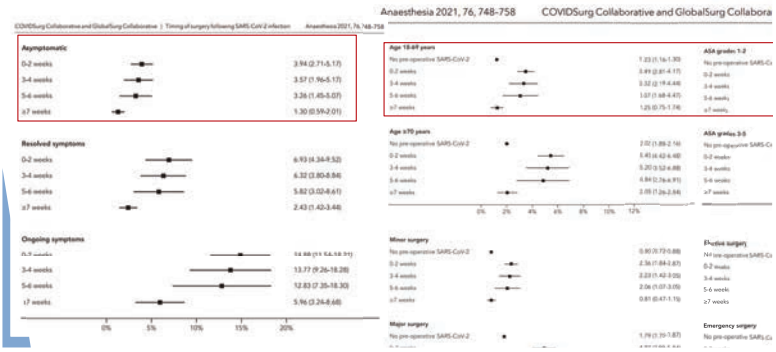
For patients with confirmed COVID-19 infection who are not severely immunocompromised and experience mild to moderate symptoms*, the CDC recommends discontinuing isolation and other transmission-based precautions when:

1. At least 10 days have passed since symptoms first appeared.
2. At least 24 hours have passed since last fever without the use of fever-reducing medications.
3. Symptoms (e.g., cough, shortness of breath) have improved.

The timing of elective surgery after recovery from COVID-19 utilizes both symptom- and severity-based categories. Suggested wait times from the date of COVID-19 diagnosis to surgery are as follows:

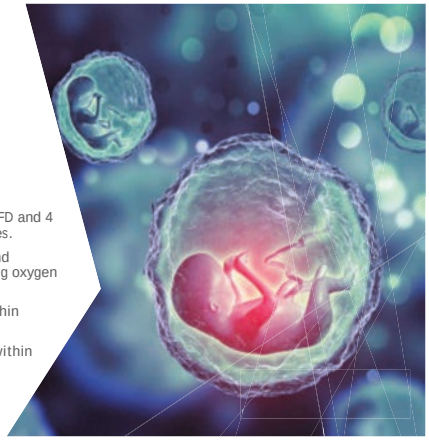
- Four weeks for an asymptomatic patient or recovery from only mild, non-respiratory symptoms.
- Six weeks for a symptomatic patient (e.g., cough, dyspnea) who did not require hospitalization.
- Eight to 10 weeks for a symptomatic patient who is diabetic, immunocompromised, or hospitalized.
- Twelve weeks for a patient who was admitted to an intensive care unit due to COVID-19 infection.

Do symptoms and timing matter?



The Fetus

- Maternal hypoxia
  - Release of potent vasoconstrictors
- Preterm birth
- Still birth (1.26% versus 0.64%)
  - COVID destroys the placenta
    - Schwartz et al. 02/10/2022: 64 IUFD and 4 neonatal deaths across 12 countries.
    - 78% destruction of the placenta and significant fibrin deposition limiting oxygen transport to the fetus
- IUGR: recent data shows birth weights within normal range
- APGAR: recent data shows APGAR scores within normal



Vertical Transmission

- ACE2 receptors throughout the placenta but……
  - Low expression of both ACE2 and transmembrane serine protease 2 (TMPRSS2)
- Some neonates testing positive within 1 h after birth
- Replication competent virus not found in amniotic fluid, breast milk, or cord blood
- 2/3 studies report no vertical transmission and 1/3 report it is possible
- Likely 1-4%

- Antibodies: Edlow et al. (JAMA 2022)
  - At two months of age: 98% born to vaccinated moms had detectable levels IgG
  - At six months of age: 57% born to vaccinated mothers still had detectable IgG levels, compared with 8% born to unvaccinated infected mothers
- Delayed cord clamping
  - Recommended due to known benefits
  - BJOG 2021
- Breastfeeding
  - Salvatore et al. (Lancet 2020)
    - 116 breast feeding COVID + mothers using hand washing and masking: No transmission

Effectiveness of Maternal Vaccination with mRNA COVID-19 Vaccine During Pregnancy Against COVID-19–Associated Hospitalization in Infants Aged <6 Months — 17 States, July 2021–January 2022

Early Release / February 15, 2022 / 71

- Vaccinated within 2 weeks of delivery versus unvaccinated mothers
- Infants <6 months admitted to the hospital
  - NO difference in comorbidities or gestational age at delivery
  - Controls were COVID-
- Take home:
  - Babies born to vaccinated mothers
    - 61% less likely to be admitted to the hospital
    - If admitted, less likely to be admitted to the ICU (12% vs. 88%)

TABLE 1. Characteristics of infants aged <6 months hospitalized with COVID-19 (case-infants) and without COVID-19 (control-infants) — 20 pediatric hospitals, 17 states,* July 2021–January 2022

Characteristic (no. missing)	Case status, n/N† (column %)		
	Case-infants (N = 176)	Control-infants (N = 203)	p-value§
Preterm birth (born <37 weeks gestation) (50)	34/146 (23.3)	38/183 (20.8)	0.58
Maternal vaccination during pregnancy¶	28 (15.9)	65 (32.0)	<0.01

TABLE 2. Clinical outcomes and severity among case-infants aged <6 months hospitalized with COVID-19, by maternal vaccination status during pregnancy* — 20 pediatric hospitals, 17 states,† July 2021–January 2022

Characteristic (no. unknown)	Maternal vaccination status during pregnancy, n/N (%)		
	Total (N = 176)	Unvaccinated (n = 148)	Vaccinated (2-doses of mRNA COVID-19 vaccine) (n = 28
Intensive care unit admission	43/176 (24.4)	38/148 (25.7)	5/28 (17.9)

Vaccination: Do it!

- Indicated in all trimesters and if breastfeeding
- No increase rate of miscarriage
- No issues with fertility
- No adverse fetal or postnatal development
  - Although delay in some development was seen for all neonates born during the pandemic
- All three vaccines recommended even if prior COVID infection regardless of symptoms
- Booster recommended
- J and J
  - Increased risk of thrombocytopenia and thrombosis seen in non-pregnant women (6 cases)
  - 12/2021: FDA recommended mRNA over J and J vaccine for everyone

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Obstet Gynecol. 2022 Jan 1;139(1):107-109. doi: 10.1097/AOG.0000000000004621.

Maternal Outcomes After Severe Acute Respiratory Syndrome Coronavirus 2 (SARS-CoV-2) Infection in Vaccinated Compared With Unvaccinated Pregnant Patients

Only 35% vaccinated as of 11/27/2021, up from 22% on 07/2021

ICU admission	0 (0)	5 (0.6)	0 (0–19.35)
Remdesivir	1 (0.08)	20 (0.23)	0.32 (0.01–2.05)
Dexamethasone	1 (0.08)	34 (0.4)	0.18 (0.04–1.15)
Tocilizumab	0 (0)	1 (0.01)	0 (0–15)

aOR, adjusted odds ratio; OR, odds ratio; COVID-19, coronavirus disease 2019; SARS-CoV-2, severe acute respiratory syndrome coronavirus 2; ICU, intensive care unit.
Data are n (%) unless otherwise specified.
* Logistic regression analysis was used to calculate an adjusted odds ratio for all statistically significant outcomes to control for age, race, body mass index, and current smoking. Adjusted odds ratios were not reported for nonstatistically significant outcomes owing to large CIs. Low total number of adverse events for nonsignificant secondary outcomes allowed insufficient statistical power to generalize nonsignificant findings.
† According to National Institutes of Health definition.
‡ Stillbirth is defined as nonspontaneous fetal death after 20 weeks of gestation.

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Treatments

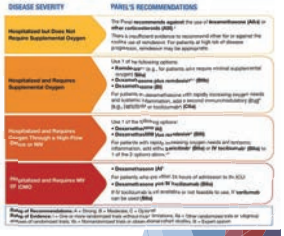
Therapeutic Management of COVID-19 in the Setting of Pregnancy

Potentially effective treatments for COVID-19 should not be withheld from pregnant people because of theoretical concerns related to the safety of using those therapeutic agents in pregnancy (AIII).

SMFM supports the NIH COVID-19 treatment guidelines and suggests that shared decision-making and acknowledgment of the limitations of the existing data should occur when considering monoclonal antibody treatment for pregnant patients. However, therapies that would otherwise be given should not be withheld specifically due to pregnancy or lactation. Therapies including monoclonal antibodies, remdesivir, dexamethasone, baricitinib, and tocilizumab, can and should be provided to pregnant patients with COVID-19 who meet clinical qualifications.

The NIH guidelines also recommend that monoclonal antibody therapy be offered as a treatment for infected individuals and that postexposure prophylaxis should be considered for inadequately vaccinated individuals exposed to SARS-CoV-2; this should also include pregnant individuals.

Figure 2. Therapeutic Management of Hospitalized Adults With COVID-19 Based on Disease Severity



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CRASH
Colorado Review of Anesthesia for Substantial and Hospitals
Guiding the future of patient care

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Monday, February 28th

WHAT'S NEW IN OBSTETRIC ANESTHESIA FROM 2020-21?

Joy L. Hawkins, M.D.
University of Colorado SOM

Disclosure: I have no financial relationships with commercial support to disclose.

1

GOALS & OBJECTIVES

Discuss how literature from the past year may:

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

2

GUIDELINES, POLICIES & PROCEDURES

3

ASA PHYSICAL STATUS FOR OBSTETRICS

The 2020 ASA Physical Status Classification System update now includes Pediatric and Obstetric examples:

- ASA II: Normal pregnancy (due to physiologic changes) + well-controlled HTN, PEC without severe features, gestational diabetes
- ASA III: PEC with severe features, DM requiring insulin, thrombophilia requiring anti-coagulation
- ASA IV: HELLP, cardiomyopathy with ↓ EF, CHD

Anesthesiology 2021; 135: 904-19

4

ASA STATEMENT ON PDPH MANAGEMENT

ASA Committee on Obstetric Anesthesia Statement on Post-Dural Puncture Headache Management → Key Points:

- PDPH needs to be evaluated and diagnosed within 24 hours
- Mild symptoms may be managed conservatively but if symptoms are severe, a blood patch should be offered.
- A second EBP may be offered but consider other causes. Prior to a 3rd EBP consider Neurology consult ± imaging.
- Post discharge, provide telephone follow-up and send her home with education on concerning symptoms.

5

ASA: REDUCING PERIPARTUM DISPARITIES

Reducing Maternal Peripartum Racial and Ethnic Disparities

- Document race, ethnicity and primary spoken language.
- EMR dashboards should include race, ethnicity and language.
- Educate caregivers on bias, identify women with ↑ risk for complications, engage in multi-disciplinary planning and safety bundles, and implement ERAS for cesarean.
- Create patient education in their language at a 6th grade level.
- Engage in QI initiatives that target reducing disparities.
- Support workplace diversity within our departments.

6

DISPARITIES IN ANESTHETIC MGT

A multi-state administrative database was used to determine anesthetic management from 2007-14.

Black women were more likely than white women to:

- receive general anesthesia for cesarean (aOR 1.44).
- receive no analgesia for vaginal delivery (aOR 1.45).
- experience *any* type of severe morbidity (aOR 1.38).

J Clin Anesth 2020; 65: 109821

7

POSTOPERATIVE BREAST-FEEDING

ASA Committee on Obstetric Anesthesia*: Statement on Resuming Breastfeeding after Anesthesia (2019)*

1. All anesthetic drugs transfer to breast milk but in low concentrations considered clinically insignificant.
2. Pain interferes with breastfeeding after surgery; women should not avoid pain medicines, but add regional and other multi-modal analgesics.
3. Resume breastfeeding as soon as she is alert and able to hold her baby safely. It is not recommended that patients "pump and dump".

8

POSTOPERATIVE BREAST FEEDING

From the Association of Anaesthetists of Great Britain:

- Women should be encouraged to breastfeed as normal following surgery.
- There is no need to express and discard breast milk after anaesthesia. Drugs are transferred to breast milk in only very small amounts…..there is no evidence of effects on the breastfed infant.

Anaesthesia July 31, 2020

9

SOAP CONSENSUS STATEMENT

"Sugammadex during pregnancy and lactation"

1. Avoid completely in early pregnancy as it binds progesterone, needed to maintain the pregnancy.
2. Avoid or use with caution at or near term.
3. It is safe to use with established lactation.
4. It is safe to use in patients of reproductive age IF they receive counseling to use additional non-hormonal contraception (e.g. condoms) for 7 days.

www.soap.org

10

OPTIMIZING IOL TO REDUCE C/S

Vaginal delivery is more frequent after elective induction of labor at 39 weeks than after expectant management.

Obstet Gynecol 2020; 136: 698-705

Elective induction does not incur greater resource use.

Am J Obstet Gynecol 2020; 222: 369

The stillbirth rate is lower if labor is induced at 39 weeks.

Am J Obstet Gynecol, January 2020 (Po')

After induction of labor in low-risk women, cesarean rates ranged widely from 19-85% across CA. Clinical management??

Obstet Gynecol 2020; 136: 1179-89

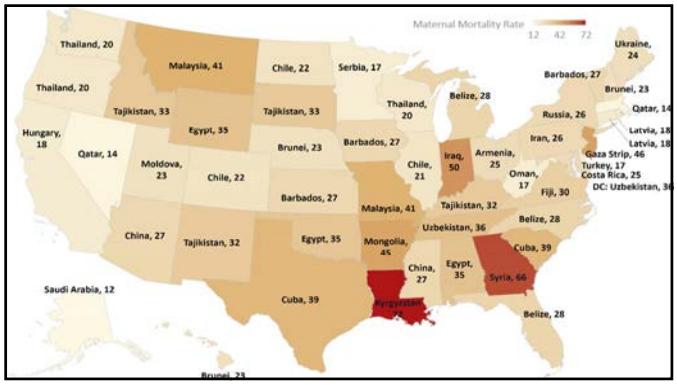
11

MATERNAL MORTALITY IN THE UNITED STATES: WHAT DO WE KNOW?

1. Pregnancy-related mortality rates are high compared to the rest of the developed world.
2. Racial disparities are large and unchanging.
3. Well over half of maternal deaths are preventable.
4. 1/3 occur during delivery, 1/3 occur in the first week after delivery, and 1/3 occur 1 week to 1 year postpartum.

Am J Obstet Gynecol, October 2020

12



13

LABOR ANALGESIA

14

BENEFITS OF VIRTUAL REALITY

VR in early labor reduced pain scores and heart rate although later epidural use did not change (85.7% vs 89.5%, p 0.28).

Am J Obstet Gynecol January 2020, abstract #39

VR was used during epidural placement for patients with extreme anxiety with excellent results and high satisfaction. The headset displayed an underwater environment of a reef and sea creatures + bubbles with "breathe" and "relax".

J Clin Anesth 2020; 61: 109635

15

SAFETY AND UTILITY OF N_2O

Nitrous oxide is safe for mother, neonate and those who work on L&D. Conversion to epidural occurs in 40-60%. Rate of neuraxial utilization does not change if nitrous is available.

APSF newsletter, June 2020, pp 60-1

18% will use nitrous as their only pain med; 82% will transition to other modalities; 3% discontinue for side effects.

J Obstet Gynecol Neonatal Nurs 2021; PMID 33493464

50% nitrous is effective at high and low altitudes although there are fewer side effects at high altitude.

Anesth Analg September 2021 (Wood)

16

OPTIMIZING NEURAXIAL: PIEB

Meta-analysis of programmed intermittent epidural bolus (PIEB) showed improved pain control and ↓ breakthrough pain with a trend to ↑ satisfaction and ↓ motor block.

Br J Anesth 2020; 125: 560-79

A single-center, double-blind RCT to compare PIEB (6 ml q 45 min) vs CEI (8 ml/hr) did not find differences in PCEA consumption but did find ↓ motor block.

Anesth Analg 2020; 130: 426-35

17

NEURAXIAL EFFECTS ON THE PLACENTA

What is the effect of epidural analgesia in active labor on uteroplacental perfusion, compared to unmedicated labor?

- Maternal blood pressures were lower (but <u>not</u> hypotensive) after onset of analgesia.
- Pulsatility indices in all vessels were stable over time.
- Mean pH of umbilical artery blood was 7.29 in the epidural group vs 7.31 in the unmedicated group. Same Apgars.
- Placental hemodynamics were stable despite ↓ BP.

Int J Obstet Anesth 2021; 45: 83-89

18

MATERNAL OXYGEN SUPPLEMENTATION

Does intrapartum maternal oxygen supplementation improve Category II electronic FHR patterns?

- NR-FHR → recurrent variables, late decels, tachycardia, prolonged decelerations or ↓ variability.
- Mothers randomized to room air or 10L face mask.
- Oxygen administration had no impact, i.e. it did not resolve high-risk category II fetal heart tracings or hasten the resolution of decels.

Am J Obstet Gynecol 2020; 223: e1-7

19

MATERNAL OXYGEN SUPPLEMENTATION

A meta-analysis of 16 RCT with 2000 patients found no association between maternal oxygen administration and improvement in umbilical artery pH or other neonatal outcomes.

JAMA Pediatr 2020; 5351

A quality improvement initiative to reduce exposure to oxygen for category II FHR tracings demonstrated adherence to the guidelines *without* worsened maternal or perinatal outcomes.

Obstet Gynecol 2021; 138: 627-32

20

ACOG STATEMENT ON PPTL

Committee Opinion #827: Many women who desire PPTL do not actually undergo the procedure. Address barriers!

- Ensure fair and equitable access regardless of insurance type.
- Designate PPTL as a non-elective procedure.
- Religiously-affiliated hospitals should inform the patient of restrictions early in prenatal care and refer them to a practitioner or hospital that can accommodate their request.
- Avoid the inclination to deny PPTL based on provider values.

Obstet Gynecol 2021; 137: e169-76

21

CESAREAN DELIVERY

22

PREVENTING SSI IN OBESE WOMEN

Obese women are at risk of SSI. What is the best regimen to keep drug levels adequate in tissue?

- Plasma and interstitial fluid levels were measured in 12 women with median BMI 41.5 having cesarean at term.
- Simulations found that both 2 gm and 3 gm initial doses should be redosed at 2 hours.
- With limited blood flow to adipose tissue, a higher plasma concentration is necessary to diffuse drug into the site.

Anesth Analg 2020; 131: 196 and 199

23

GA: SAFETY OF THE LMA

Should supra-glottic airway devices replace endotracheal tubes for elective cesarean delivery in selected patients?

- 2nd generation SGA devices have better protection from aspiration and are recommended to rescue failed intubation.
- Several studies (~8000 women) have been studied using an SGA as the primary airway device → no aspiration events.
- Caveat: fasted, non-obese, no reflux – gastric ultrasound?

Br J Anesth 2020; 125: e7

24

GA: OPTIMAL PRE-OXYGENATION

What is the time interval for 90% of parturients to achieve ≥ 90% ET oxygen using face mask vs high-flow nasal oxygen during pre-oxygenation?

- Face mask required 3.6 minutes.
- Time interval for nasal oxygen could not be calculated – only 92% had achieved target after 8 minutes – 0% at 3 minutes, 67% at 4 minutes.

Anaesthesia 2020; 75: 609-16

25

GA: ACCIDENTAL AWARENESS

Awareness in obstetric patients may be as high as 1:256.

- 3115 obstetric patients were interviewed after GETA; 12 had accidental awareness.
- 58% were distressed, 42% felt paralyzed, 17% had pain.
- 75% occurred during induction or emergence.
- Direct postoperative questioning should be done to elicit accidental awareness after cesarean using GETA.

Anaesthesia 2021; 15385

26

SPINAL: UTERINE DISPLACEMENT

75 women having elective cesarean under spinal anesthesia were randomized into 3 groups: supine, 15^0 tilt, or 30^0 tilt from spinal placement to delivery.

- There was no difference in umbilical arterial pH between groups (7.31 vs 7.30 vs 7.31).
- But, the 30 degree group required significantly less phenylephrine and ephedrine.

Anesth Analg 2021; 133: 1235-43

Eur J Anaesthesiol 2022; 39: 236-43

27

SPINAL: LIPOPHILIC OPIOIDS

Is fentanyl a valuable addition to spinal bupivacaine (± morphine) for cesarean delivery? Yes it is.

- Meta analysis of 17 RCT with 1064 parturients.
- Although there was more pruritus with fentanyl (RR 5.89).....
- ↓ need for supplemental analgesia by 82%
- ↓ incidence of intraoperative nausea and vomiting by 59%
- ↑ time to first request for analgesia: 91 m difference

Anesth Analg 2020; 130: 111

28

SPINAL: ONDANSETRON TO PREVENT ↓BP

Ondansetron has been shown to reduce hypotension and vasopressor needs after spinal for cesarean. By how much?

- Women were randomized to 4mg ondansetron or saline control 10 min before positioning for spinal anesthesia.
- A single dose of ondansetron reduced the ED50 of prophylactic phenylephrine infusion by 26%.
- Granisetron 3mg similarly lowers pressor requirement.

Anesth Analg 2020; 131: 564-9

J Clin Anesth 2021; 110469

29

SPINAL: NOREPINEPHRINE TO PREVENT ↓BP

Norepinephrine may preserve cardiac output and HR better than phenylephrine after spinal for cesarean.

- What dose? An RCT found an infusion of 0.08 μg/kg/min prevented hypotension in 90% of parturients.

Br J Anesth 2020; 124: e108

- What are the effects of NE infusion on fetal cord pH vs phenylephrine? A randomized trial found no difference in umbilical arterial pH between pressor groups.

Br J Anesth 2020; 125: 588-95

30

A review of the current ERAC literature found 44 different protocols and 100 different outcomes.
IJOA 2020; 43: 72


Anesth Analg 2021; 132: 1362-77

Obstetric Anesthesiology

SPECIAL ARTICLE

Society for Obstetric Anesthesia and Perinatology: Consensus Statement and Recommendations for Enhanced Recovery After Cesarean

Laurent Bollag, MD,* Grace Lim, MD, MS,† Pervez Sultan, MBChB, FRCA,‡ Ashraf S. Habib, MBBCh, MSc, MHSc, FRCA,§ Ruth Landau, MD,‖ Mark Zakowski, MD,¶ Mohamed Tiouririne, MD,# Sumita Bhambhani, MD,** and Brendan Carvalho, MBBCh, FRCA‡

31

ERAC: OPTIMIZING PAIN CONTROL

There was no difference in opioid use between cesarean patients receiving either 15mg or 30mg ketorolac intraop.

Int J Obstet Anesth 2020; 44: 116-21

Administering acetaminophen and ketorolac simultaneously instead of alternating significantly reduced opioid use.

ASA Annual Meeting abstract #A2103, 2019

A 5% lidocaine patch placed at end of cesarean was effective in reducing pain scores for 36 hours, although no ↓ opioid use.

J Clin Anesth 2021; 73: 110328

32

DOES ERAC WORK? YES!

- Oral morphine equivalents administered postpartum were 42% lower despite more mobilization in the ERAC group. Use of oxycodone after discharge also ↓ 41%.

  Int J Obstet Anesth 2020; 43: 47
- Total morphine equivalents were reduced 38% despite increased activity in the ERAC group. Mean pain scores during hospitalization were similar.

  Int J Obstet Anesth 2020; 43: 38
- *Next* we need to know which elements are most important.

  Anesthesiology Clin 2021; 39: 743-60

33

ERAS: PONV PREVENTION

Fourth Consensus Guidelines for the Management of Postoperative Nausea and Vomiting produced jointly by SAMBA and the American Society of Enhanced Recovery with literature review through 2019.

- Parturients have multiple risk factors: female, young, non-smoker, laparotomy, opioid analgesia ± hx PONV → give 3-4 agents for prophylaxis.
- Use agents from different classes for rescue treatments.

Anesth Analg 2020; 131: 411-48

34

RISK FACTORS FOR SEVERE PAIN

Severe post-cesarean pain is associated with poor breast-feeding, postpartum depression and ↑ length of stay.

J Clin Anesth 2020; 62: 109697

What are the risk factors for increased pain after cesarean?

- History of chronic pain (OR 4.12), current smoker (OR 2.52), pre-existing anxiety (OR 1.93), receipt of IV ketamine or fentanyl (OR 1.56), and repeat cesarean (OR 1.54).
- Non-black race and private insurance ↓ pain (OR 0.44).

Int J Obstet Anesth 2020; 44: 60-67

35

NERVE BLOCKS FOR C/S PAIN

A couple great reviews on peripheral blocks for cesarean:

Reg Anesth Pain Med 2020; 45: 52-62

Anaesthesia 2021; 76: 136-47

Bottom line: Neuraxial morphine is best for post-cesarean analgesia, but if not available quadratus Lumborum (QL) *may* be slightly superior to TAP blocks. Both > control / placebo.

Anesthesiology 2021; 134: 72-87 → IT morphine better than QL

Anaesthesia 2021; 76: 393-403 → QL better than TAP blocks

36

ANESTHETIC MORBIDITY

37

GA: FAILED AIRWAY

Review of MPOG data on intubation during cesarean 2000-18:

- Difficult intubation was **1:55** ; 85% were classified as difficult based on the view and 15% had ≥ 3 attempts.
- Failed intubation was **1:1250** (defined as any attempt without successful ETT placement). All 12 cases were rescued using a supraglottic airway. There were no deaths.
- Risk factors: MP 3 or 4, obesity, and maternal age > 35.

SOAP abstract #BCPS-05, 2020

38

GA: ASSOCIATION WITH DEPRESSION

Is general anesthesia for cesarean associated with ↑ odds of maternal psychiatric complications?

- New York State database with 8% rate of GA for cesarean.
- Relative to neuraxial: postpartum depression OR 1.54, suicidal ideation or self-harm OR 1.91.
- Possible reasons? More postoperative pain, delayed skin-to-skin bonding and breast-feeding, emergent nature of the delivery (often fetal concerns).

Anesth Analg 2020; 131: 1421-9

39

PDPH: METHODS OF PREVENTION

Prophylactic IT morphine administered after delivery does not ↓ incidence or severity of PDPH after "wet tap".

Anesthesiology 2020; 132: 1045-52

Case volume and experience inversely relate to accidental dural puncture. Faculty with high volume = 0.6%, low volume = 2.4%, OR 3.77. Trainees 3.1%, registrars 1.2%.

Anaesthesia 2021; 76: 1060-7

An IT catheter can be used for analgesia / anesthesia after "wet tap", but there is not firm evidence it reduces PDPH.

Int J Obstet Anesth 2020; 41: 71-82

40

PDPH: LONG-TERM CONSEQUENCES

At *least* 4 studies in 2021 showed that women who develop PDPH after neuraxial - whether treated or not - have ↑ incidence of chronic headache, backache, depression, and disability over women with no neuraxial or no accidental dural puncture: *Eur J Anesthesiol 2021; 38: 130-37*

Anaesthesia 2021; 76: 1068-76

Br J Anaesth 2021; 127: 600-7

Acta Anaesthesiol Scand 2021; 65: 959-66

What should our follow-up be? Can we prevent these?

41

PREGNANCY TESTING & LAWSUITS

From the ASA *Statement on Pregnancy Testing Prior to Anesthesia and Surgery*: "…..routine pregnancy testing may pose greater medicolegal risk to anesthesiologists due to failure to check the result…..prior to elective surgery."

- Patient with abdominal pain underwent surgery for presumed ectopic because a negative test was not noticed preop.
- A positive test was disclosed to family before the patient was notified; prevented her from terminating the pregnancy.
- A D&C was performed for AUB; a prior negative pregnancy test was copied and pasted into her EMR; pregnancy lost.

42

SOAP THROMBOCYTOPENIA CONSENSUS

Multidisciplinary expert consensus on neuraxial procedures in obstetric patients with thrombocytopenia.

- Determine the etiology and take a bleeding history.
- Platelet count ≥ 70K is extremely low risk, especially in OB.
- Re-check on admission or within 72 hours, unless HELLP.
- May proceed if < 70K if risk/benefit calculation favorable.
- There are risks to withholding neuraxial as well. Consider co-morbidities, OB risk factors, airway, patient preference.

Anesth Analg 2021; 132: 1531-44 and 1527 (editorial)

43

LITIGATION: POSTPARTUM NERVE INJURY

Review of British malpractice claims for nerve injury following central neuraxial blockade – themes:

- Inadequate consent for risks, e.g. 1:250K for paralysis.
- Nerve injuries were due to direct trauma (stop for paresthesias), chemical injury (e.g. injecting chlorhexidine), compression by hematoma (very rare - only 1 case).
- Recognition, then management of complications promptly.
- Many case studies are included; fascinating!

Anaesthesia 2020; 75: 541-8 and 913-9

44

LAST REVISITED: ASRA 2020 UPDATE

1. The 2020 checklist's main modification was conversion of the traditional bullet-pointed design to a process-flow format similar to the ASRA LAST smartphone application.
2. An ongoing management deficit was failure to recognize that LAST resuscitation differs from ACLS-guided resuscitation (animal studies show many standard ACLS drugs worsen LAST outcomes).
3. Lipid emulsion dosing instructions simplified in response to reported difficulties calculating weight-based dosing and timing of lipid administration; a level of precision that is unnecessary.

Reg Anesth Pain Med 2021; 46: 81-2

45

EPIDURAL ANALGESIA & AUTISM

2 studies from Canada and Denmark found small increases in autism in children whose mothers received labor epidurals. Negative responses were rapid and vigorous!

- SOAP / ASA / SPA / ACOG / SMFM: "no credible evidence".
- U.S. database study: "…do not support neuraxial labor analgesia is associated with increase risk of autism."

JAMA Network Open 2021; 4: e2140458

- Canadian counter results: JAMA Pediatr 2021.0376
- Danish counter results: JAMA 2021; 326: 1170-7

46

47

GENERAL ANESTHESIA & AUTISM

"Our findings suggest that the reported associations between CS and ASD is likely due to the exposure to GA…..resonate well with a recent FDA warning regarding use of GA among young children or pregnant women and its potential effect on brain development."

J Autism and Developmental Disorders 2019; 49: 3127-35

Multiple rebuttals in the same journal: "Not very likely", "Numerous confounders" *JADD 2020; 50: 688 and 1451*

48

EPIDURAL + FEVER = FETAL BRAIN INJURY?

Systematic review and meta-analysis of epidural-related fever and potential neonatal effects.

- Epidural analgesia is associated with intrapartum hyperthermia, OR 4.21 (although not with infection).
- Intrapartum hyperthermia of any cause is associated with neonatal brain injury, OR 2.79.
- It was not possible to quantify any association between epidural-induced hyperthermia and neonatal brain injury.

Br J Anaesth 2021; 126: 500-15

49

GA & FETAL NEUROTOXICITY

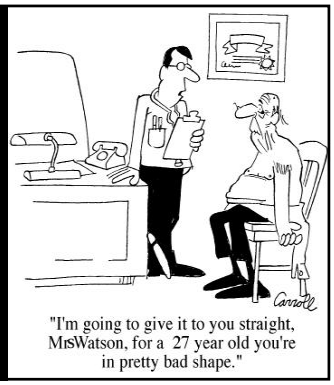
Recent studies and editorials on this controversial subject:

- Anesth Analg 2021; 133: 595 and editorial page 592
- Anesthesiology January 2022 (Ing)
- Br J Anaesth 2021; 126: 1128-40
- Anesthesiology 2020; 133: 1007 and editorial page 967

Bottom line: we have no phenotype for what this neurotoxicity might look like, but current clinical studies on single exposure are reassuring.

50

OBSTETRIC & MEDICAL COMPLICATIONS



51

PREECLAMPSIA: UPDATED GUIDELINES

Both ACOG and the American Heart Association published updated guidelines on hypertension in pregnancy.

Obstet Gynecol 2020; 135: 1492

Hypertension 2022; 79: PAP

Common themes: 1) Ensure more aggressive treatment of HTN to reduce maternal morbidity and mortality due to cardiovascular complications and stroke. 2) Treatment of HTN, prevention of seizures, and timed delivery are the main therapeutic options for preeclampsia.

52

UPDATED ACOG HTN GUIDELINES

Anesthesia-related items in the updated ACOG guidelines:

- NSAIDs should continue to be used preferentially over opioid analgesics…….no differences in BP, anti-hypertensive requirements or other adverse events.
- Epidural or spinal anesthesia is considered acceptable, and the risk of epidural hematoma is exceptionally low in patietns with platelet counts > 70K, provided the count is stable, function is normal, she is not on any anti-coagulant therapy, and there is no other coagulopathy.

53

TESTING REQUIREMENTS?

What is the incidence of thrombocytopenia in women with preeclampsia, and how often should we repeat labs?

- Single center retrospective analysis of 984 patients with PEC
- Incidence: 6.5% < 100K; 2.1% < 70K; 0.5% < 50K
- Platelets did not change significantly over 72 hours; the median % change was 0.
- There were no neuraxial hematomas in 40 patients who had an epidural placed with platelets < 100K.

J Clin Anesth 2020; 62: 109741

54

PREECLAMPSIA: ASPIRIN REAFFIRMED

ACOG, SMFM, and the US Preventive Services Task Force recommend the use of low-dose aspirin (81 mg/day) as preventive medication for preeclampsia after 12 weeks of gestation in persons who are at high risk for preeclampsia (B recommendation).

JAMA 2021; 326: 1186

55

High Risk	Moderate Risk (2)
Hx of preeclampsia	Nulliparity
Multi-fetal gestation	Obesity
Chronic HTN	Family history
Pre-existing diabetes	Low income
Kidney disease	Age > 35 years
Autoimmune disease	Use of IVF to conceive

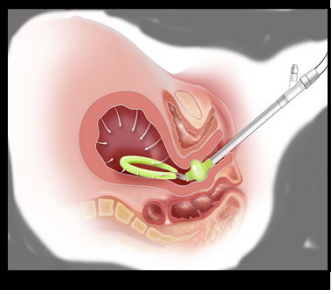
Women with ≥ 1 high risk or ≥ 2 moderate risk factors should begin aspirin therapy 81 mg/day by 16 weeks gestation to prevent preeclampsia. *JAMA 2021; 326: 1192*

56

HEMORRHAGE: NEW DEVICES

Intrauterine vacuum-induced hemorrhage control may provide a new rapid and effective treatment option for postpartum hemorrhage. Control of PPH occurred in 3 minutes; 98% found it easy to use.

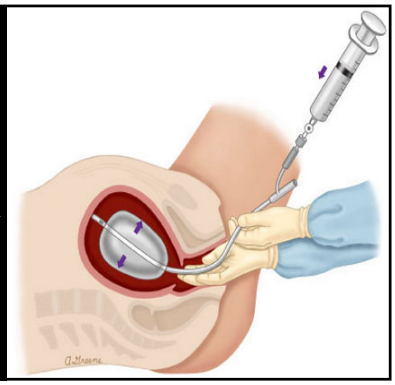
Obstet Gynecol 2021;136:882



57

New data: Uterine balloon tamponade has a success rate of 86% in treating PPH, especially bleeding due to atony or placenta previa, and has a low complication rate of < 6.5%.

Am J Obstet Gynecol 2020; 222: 293



58

HEMORRHAGE: NEW DRUGS

Is ionized calcium level associated with PPH severity?

- 436 patients had calcium levels drawn at the onset of PPH.
- Hypocalcemia at the time of diagnosis of PPH was associated with progression to severe bleeding: 51.5% with severe PPH had ↓ calcium vs 10.6% with mild PPH.
- Calcium and fibrinogen were the only variables that were independently associated with risk of severe bleeding.

Br J Anaesth 2021; 126: 1022

59

HEMORRHAGE: NEW LAB MANAGEMENT

What is the incidence of elevated fibrinolytic activity during postpartum hemorrhage?

- TEG results were obtained during PPH in 118 women.
- Only 15 women had elevated fibrinolytic activity (12.7%)
- And further analysis of these 15 women's TEG profiles indicated platelet-mediated clot retraction – not fibrinolysis.
- We don't understand the pathophysiology of PPH-associated coagulopathy. Implications for use of TXA??

Anesth Analg 2020; 131: 1373 and 1370 (editorial)

60

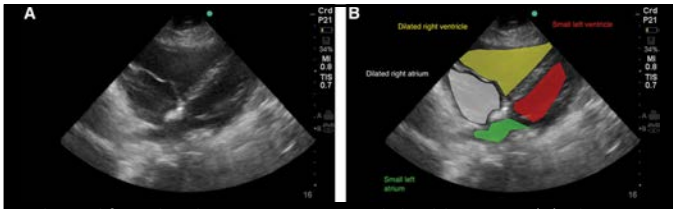
AFE: MANAGEMENT PRINCIPLES

Principles of early management of AFE target the evolving patho-physiology. These are caused by the maternal response to introduction of foreign antigenic material of fetal origin:

1. Begin high quality CPR for cardiac arrest.
2. Use TEE or TTE to manage pulmonary hypertension and cardiac failure with pressors, inotropes, or pulm vasodilators.
3. Manage coagulopathy with products and POC testing.
4. Consider preparing for ECMO.

Am J Obstet Gynecol 2020; 222: 48

61



Subcostal four-chamber view in a previously healthy patient (A) who developed sudden cardiac arrest (B) at the conclusion of a cesarean section. RV to LV area ratio greater than 1 in any four-chamber view identifies RV dilation which implicates high RV afterload. In otherwise healthy parturients, this narrows the differential diagnosis of shock primarily to amniotic fluid embolism and pulmonary embolism.

Anesthesiology 2019; 130: 1032 / Can J Anesth 2021; 68: 1541

62

MANAGEMENT OF ONGOING PPH

- Don't wait for labs to start blood products ± call an MTP.
- Transfuse RBC: FFP: platelets close to a 1:1:1 ratio.
- Add cryoprecipitate to keep fibrinogen > 200-300.
- Avoid large volumes of crystalloids. Consider giving calcium.
- Administer TXA as early as possible; within 3 hours.
- Use rFVIIa with caution → no survival benefit, high cost, 5% risk of thrombotic complications.
- Prothrombin complex and fibrinogen complexes are promising, but little or no data in obstetric cases.

Transfusion 2020; 60: 897

63

MENTAL HEALTH: NEW ANTI-DEPRESSANT

Anti-depressants are used to treat postpartum depression but have a slow onset and frequent failure.

- A Phase 3 trial randomized women with PPD to a 2-week course of a new oral $GABA_a$ receptor modulator or placebo.
- The treatment group → clinically meaningful improvement at day 3 that was sustained through day 45, plus ↓ anxiety and improved maternal functioning.

JAMA Psychiatry 2021.1559

64

SUBSTANCE ABUSE: CANNABIS TRENDS

Did rates of prenatal cannabis use ↑ during the COVID-19 pandemic? Yes.

- Large health system with universal prenatal urine tox screen.
- Pre-pandemic rate of use = 6.75% of pregnancies; during the pandemic rate of use ↑ to 8.14%.
- Rates ↑ 25% during the pandemic vs the 15 months before.
- Cannabis use in pregnancy is associated with low birth weight and potential neurodevelopmental effects.

JAMA online September 27, 2021

65

BREECH: ACOG UPDATE

ACOG Practice Bulletin (update): *External Cephalic Version*

- Because the risks of ECV are small, and because cesarean delivery rate is lower among women who undergo a successful ECV, all women with breech presentations near term should be offered an ECV attempt.
- Neuraxial analgesia can be considered a reasonable intervention to increase ECV success rate.
- Parenteral tocolytics should be used to improve success.

Obstet Gynecol 2020; 135: e203-12

66

BREECH: ANESTHETIC MGT FOR VERSION

Can anesthetic intervention facilitate successful ECV? Which anesthetic choice is best? A network meta-analysis found:

- Neuraxial: OR 2.6 of success, most ↓ BP, lowest pain.
- Intravenous: OR 2.1 vs control, highest patient satisfaction, least non-reassuring fetal response (OR 0.36)
- Inhalational: OR 2.3
- All provided good pain control, no difference in CS rates.

Anesth Analg 2020; 131: 1800-11

67

INFECTION: PERIPARTUM HIV MGT

Clinical Expert Series: L&D intrapartum management is based on viral load and presence of ROM ± labor.

- Cesarean indicated at 38 weeks or earlier if viral load > 1000 copies/ml or unknown, to avoid perinatal transmission.
- Induce based on obstetric indications if viral load < 1000.
- Avoid AROM, fetal scalp electrode and forceps if possible.
- Continue oral ART regimen intrapartum + IV zidovudine if viral load is detectable (> 50 copies/ml) or unknown.

Obstet Gynecol 2021; 138: 119-30

68

COVID: MATERNAL OUTCOMES

What are the outcomes when giving birth having COVID-19?

- A cohort study in 500 academic medical centers with 869K women → 2.2% had COVID while pregnant, 97.8% did not.
- No difference in cesarean delivery rates.
- More preterm births with COVID: 16.4% vs 11.5%.
- Higher rates of ICU admission: 5.2% vs 0.9%, OR 5.84
- More need for intubation and ventilation, OR 14.33
- Higher mortality: 0.1% vs 0.01%, OR 15.38

JAMA Network Open 2021;4: e2120456 / JAMA Pediatr 2021;175: 817

69

COVID: MATERNAL VACCINATION

Population-level data in Scotland 12/2020-10/2021:

- Vaccination rates were lower in pregnant women than the general female population: 32% vs 77%.
- Overall, unvaccinated women accounted for 77% of COVID infections, 91% of hospital admissions associated with COVID, and 98% of ICU admissions for COVID.
- All fetal/newborn deaths during COVID infections were in unvaccinated women.

Nature Medicine, January 2022

70

COVID: MATERNAL VACCINATION

Vaccine surveillance system reviewed 36K pregnant women who received mRNA COVID-19 vaccines → no safety signals.

N Engl J Med 2021; 384: 2273-82

100% of infants had antibodies to the COVID spike protein at high levels when mothers were vaccinated during pregnancy.

AJOG MFM 2021; 100481

COVID+ mom → infant transmission is only about 2%.

JAMA Pediatr 2020.4304

71

COVID + MOTHERS & THEIR INFANTS

2 studies found breast milk from women vaccinated with mRNA vaccines contains specific IgA and IgG antibodies, and after a second dose the breast milk antibody levels increased. These antibodies showed strong neutralizing effects, potentially protecting the infant.

JAMA Network Open 2021; 4: e2120575

JAMA 2021; online 4/12/21

72

OBESITY: ACOG UPDATE

ACOG Practice Bulletin #230: Obesity in Pregnancy

- Allow a longer first stage of labor before performing cesarean for labor arrest.
- Mechanical thromboprophylaxis is recommended perioperatively. Weight-based anti-coagulant dosing may be considered rather than BMI-stratified dosage strategies.
- Consultation with anesthesia service should be considered for obese pregnant women with OSA because they are at increased risk of hypoxemia, hypercapnia, and sudden death.

Obstet Gynecol 2021; 137: e128-44

73

BARIATRIC SURGERY CONSIDERATIONS

Bariatric surgery in reproductive-age women was associated with reduced pregnancy risks (vs those who declined).

- Included ↓ rates of DM (OR 0.6), preeclampsia (OR 0.53), cesarean (OR 0.65), macrosomia or LGA baby (OR 0.24), chorioamnionitis (OR 0.45), and NICU admission (OR 0.7).
- But associated with ↑ risk of SGA neonates (OR 2.46).
- Delay pregnancy for 12 months after bariatric surgery.

Am J Obstet Gynecol 2021; 226: 121

74

SPINAL CORD INJURY: ACOG UPDATE

Obstetric Management of Patients with Spinal Cord Injuries

- Treat autonomic dysreflexia immediately; this is a life-threatening complication that is most likely to arise during labor. Treatment involves stopping any stimuli.
- Anesthesiologists with expertise in OB should be involved.
- Neuraxial anesthesia *should* be used to reduce autonomic dysreflexia. Hypertension may be treated with agents that have a rapid onset and short duration of action.

Obstet Gynecol 2020; 135: e230-6

75

PERIPARTUM STRESS DOSE STEROIDS?

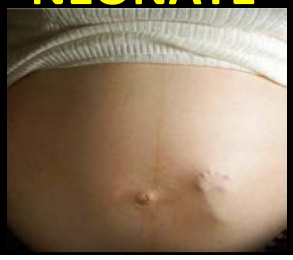
Should a patient on chronic steroids (e.g. rheumatoid arthritis) receive stress-dose steroids during labor?

- No evidence that adrenal insufficiency occurs peripartum, so continue on their usual course but don't supplement for vaginal delivery or cesarean.
- Do administer stress-dose steroids for primary adrenal insufficiency, i.e. disorders of the hypothalamic-pituitary-adrenal axis. They *are* at increased risk of adrenal insufficiency, although it's still very low.

Obstet Gynecol 2020; 135: 522-5

76

THE FETUS AND NEONATE



77

FETAL MEDICATION EXPOSURES

50-80% of women use prescription meds in pregnancy but there's little data on safety since pregnancy is excluded from trials.

Am J Obstet Gynecol July 2021

Ondansetron: no association with adverse fetal outcomes.

JAMA Network Open April 23, 2021 / JAMA Pediatrics June 1, 2020

Acetaminophen: ACOG counters concerns with strong support.

ACOG.org, Sept 29, 2021

Fenfoxidine (for allergies): not associated with adverse outcomes.

JAMA Pediatrics, June 1, 2020

78

FETAL MEDICATION EXPOSURES

Chemotherapy: after 12 weeks gestation, major malformations were no different than expected rates.

JAMA Network Open 2021; June 9, 2021

Influenza vaccine: after 3.6 years follow-up, no increased risk of adverse early childhood outcomes.

JAMA 2021; 325: 2285

Anti-depressants: the risks (if any) for birth defects is acceptable compared to risks of untreated depression.

JAMA Psychiatry 2020; 77: 1215

79

FETAL MEDICATION EXPOSURES

Opioids: prescription opioid use in the 1st trimester is not associated with risk of fetal malformations.

BMJ 2021; 372: n102

Benzodiazepines: treatment for anxiety or sleep did not cause significantly ↓ birth weight or gestational age at birth.

JAMA Network Open June 22, 2020

Cannabis: use ↑ substantially and is associated with maternal nausea, depression and anxiety. Prenatal exposure is associated with ↑ autism and intellectual disability.

JAMA Psychiatry Sept 23, 2020 and Nov 3, 2021 / Nat Med 2020

80

PTL: STEROIDS & MAGNESIUM

Incidence of severe neurodevelopmental impairment or death for extremely preterm children (born 22-27 weeks):

- 48% if they receive neither steroids or magnesium
- 53% if they receive magnesium sulfate alone
- 44% if they receive antenatal steroids
- 36% if they receive both.
- Administration of both steroids and magnesium is best care.

Obstet Gynecol 2020; 135: 1377

81

DELAYED CORD CLAMPING

Delaying cord clamping for 60 seconds is standard of care for term and premature babies per ACOG and AAP. A new study compared outcomes at 2 years for 1500 babies < 30 weeks GA:

- Risk of death or major disability was ↓ 30% before age 2 and 17% through early childhood in delayed cord clamping group.
- 15% fewer infants needed blood transfusions after birth.
- "Rare to find a no-cost intervention with such impact."

The Lancet Child & Adolescent Health 2021

Obstet Gynecol 2020; 136: e100-6

82

AHA UPDATE ON NEONATAL RESUSCITATION

A focused update emphasizes ↓ initial oxygen concentration:

- Newborns ≥ 35 weeks requiring respiratory support at birth should receive 21% oxygen.
- 100% oxygen should not be used as it is associated with excess mortality.
- Newborns < 35 weeks may receive 21-30% oxygen with subsequent titration based on oxygen saturation targets.

Pediatrics 2020; 145: e20191382

83

COMPLEX UMBILICAL CORD KNOT

G2P1 at 32 weeks with mo-mo twins presented with severe variable decelerations in one twin; normal tracing in the other.

N Engl J Med 2020;383:664-664. the NEW ENGLAND JOURNAL of MEDICINE

84

BENEFITS OF KANGAROO CARE

Kangaroo care = skin-to-skin contact with caregivers. It reduces mortality in LBW infants after they are stabilized, but what if initiated immediately after birth?

- 3200 infants with birth weight < 2 kg were randomized to 17 vs 1.5 hours of skin-to-skin contact in the NICU.
- Neonatal death occurred in 12% vs 15.7% in the first 28 days.
- Death occurred in the first 72 hours in 4.6 vs 5.8%.
- Trial stopped early due to ↓ mortality in treatment group.

N Engl J Med 2021; 354: 2028

85

MMC REPAIR: PRE / INTRA / POSTOP

Am J Obstet Gynecol 2021; 224: 108-9

86

FETAL SURGERY: MMC REPAIR UPDATE

Follow-up of children randomized to prenatal or post-delivery repair of MMC in the MOMS trial at 5-10 years old:

- Able to walk independently – 51% prenatal repair vs 23%
- Prenatal repair less likely to have a motor function level worse than their anatomic lesion level – RR 0.44
- Prior work already showed prenatal repair → better neuro-development and composite measures of self care.

JAMA Pediatrics online February 2021 + editorial

87

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How Sweet It Is!
Perioperative Glycemic Management

Basem Abdelmalak, MD, FASA, SAMBA-F

Professor of Anesthesiology
Director, Anesthesia for Bronchoscopic Surgery
Director, Center for Procedural Sedation
Anesthesiology Institute, Cleveland Clinic

Past President, Society For Ambulatory Anesthesia
Past president, Society For Head and Neck Anesthesia

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Cleveland Clinic

Objectives

1. Describe the epidemiology of DM and hyperglycemia in the perioperative period
2. Justify a management plan of pre and post-operative hyperglycemia
3. Discuss appropriate glucose control target
4. Formulate a plan for intra-operative insulin dosing, route and the impact of diabetic status

American Society of Anesthesiologists

Anesthesiologist's Guide to Perioperative Glycemic Management

Basem B. Abdelmalak, MD
Departments of General Anesthesiology and Outcomes Research
Anesthesiology Institute
Cleveland Clinic
Cleveland, Ohio

Introduction

- DM affects almost 10% of Americans
- 50% of diabetics will require surgery during their lifetime
- A third to half of patients with type 2 DM do not know they are diabetic at the time of surgery

Center for Disease Control and Prevention: Prevalence of diabetes and impaired fasting glucose in adults-United States, 1999-2000. *MMWR Morb Mortal Wkly Rep* 2003; 52: 833-7

Cleveland Clinic

Pre-operative Hyperglycemia

Pre-operative Hyperglycemia

Can J Anesth/J Can Anesth
DOI 10.1007/s12630-010-9391-4

REPORTS OF ORIGINAL INVESTIGATIONS

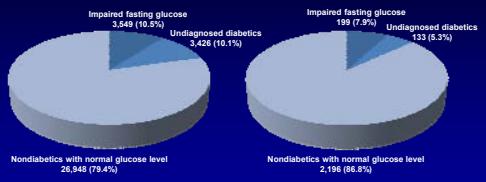
The prevalence of undiagnosed diabetes in non-cardiac surgery patients, an observational study

La prévalence de diabète non diagnostiqué chez les patients subissant une chirurgie non cardiaque, une étude observationnelle

Basem Abdelmalak, MD · Joseph B. Abdelmalak, MD · Justin Knittel, MD · Eric Christiansen, MBA · Edward Mascha, PhD · Robert Zimmerman, MD · Maged Argalious, MD · Joseph Foss, MD

Received: 3 June 2010 / Accepted: 15 September 2010

Prevalence of Undiagnosed Diabetes in Non-cardiac Surgery Patients



All noncardiac surgery patients

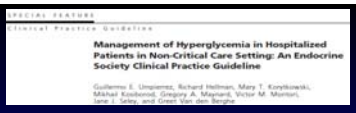
Ambulatory patients

B. Abdelmalak, JB Abdelmalak, J. Knittel, E. Christiansen, E. Mascha, R. Zimmerman, M. Argalious, J. Foss. The Prevalence of Undiagnosed Diabetes in Noncardiac Surgery Patients, An Observational Study. *Can J Anaesth*. 2010 Dec;57(12):1058-1064

Impact of Early Diagnosis of Diabetes

Early diagnosis and treatment of diabetes reduce its burden and poor consequences

The effect of intensive treatment of diabetes on the development and progression of long-term complications in insulin-dependent diabetes mellitus. The Diabetes Control and Complications Trial Research Group. *N Engl J Med* 1993; 329: 977-86
Report of the expert committee on the diagnosis and classification of diabetes mellitus. *Diabetes Care* 2003; 26 Suppl 1: S5-20


Management of Hyperglycemia in Hospitalized Patients in Non-Critical Care Setting: An Endocrine Society Clinical Practice Guideline

- Suggest BG testing in all patients on admission
- Recommend A1c and monitoring of non-diabetics with BG > 140 mg/dL for 24-48 hours
- Recommend Hb A1c testing in inpatients diabetics

Umiperez et al, Manmagement of Hyperglycemia in Hospitalized Patients in Non-Critical Care Setting: An Endocrine Society Clinical Practice Guidelines. *J Clin Endocrinology Metab* 97:16-38, 2012

Cleveland Clinic

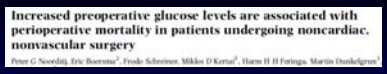
Pre-operative Hyperglycemia & Outcomes

Cancelling Elective Surgery For Hyperglycemia

Pre-op Hyperglycemia and Outcomes in Non-cardiac Surgery

- Retrospective review of total joint patients
- Pulmonary embolism (PE)
  - Up to a 4-fold increased risk with preoperative levels greater than 200 mg/dL

Mraovic BJ, J :Grunwald,Z; Parvizi, J; Hipszer,B; Pulido,L; and Restrepo, C. PREOPERATIVE HYPERGLYCEMIA - A NEW RISK FACTOR FOR PULMONARY EMBOLISM. *Canadian Journal of Anesthesia*:44544 (2007) 2007; 54: 44544


Increased preoperative glucose levels are associated with perioperative mortality in patients undergoing noncardiac, nonvascular surgery

- In the Netherlands:
  - They compared 900 who died after their non-cardiac surgery with controls
- Blood glucose levels > 200 mg/dL →
  - 2.1-fold increased risk in overall mortality
  - 4-fold increased cardiovascular mortality
- Risk of mortality was directly related to glucose concentrations between 110-200 mg/dL

Noordzij PG, Boersma E, Schreiner F, et al: Increased preoperative glucose levels are associated with perioperative mortality in patients undergoing noncardiac, nonvascular surgery. *Eur J Endocrinol* 2007; 156: 137-42

High preoperative hemoglobin A1c is a risk factor for surgical site infection after posterior thoracic and lumbar spinal instrumentation surgery

Tomohiro Hikata · Akio Iwanami · Naobumi Hosogane · Kota Watanabe · Ken Ishii · Masaya Nakamura · Michihiro Kamata · Yoshiaki Toyama · Morio Matsumoto

Received: 21 July 2013 / Accepted: 5 December 2013 / Published online: 25 December 2013

Many Diabetic Total Joint Arthroplasty Candidates Are Unable to Achieve a Preoperative Hemoglobin A1c Goal of 7% or Less

Nicholas J. Giori, MD, PhD, Laura S. Ellerbe, MS, Thomas Bowe, PhD, Shalini Gupta, MS, and Alex H.S. Harris, PhD, MS

Investigation performed at the Center for Health Care Evaluation, VA Palo Alto Health Care System, Palo Alto, California

Guidelines for Improving the Care of the Older Person with Diabetes Mellitus

California Healthcare Foundation/American Geriatrics Society Panel on Improving Care for Elders with Diabetes

Glycemic Control

General Recommendations

1. For older persons, target hemoglobin A_{1c} (A1C) should be individualized. A reasonable goal for A1C in relatively healthy adults with good functional status is 7% or lower. For frail older adults, persons with life expectancy of less than 5 years, and others in whom the risks of intensive glycemic control appear to outweigh the benefits, a less stringent target such as 8% is appropriate. (IIIB)

Brown A, Mangione C, Saliba D, J Am Geriatr Soc. 2003;51(5 Suppl Guidelines): S265-80

Cancelling Elective Surgery

- The current evidence offers no guidance on:
  - Whether an elective procedure should be cancelled in light of a given level of hyperglycemia
  - A recommended management strategy
  - Optimal waiting period for controlling hyperglycemia before rescheduling
  - Whether such an intervention would indeed result in improvement in surgical outcomes

Sebranek JJ, Lugli AK, Coursin DB: Glycaemic control in the perioperative period. Br J Anaesth 2013; 111 Suppl 1:118-34
CDC and Preventions guidelines for the prevention of SSI JAMA May 2017

Cancelling Elective Surgery

- Cancelling elective noncardiac surgery for mild to moderate hyperglycemia may not be justified
- On the other hand, in light of the documented risks associated with hyperglycemia , surgeries still get cancelled for severe hyperglycemia
- There may be potential risks associated with proceeding with surgery for
  - BG >350 mg/dL
  - Any BG associated with diabetic ketoacidosis and /or hyperosmolar state

Akhtar S, Barash PG, Inzucchi SE: Scientific principles and clinical implications of perioperative glucose regulation and control. *Anesth Analg*; 110: 478-97

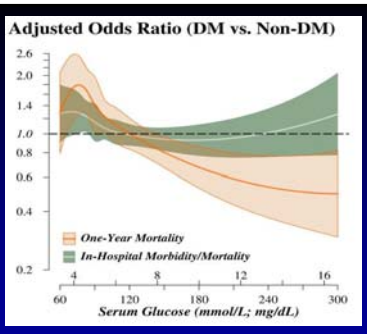
BJA

Preoperative blood glucose concentrations and postoperative outcomes after elective non-cardiac surgery: an observational study

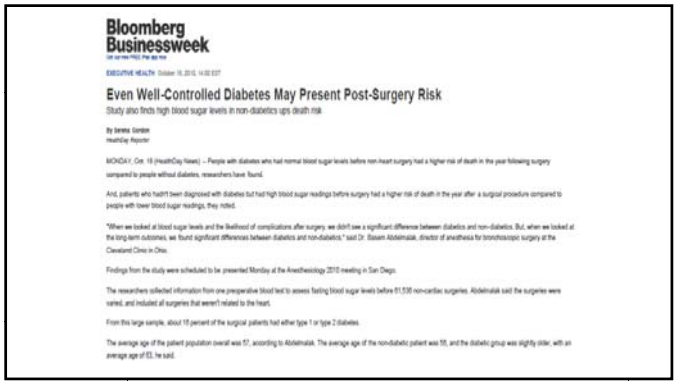
R. B. Abdelmalak[1,2*], J. Knittel[1], J. B. Abdelmalak[3], J. E. Dalton[1,2], E. Christiansen[4], J. Foss[1], M. Argalious[1], R. Zimmerman[5] and G. Van den Berghe[2]

- 65,000 elective non-cardiac surgery patients between 2005 and 2009
- Hypotheses:
  - Pre-op BG is related to surgical outcomes (composite in-hospital morbidity/mortality, one-year mortality)
  - These relationships are dependent on the diabetic status

Abdelmalak B, Knittel J, Abdelmalak J, Dalton J, Christiansen E, Foss J, Argalious M, Zimmerman R, Van den Berghe G. Preoperative Blood Glucose Concentrations and Postoperative Outcomes Following Elective Noncardiac Surgery. Br J Anaesth 2014 Jan;112(1):79-88



Abdelmalak B, Knittel J, Abdelmalak J, Dalton J, Christiansen E, Foss J, Argalious M, Zimmerman R, Van den Berghe G. Preoperative Blood Glucose Concentrations and Postoperative Outcomes Following Elective Noncardiac Surgery. Br J Anaesth 2014 Jan;112(1):79-88



Bloomberg Businessweek

EXECUTIVE HEALTH

Even Well-Controlled Diabetes May Present Post-Surgery Risk

Study also finds high blood sugar levels in non-diabetics ups death risk

By Serena Gordon
HealthDay Reporter

MONDAY, Oct. 19 (HealthDay News) -- People with diabetes who had normal blood sugar levels before non-heart surgery had a higher risk of death in the year following surgery compared to people without diabetes, researchers have found.

And, patients who hadn't been diagnosed with diabetes but had high blood sugar readings before surgery had a higher risk of death in the year after a surgical procedure compared to people with lower blood sugar readings, they noted.

"When we looked at blood sugar levels and the likelihood of complications after surgery, we didn't see a significant difference between diabetics and non-diabetics. But, when we looked at the long-term outcomes, we found significant differences between diabetics and non-diabetics," said Dr. Basem Abdelmalak, director of anesthesia for bronchoscopic surgery at the Cleveland Clinic in Ohio.

Findings from the study were scheduled to be presented Monday at the Anesthesiology 2015 meeting in San Diego.

The researchers collected information from one preoperative blood test to assess fasting blood sugar levels before 61,536 non-cardiac surgeries. Abdelmalak said the surgeries were varied, and included all surgeries that weren't related to the heart.

From this large sample, about 18 percent of the surgical patients had either type 1 or type 2 diabetes.

The average age of the patient population overall was 57, according to Abdelmalak. The average age of the non-diabetic patient was 56, and the diabetic group was slightly older, with an average age of 63, he said.

Hyperglycemia and Outcomes in the ICU

- ICU admission hyperglycemia was an independent risk factor for in-hospital mortality only in ND patients
- Increased mortality with increasing mean BG concentrations in ND ICU patients compared to D
- In the ICU intensive insulin therapy reduced mortality in all patients except for diabetics

Van den Berghe G, Wilmer A, Milants I, Wouters PJ, Bouckaert B, Bruyninckx F, Bouillon R, Schetz M: Intensive insulin therapy in mixed medical/surgical intensive care units: benefit versus harm. *Diabetes* 2006; 55: 3151-9
Krinsley JS: Glycemic control, diabetic status, and mortality in a heterogeneous population of critically ill patients before and during the era of intensive glycemic management: six and one-half years experience at a university-affiliated community hospital. *Semin Thorac Cardiovasc Surg* 2006; 18: 317-25

GLUCO-CABG Trial

- In this RCT:
  - Postoperative glucose control to 100-140 vs. 141-180 mg/dL
  - Reduction in postoperative complication was observed among patients without diabetes and not in those with diabetes in the intensive control group

Umpierrez G, Cardona S, Pasquel F, Jacobs S, Peng L, Unigwe M, Newton CA, Smiley-Byrd D, Vellanki P, Halkos M, Puskas JD, Guyton RA, Thourani VH: Randomized Controlled Trial of Intensive Versus Conservative Glucose Control in Patients Undergoing Coronary Artery Bypass Graft Surgery: GLUCO-CABG Trial. Diabetes Care 2015, 38: 1665-72

Chronic Vs. Acute Hyperglycemia

- In a retrospective study by Egi et al
- A time-weighted glucose level of > 180 mg/dL (10 mmol/L) during ICU stay was associated with a lower mortality in those with a preadmission HbA1c of > 7% compared to patients whose A1c was <7%

Egi M, Bellomo R, Stachowski E, French CJ, Hart GK, Taori G, Hegarty C, Bailey M: The interaction of chronic and acute glycemia with mortality in critically ill patients with diabetes. *Crit Care Med*; 39: 105-11

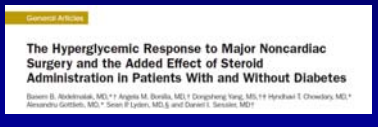
The Impact of Diabetic Status

- Hyperglycemic diabetic may have reset their metabolism and can not tolerate normal (lower) glucose concentrations
- Study bias: differential management by clinicians
  - Clinicians' belief in differential sensitivity to IV insulin
  - Fear of hypoglycemia
- These results highlight the complex relationship between glucose metabolism and outcomes

Whitcomb BW, Pradhan EK, Pittas AG: Crit Care Med 2005; 33: 2772-7 Egi M, Bellomo R, Stachowski E, . *Crit Care Med* 2008; 36: 2249-55, Van den Berghe G,et al. *Diabetes* 2006; 55: 3151-9, Krinsley JS:Semin *Thorac Cardiovasc Surg* 2006; 18: 317-25

Cleveland Clinic

Surgical Stress Induced Hyperglycemia

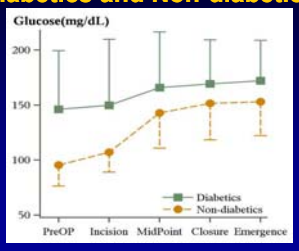


General Articles

The Hyperglycemic Response to Major Noncardiac Surgery and the Added Effect of Steroid Administration in Patients With and Without Diabetes

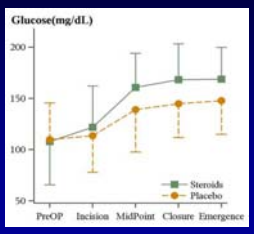
Basem B. Abdelmalak, MD,*† Angela M. Bonilla, MD,† Dongsheng Yang, MS,†‡ Hyndhavi T. Chowdary, MD,* Alexandru Gottlieb, MD,* Sean P. Lyden, MD,§ and Daniel I. Sessler, MD†

Pattern of Intra-op Hyperglycemic Surgical Stress Response in Diabetics and Non-diabetics



Abdelmalak BB, Bonilla AM, Yang D, et al: The hyperglycemic response to major noncardiac surgery and the added effect of steroid administration in patients with and without diabetes. *Anesth Analg* 2013; 116: 1116-22

Pattern of Intra-op Hyperglycemic Response in Dexamethasone vs. Placebo Patients

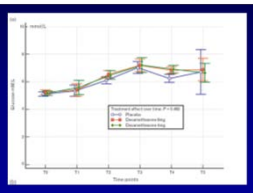


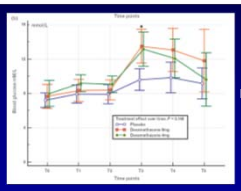
Abdelmalak BB, Bonilla AM, Yang D, et al.: The hyperglycemic response to major noncardiac surgery and the added effect of steroid administration in patients with and without diabetes. *Anesth Analg* 2013; 116: 1116-22

Perioperative ADministration of Dexamethasone And blood Glucose concentrations in patients undergoing elective non-cardiac surgery – the randomised controlled PADDAG trial

Tomás B. Corcoran, Edmond O'Loughlin, Matthew T.V. Chan and Kwok M. Ho

Non diabetics





Diabetics

Eur J Anaesthesiol 2020; **37**:1 – 11

Cleveland Clinic

Intra-operative Glucose Control and Outcomes


The New England Journal of Medicine

INTENSIVE INSULIN THERAPY IN CRITICALLY ILL PATIENTS

- Prospective randomized trial, 1548 SICU patients
- Intensive insulin therapy (80-110) decreased:
  - Inflammatory markers,
  - Overall hospital mortality by 34%,
  - Blood stream infections by 46%,
  - Acute renal failure by 41%
  - Transfusion requirements

Van den Berghe G, Wouters P, Weekers F, et al. *N Engl J Med* 2001;345:1359-67


Annals of Internal Medicine | ARTICLE

Intensive Intraoperative Insulin Therapy versus Conventional Glucose Management during Cardiac Surgery

A Randomized Trial

- A single center randomized trial[1]
- 400 cardiac surgery patients
- Tight glycemic control 80-100 mg/dL intraoperatively or usual care (treat BG > 200 mg/ dL)
- No difference in outcomes between the two groups.
- There was a relatively small difference in blood glucose levels between the two groups[2]
- All patients were admitted to ICU where they all received intensive glucose control

1. Gandhi GY, Nuttall GA, Abel MD, Mullany CJ, Schaff HV, O'Brien PC, Johnson MG, Williams AR, Cutshall SM, Mundy LM, Rizza RA, McMahon MM: Intensive intraoperative insulin therapy versus conventional glucose management during cardiac surgery: a randomized trial. *Ann Intern Med* 2007; 146: 233-43
2. Van den Berghe G: Does tight blood glucose control during cardiac surgery improve patient outcome? *Ann Intern Med* 2007; 146: 307-8

Abdelmalak et al. BMC Anesthesiology 2010, 10:11
http://www.biomedcentral.com/1471-2253/10/11

BMC Anesthesiology

STUDY PROTOCOL Open Access

Design and Organization of the Dexamethasone, Light Anesthesia and Tight Glucose Control (DeLiT) Trial: a factorial trial evaluating the effects of corticosteroids, glucose control, and depth-of-anesthesia on perioperative inflammation and morbidity from major non-cardiac surgery

Basem Abdelmalak[1], Ankit Maheshwari[2], Edward Mascha[3], Sunita Srivastava[4], Theodore Marks[5], WH Wilson Tang[6], Andrea Kurz[2] and Daniel I Sessler*[1,3]

DeLiT Trial

- Multifactorial randomized single-center study
- We tested the primary hypotheses that major perioperative morbidity is reduced by:
  - 1) low-dose dexamethasone
  - 2) intensive intraoperative glucose control
  - 3) lighter anesthesia
- Patients ≥40 years of age, ASA ≤ 4 scheduled for elective major non-cardiac surgery

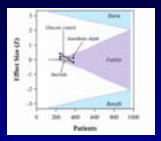
Abdelmalak B, Maheshwari A, Mascha E, et al : Design and Organization of the Dexamethasone, Light Anesthesia and Tight Glucose Control (DeLiT) Trial: a factorial trial evaluating the effects of corticosteroids, glucose control, and depth-of-anesthesia on perioperative inflammation and morbidity from major non-cardiac surgery. *BMC Anesthesiol.* 2010 Jun 30;10(1):11

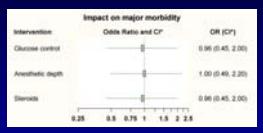
British Journal of Anaesthesia 113 (2): 209–17 (2013)
Advance Access publication 28 March 2013 · doi:10.1093/bja/aet050

BJA

Dexamethasone, light anaesthesia, and tight glucose control (DeLiT) randomized controlled trial†

B. B. Abdelmalak[1,2*], A. Bonilla[1,3], E. J. Mascha[1,3], A. Maheshwari[4], W. H. Wilson Tang[5], J. You[1,3], M. Ramachandran[3], Y. Kirkova[4,5], D. Clair[4], R. M. Walsh[1], A. Kurz[2] and D. I. Sessler[1]





Tight glucose control had no effect on the primary outcome of major morbidity, with odds ratio (95% CI) of 0.96 (0.45, 2.0), P=0.86.

Abdelmalak B BA, Mascha E, Maheshwari A, et al. : The Dexamethasone, Light Anaesthesia, and Tight Glucose Control (DeLiT) randomized controlled trial. *Br J Anaesth* 2013 Mar 28;

Hypoglycemia with Tight Glucose Control

- VDB SICU: hypoglycemia was 5.1 % compared to 0.8 % in conventional group
- VDB MICU: hypoglycemia was 18.7% vs. 3.1 in conventional group
- Glucontrol: Stopped for hypoglycemia incidence of 9.7 vs. 2.7%
- VISEP: stopped after 537 patients for hypoglycemia incidence of 17.0 vs. 4.1%

van den Berghe G, Wouters P, Weekers F, et al.: Intensive insulin therapy in the surgical intensive care unit. *N Engl J Med* 2001; 345: 1359-67
Van den Berghe G, Wilmer A, Hermans G et al Intensive insulin therapy in the MICU *N Eng J Med* 2006; 354:449-61
Preiser JC, Devos P, Ruiz-Santana S, et al. A prospective randomised multi-centre controlled trial on tight glucose control by intensive insulin therapy in adult intensive care units: the Glucontrol study. *Intensive Care Med* 2009; 35: 1738-48
Brunkhorst FM, Engel C, Bloos F, et al.: Intensive insulin therapy and pentastarch resuscitation in severe sepsis. *N Engl J Med* 2008; 358: 125-39

ELSEVIER
Anesthesia
Review Article

Revisiting tight glycemic control in perioperative and critically ill patients: when one size may not fit all

Basem B. Abdelmalak MD (Associate Professor of Anesthesiology)[a,*],
M. Cecilia Lansang MD, MPH (Associate Professor of Medicine)[b]

- 0% severe hypoglycemia, and yet tight control did not help
- 108 vs 139 mg/dL
- We used the same target for both diabetic and non diabetic

Abdelmalak B, Lansang C Revisiting Tight Glycemic Control In Perioperative and Critically Ill Patients, When One Size Might Not Fit All, *J Clin. Anesth.* 2013; 25: 499-507

Cleveland Clinic

Glycemic Target

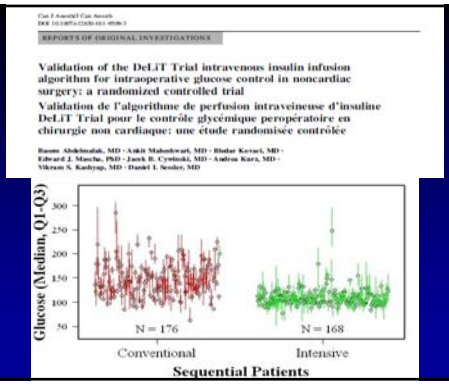
- RCT 6104 patients
- Target 81-108 vs 144-180 mg/dL
- Separated by 29 mg/dL
- More death 27.5vs 24.9 % in tight vs conventional
- Hypoglycemia rates 6.8vs 0.5%
- No difference in ICU or hospital LOS

The Nice Sugar Study investigators, Intensive vs conventional glucose control in critically ill patients. *N Eng J Med* 2009;360:1283-97

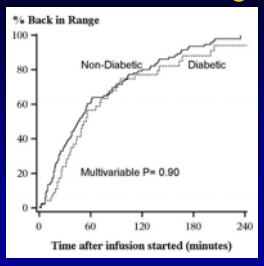
Glycemic Management Target?

- Hyperglycemia and hypoglycemia are harmful
- Tight control is not beneficial in cardiac and noncardiac surgery
- Moderate target has been beneficial 140-180
- Tighter target 110-140 may be beneficial in certain patients and situations
- Use protocols that will achieve targets without hypoglycemia

Finfer S, Chittock DR, Su SY, et al. : Intensive versus conventional glucose control in critically ill patients. *N Engl J Med* 2009; 360: 1283-97
Lazar HL, McDonnell M, Chipkin SR, et al. The Society of Thoracic Surgeons practice guideline series: Blood glucose management during adult cardiac surgery. *Ann Thorac Surg* 2009; 87: 663-9
Umpierrez GE, Hellman R, Korytkowski MT, et al: Management of hyperglycemia in hospitalized patients in non-critical care setting: an endocrine society clinical practice guideline. *J Clin Endocrinol Metab* 2012; 97: 16-38

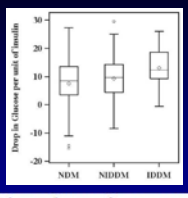


Relationship Between Diabetes Status and Time to Achieve Target



Abdelmalak B, Maheshwari A, Kovaci B, Mascha EJ, Cywinski JB, Kurz A, Kashyap VS, Sessler DI: [Validation of the DeLiT Trial intravenous insulin infusion algorithm for intraoperative glucose control in noncardiac surgery: a randomized controlled trial.]. *Can J Anaesth* 2011; 58: 606-616

Insulin Induced Glucose Lowering Effects Per Unit of R Insulin I.V.



The intraoperative glycemic response to intravenous insulin during noncardiac surgery: a subanalysis of the DeLiT randomized trial

Basem B. Abdelmalak MD[a,*,1], Andra E. Duncan MD[b], Angela Bonilla MD[c,2], Dongsheng Yang MS[d], Ivan Parra-Sanchez MD[c,3], Amr Fergany MD[e], Samuel A. Irefin MD[a], Daniel I. Sessler MD[f]

JCA (2016)29,19-29

Cleveland Clinic

Route of Insulin Administration

SPECIAL ARTICLE

Society for Ambulatory Anesthesia Consensus Statement on Perioperative Blood Glucose Management in Diabetic Patients Undergoing Ambulatory Surgery

Girish P. Joshi, MB, BS, MD, FFARSCI,* Frances Chung, MD, FRCPC,† Mary Ann Vann, MD,† Shireen Ahmad, MD,§ Tong J. Gan, MD, FRCA,‖ Daniel T. Goulson, MD,¶ Douglas G. Merrill, MD,# and Rebecca Twersky, MD, MPH**

Joshi GP, Chung F, Vann MA, et al: Society for Ambulatory Anesthesia consensus statement on perioperative blood glucose management in diabetic patients undergoing ambulatory surgery. *Anesth Analg* 2010; 111: 1378-87

SQ Insulin Dosing

- Measured glucose minus 100/insulin sensitivity factor.
- Insulin sensitivity factor is equal to 1,800 divided by the patient's total daily dose (TDD) of insulin.

Duggan EW, Carlson K, Umpierrez GE: Perioperative Hyperglycemia Management: An Update. Anesthesiology 2017; 126: 547-560
Joshi GP, Chung F, Vann MA, et al: Society for Ambulatory Anesthesia consensus statement on perioperative blood glucose management in diabetic patients undergoing ambulatory surgery. *Anesth Analg* 2010; 111: 1378-

SQ vs. IV

- SQ may be a reasonable choice for treating mild to moderate hyperglycemia[1]
- Concerns:
  - Varied absorption
  - Delayed onset and long duration of action
  - Challenging titratability and variability
  - Would not allow for timely management of dangerously severe hyperglycemia and thus the risk of "stacking" doses and the resulting hypoglycemia

1. Joshi GP, Chung F, Vann MA, et al: Society for Ambulatory Anesthesia consensus statement on perioperative blood glucose management in diabetic patients undergoing ambulatory surgery. *Anesth Analg* 2010; 111: 1378-87
2. Duggan EW, Carlson K, Umpierrez GE: Perioperative Hyperglycemia Management: An Update. Anesthesiology 2017; 126: 547-560

Glycemic variability: A strong independent predictor of mortality in critically ill patients*

James S. Krinsley, MD, FCCM, FCCP

- Retrospective, 3252 ICU patients
  70-99 mg/dL → 18.1 mortality
  - Ranged from 5.9% in the first quartile variability to 30.1 in the fourth
- 180+ mg/dL → 35.9 % mortality
- The entire population ranged from 12.1- 37.8 according to their variability

Krinsley. Glycemic variability: A strong independent predictor of mortality in critically ill patients. *Crit Care med* 2008, 36 (11) 3008-13.

Continuous Perioperative Insulin Infusion Decreases Major Cardiovascular Events in Patients Undergoing Vascular Surgery

A Prospective, Randomized Trial

Balachundhar Subramaniam, M.B.B.S., M.D.,* Peter J. Panica, M.D.,† Victor Novack, M.D., Ph.D.,‡ Feroze Mahmood, M.D.,† Robina Matyal, M.B.B.S.,† John D. Mitchell, M.D.,† Eswar Sundar, M.B.B.S.,† Ruma Bose, M.B.B.S.,† Frank Pomposelli, M.D.,§ Judy R. Kersten, M.D.,‖ Daniel S. Talmor, M.D., M.P.H.#

- Single center, prospective, unblinded in 236 patients
- IV Infusion + bolus vs boluses to treat BG > 150
- Intraoperative and post-op 48 hours
- Outcomes: composite of all-cause mortality, MI, and CHF
- 3.5% in the intervention group compared with the control group - 12.3%

Subramaniam, B et al Continuous Perioperative Insulin Infusion Decrease Major Cardiovascular Events in Patients Undergoing Vascular Surgery *Anesthesiology* 2009; 110:970– 7

Initiation of Insulin Infusion

Blood Glucose (mg/dL)	Bolus (IV)	Start Infusion At:
101-200	2 units	2 units/hour, recheck in 1/2 hour
201-250	3 units	3 units/hour, recheck in 1/2 hour
251-300	4 units	4 units/hour, recheck in 1/2 hour
301-350	6 units	6 units/hour, recheck in 1/2 hour
>350	7 units	8 units/hour, recheck in 1/2 hour

Dynamic Insulin Infusion Protocol

Blood Glucose (mg/dL)	Decreasing Blood Glucose (↓ by more than 30mg/dL)	Stable Blood Glucose (No more than 30 mg/dL ↓ or ↑)	Increasing Blood Glucose (↑ by more than 30mg/dL)	Re-check in
< 70	Hold infusion, give 12.5-25ml dextrose 50% Notify staff anesthesiologist	Hold infusion, give 12.5-25ml dextrose 50% Notify staff anesthesiologist	Hold infusion, give 12.5-25ml dextrose 50% Notify staff anesthesiologist	Immediately
71-140	Stop infusion	Stop infusion	Decrease the infusion by 50%	½ hour
141-180	Stop infusion	Continue same rate	increase rate by 25%*	½ hour
181-200	Decrease rate by 25%	Bolus 2 units I.V. and increase rate by 25%*	Bolus 2 units I.V. and increase rate by 25%*	½ hour
201- 250	Continue same rate	Bolus 3 units I.V. and increase rate by 50%*	Bolus 3 units I.V. and increase rate by 50%*	½ hour

Management of Patients Using Insulin Pumps

6204 *Current Pharmaceutical Design, 2012, 18, 6204-6214*

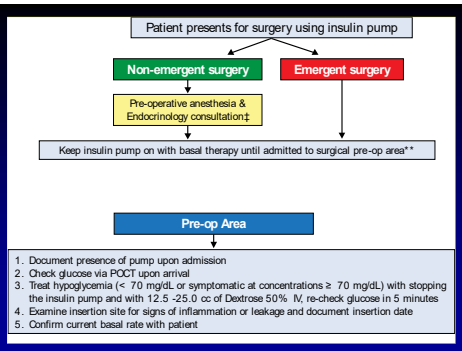
Perioperative Glycemic Management in Insulin Pump Patients Undergoing Noncardiac Surgery

Basem Abdelmalak[1,*], Michael Ibrahim[2], Jean-Pierre Yared[3], Mary Beth Modic[4] and Christian Nasr[3]

Patient Safety Issues

- Many clinicians are unfamiliar with this evolving technology
- Substantial rates of pump failures have been reported, with complete failure in 44% of cases
- FDA announced that there has been a rise in problems with insulin pumps, both in the hardware and software → grave consequences
- Hot or cold environments may decrease pump insulin effectiveness
- DKA developed from exposure of insulin pumps to heat and sunlight
- Excessive sweating can occur during or after surgery, potentially dislodging the subcutaneous needle or catheter

U.S. Food and Drug Administration. Genera Hospital and Personal Use Medical Devices Panel. Insulin Infusion Pumps Panel Information. March 5, 2010.
Amodio A. Insulin Pumps: The Basics (blog post).http://health.families.com/blog/insulin-pumps-the-basics. Accessed January 28, 2011.
Pryce R . Diabetic ketoacidosis caused by exposure of insulin pump to heat and sunlight. *BMJ* 2009; 338:a2218.



Abdelmalak B,Ibrahim M, Yared JP, Modic M,Nasr C. Perioperative Glycemic Management In Insulin Pump Patients Undergoing Noncardiac Surgery. *Current Pharmaceutical Design*, 2012,18,6204-6214.

Short (< 1 hour)# procedure

1. If blood glucose is above patient's own target, ask patient to treat self in the usual fashion**
2. May keep insulin pump connected, secured and continue with basal rate infusion or in suspend mode†
3. For pre-operative blood glucose levels > 300 mg/dL consider using IV insulin infusion as in cases > 3 hours

Intermediate (1-3 hours)# procedure

1. If Blood glucose is within patient's target, ask patient to self administer a bolus equivalent to the insulin pump basal rate/ 1 hour,** hold bolus for blood glucose ≤ 110 mg/dL
2. If blood glucose is above patient's own target, ask patient to treat self in the usual fashion
3. Disconnect the pump and keep outside the procedure room in a safe place or with the family
4. For pre-operative blood glucose levels > 300 mg/dL, or expected major bleeding, fluid or temperature swings consider using IV insulin infusion as in cases > 3 hours
5. Re-check glucose at the time of reconnecting the pump in the recovery room

Abdelmalak B,Ibrahim M, Yared JP, Modic M, Nasr C. Perioperative Glycemic Management In Insulin Pump Patients Undergoing Noncardiac Surgery. *Current Pharmaceutical Design*, 2012,18,6204-6214.

Long (> 3 hours)# procedure

1. DC insulin pump
2. Pump should be secured or given to family member
3. Begin IV insulin infusion (within an hour of stopping the insulin pump)

Patients within target (140-180 mg/dL)*:
- If basal rate < 1 unit/h, start IV insulin at 0.5 unit/h
- If basal rate > 1 unit/h, start IV insulin at 2/3 of the basal rate
- If patient is hyperglycemic, follow insulin infusion algorithm

Continue IV insulin infusion intraoperatively to achieve blood glucose target range of 140-180 mg/dL*

Post-operatively continue insulin infusion to achieve blood glucose target range of 140-180 mg/dL*

When the patient recovers from anesthesia, assess whether the patient is physiologically stable, no inotropes, no additional surgery and psychologically competent??

Post-op Endocrinology consultation

No
- The same intraoperative insulin infusion algorithm and target can be used while patient is incompetent to manage own insulin pump
  or
- Calculate transition dose of basal SQ insulin

Yes
- Patient may resume self-management of pump when: Patient is cognitively alert to make rate adjustments and maintain records of Boluses and carbohydrate consumption
- May start insulin pump ½ hour prior to the discontinuation of the IV insulin infusion

Abdelmalak B, Ibrahim M, Yared JP, Modic M, Nasr C. Perioperative Glycemic Management in Insulin Pump Patients Undergoing Noncardiac Surgery. *Current Pharmaceutical Design* 2012,18,6204-6214.

Postoperative Glycemic Management

- Postoperative hyperglycemia was associated with worse outcomes in both cardiac and non cardiac surgery.
- Moderate targets are preferred.
- Both basal bolus, and basal plus regimens have been both more effective compared to SSI.

Ramos M , et al.: Relationship of perioperative hyperglycemia and postoperative infections in patients who undergo general and vascular surgery. *Ann Surg* 2008; 248: 585-91 Pomposelli JJ, et al: Early postoperative glucose control predicts nosocomial infection rate in diabetic patients. JPEN *J Parenter Enteral Nutr* 1998; 22: 77-81. Umpierrez GE, et al: Randomized study of basal-bolus insulin therapy in the inpatient management of patients with type 2 diabetes undergoing general surgery (RABBIT 2 surgery). *Diabetes Care* 2011; 34: 256-61
67.Umpierrez GE, et al: Randomized Study Comparing a Basal Bolus With a Basal Plus Correction Insulin Regimen for the Hospital Management of Medical and Surgical patients With Type 2 Diabetes: Basal Plus Trial. *Diabetes Care* 2013

Using Technology in the OR

- Real time audiovisual alerts improve the rate of glucose measurement and management
- A perioperative systems design to improve intraoperative glucose monitoring is associated with a reduction in surgical site infections in a diabetic patient

Salhishkumar S, Lai M, Picton P, Kheterpal S, Morris M, Shanks A, Ramachandran SK. Behavioral Modification of Intraoperative Hyperglycemia Management with a Novel Real-time Audiovisual Monitor. Anesthesiology 2015; 123: 29-37
Ehrenfeld J, Wanderer,Maxim Terekhov, Rothman, M.D.; Sandberg, A Perioperative Systems Design to Improve Intraoperative Glucose Monitoring Is Associated with a Reduction in Surgical Site Infections in a Diabetic Patient Population.Anesthesiology 3 2017, Vol.126, 431-440

Summary

- An alarming proportion of our surgical patients are hyperglycemic and many are undiagnosed diabetics
- Hyperglycemic surgical stress response is real, and is not linear throughout surgery
- It is OK to administer steroids for PONV to patients with and without DM
- Close monitoring of blood glucose levels intraoperatively is of prime importance

Summary Contd.

- Symptoms and signs of hypo and hyper glycemia are for the most part masked by general anesthesia
- Intra-op tight glucose control is not beneficial neither in cardiac nor in non-cardiac surgery
- Consequences of untreated hypoglycemia are grave
- Current evidence supports moderate targets and IV insulin infusion + boluses for BG management intraoperatively

Cleveland Clinic

Every life deserves world class care.

Thank you !
Basem Abdelmalak, MD, FASA, SAMBA-F
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@basemcc

CRASH

Guiding the future of patient care

Your OB Anesthesia Questions Answered

Joy L. Hawkins, MD
Brenda A. Bucklin, MD, MEHP
Rachel Kacmar, MD

Disclosure: We have no financial relationships with commercial support to disclose.

Anesthesiology
UNIVERSITY OF COLORADO ANSCHUTZ MEDICAL CAMPUS

1

Topics

- External cephalic version
- Anticoagulants in OB patients
- Treatment of PDPH
- Thrombo-cytopenia
- ERAC
- Postpartum headache
- Epidural-breakthrough pain
- Maternal mortality
- Obstetric nerve injury
- LAST
- Horner's syndrome
- Use of sugammadex
- Pulmonary HTN management

2

Polling Question #1

A 25-year-old G3P2 woman at 37 weeks gestation arrives for external cephalic version (ECV) for breech presentation and inquires about the risks and benefits of anesthetic intervention. **Which of the following is MOST likely to improve the success rate of ECV?**

A. IV anesthesia
B. No anesthesia
C. Neuraxial anesthesia
D. Inhaled nitrous oxide

3

Answer

C. Neuraxial anesthesia

- ECV: for abnormal fetal presentation between 36 and 38 wks gestation.
- No anesthesia is required but…
- **Higher success with neuraxial anesthesia** compared to no, inhalation, or IV anesthesia.
- **All anesthetic techniques improve procedure-related pain.**

Anesth Analg. 2020; 131: 1800-1811

4

Polling Question #2

A pregnant woman at term is in labor and requests neuraxial analgesia. She has Factor V Leiden mutation and has been treated with heparin 5,000 U subcutaneous TID for 2 weeks, with the last dose 10 hours ago. **Which of the following is the MOST appropriate next step?**

A. Proceed with neuraxial anesthesia
B. Wait 2 hours
C. Tell the patient that she's not a candidate for neuraxial anesthesia
D. Obtain a platelet count

5

Answer

D. Obtain a platelet count

Check a platelet count when patients receive heparin therapy for >4 days to exclude heparin-induced thrombocytopenia (HIT) before proceeding with neuraxial block.

- ASRA guidelines address the timing of neuraxial block in the setting of thromboprophylaxis with heparin.
- Low-dose subcutaneous heparin (dosing regimens of 5,000 U BID or TID): neuraxial block may occur 4-6 hours after the last dose.
- **Guidelines: obtain a platelet count for patients receiving subcutaneous heparin for more than 4 days due to risk of HIT.**

Reg Anesth Pain Med. 2018; 43: 263-30
Anesth Analg. 2018; 126: 928-94

6

Polling Question #3

A 27-year-old postpartum woman receives an epidural blood patch for treatment of a postdural puncture headache. She describes complete headache relief, but her symptoms return 2 days later. **Which of the following options is MOST appropriate?**

A. Obtain a neurology consult
B. Repeat the epidural blood patch
C. Oral ibuprofen
D. Intravenous caffeine

7

Answer

B. **Repeat epidural blood patch (EBP)**

Unintentional dural puncture: PDPH more than 50% of the time in OB patients.

- PDPH causes profound morbidity: early diagnosis
- New evidence suggests long-term morbidity and consequences.
- EBP is the gold standard for treatment. ~70% success.
- I**f PDPH symptoms recur after a successful EBP, a second EBP is likely to be beneficial.**
- Little benefit from oral analgesics. Minimal evidence that caffeine (oral or IV) is effective in the treatment of OB PDPH.

ASA Statement on PDPH Management
Int J Obstet Anesth.2019; 38: 93-103.
Int J Obstet Anesth. 2019 May; 38: 104-118.
Anaesthesia 2021; 76: 1068-76
Br J Anaesth 2021; 127: 600

8

Polling Question #4

29-year-old GlP0 woman has gestational thrombocytopenia and presents in active labor. She has no clinical history of bleeding or any signs of coagulopathy. **At which of the following platelet count thresholds does the benefit of neuraxial anesthesia likely outweigh the risk of spinal epidural hematoma?**

A. $\geq 50 \times 10^9$/L
B. $\geq 60 \times 10^9$/L
C. $\geq 70 \times 10^9$/L
D. $\geq 100 \times 10^9$/L

9

Answer

C. $\geq$ 70 x 10^9/L

According to the 2021 Society for Obstetric Anesthesia and Perinatology consensus statement, the **risk of spinal epidural hematoma associated with a platelet count of 70 x 109 /L or greater is likely to be very low** and the benefits of neuraxial anesthesia outweigh the risks.

Anesth Analg 2021; 132: 1531-1544.

10

Polling Question #5

You are considering placing an epidural in your patient whose platelet count is 76 x 10^9/L. **According to a recent meta-analysis, which of the following is MOST likely true regarding the complication of spinal epidural hematoma after lumbar neuraxial procedures in thrombocytopenic patients?**

A. More than 100 cases of spinal epidural hematoma were reported from 1947 to 2018.
B. Spinal epidural hematoma was rare in OB patients.
C. Spinal epidural hematoma was most commonly seen after a combined spinal-epidural procedure.
D. None of the above.

11

Answer

B. Spinal epidural hematoma was rare in OB patients.

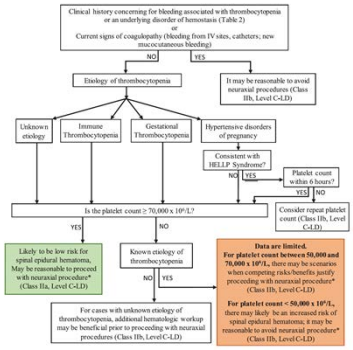
- Systematic review and meta-analysis: 131 articles; 7,509 lumbar neuraxial procedures performed in thrombocytopenic adults and children from 1947-2018.
- 33 total spinal epidural hematomas
- Spinal epidural hematoma event rate (0.097%) was found in patients with a platelet count of 75,000 × 10^6/L or above.
- Of 5 OB cases, platelet counts ranged from 44,000 to 91,000 × 10^6/L.

J Clin Anesth 2020;61:109666
doi:10.1016/j.jclinane.2019.109666

12

Decision-making: Thrombocytopenia

How low can you go?



Anesth Analg 2021; 132: 1531-1544.

13

Polling Question #6

36-year-old G1P1 postpartum woman presents to the ED with complaints of non-positional headache. She had an uncomplicated epidural placement and vaginal delivery 1 week ago. Her BP is 160/100 mmHg. The ED doc is requesting a blood patch. **What is the most likely diagnosis?**

A. Meningitis
B. Postdural puncture headache
C. Postpartum preeclampsia
D. Cerebral vasoconstriction syndrome

14

Answer

C. Postpartum preeclampsia

- Readmission >2 day or < 6 weeks after delivery for headache (70%) and SOB (30%)
- Risk factors similar to other preeclampsia
- Key features of this case: hypertension, non-positional headache

Obstet Gynecol 2019; 134: 995.

15

Polling Question #7

Which of the following are included in the ERAC recommendations?

A. Minimize fasting
B. Preoperative carbohydrate loading
C. Use of neuraxial anesthesia
D. Initiate multimodal analgesia based on long acting neuraxial opioids
E. All of the above

16

Answer

E. All of the above

Commonly used anesthesia-related components of ERAC protocols
Minimize fasting; encourage clear liquids up to 2 hours before surgery
Suggest preoperative oral carbohydrate loading
Use neuraxial anesthesia
Administer antibiotic prophylaxis
Initiate multimodal analgesia based on long acting neuraxial opioid
Administer prophylaxis for intraoperative and postoperative nausea and vomiting
Maintain normothermia (e.g., warm the OR, warm IV fluids, use forced air warming)
Optimize IV fluid administration, aiming for euvolemia
Promote early skin to skin contact, mother and neonate

Anesth Analg 2021; 132: 1362.
Int J Obstet Anesth 2020; 43:72.

17

Polling Question #8

A 35 y/o G1P0 is at 6 cm cervical dilation and is having pain during contractions. You placed her epidural about 8 hours ago when she was 3 cm (easy placement).

What is your initial plan to treat her pain?

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

18

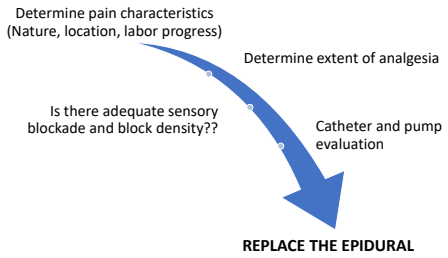
Breakthrough Pain

Maternal Risk Factors	Obstetric Risk Factors
Obesity	Nulliparity
Structural back abnormalities	Increased fetal weight
Chronic low back pain	Abnormal fetal position
Opioid tolerance	Induction/ augmentation of labor
Increasing age	Epidural request at cervical dilation > 7 cm
	Prolonged/ rapid labor progression

Curr Opin Anesthesiol 2019, 32:307–314

19

Stepwise Approach to Breakthrough Pain



Curr Opin Anesthesiol 2019, 32:307–314

20

Polling Question #9

Which of the following statements is most likely true about maternal mortality in the U.S.?

A. Few deaths are preventable
B. Rates of death due to preeclampsia are increasing
C. Racial disparity is rarely a factor
D. Pregnancy-related mortality rates are high compared to the rest of the developed world

21

Answer

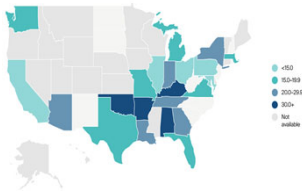
D. Pregnancy-related mortality rates are high in the U.S. compared to the rest of the developed world.

- Racial disparities are large and unchanging.
- Well over half of maternal deaths are preventable.
- Rates of death due to preeclampsia are decreasing.
- 1/3 occur during delivery, 1/3 occur in the first week after delivery, and 1/3 occur 1 week to 1 year postpartum.

Am J Obstet Gynecol 2020; 223: 486.
Obstet Gynecol 2021; 137: 763

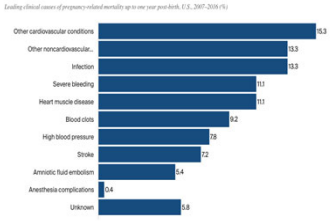
22

A woman's chance of dying in childbirth is twice as high in some states as in others.



National Center for Health Statistics, Maternal Mortality by State, 2018.

Pregnancy-related deaths are a clinical and a public health challenge.



Morbidity and Mortality Weekly Report 68, no. 35 (Sept. 6, 2019): 762–65.

23

Polling Question #10

Which of the following statements is most likely true about litigation after obstetric nerve injury ?

A. Childbirth by itself is a less common mechanism of nerve injury than neuraxial anesthesia.
B. Prior to neuraxial anesthesia, consent is generally adequate for addressing risks.
C. There is often delayed neurologic recovery after neuraxial blockade.
D. Anesthesia providers are often inaccurate in identification of the L_{3-4} interspace, increasing risk for nerve injury.

24

Answer

D. Anesthesia providers are often inaccurate in identification of the L3-4 interspace, decreasing risk for nerve injury.

- **Childbirth by itself is a more common mechanism** of nerve injury than neuraxial anesthesia.
- Prior to neuraxial anesthesia, consent is generally inadequate for addressing risks.
- There should be a high index of suspicion if recovery of normal neurological function is delayed.

Anaesthesia 2020; 75: 541.
Anaesthesia 2000; 55: 1122

25

Anesthesiologists' opinions of vertebral level compared with actual MRI marker levels

Anesthesiologists' opinions about level. Anaesthesia 2000;55:1122
Correct identification of vertebral level is indicated in red.

	T_{12}-L_1	L_{1-2}	L_{2-3}	L_{3-4}	L_{4-5}	L_5-S_1	S_{1-2}
Actual level							
T_{11-12}	2	3		1			
T_{12}-L_1		10	4	2			
L_{1-2}	1	16	39	24			
L_{2-3}		5	26	45			
L_{3-4}				13	5		
L_{4-5}					2		
L_5-S_1						1	1

26

Polling Question #11

Which of the following statements is most likely true local anesthetic systemic toxicity (LAST)?

A. LAST resuscitation differs from ACLS-guided resuscitation.
B. The order (bolus or infusion) and method of lipid emulsion 20% is not critical.
C. If needed, a smaller than normal dose of epinephrine is preferred (≤ 1mcg/kg).
D. Benzodiazepines are preferred over propofol when airway management is necessary.
E. All of the above.

27

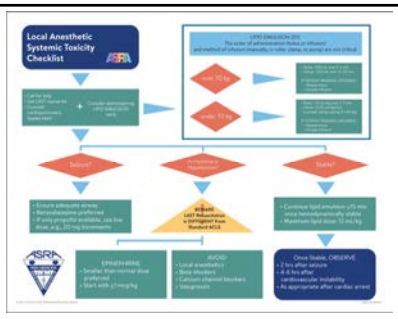
Answer

E. All of the above.

- LAST resuscitation differs from ACLS-guided resuscitation. Many standard ACLS drugs worsen LAST outcomes
- The order (bolus or infusion) and method of lipid emulsion 20% is not critical.
- Use smaller doses of epinephrine (< 1mcg/kg), if needed.
- Benzodiazepines are preferred over propofol when airway management is necessary.

Reg Anesth Pain Med 2021;46:81-82
ASRA PBLD LAST 2021

28



Joseph M Neal et al. Reg Anesth Pain Med 2021;46:81-82

29

Polling Question #12

A 27-year-old obese primigravida receives an epidural for labor analgesia. A 6-mL bolus of 0.125% bupivacaine was followed by a PCEA infusion of 0.125% bupivacaine with 2 µg/mL of fentanyl at a rate of 8 mL/h. Approximately one hour after initiation of the infusion, the patient was noted to exhibit Horner syndrome. **Which of the following steps would be MOST appropriate for management of this patient?**

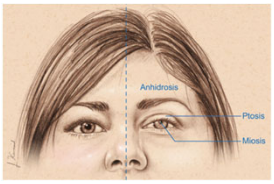
A. Request an immediate neurosurgery consult.
B. Obtain a CT or MRI of the neck.
C. Temporarily stop the epidural infusion.
D. Remove the epidural catheter.

30

Answer

C. Temporarily stop the infusion via the epidural catheter.

- Horner's syndrome: can occur after epidural anesthesia.
- Local anesthetic migrates cephalad and produces blockade.
- Decreased capacity of the epidural space during pregnancy and in the obese predisposes to migration of LA.
- Symptoms resolve simultaneously in a few hours.



Horner syndrome. © 2018 American Society of Anesthesiologists.

31

Polling Question #13

Which of the following is/are true regarding sugammadex administration in pregnancy and during breastfeeding?

A. Sugammadex should be avoided in early pregnancy
B. Avoid or use sugammadex with caution in term pregnancy
C. Sugammadex is safe to use in patients with established lactation
D. In patients of reproductive age, sugammadex is safe to use when patients are counseled
E. All of the above

32

Answer

E. All of the above.

- In-vitro studies suggest that sugammadex binds to progesterone.
- Avoided because progesterone is needed to maintain the pregnancy.
- Can be used in patients undergoing CD under GA but evidence is limited regarding extent of drug exposure through breast milk.
- Sugammadex is safe to use in patients with established breastfeeding.
- Patients of reproductive age should be counseled about contraceptive use if they've received sugammadex.

www.soap.org

33

Polling Question #14

A parturient with pulmonary HTN is undergoing urgent CD with spinal anesthesia due breech presentation and fetal macrosomia. She is currently taking sildenafil three times daily for the pulmonary HTN. The obstetricians are having difficulty delivering the fetus and request sublingual nitroglycerin, which you refuse. **You refuse because of which of the following adverse effects?**

A. Uterine hypertonicity
B. Hypotension
C. Bradycardia
D. None of the above

34

Answer

B. Hypotension.

- Sildenafil selectively inhibits cGMP resulting in smooth muscle relaxation.
- IN patients taking sildenafil, concomitant administration: profound hypotension
- Nitrate administration is contraindicated for at least 24h after last dose.
- Tachycardia, not bradycardia occurs because of hypotension.
- With sildenafil, uterine hypertonicity is unlikely.
- B_2-receptor agonist or calcium channel blockers can be considered.

35

Thank you!

See you all next year!

36

Conflict Management In & Out of the OR

Change Management; C-Suite Interactions; Surgeons

Basem Abdelmalak, MD; Professor, Cleveland Clinic Lerner College of Medicine
Angela Selzer, MD; Associate Professor, CU Department of Anesthesiology
Thomas Majcher, DO; Professor of Clinical Practice, CU Department of Anesthesiology
Moderator: Beth Benish, MD; Associate Professor, CU Department of Anesthesiology

1

Conflict Management in and Out of the OR: C-Suite Interactions

Basem Abdelmalak, MD, FASA, SAMBA-F

Professor of Anesthesiology
Director, Anesthesia for Bronchoscopic Surgery
Director, Center for Procedural Sedation
Anesthesiology Institute, Cleveland Clinic

Past President, Society For Ambulatory Anesthesia
Past president, Society For Head and Neck Anesthesia

2

No Financial Disclosures

3

Interaction With the C Suite

4

Interactions With the C Suite: Where to Begin

- Excel at what you do
- Maintain professionalism
- Know your C suite members
- Speak their language

5

Interactions With the C Suite: How to Maintain

- Build relationships
- Be helpful
- Be present and known (in a good way ☺)

6

Interactions With the C Suite: How to Approach

- Explain the challenge
- Present data
- Show Value:

Value: Product (Service/Quality)
Cost

7

Resources

file:///C:/Users/abdelmb/Downloads/ASA%20Health%20Care%20Executive%20%20Outreach%20Toolkit%20(1).pdf

8

Conflict Resolution with the C Suite

9

Strategies to Resolve Conflict

- Do not fight nor flight
- Distance is not a strategy: doesn't mitigate conflict
  - Conflict in the virtual world
- Giving the benefit of the doubt and being empathetic can get you a long way in resolving conflict

https://ceoworld.biz/2021/12/28/how-to-resolve-conflict-in-the-workplace-before-it-gets-out-of-control/

10

Before You Start the Conflict Resolution

- **Define the cause of the conflict:** Make sure both parties know what the conflict is really about.
- **Accept your opponent's view:** does not mean agreeing with it. It simply means you understand the difference of opinion.
- **Be specific about your complaints**: "My idea about the new protocol was unjustly ignored"
- **Resist getting involved:** if the conflict does not involve you or your responsibilities.

11 Tips For Conflict Resolution in the Workplace for Managers | HR C-Suite (hrcsuite.com) https://hrcsuite.com/conflictresolution/

11

During the Conflict Resolution

- **Keep it private: do not be part of the gossip**
- **Depersonalize the conflict**: C suite vs. you to People vs. problem.
- **Listen actively**
- **Vent**. once both parties have been able to vent their issues, they generate solutions more easily
- Acknowledge anger, but refrain from letting it take over the conflict resolution process
- **Look for win-win solutions**
  - Thinking outside of the box.
  - Compromise.

11 Tips For Conflict Resolution in the Workplace for Managers | HR C-Suite (hrcsuite.com) https://hrcsuite.com/conflictresolution/

12

After an Agreement Has Been Made

- Document the solution and the plan of action.
  - Accountability
  - Follow up
  - Legal considerations

11 Tips For Conflict Resolution in the Workplace for Managers | HR C-Suite (hrcsuite.com) https://hrcsuite.com/conflictresolution/

13

Thank you for your attention!

14

Conflict Management while Leading Change

Angela Selzer, MD
Associate Professor of Anesthesiology
University of Colorado
Medical Director, Pre-Procedure Services

15

No Financial Disclosures

16

So, you want to initiate a change?

Implement an ERAS protocol *or*
Order new equipment *or*
Update your staffing model *or*
Improve staff orientation *or*
Improve preop efficiency *or*
Develop an anemia pathway *or*
Reduce unnecessary testing
or…?

17

Change is Necessary!

If you are not actively working on improving, you are getting worse

We need change!

18

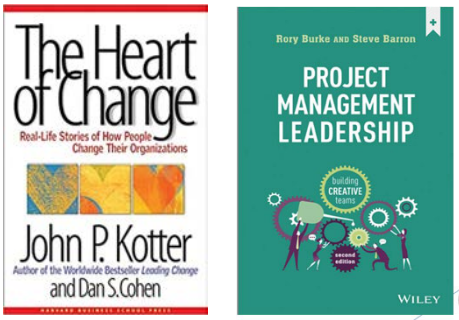
Change is Great!

- We all want to get better
- Institutions want to improve
- Hospitals and health care workers all want to provide the best possible care

But…

- Institutions are designed to resist change
- People struggle with change
- Change is hard and often painful
- Any change creates conflict!

19



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Personal Experiences with Change:

- Case #1:
  - Becoming medical director of Pre-Procedure Services

Get to move back to Colorado!

Have a leadership position in a department excited about having a medical director in the pre-procedure services clinic!

In a position to make positive changes for patient care!

21

Personal Experiences with Change:

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In a position to make positive changes for patient care!

22

Case #1: Medical Director Position

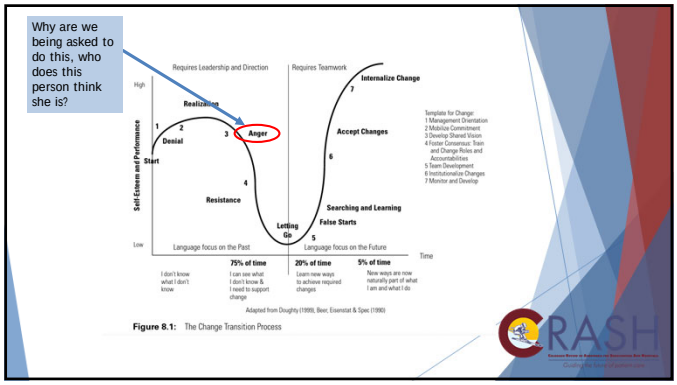
- Case #1:
  - Becoming medical director of Pre-Procedure Services
- Reality:
  - The clinic had been run and managed by nurse practitioners for 20 years without physician involvement
  - The clinic NPs liked being independent (for the most part)
  - The NPs didn't understand why a medical director was being hired
  - In general, they did not see an "upside" to this position because they were happy with things the way they were

23

How we were doing things was fine/we all liked it, etc

Figure 8.1: The Change Transition Process

24



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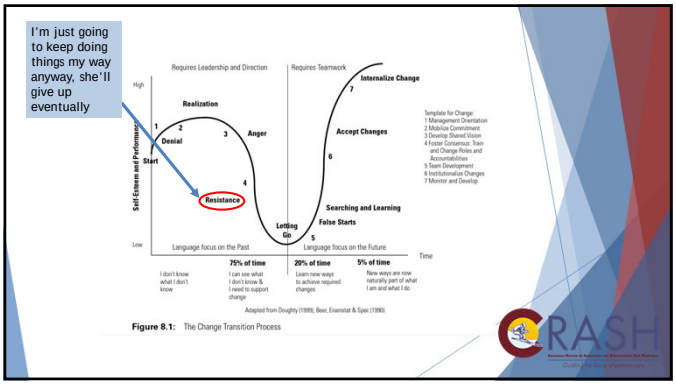

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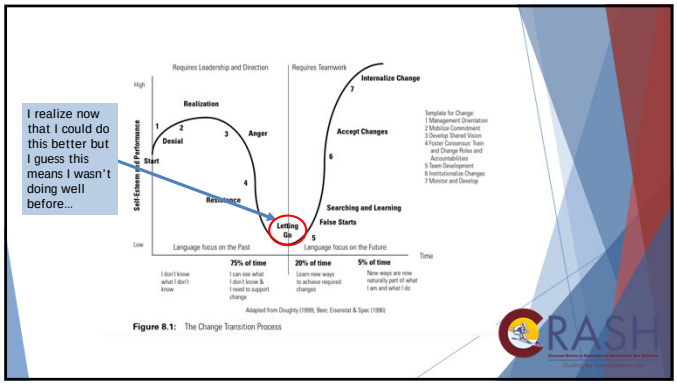

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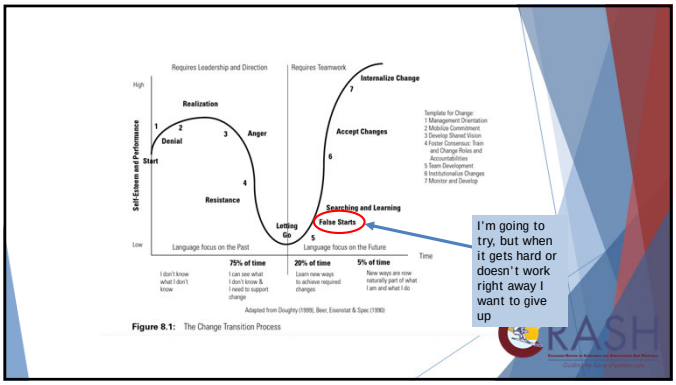

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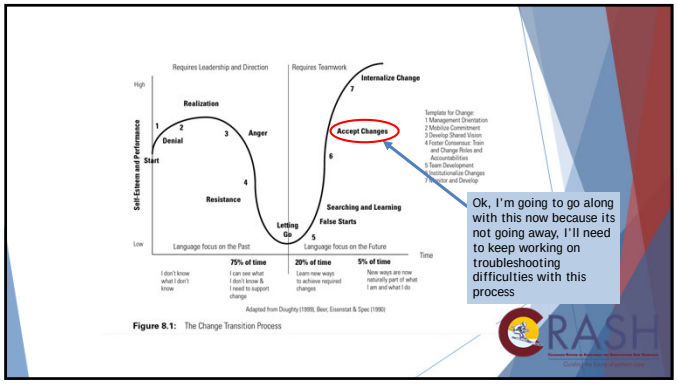

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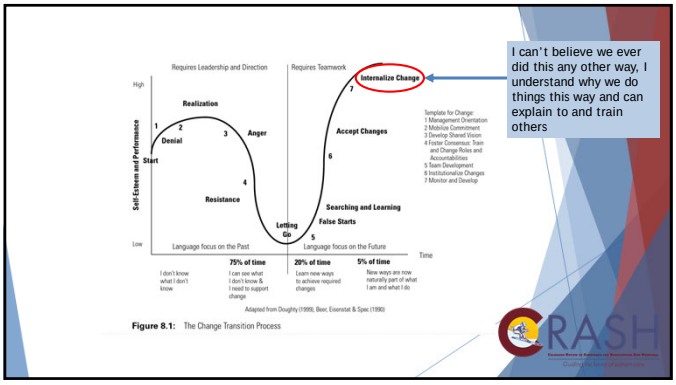

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Case #1: Medical Director Position

- Lessons:
  - When asked to lead in a new role, remember you are the novice (regardless of academic expertise)
  - Spend as much time as you can listening and learning
    - Do this first, before making any changes
  - Prioritize their issues before your own objectives
  - Be available for criticism
  - Expect normal reactions to change
    - Be patient and try to see things from their perspective
  - Don't make too many changes at once!

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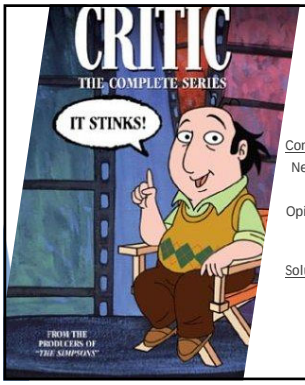

Case #2: Developing a faculty group

Conflict:

Needed a faculty group to staff clinic

but

Opinion of and interest in participating in the clinic was very low

Solutions:

Recruit the most vocal critics

Tap into overlooked talents

Be grateful and supportive

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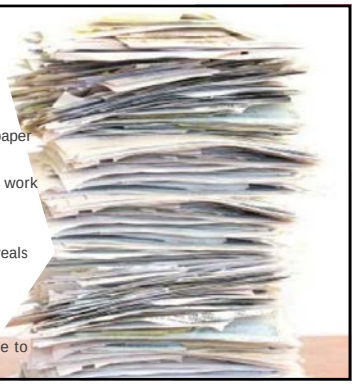
Case #3: Ending the printing of patient charts



Conflict:

Unnecessary waste of staffing resources & paper

but

NPs "need" printed copies to complete their work

Solutions:

Understand the insecurities this change reveals

Provide an alternative

Make a clear new standard

Reinforce clinic values

Celebrate those who were resistant but able to adapt to the new process

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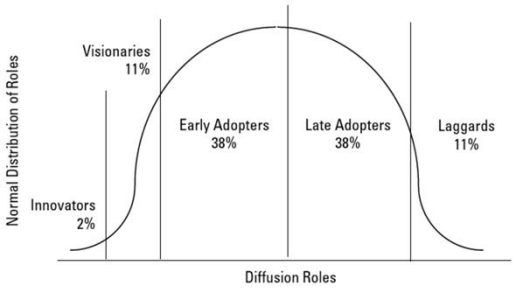

Figure 8.2: Diffusion of Innovations – Everett Rogers

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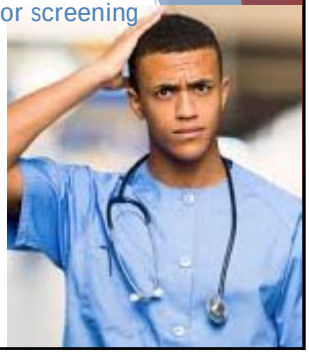
Case #4: Creating guidelines for screening



Conflict:

Surgeons wanted their patients to be seen in our clinic

but

The RN screening the patient would decide a patient didn't need to be seen by us based on her own criteria

Solution:

Look further into the process

Reinforce the mission of the clinic

Create clear guidelines

Seek feedback

Have a process for continued follow up

Ultimately, staff who are unwilling to change may need to move on

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CRASH
Colorado Review of Anesthesia for Subscriptions And Hospitals
Guiding the future of patient care

Conflict with Surgeons

Your patient is not NPO, but the surgeon wants to proceed. What do you do now?

Thomas Majcher, DO; Professor of Clinical Practice, CU Department of Anesthesiology

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Guiding the future of patient care

No Financial Disclosures

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Story

- It's 0945, you are seeing a 16-month-old for a one-hour elective surgery scheduled at 1000
- The family drove in from Cheyenne this morning and our patient ate an unknown quantity of spilled Cheerios found in his car seat
- Parents discovered this at 0600, cleaned up the Cheerios and re-started NPO
- Hospital policy suggests 6 hours fasting prior to surgery, after a light meal
- The surgeon has clinic starting at 1300
- The family and surgeon are upset when you consider cancelling for today

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Why is the anesthesiologist-surgeon relationship important?

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It makes life easier

40

... and sets the tone in the operating room

41

A great relationship improves Operating Room productivity

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Colorado Review of Anesthesia for Surgicenters And Hospitals
Guiding the future of patient care

Critical Role of the Surgeon–Anesthesiologist Relationship for Patient Safety

Jeffrey B. Cooper, Ph.D.

ABSTRACT

Teamwork is now recognized as important for safe, high-quality perioperative care. The relationship in each surgeon–anesthesiologist dyad is perhaps the most critical element of overall team performance. A well-functioning relationship is conducive to safe, effective care. A dysfunctional relationship can promote unsafe conditions and contribute to an adverse outcome. Yet, there is little research about this relationship, about what works well or not well, what can be done to optimize it. This article explores functional and dysfunctional aspects of the relationship, identifies some negative stereotypes each profession has of the other and calls for research to better characterize and understand how to improve working relationships. Suggestions are given for what an ideal relationship might be and actions that surgeons and anesthesiologists can take to improve how they work together. The goal is safer care for patients, and more joy and meaning in work for surgeons and anesthesiologists. (Anesthesiology 2018; 129:402-5)

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Surgeon-Anesthesiologist Relationship
(J.B. Cooper)

- Surgeon-Anesthesiologist Dyad
- Concept of "Tribes" (some conflict expected)
- Perhaps the most critical element of team performance and patient safety is the health of their relationship
  - How well they get along
  - How much they rely on each other for advice
  - Do they keep each other informed on actions impacting their dyadic partner

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Dispelling Myths

Perceptions of Anesthesiologists
- Concerned with finishing the day rather than serving patient needs
- Unreasonable eagerness to cancel
- Lack of concern to maintain a schedule
- Long turnover times
- Failure to communicate vital sign changes/pressors
- Rigidity around anesthetic technique

Perceptions of Surgeons
- Unknowledgeable about medical (anesthesia-related) issues
- Failure to perceive or acknowledge extent of blood loss
- Underestimation of surgical time
- Portraying unrealistic expectations to patients and families
- Failure to consider patient desires
- Discouraging others to speak up about safety concerns

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System Fixes

- Anesthesiologists and surgeons both participating in **patient simulation** sessions with consideration for appropriate interactions, communication
- **Huddles** at beginning of day,
- **Debriefings** after last case
- Multidisciplinary **case review, M&Ms**

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How to develop a relationship with your surgeons

- **New encounters are often a source for problems**
- **Introduce yourself**
- **Communicate, close the loop**
- **Anticipate issues and discuss**
- **Get to know your surgeons**
- **Have mutual respect**
- **Keep the patient first**

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How to Handle a Disagreement on Your Team; Jeanne Brett and Stephen B. Goldberg; July 10, 2017; Harvard Business Review

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Conflict Management (Indeed.com)

- **Take immediate action**: Minimizes tension and keeps others out of the disagreement.
- **Frame the discussion positively**: Say "I'd like to get your opinion on this matter".
- **Focus on the issue, not the person**: Avoid personal attacks and focus on problem-solving.
- **Practice active listening**: Eye contact, open-ended questions to understand their message without interruption. Re-state your understanding of the issue: "I hear you saying…"
- **Encourage consensus:** Often possible without compromising patient care

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So, what about that NPO patient?

- I listened and understood the surgeon's and family's perspective
  - Busy clinic starting at 1300
  - Lunch from noon until then
- We delayed the case until noon (the surgeon ate lunch at 1100)
- The case went without incident.
- Everyone compromised, but not patient safety!

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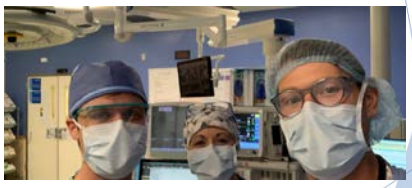
CRASH

Guiding the future of patient care



Discussion

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Tuesday, March 1st

NORA Challenges and Pitfalls

Basem Abdelmalak, MD, FASA, SAMBA-F

Professor of Anesthesiology
Director, Anesthesia for Bronchoscopic Surgery
Director, Center for Procedural Sedation
Anesthesiology Institute, Cleveland Clinic

Past President, Society For Ambulatory Anesthesia
Past president, Society For Head and Neck Anesthesia

@basemcc

Objectives

- Enlist sources of complexity in NORA and propose solutions
- Identify a frame work for a successful efficient NORA service
- Outline safety issues related to sedation and anesthesia in NORA
- Discuss interventions to improve NORA outcomes

2

Conflict Of Interest Disclosure

- Consultant and Speaker – Medtronic and Acacia Pharma
- Past-president, Society for Ambulatory Anesthesia (SAMBA)

SOCIETY FOR AMBULATORY ANESTHESIA
Outpatient • Office Based • Non-Operating Room

WWW.SAMBAHQ.ORG

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Consents And Copyright

- All pictures are copyrighted, and no reproduction or use is permitted without permission please
- Patients have consented to the presented pictures
- Moreover, the identifying features have been covered to the extent possible to ensure privacy

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NORA: Definition

Any anesthesia service provided in a location (procedure room, CT/MRI suite, etc.,) outside the main operating room pavilion

Old term: “Remote” Anesthesia

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Locations for NORA Services

- Gastroenterology Endoscopy Suite
- Interventional Radiology areas including CT
- Bronchoscopy Suite
- Cardiac Catheterization Lab
- Electrophysiology Lab
- MRI (diagnostic, and surgical)
- Nuclear Medicine
- PACU (Electroconvulsive therapy)
- Pain Management procedure rooms

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Journal of Clinical Anesthesia 78 (2022) 110668

Contents lists available at ScienceDirect

Journal of Clinical Anesthesia

journal homepage: www.elsevier.com/locate/jclinane

Non-operating room anesthesia in the intensive care unit

Anthony Bonavia, MD, FCCP [a], Basem Abdelmalak, MD, FASA, SAMBA-F [b], Kunal Karamchandani, MD, FCCP, FCCM [c,*]

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Why Did NORA Exist?

- New advances in the procedures:
  - Not requiring the full capabilities of an operating room
  - Requiring complex and immobile technology
- Higher risk patients who were not previously considered candidates for any intervention, now have an option
- Economic trend for more outpatient vs. inpatient services
- Procedural sedation Vs. Anesthesia services

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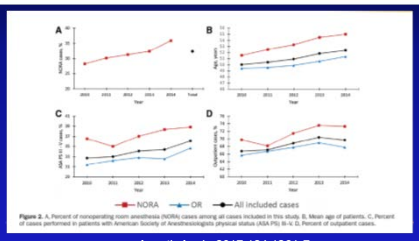
Growth of Nonoperating Room Anesthesia Care in the United States: A Contemporary Trends Analysis

Alexander Nagrebetsky, MD, MSc,* Rodney A. Gabriel, MD,† Richard P Dutton, MD, MBA,§ and Richard D. Urman, MD, MBA‡



Anesth Analg 2017;124:1261-7

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Sources of Complexity and Challenge In NORA

- Space
- Equipment
- Staff
- Patients
- Procedures

Sources of Complexity and Challenge in NORA……And Solutions

- Space
- Equipment
- Staff
- Patients
- Procedures

Thoracic Oncology How I Do It] CHEST

A Blueprint for Success

A Multidisciplinary Approach to Clinical Operations Within a Bronchoscopy Suite

Basem B. Abdelmalak, MD; Thomas R. Gildea, MD, FCCP; D. John Doyle, MD, PhD, DPhil; and Atul C. Mehta, MD, FCCP

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Modern Bronchoscopy Suite

Abdelmalak BB, Gildea TR, Doyle DJ, Mehta AC A Blueprint for Success: A Multidisciplinary Approach to Clinical Operations within a Bronchoscopy Suite. Chest. 2021 Nov 12:S0012-3692(21)04285-9 [13]

Minimal Requirements For Anesthesia In NORA

- A reliable oxygen source along with backup
- Adequate suction
- Ability to scavenge waste gases
- A resuscitator bag
- Anesthetic meds, monitoring equipment, and supplies
- Adequate lighting and electrical outlets
- Sufficient space

ASA Guidelines for Nonoperating Room Anesthetizing Locations. Approved by the ASA HOD on October 15, 2003 and Last ammended on October 16, 2013 http://www.asahq.org/~/media/Sites/ASAHQ/Files/Public/Resources/standards-guidelines/statement-on-nonoperating-room-anesthetizing-locations.pdf. 14

Minimal Requirements For Anesthesia In NORA Contd.

- Unobstructed access to the patient, anesthesia equipment, and emergency supplies
- Emergency cart with a defibrillator
- Building codes and facility standards
- Adequately trained staff for immediate assistance
- A reliable two-way communication to request additional assistance
- Adequate post-anesthesia care

ASA Guidelines for Nonoperating Room Anesthetizing Locations. Approved by the ASA HOD on October 15, 2003 and Last ammended on October 16, 2013 http://www.asahq.org/~/media/Sites/ASAHQ/Files/Public/Resources/standards-guidelines/statement-on-nonoperating-room-anesthetizing-locations.pdf 15

Sources of Complexity and Challenge in NORA

- **Space**
- **Equipment**
- **Staff**
- **Patients**
- **Procedures**

Staff Proceduralist

- Stranger in a strange land
- This can impede teamwork
- Proceduralists may have unrealistic expectations
- COMMUNICATION
- TEAM BUILDING

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Anesthesia Services Staffing

- Anesthesiologist only
  - Similar to other assignments
- Anesthesia Care Team
  - Geographic proximity of sites
  - Requirement to “remain immediately available”
- Teaching Physician
  - CMS billing rules versus accreditation standards
- Supervision
  - When might this be appropriate versus medical direction?

Adopted with permission from Dr. Alan Marco

Solutions for Large Vs. Small Centers

- Large centers may have enough demand to run NORA as mini procedures suites to allow efficient staffing
- Small centers can plan for renovations/new construction aiming for multi-purpose suites and/or within the main OR pavilion for better efficiency

Adopted with permission from Dr. Alan Marco

Scheduling of Anesthesia Services

- Block time versus fitting into gaps
  - If sufficient volume, block time may improve utilization
  - Scheduling full days rather than partial days of coverage should improve efficiency
    - for lower volume services a long day every other week rather than shorter blocks every week
  - economic goal is to reduce overutilized time
    - more expensive than underutilized time

Adopted with permission from Dr. Alan Marco

Dexter, Franklin; Wachtel, Ruth E Current Opinion in Anaesthesiology: August 2014 - Volume 27 - Issue 4 - p 426–430
Strum DP. Vargas LG, May JH. Anesthesiology 1999;90:1176-1185

J Med Syst (2017) 41: 120
DOI 10.1007/s10916-017-0765-9

SYSTEMS-LEVEL QUALITY IMPROVEMENT

Analysis to Establish Differences in Efficiency Metrics Between Operating Room and Non-Operating Room Anesthesia Cases

Albert Wu[1] · Joseph A. Sanford[2] · Mitchell H. Tsai[3,4] · Stephen E. O'Donnell[3] · Billy K. Tran[3] · Richard D. Urman[1]

- Retrospective, university MC, 2015 data
- Faster turnover 16 Vs. 37 min
- Less case cancellation .86 Vs 1.35 %
- Delayed first case start time 24 Vs. 11 min

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Sources of Complexity and Challenge in NORA

- **Space**
- **Equipment**
- **Staff**
- **Patients**
- **Procedures**

Re-do PVI in EP Lab

- 61 Y/O male: 92 Kg / 6', MP I, short TM
- Admitted to re start Tikosyn and for treatment of CHF
- PMH:
  - HTN, CAD with large remote anterior MI, s/p PCI , remote 4v CABG, s/p ICD for VF arrest
  - Severe LV dysfunction EF 30%
  - Longstanding atrial trachyarrhythmia (s/p surgical cryoMAZE then catheter based PVAI)

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Severe Comorbidity and Aspiration Risk

- 65 Y/O male, severe AS, who has a PE
- Gastric outlet obstruction due to stomach CA, scheduled for EGD and BX
- Would you accept him in the endoscopy suite?
- MAC? Vs. GA
- RSI? with or without cricoid pressure? Or awake Intubation?
- Invasive monitors?

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EGD For LVAD Patients

- Increased need due to acquired VW
- Pulsatile Vs non pulsatile
- Monitoring oxygenation and perfusion
- Pump flow and pulse index

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Routine EBUS with a Twist

- 70 Y/O F
- HTN
- Chronic hoarseness
- COPD
- Rt renal mass
- LUL 6.9cm mass associated with mild left hilar adenopathy
- Scheduled for staging EBUS/TBNA

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Sources of Complexity in NORA

- **Space**
- **Equipment**
- **Staff**
- **Patients**
- **Procedures**

CT Guided Lung Cancer Cryoablation

- 70 year old patient scheduled for cryoablation of LU lung cancer.
- A fib takes sotalol, pradaxa
- COPD uses supplemental O_2 @ 3L
- LLE embolism resulting in a BKA
- ETOH abuse, cut back to 3 beers QD

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Issues and Complications

- Procedure specific
  - Lung parenchymal hemorrhage
  - Pneumothorax
  - Hypothermia
  - Loss of airway
- Patient specific
  - Alcohol withdrawal
  - Chronic hypoxemia

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NORA Service Specific issues

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Anesthetic Considerations And Techniques For Advanced Diagnostic And Therapeutic Bronchoscopy

Challenges in GI NORA

- Monitoring ventilation
- Airway management
- NPO status
- LVAD patients
- CO_2 Bowel insufflation

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Indications for Intubation in GI Endoscopy

Nonoperating Room Anesthesia
Anesthesia in the Gastrointestinal Suite
Sekar S. Bhavani, MD, Basem Abdelmalak, MD

- **Patient related**
  - Emergency
  - Significant cardiac or respiratory comorbidities
  - Sepsis
  - Intestinal obstruction (esophagus, stomach, duodenum or small or large intestines)
- **Anatomical problems**
  - Complex anatomy
  - Short gut syndrome
  - Zenker's diverticulum
  - Short Roux-N-Y loop
  - Large hiatus hernia
- Morbid obesity

Anesthesiology Clin 37 (2019) 301–316
https://doi.org/10.1016/j.anclin.2019.01.010
1932-2275/19/© 2019 Elsevier Inc. All rights reserved.
anesthesiology.theclinics.com

Indications for Intubation in GI Endoscopy

Nonoperating Room Anesthesia
Anesthesia in the Gastrointestinal Suite
Sekar S. Bhavani, MD, Basem Abdelmalak, MD

- **Procedure related**
  - Long duration of procedure
  - Complex procedure
  - Drainage of a pancreatic pseudo cyst
  - Use of large volume of fluid irrigant
  - Double balloon
- **Anesthesia related**
  - Known difficult intubation
  - Inadequate NPO duration
  - Retained food
- CO_2 use during the endoscopy

Bhavani S and Abdelmalak B. NORA – Anesthesia in the GI suite
Anesthesiology Clin 37 (2019) 301–316

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Other Challenges

- Hypovolemia from bowel prep
- Uncorrected anemia from GI Bleed
- Bradycardia, and/or arrhythmia from bowel distension, or scope insertion
- Other complications:
  - Bleeding
  - Perforation
  - Aspiration

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Policies and Procedures: Definitions

- **POLICY:**
  - a mandatory, high level overall standard to establish a course of action toward organization and/or enterprise-wide accepted strategies and objectives
- **PROCEDURE:**
  - provides detail on how to implement an existing policy
- **GUIDELINE:**
  - suggested best practice which sets out a process to follow in a particular set of circumstances to reach certain quality outcomes. Guidelines are not mandatory.

https://ccf.policytech.com/docview/?docid=13475

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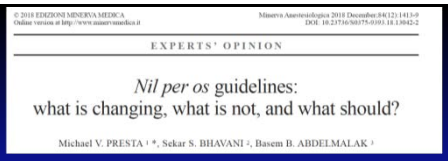
Preop NPO Guidelines

Practice Advisory for Preanesthesia Evaluation

An Updated Report by the American Society of Anesthesiologists Task Force on Preanesthesia Evaluation

Ingested Material	Minimum Fasting Period[2]
Clear liquids[3]	2h
Breast milk	4h
Infant formula	6h
Non-human milk[4]	6h
Light meal[5]	6h
Regular meal	8h

Anesthesiology, V 116 * No 3



- Split dose bowel prep:
  - Clinical superiority
  - Better patient acceptability
- The residual gastric volume did not differ between split dose and a single dose.

- Huffman M, Unger RZ, Thatikonda C, Amstutz S, Rex DK. Split-dose bowel preparation for colonoscopy and residual gastric fluid volume: an observational study. Gastrointest Endosc. 2010;72(3):516-22.
- Tandon K, Khalil C, Castro F, Schneider A, Mohameden M, Hakim S, et al. Safety of Large-Volume, Same-Day Oral Bowel Preparations During Deep Sedation: A Prospective Observational Study. Anesth Analg. 2017;125(2):469-76.
- Bhavani SS, Abdelmalak BB. Fasting Before Anesthesia: An Unsettled Dilemma. 2017;125(2):369-71.

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Recovery and Discharge Common Questions:

- Requirement for urination before discharge?
- Requirement for drinking clear liquids?
- Responsible adult to accompany them home?
  - Adult observation overnight???
- Minimum duration of stay in recovery?

Practice Guidelines for Postanesthetic Care

An Updated Report by the American Society of Anesthesiologists Task Force on Postanesthetic Care

Anesthesiology 2013; 118:291-307

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Other Guidelines/Policies

- Pre-op evaluation
- Infection control
- Medication management
- Endoscope management
- Pacemaker/AICD management

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NORA and COVID-19

- Follow the same COVID-19 screening testing policy as in the main OR
- Follow the same infection control practices

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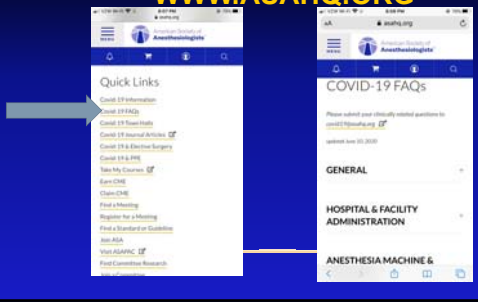
ASA COVID-19 Resources Free to All WWW.ASAHQ.ORG



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SAMBA COVID-19 Resources
WWW.SAMBAHQ.org

SAMBA COVID-19 Webinar Series Recordings

WATCH ANYTIME (Free)!

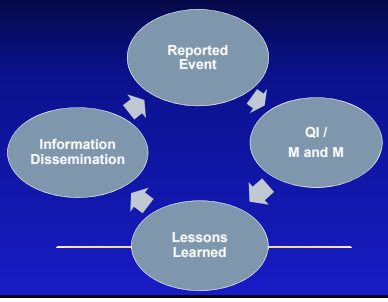
Bronchoscopy Under Procedural Sedation
New Relevant Publications

https://www.ccjm.org/cc/covid-19-curbside-consults

Bronchoscopy Under Procedural Sedation

- Many patients are home oxygen dependent
- Even if not, they typically require many liters of oxygen supplementation
- Frequent coughing would increase the aerosolization of the virus during and after this already AGP,
- Use of the nasal route for bronchoscopy is common, known for high virus load
- Thus, Consider General Anesthesia

Registry and QI Process



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Patient Safety in NORA

- 12 M NACOR patients from 1500 facilities
- NORA patients were older
- MAC is more common in NORA
- Most common minor complications: PONV, and pain
- Hemodynamic instability was reported in 0.1% of NORA patients
- Respiratory complications in 0.09%,
- Both significantly lower than rates reported in the OR data

Chang B, Kaye AD, Diaz JH, Westlake B, Dutton RP, Urman RD. Complications of Non-Operating Room Procedures: Outcomes From the National Anesthesia Clinical Outcomes Registry. Journal of patient safety. 2015.

48

Patient Safety in NORA

- Overall mortality was greater in OR patients compared to NORA patients, 0.4 vs 0.2 %, respectively
- The cardiology and radiology areas had a mortality rate significantly greater than the OR of 0.5%
- Wrong patient/side procedures were higher in NORA

Chang B, Kaye AD, Diaz JH, Westlake B, Dutton RP, Urman RD. Complications of Non-Operating Room Procedures: Outcomes From the National Anesthesia Clinical Outcomes Registry. Journal of patient safety. 2015.

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Patient Safety in NORA

- Closed claims study
- In MAC cases, respiratory depression was responsible for 21% MAC-related claims
- Over half of these adverse events were felt to be preventable with better monitoring[1]
- Compared with OR claims, those in the NORA locations are more often associated with patient death, issues with ventilation and higher payout[2]

1. Bhananker SM, Posner KL, Cheney FW, Caplan RA, Lee LA, Domino KB. Injury and liability associated with monitored anesthesia care: a closed claims analysis. Anesthesiology. 2006;104(2):228-34.
2. Metzner J, Posner KL, Domino KB. The risk and safety of anesthesia at remote locations: the US closed claims analysis. Curr Opin Anaesthesiol. 2009;22(4):502-8.

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Safety of Non–Operating Room Anesthesia

A Closed Claims Update

Zachary G. Woodward, MD[a],
Richard D. Urman, MD, MBA, FASA[a,b,*], Karen B. Domino, MD, MPH[c]

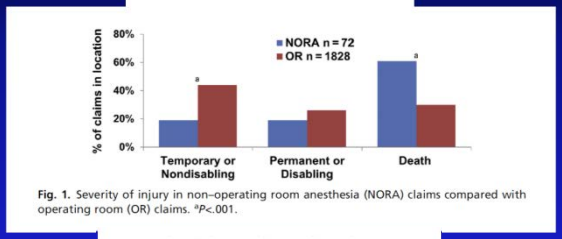

Fig. 1. Severity of injury in non–operating room anesthesia (NORA) claims compared with operating room (OR) claims. [a]$P < .001$.

Anesthesiology Clin 35 (2017) 569–581

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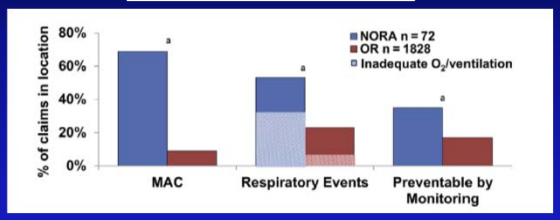
Safety of Non–Operating Room Anesthesia

A Closed Claims Update

Zachary G. Woodward, MD[a],
Richard D. Urman, MD, MBA, FASA[a,b,*], Karen B. Domino, MD, MPH[c]



Anesthesiology Clin 35 (2017) 569–581

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Monitors in NORA

Electrocardiogram
Blood pressure (manual, automatic, arterial catheter)
Pulse oximeter
Capnograph
Oxygen analyzer
Anesthetic agent concentration analyzer
Temperature (when indicated)
Gas flows/spirometry (part of anesthesia machine)
Airway pressure monitor (part of anesthesia machine)
Airway disconnect alarm
Nerve Stimulator (where non-depolarizing muscle relaxants have been used)
Urometer (measure urine output - where appropriate)
Depth of hypnosis monitor (optional, more so preferred for TIVA)

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Summary

- NORA is growing fast, and its future is bright
- Some complexities can be addressed by pre-planning such as the space, equipment and personnel challenges
- We have to be familiar with, prepared for, and ready to manage patients' comorbidities
- Successful safe delivery of NORA would require well thought out plan and organization

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Summary Contd.

- Patient safety in NORA areas is our #1 priority and focus
- Flexibility is needed to tailor and modify old anesthetic techniques and develop new ones to meet the new needs
- Effective communications and team work are essential for successful management of these challenging cases

Cleveland Clinic

Every life deserves world class care.

Thank you for your attention

Basem Abdelmalak, MD, FASA, SAMBA-F
abdelmb@ccf.org
@basemcc

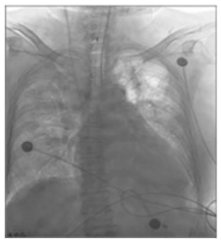
Optimizing Patients from the ICU- Pearls for Practice

Breandan L. Sullivan MD
Associate Professor, University of Colorado School of Medicine
Co-Medical Director Cardiothoracic Intensive Care Unit

1

I have no financial disclosures

2



3

Case

- 45 y/o coming to the OR emergently cold leg
- Intubated in ED 5 days ago
- Progressive Hypoxemia
  - Covid-19 pneumonia
  - Sedated, intubated, paralyzed
- PMH: obesity BMI 35, newly diagnosed diabetic, smoker, unvaccinated
- Sound familiar?

4

Vent Settings

- Pressure Control
  - 15/10
- Tidal Volumes
  - 350 ml (6 ml/kg of ideal body weight)
- Minute Ventilation
  - 6 L/min
- PEEP
  - 10 cm H20
- Plateau Pressure
  - 25
- Saturations/most recent ABG/Fio2
  - 94%
- I/O's (fluid goals for the day)

5

What are we dealing with? What do I need?

- Transport ventilator vs ambu bag
- Can My anesthesia machine match this?
- Does the surgery/anesthesia require different vent settings?
- Tidal volumes vs plateau pressure vs PEEP
- Drive Pressure?

6

Nuances in vent management

- Tidal Volumes
- High/Low PEEP
- Plateau Pressures
- Delta Pressure
  - Drive pressure!!!!!
    - Plateau-PEEP

7

Outline

- Define ARDS
  - American-European Concensus Definition
  - Berlin Definition

8

Acute Respiratory Distress Syndrome

- Definition 1994
  - American-European Consensus Conference
  - Incidence in literature all over the place
  - How do you study a disease if nobody agrees what the disease is?

9

Acute Respiratory Distress Syndrome

- Acute Lung Injury
- PaO2:FIo2
  - Less then 300
- ARDS
- PaO2:FIo2
  - Less then 200
- Exclusion criteria
  - Low cardiac output syndrome
  - Pulmonary Capillary Wedge Pressure >18mmHg

10

Problems with the old definition

- Concurrent ARDS and ALI
- No consideration of vent settings
- Rare use of PA catheters in critically ill patients
  - Reliance on echocardiography
- Heart failure co-exist with ARDS
  - PAWP criteria removed

11

Confusing?

Acute Lung Injury (lung inflammation)

Acute Lung Injury (less severe)

ARDS (severe)

12

Concerns

- Reliability
- Validity
- Here come the Germans!

13

Berlin Definition

- Consensus Panel
  - 2011
  - European Society of Intensive Care Medicine
  - American Thoracic Society
  - Society of Critical Care Medicine
- 3 Mutual Exclusive Categories of hypoxemia
- Better Predictor of Mortality

14

Berlin Definition

- Mild
  - PaO2:FIo2
  - 200-300
  - PEEP≥5
- Moderate
- Severe

15

Berlin Definition

- Mild
- Moderate
  - PaO2:FIO2 100-200
  - PEEP≥5
- Severe

16

Berlin Definition

- Mild
- Moderate
- Severe
  - PaO2:FIO2<100
  - PEEP>10

17

Berlin Definition

- No PA Catheter needed
- However:
- "as long as they have respiratory failure not fully explained by cardiac failure or fluid overload"
- Acuteness
  - Within one week of offending circumstance

18

Berlin Definition

- German Engineering
  - 3 mutually exclusive categories (hospital or 90-day mortality)
    - Mild (Mortality 27%)
    - Moderate (Mortality 32%)
    - Severe (Mortality 45%)

19

Outline

- Define ARDS
- Major Iatrogenic Factors

20

Major Iatrogenic Factors

- Ventilator
- Blood Products
- Fluid Administration
- Pneumonia

21

Major Iatrogenic Factors

- Ventilator
- Blood Products
- Fluid Administration
- Pneumonia

22

Major Iatrogenic Factors

- Ventilator
  - Ventilator induced lung injury
    - Sick Lungs
    - Healthy Lungs
- Blood Products
- Fluid Administration
- Pneumonia

23

Ventilator induced lung injury

- Acute lung injury directly induced by mechanical ventilation
- Alveolar over distention
- Cyclic atelectasis
- Unclear exact mechanism
- Mechanical stretch may
  - Induce inflammatory cytokine production
  - Injure alveolar capillary bed

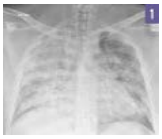
24

VENTILATOR INDUCED LUNG INJURY (VILI)

- Clear Problem in sick lungs
- In ARDS lung protective strategy
  - Reduces the rates of multi-organ dysfunction
  - Saves lives

25

Sick Lungs…



- Nobody debates the fact…
- Sick Lungs need rest…

The New England
Journal of Medicine

VOLUME 342 MAY 4, 2000 NUMBER 18

VENTILATION WITH LOWER TIDAL VOLUMES AS COMPARED WITH TRADITIONAL TIDAL VOLUMES FOR ACUTE LUNG INJURY AND THE ACUTE RESPIRATORY DISTRESS SYNDROME

THE ACUTE RESPIRATORY DISTRESS SYNDROME NETWORK*

26

N Eng J Med Vol 342; 18:1301-1308

TABLE 4. MAIN OUTCOME VARIABLES.*

VARIABLE	GROUP RECEIVING LOWER TIDAL VOLUMES	GROUP RECEIVING TRADITIONAL TIDAL VOLUMES	P VALUE
Death before discharge home and breathing without assistance (%)	31.0	39.8	0.007
Breathing without assistance by day 28 (%)	65.7	55.0	< 0.001
No. of ventilator-free days, days 1 to 28	12± 11	10± 11	0.007
Barotrauma, days 1 to 28 (%)	10	11	0.43
No. of days without failure of nonpulmonary organs or systems, days 1 to 28	15± 11	12± 11	0.006

27

The NEW ENGLAND JOURNAL of MEDICINE

SPECIAL ARTICLE

Driving Pressure and Survival in the Acute Respiratory Distress Syndrome

Marcelo B.P. Amato, M.D., Maureen O. Meade, M.D., Arthur S. Slutsky, M.D., Laurent Brochard, M.D., Eduardo L.V. Costa, M.D., David A. Schoenfeld, Ph.D., Thomas E. Stewart, M.D., Matthias Briel, M.D., Daniel Talmor, M.D., M.P.H., Alain Mercat, M.D., Jean-Christophe M. Richard, M.D., Carlos R.R. Carvalho, M.D., and Roy G. Brower, M.D.

28

Nobody does that…

- This only applies in the ICU…
- I don't take people with ARDS to the operating ro
- Nobody would ventilate
  - Without PEEP
  - With massive tidal volumes

29

High Risk Surgeries

- Cardiopulmonary Bypass
  - As high as 20% develop ARDS
  - Mortality of 80%
    - Ann Thorac Surg 2013; 95:1122-9
- Thoracic Surgery
  - Pneumonectomies
    - 8% develop ARDS (Berlin Definition)
      - Anesthesiology vol 105, no 1, 2006

30

What are the usual suspects?

Anesthesiology 2013;118: 19-29

Preoperative and Intraoperative Predictors of Postoperative Acute Respiratory Distress Syndrome in a General Surgical Population

James M. Blum, M.D.,* Michael J. Sentz, M.D., M.S.,† Ronald Dechert, R.D.T., D.R.H., M.S.,‡ Elizabeth Jewell, M.S.,§ Mitchell Engoren, M.D.,‖ Andrew L. Rosenberg, M.D.,# Pauline K. Park, M.D.**

- Retrospective analysis
- 50,367 Non-emergent
- General surgery
- Rate of post operative ARDS within 7 days
- 0.2%

31

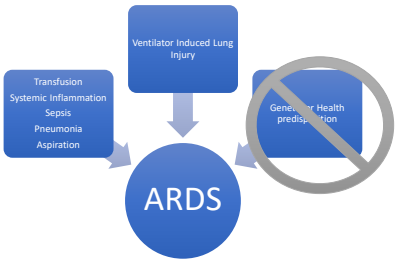
What are the usual suspects?

Anesthesiology 2013;118: 19-29

- What were the usual suspects?
  - Higher Volume of Crystalloid
  - Transfusion of blood products
  - Higher Mean Airway pressures
  - Higher FI02
- Causal or not?

32

Multi-hit hypothesis or one big hit



33

What is the real world practice?

Intraoperative ventilation: incidence and risk factors for receiving large tidal volumes during general anesthesia

Ana Fernandez-Bustamante[1*], Cristina L Wood[1], Zung V Tran[2] and Pierre Moine[1]

34

Fernandez et al

BMC Anesthesiology 2011 11:22

- What is a single "ARDSnet" center OR practice?
- Cross Section Analysis
  - Electronic Database
- Patients having major abdominal surgery
- >4hs of surgery
- All patients with complete data
  - 2007-2010
  - 429 patients

35

Fernandez et al

BMC Anesthesiology 2011 11:22

- Tidal volume range
  - 5.1 -15 ml/kg ideal body weight
- >8ml/kg ideal body weight
  - 64%

36

"Healthy" Lungs

- Not a problem
- You can't hurt a 25-year-old getting his knee scoped…
- Right?

37

Fernandez et al

BMC Anesthesiology 2011 11:22

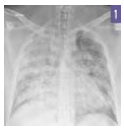
- Tendency to give larger tidal volumes
- Especially in short obese females
- Bad habit
  - Actual vs Ideal body weight
  - **Ideal Body Weight (IBW):**
    Female: (2.3 x # of inches height > 60) + 45.5 = Kg IBW **Male:** (2.3 x # of inches height > 60) + 50 = Kg IBW

38

Fernandez et al

BMC Anesthesiology 2011 11:22

- Intraoperative Tidal volumes >10ml/kg
  - Higher incidence of post-op ventilation
  - Longer ICU and hospital stay

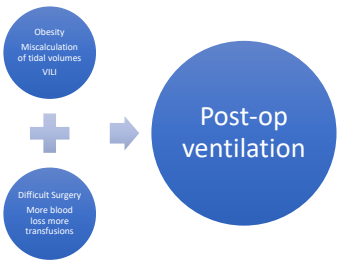


39

Retrospective, what's first?

40

What could explain this?



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Another Possible Explanation

- Mechanical Ventilation
- Too high of tidal volumes
- Screw up a lot of organ systems:
  - Coagulation
  - Renal Function
  - Vascular Tone
  - Cardiac Performance

42

Lungs as inflammatory mediators

- Protective ventilation in sick lungs
  - Protects from MODS (ARDSnet trial)
- JAMA 2003: 289:2104-2112
- Nonprotective ventilation in sick lungs:
  - Induces pro-inflammatory cytokine production
  - Micro vascular injury
  - Multiple organ dysfunction
    - transamin
  - Cell apoptosis
    - Small bowel
    - Kidneys

43

It is our training...

- Correct the numbers
- SPO2
  - Make it normal
- PACO2
  - Make it normal

44

What about "healthy" lungs

- "IMPROVE" TRIAL NEJM 2013;369,5:428-437
- 400 Pts.
  - Elective abdominal surgery
  - At risk for postoperative pulmonary complications
- Randomized
  - Protective Mechanical Ventilation
  - Non-protective Mechanical Ventilation

45

"IMPROVE" TRIAL NEJM 2013;369,5:428-437

- Primary outcomes
  - Occurring within 7 days after surgery
- Major Pulmonary Complications
  - Pneumonia
  - Need for Ventilation (invasive or non-invasive)
- Major Extra-pulmonary Complications
  - Sepsis, Severe Sepsis, Septic Shock
  - Death

46

Protective Mechanical Ventilation

NEJM 2013;369,5:428-437

- 6-8 ml/kg predicted body weight
- 6-8 cm H2O PEEP
- Recruitment breath every 30 min
  - 30 cm H2O pressure
  - 30 sec
- No plateau pressure >30 cmH2O

47

Nonprotective mechanical ventilation NEJM 2013;369,5:428-437

- 10-12 ml/kg predicted body weight
- No PEEP
- Plateau pressure goal less the 30cm H2O
- No scheduled recruitment maneuvers
- If patient de-saturated (sats <92%)
  - Anesthesiologists could use:
    - PEEP
    - Recruitment maneuvers
- Sound familiar?

48

Who were these patients?

NEJM 2013;369,5:428-437

Table 1. Baseline Characteristics of the Patients.*

Characteristic	Nonprotective Ventilation (N = 200)	Lung-Protective Ventilation (N = 200)
Age — yr	63.4±10.0	61.6±11.0
Male sex — no. (%)	121 (60.5)	116 (58.0)
Height — cm	169.5±9.0	169.1±8.8
Body weight — kg		
Actual	71.3±13.9	71.4±14.2
Predicted†	63.8±9.9	63.3±9.7
Body-mass index‡		
Mean	24.7±3.8	24.8±3.8
25–35 — no. (%)	88 (44.0)	99 (49.5)
Preoperative risk index — no. (%)§		
Risk class 2	100 (50.0)	101 (50.5)
Risk class 3	94 (47.0)	93 (46.5)
Risk class 4 or 5	6 (3.0)	6 (3.0)

49

Who were these patients?

Coexisting condition — no. (%)¶		
Any alcohol intake	10 (5.0)	21 (10.5)
Not fully independent in activities of daily living	8 (4.0)	8 (4.0)
Chronic obstructive pulmonary disease	20 (10.0)	20 (10.0)
previous 6 mo		
Long-term glucocorticoid use	4 (2.0)	7 (3.5)
Laparoscopic surgery — no. (%)	44 (22.0)	41 (20.5)
Type of surgery — no. (%)		
Liver resection	52 (26.0)	44 (22.0)
Gastrectomy	17 (8.5)	15 (7.5)
Colorectal resection	40 (20.0)	47 (23.5)
Other procedure	11 (5.5)	10 (5.0)

50

Results

NEJM 2013;369,5:428-437

- Average Tidal volume
  - Non-Protective Ventilation Strategy
    - 11.1 ml/kg
  - Protective Ventilation Strategy
    - 6.4 ml/kg
- Major Pulmonary and Extra pulmonary complications
  - 10.5% Protective-Ventilation-Strategy
  - 27.5% Nonprotective-Ventilation-Strategy
  - P=0.001

51

Results

NEJM 2013;369,5:428-437

- "There were no relevant between-group differences in gas exchange after extubation on day one after surgery."

52

Oxygenation and Ventilation

Table S5. Gas Exchange after Extubation and at Postoperative Day 1.

Variable	Non-protective [illegible] group		Ventilation (N = 20[illegible] group		P Value
	No. Assessed†	Value	No. Assessed†	Value	
pH					
After extubation	122	.4 (0.05)	122	.4 (0.05)	0.02
Day 1 ‡	108	.4 (0.05)	103	.3 (0.05)	0.92
PaO_2 – mmHg					
After extubation	123	0.8 (46.6)	122	0.2 (53.5)	0.66
Day 1 ‡	108	5.7 (27.2)	104	.6 (28.5)	0.17
$PaCO_2$ – mmHg					
After extubation	122	0.6 (5.3)	122	.8 (4.6)	0.03
Day 1 ‡	107	9.4 (5.0)	103	.1 (4.8)	0.17
HCO_3 – mmol/lit					
After extubation	119	3.0 (2.6)	118	.2 (2.9)	0.35
Day 1 ‡	99	4.6 (2.7)	99	.5 (2.5)	0.90
SaO_2 – %					
After extubation	123	5.3 (3.4)	121	.4 (3.2)	0.96
Day 1 ‡	107	4.9 (3.3)	102	.6 (2.8)	0.04

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A Case Based Discussion: Geriatric Anesthesia

Angela Selzer, MD
Associate Professor of Anesthesiology
University of Colorado

1

Disclosures

- I have no financial disclosures to make

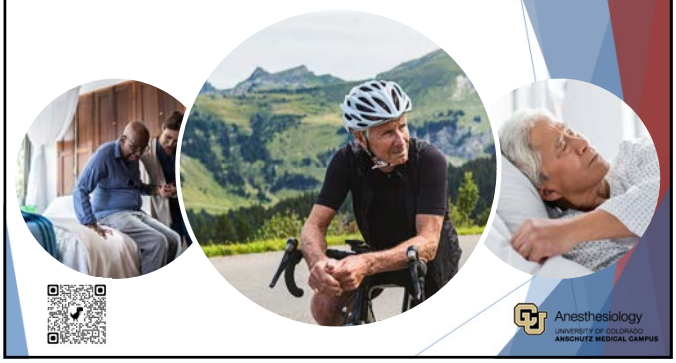
SCAN ME!

2

Learning Objectives

1. Describe the physiologic changes in elderly patients and their impact on perioperative management.
2. Identify risk factors for adverse perioperative outcomes in the elderly and explain the components of a comprehensive preoperative assessment.
3. Review perioperative management strategies and benefits of a multidisciplinary team that may help reduce the risk of adverse outcomes commonly seen in this population.

3



4

Preoperative Assessment & Optimization

- Geriatric Assessments:
  - Overall Risk
  - Cognitive Function
  - Frailty
  - Nutrition
  - Goals of care
- Preop COVID infections

5

Case Presentation

72 yo male with a history of Type 2 Diabetes Mellitus, CAD s/p stent in 2015, prior CVA without residual effect, PVD, paroxysmal afib, history of tobacco use (quit 5 years ago), and COPD requiring 2L O2 with activity, history of EtOH abuse. He has received 3 total COVID vaccine doses, with a booster in October, 2021. He tested positive for COVID on 1/6/2022 with dyspnea, cough and an increased oxygen requirement. He received outpatient therapy and believes he is now fully recovered. He uses a cane for ambulation and is able to perform activities of daily living.

The patient presents for preoperative evaluation prior to revision total hip arthroplasty scheduled in 2 months.

PMH:
DM Type 2 - c/b peripheral neuropathy
PVD
previous CVA
CAD s/p stent to LAD (2015)
paroxysmal afib
COPD on 2 L O2
CKD creat 1.2
Recent COVID infection (1/5/2022)
Anxiety

MEDS:
Metformin
Pregabalin
ASA 81 mg
Carvedilol 25 mg PO BID
Apixaban 5 mg PO BID
Lasix 20 mg qday
Fluticasone/Salmeterol 1 puff BID
Albuterol PRN
Ativan 0.5 mg PRN

PSH:
previous right total hip arthroplasty
inguinal hernia repair

SH:
History of tobacco use - quit 2015
History of EtOH abuse - quit 2015
Cannabis use - "gummies daily"

FMH:
History of Alzheimer's in father

6

Preoperative Assessment & Optimization

- **Geriatric Assessments:**
  - **Overall Risk**
  - Cognitive Function
  - Frailty
  - Nutrition
  - Goals of care
- Preop COVID infections

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Table 1. Checklist for the Optimal Preoperative Assessment of the Geriatric Surgical Patient

In addition to conducting a complete history and physical examination of the patient, the following assessments are strongly recommended:

- ☐ Assess the patient's **cognitive ability** and **capacity** to understand the anticipated surgery.
- ☐ Screen the patient for **depression**.
- ☐ Identify the patient's risk factors for developing postoperative **delirium**.
- ☐ Screen for **alcohol** and other **substance abuse/dependence**.
- ☐ Perform a preoperative **cardiac** evaluation according to the American College of Cardiology/American Heart Association algorithm for patients undergoing noncardiac surgery.
- ☐ Identify the patient's risk factors for postoperative **pulmonary** complications and implement appropriate strategies for prevention.
- ☐ Document **functional status** and history of **falls**.
- ☐ Determine baseline **frailty** score.
- ☐ Assess patient's **nutritional status** and consider preoperative interventions if the patient is at severe nutritional risk.
- ☐ Take an accurate and detailed **medication history** and consider appropriate perioperative adjustments. Monitor for **polypharmacy**.
- ☐ Determine the patient's **treatment goals** and **expectations** in the context of the possible treatment outcomes.
- ☐ Determine patient's **family** and **social support system**.
- ☐ Order appropriate preoperative **diagnostic tests** focused on elderly patients.

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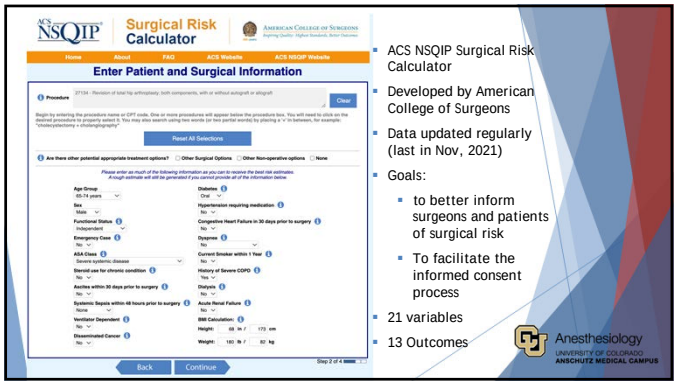

- ACS NSQIP Surgical Risk Calculator
- Developed by American College of Surgeons
- Data updated regularly (last in Nov, 2021)
- Goals:
  - to better inform surgeons and patients of surgical risk
  - To facilitate the informed consent process
- 21 variables
- 13 Outcomes

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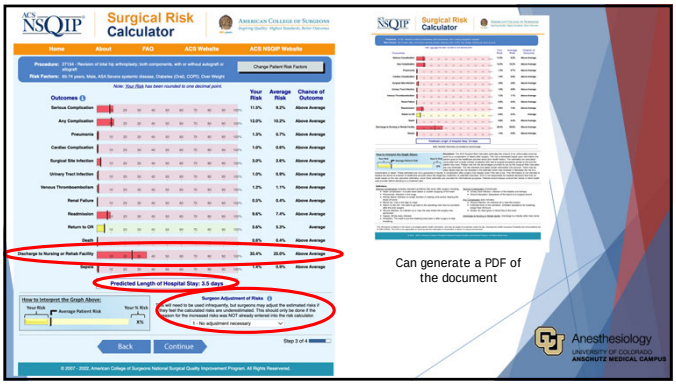

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Risk Assessment

Enhancing the American College of Surgeons NSQIP Surgical Risk Calculator to Predict Geriatric Outcomes

Melissa A Hornor, MD, MS, Meixi Ma, MD, MS, Lynn Zhou, PhD, Mark E Cohen, PhD, Ronnie A Rosenthal, MD, MS, FACS, Marcia M Russell, MD, FACS, Clifford Y Ko, MD, MS, MSHS, FACS, FASCRS

- The Geriatric Surgery ACS NSQIP collaborative launched the Geriatric Pilot Project
- Collected data on 60,000 patients from a subset of 33 NSQIP hospitals
- 6 additional variables reflecting: cognition, function, mobility & decision making
- 4 new geriatric specific outcomes: pressure ulcer, delirium, new mobility aid, functional decline

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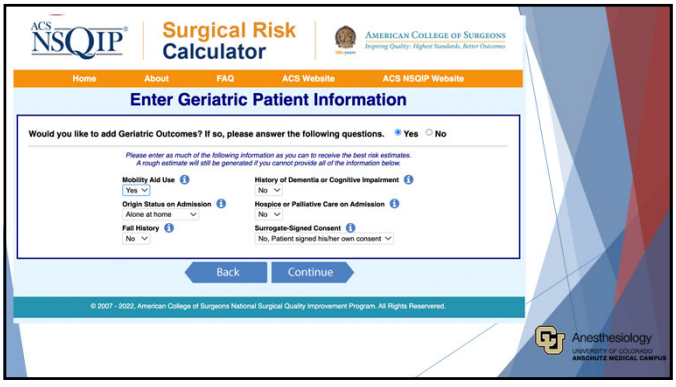

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13

A Simple Procedure for General Screening for Functional Disability in Elderly Patients

Mark S. Lachs, MDAlvan R. Feinstein, MDLeo M. Cooney Jr., MD ... See More +
Author, Article and Disclosure Information
https://doi.org/10.7326/0003-4819-112-9-699

Table 8. Short Simple Screening Test for Functional Assessment[13,78]

ASK THE PATIENT THE FOLLOWING QUESTIONS:
1. "Can you get out of bed or chair yourself?"
2. "Can you dress and bathe yourself?"
3. "Can you make your own meals?"
4. "Can you do your own shopping?"
If NO to any of these questions, more in-depth evaluation should be performed, including full screening of activities of daily living and instrumental activities of daily living.
Deficits should be documented and may prompt perioperative interventions (ie, referral to occupational therapy and/or physical therapy) and proactive discharge planning.

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Case Presentation

- The patient says yes to all functional screening questions
- He is able to care for himself at home without help
- He also reports that he has had no falls over the last year

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ACS NSQIP® Surgical Risk Calculator
American College of Surgeons
Inspiring Quality: Highest Standards, Better Outcomes

Home | About | FAQ | ACS Website | ACS NSQIP Website

Enter Geriatric Patient Information

Would you like to add Geriatric Outcomes? If so, please answer the following questions. ◉ Yes ○ No

Please enter as much of the following information as you can to receive the best risk estimates. A rough estimate will still be generated if you cannot provide all of the information below.

Mobility Aid Use: Yes
History of Dementia or Cognitive Impairment: No
Origin Status on Admission: Alone at home
Hospice or Palliative Care on Admission: No
Fall History: No
Surrogate-Signed Consent: No, Patient signed his/her own consent

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ACS NSQIP® Surgical Risk Calculator
American College of Surgeons
Inspiring Quality: Highest Standards, Better Outcomes

Home | About | FAQ | ACS Website | ACS NSQIP Website

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17

Preoperative Assessment & Optimization

- **Geriatric Assessments:**
  - Overall Risk
  - **Cognitive Function**
  - Frailty
  - Nutrition
  - Goals of care
- Preop COVID infections

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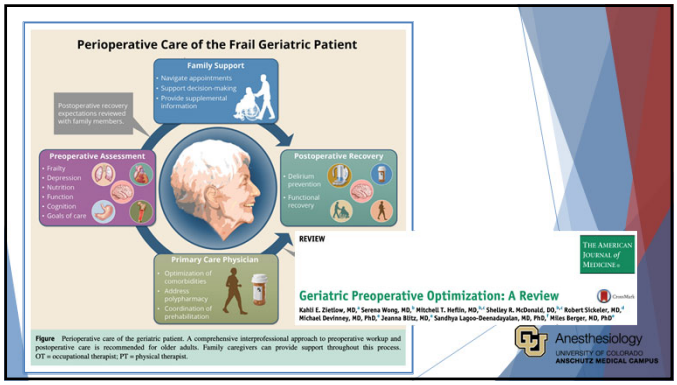

19

Cognitive Impairment

- In the US, in patients over 70 years old:
  - 22.2% have cognitive impairment
  - 13.9% have dementia
- Cognitive impairment is associated with:
  - Prolonged hospitalization
  - Increased perioperative morbidity
  - Increased incidence of delirium

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SPECIAL ARTICLE

Optimal Preoperative Assessment of the Geriatric Surgical Patient: A Best Practices Guideline from the American College of Surgeons National Surgical Quality Improvement Program and the American Geriatrics Society

Warren B Chow, MD, MS, MSHSOR, Ronnie A Rosenthal, MD, MS, FACS, Ryan P Merkow, MD, MSHSOR, Clifford Y Ko, MD, MS, MSHS, FACS, Nestor F Esnaola, MD, MPH, MBA, FACS

- Expert Opinion: **Assess cognition in every geriatric patient**
- Any assessment is fine, specifically mention the mini-cog
- Screen early in assessment
  - *may need a family member or care provider to help with history taking, medications, etc*

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Table 1. Checklist for the Optimal Preoperative Assessment of the Geriatric Surgical Patient

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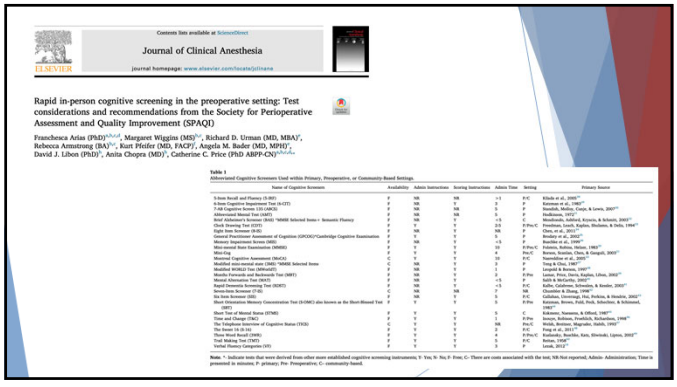

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Scoring the Mini-Cog©

The Mini-Cog© is scored in two parts: 1) 3-item recall, and 2) clock drawing. These are added together for a total score.

3-Item Recall Score:

1 point for each word recalled without cues, for a 3-item recall score of 1, 2, or 3.

Clock Drawing Score:

2 points for a normal clock or 0 (zero) points for an abnormal clock drawing. A normal clock must include all numbers (1-12), each only once, in the correct order and direction (clockwise). There must also be two hands present, one pointing to the 11 and one pointing to 2. Hand length is not scored in the Mini-Cog© algorithm.

Normal Clock | Abnormal Clock (abnormal hands) | Abnormal Clock (missing number)

Mini-cog.com

Table 3. Interpretation of the Mini-Cog©

SCORING:	
3 item recall (0 to 3 points):	1 point for each correct word
Clock draw (0 or 2 points):	0 points for abnormal clock 2 points for normal clock

A NORMAL CLOCK HAS ALL OF THE FOLLOWING ELEMENTS:
All numbers 1 to 12, each only once, are present in the correct order and direction (clockwise) inside the circle.
Two hands are present, one pointing to 11 and one pointing to 2.

ANY CLOCK MISSING ANY OF THESE ELEMENTS IS SCORED ABNORMAL. REFUSAL TO DRAW A CLOCK IS SCORED ABNORMAL.

Total score of 0, 1, or 2 suggests possible impairment.
Total score of 3, 4, or 5 suggests no impairment.

(Mini-Cog™ copyright S Borson [soon@uw.edu]. From: S Borson, with permission).

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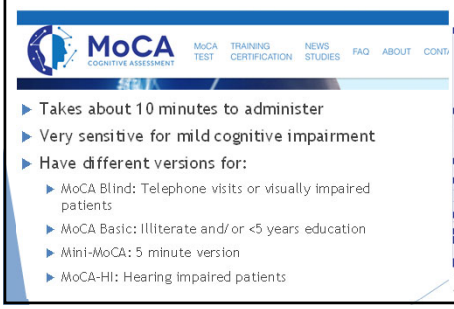
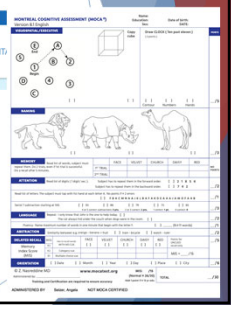
Montreal Cognitive Assessment Test



- Takes about 10 minutes to administer
- Very sensitive for mild cognitive impairment
- Have different versions for:
  - MoCA Blind: Telephone visits or visually impaired patients
  - MoCA Basic: Illiterate and/or <5 years education
  - Mini-MoCA: 5 minute version
  - MoCA-HI: Hearing impaired patients



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Cognitive Assessment

- Any cognitive tool is acceptable
  - MiniCog is easy
  - MOCA is comprehensive & sensitive
  - MOCA-Blind can be used on telehealth visits
- Choose a tool & train the staff
- Perform on every patient over 65

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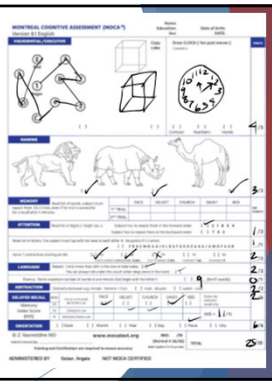
Case Presentation

- We perform a MoCA cognitive exam on our patient and he scores a 25/30 revealing mild cognitive impairment



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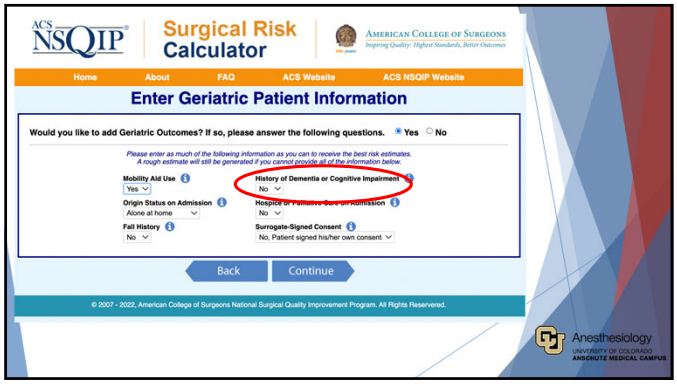

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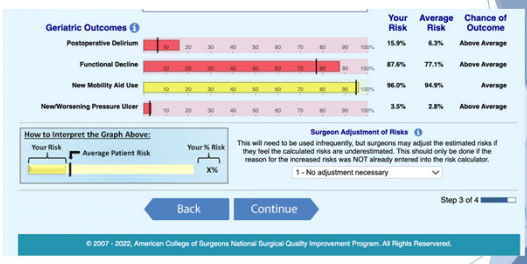

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Preoperative Assessment & Optimization

- **Geriatric Assessments:**
  - Overall Risk
  - Cognitive Function
  - **Frailty**
  - Nutrition
  - Goals of care
- Preop COVID infections

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Table 1. Checklist for the Optimal Preoperative Assessment of the Geriatric Surgical Patient

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Frailty

- Age related state of decreased physiologic reserve that results in diminished resiliency, loss of adaptive capacity and increased vulnerability to stressors
- Predicts perioperative morbidity and mortality better than chronologic age
- Highlights opportunities to intervene

Journal of Clinical Anesthesia

Original Contribution

Recommendations for Preoperative Management of Frailty from the Society for Perioperative Assessment and Quality Improvement (SPAQI)*

Table 2
FRAIL Questionnaire Screening Tool.
(Adapted from Morley et al. [5].)

Fatigue	Are you fatigued? (yes = 1 point)
Resistance	Can you walk up one flight of stairs? (no = 1 point)
Aerobic	Can you walk more than a block? (no = 1 point)
Illnesses	Do you have more than five illnesses? (yes = 1 point)
Loss of weight	Have you lost more than 5% of your weight in the past 6 months? (yes = 1 point)

Scoring: ≥3 points = **frail**; 1–2 points = **prefrail**; 0 points = **robust**.

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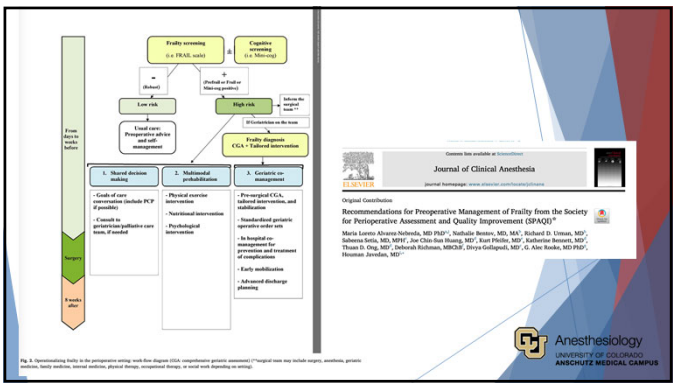

Journal of Clinical Anesthesia

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Recommendations for Preoperative Management of Frailty from the Society for Perioperative Assessment and Quality Improvement (SPAQI)*

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Case Presentation

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Loss of weight	Have you lost more than 5% of your weight in the past 6 months? (yes = 1 point)

Scoring: ≥3 points = **frail**; 1–2 points = **prefrail**; 0 points = **robust**.

- Our patient cannot walk up one flight of stairs or more than one block. He has greater than five illnesses but does not feel fatigued and has not lost weight in the past six months.
- He scores 3 on the frailty screening, identifying him as high risk
- He is referred to a geriatrician for a comprehensive assessment and tailored intervention plan

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Nutritional Assessment

- In the elderly malnutrition is estimated in:
  - 5.8% of individuals in community
  - 13.8% in nursing homes
  - 38.7% in hospitals
  - 50.5% in rehab centers
- Poor nutritional status is associated with an increased risk of:
  - Postoperative adverse events
  - Infection (SSI, pneumonia, UTI)
  - Wound complications (dehiscence, anastomotic leaks)
  - Prolonged hospital length of stay

Mini Nutritional Assessment
MNA®
Nestlé Nutrition Institute

38

Case Presentation

- Nutrition screening revealed a normal nutritional status
- Referral to a dietician was deferred at this time

Screening

A Has food intake declined over the past 3 months due to loss of appetite, digestive problems, chewing or swallowing difficulties? 2
0 = severe decrease in food intake
1 = moderate decrease in food intake
2 = no decrease in food intake

B Weight loss during the last 3 months 3
0 = weight loss greater than 3 kg (6.6 lbs)
1 = does not know
2 = weight loss between 1 and 3 kg (2.2 and 6.6 lbs)
3 = no weight loss

C Mobility 1
0 = bed or chair bound
1 = able to get out of bed / chair but does not go out
2 = goes out

D Has suffered psychological stress or acute disease in the past 3 months? 2
0 = yes 2 = no

E Neuropsychological problems 2
0 = severe dementia or depression
1 = mild dementia
2 = no psychological problems

F1 Body Mass Index (BMI) (weight in kg) / (height in m)² 3
0 = BMI less than 19
1 = BMI 19 to less than 21
2 = BMI 21 to less than 23
3 = BMI 23 or greater

IF BMI IS NOT AVAILABLE, REPLACE QUESTION F1 WITH QUESTION F2
DO NOT ANSWER QUESTION F2 IF QUESTION F1 IS ALREADY COMPLETED.

F2 Calf circumference (CC) in cm
0 = CC less than 31
3 = CC 31 or greater

Screening score (max. 14 points)

12-14 points: Normal nutritional status
8-11 points: At risk of malnutrition
0-7 points: Malnourished

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Shared Decision Making

Contents lists available at ScienceDirect
Best Practice & Research Clinical Anaesthesiology
journal homepage: www.elsevier.com/locate/bean
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Shared decision-making – Creating pathways and models of care

Sarah K. Abbett, MD, MPH, Perioperative Medicine Fellow *,
Richard D. Urman, MD, MBA, Associate Professor of Anaesthesia,
Angela M. Bader, MD, MPH, Professor of Anaesthesia
Department of Anesthesiology, Perioperative and Pain Medicine, Brigham and Women's Hospital, 75 Francis St., Boston, MA, 02115, USA

Table 1
Components of high-quality shared decision-making.

Component	Description
Right operation	Procedure is the best treatment for the diagnosis
Right patient	The decision reflects the individual patient's values and preferences
Right place	The healthcare facility chosen has all necessary resources
Right provider	The surgeon selected has the requisite skills to safely perform the procedure

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Shared Decision Making

- Patients often proceed with surgery:
  - Believing they had no other choice
  - Underestimating how difficult recovery will be
  - Without advanced directives

JAMA Surgery | Original Investigation

Engaging Patients, Health Care Professionals, and Community Members to Improve Preoperative Decision Making for Older Adults Facing High-Risk Surgery

Nicole M. Steffens, MPH; Jennifer L. Tucholka, BS; Michael J. Nabozny, MD; Andrea E. Schmick, BA; Karen J. Brasel, MD, MPH; Margaret L. Schwarze, MD, MPP

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Shared Decision Making

Benefits
Risks
Alternatives
Nothing

Use the speech bubble under each section to write down any questions to take to your appointment

What are the Benefits of the treatment?
- What can I expect to gain from the treatment?
- What is the chance of the treatment being successful?

What are the Risks?
- What is the chance the treatment won't work?
- What are the possible side effects?
- What are the possible complications?
- How might the treatment affect my quality of life?

What are the Alternatives to this treatment?
- What are the other treatment options?
- What are benefits and risks of the other treatment options?
- Which treatment options should be used first?

What if I do Nothing?
- How will my condition change if I don't have treatment?
- Will my condition be more difficult to treat later?

https://www.choosingwisely.co.uk/shared-decision-making-resources/

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Preoperative Assessment & Optimization

- Geriatric Assessments:
  - Overall Risk
  - Cognitive Function
  - Frailty
  - Nutrition
  - Goals of care
- Preop COVID infections

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Preoperative Assessment & Optimization

- Geriatric Assessments:
  - Overall Risk
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  - Frailty
  - Nutrition
  - Goals of care
- **Preop COVID infections**

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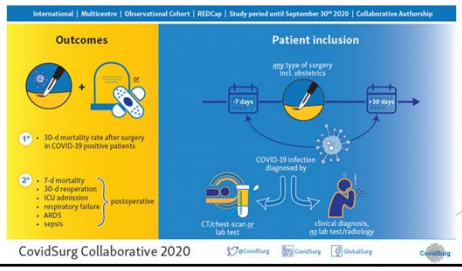
Timing of Surgery with COVID infection

CovidSurg – Study Protocol

Outcomes of Surgery in COVID-19 infection: international cohort study



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Timing of Surgery with COVID infection

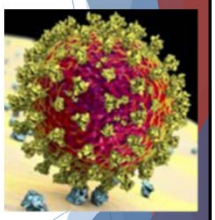
Anaesthesia 2021, 76, 748-758 doi:10.1111/anae.15458

Original Article

Timing of surgery following SARS-CoV-2 infection: an international prospective cohort study

COVIDSurg Collaborative* and **GlobalSurg Collaborative***

NIHR Global Health Research Unit on Global Surgery, Birmingham, UK



- 140,231 Patients from 116 countries
- Primary Outcome, 30-day mortality

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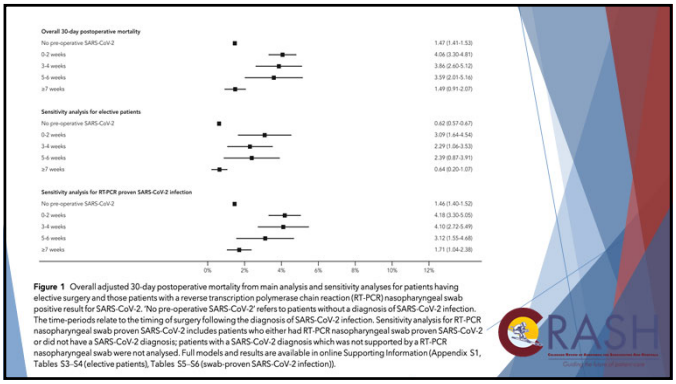

Figure 1 Overall adjusted 30-day postoperative mortality from main analysis and sensitivity analyses for patients having elective surgery and those patients with a reverse transcription polymerase chain reaction (RT-PCR) nasopharyngeal swab positive result for SARS-CoV-2. 'No pre-operative SARS-CoV-2' refers to patients without a diagnosis of SARS-CoV-2 infection. The time-periods relate to the timing of surgery following the diagnosis of SARS-CoV-2 infection. Sensitivity analysis for RT-PCR nasopharyngeal swab proven SARS-CoV-2 includes patients who either had RT-PCR nasopharyngeal swab proven SARS-CoV-2 or did not have a SARS-CoV-2 diagnosis; patients with a SARS-CoV-2 diagnosis which was not supported by a RT-PCR nasopharyngeal swab were not analysed. Full models and results are available in online Supporting Information (Appendix S1, Tables S3–S4 (elective patients), Tables S5–S6 (swab-proven SARS-CoV-2 infection)).

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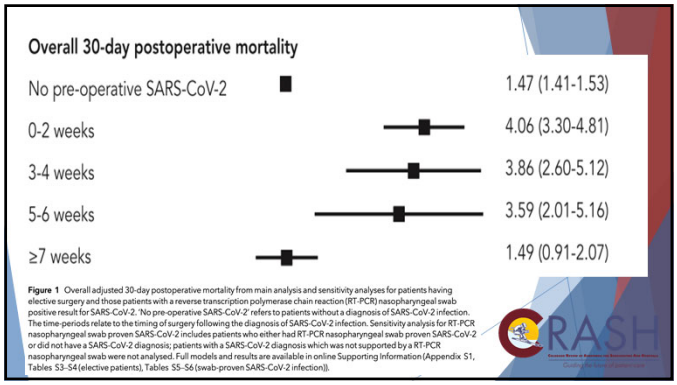

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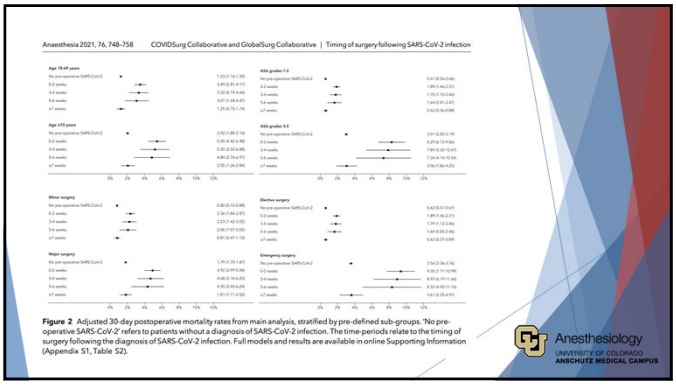

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Timing of Surgery with COVID infection

- Conclusions of COVIDSurg Trial:
  - Asymptomatic COVID infections confer a higher mortality rate for 7 weeks after infection
  - Patients with continued symptoms after 7 weeks have an increased mortality rate
- Data were collected until Oct, 2020:
  - Unvaccinated patients
  - Predominantly Alpha, with Beta and Delta variants
- COVID Surg 3 trial: collecting data Feb, 2022
  - More vaccinated patients
  - Predominantly Omicron variant

"Decisions should be tailored for each patient since the possible advantages of delaying surgery for at least 7 weeks following SARS-COV-2 diagnosis must be balanced against the potential risks of delay"

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A Case Based Discussion: Geriatric Anesthesia

Ramu Gumidyala, MD
Assistant Professor of Anesthesiology
University of Colorado

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Disclosures

- I have no financial disclosures to make

2

Learning Objectives

1. Identify risk factors for adverse perioperative outcomes in the elderly and explain the components of a comprehensive preoperative assessment.
2. Describe the physiologic changes in elderly patients and their impact on perioperative management.
3. Review perioperative management strategies and benefits of a multidisciplinary team that may help reduce the risk of adverse outcomes commonly seen in this population.

3

Preoperative Assessment & Optimization

- Geriatric Assessments:
  - Overall Risk
  - Cognitive Function
  - Frailty
  - Nutrition
  - Goals of care
- Preop COVID infections

4

Intraoperative Management

- Geriatric Physiology
  - Structural
  - Functional
  - Anesthetic Considerations
- Geriatric Pharmacology
- Anesthetic Choice

5

Case Presentation

72 yo male with a history of Type 2 Diabetes Mellitus, CAD s/p stent in 2015, prior CVA without residual effect, PVD, paroxysmal afib, history of tobacco use (quit 5 years ago), and COPD requiring 2L O2 with activity, history of EtOH abuse. He has received 3 total COVID vaccine doses, with a booster in October, 2021. He tested positive for COVID on 1/6/2022 with dyspnea, cough and an increased oxygen requirement. He received outpatient therapy and believes he is now fully recovered. He uses a cane for ambulation and is able to perform activities of daily living.

The patient presents for preoperative evaluation prior to revision total hip arthroplasty scheduled in 2 months.

PMH:
DM Type 2 – c/b peripheral neuropathy
PVD
previous CVA
CAD s/p stent to LAD (2015)
paroxysmal afib
COPD on 2 L O2
CKD creat 1.2
Recent COVID infection (1/5/2022)
Anxiety

MEDS:
Metformin
Pregabalin
ASA 81 mg
Carvedilol 25 mg PO BID
Apixaban 5 mg PO BID
Furosemide 20 mg qday
Fluticasone/Salmeterol 1 puff BID
Albuterol PRN
Ativan 0.5 mg PRN

PSH:
previous right total hip arthroplasty
inguinal hernia repair

SH:
History of tobacco use - quit 2015
History of EtOH abuse - quit 2015
Cannabis use - "gummies daily"

FMH:
History of Alzheimer's in father

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Intraoperative Management

- **Geriatric Physiology**
  - **Structural**
  - **Functional**
  - **Anesthetic Considerations**
- Geriatic Pharmacology
- Anesthetic Choice

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Neurologic Changes

STRUCTURE	FUNCTION	ANESTHETIC CONSIDERATIONS
↓ Brain Volume	↓ CMR	↑ Memory Decline
↓ DA, 5-HT, Ach, NE receptors	↑ BBB permeability	↑ POD/POCD risk
↓ Epidural space		↑ Sensitivity to anesthetic agents
↓ CSF volume		↑ Sensitivity to neuraxial/regional anesthesia
↓ Number/diameter nerve root fibers		
↑ Distance between Schwann cells		

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How much is too much?

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Cardiovascular

STRUCTURE	FUNCTION	ANESTHETIC CONSIDERATIONS
↓ Elastin/Collagen	↓ β-adrenergic activity	↓ SV/CO
↓ Myocyte #	↓ Baroreceptor sensitivity	↓ Max HR
↓ Conduction fiber density	↓ Vascular compliance	↑ SVR/SBP
↓ SA node #	↓ Contractility	↑ HD instability
↑ LVH	↓ Pulse pressure	↑ Risk of CAD, arrhythmias, valvulopathy
↑ Vascular Rigidity	↓ Endothelial dysfunction	Autonomic dysfunction
	↑ LV Diastolic dysfunction	
	↑ MAP	

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Respiratory

STRUCTURE	FUNCTION	ANESTHETIC CONSIDERATIONS
↓ Respiratory muscle strength	↓ **Chest wall compliance**	↓ Time to desaturation
↓ Elasticity	↓ Central response to hypoxia, hypercarbia, stress	↑ atelectasis
↓ Small airway size	↓ Vital capacity	↑ hypoxia/hypercarbia
↓ surfactant	↓ FEV1	↑ sensitivity to respiratory depressants
↓ Pulmonary vascular area	↓ Hypoxic pulmonary vasoconstriction	↑ risk of bronchospasm
↑ Chest wall rigidity	↑ **Lung compliance**	↑ risk of obstruction
↑ Central airway size	↑ Expiratory flow limit	↑ risk of aspiration
	↑ RV	↑ risk of infection
	↑ V/Q Mismatch	

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Prevention of Pulmonary Complications

- Risk Factors
  - Obstructive lung disease
  - Recent infection
  - Smoking history
  - OSA
  - Age > 70
  - ASA ≥ 2
  - Deconditioned
  - Upper abdominal/thoracic surgery
  - EtOH
  - Transfusion
  - General anesthesia
  - Emergency Procedure
- Prevention
  - Epidural use when appropriate
  - Minimizing use of intermediate/long-acting NMBDs
  - Ensuring adequate reversal
  - Laparoscopic choice for bariatric surgery
  - Preoperative inspiratory muscle training
  - Protective lung strategy
  - Adequate reversal
  - Use of NIPPV

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Gastrointestinal/Hepatic

STRUCTURE	FUNCTION	ANESTHETIC CONSIDERATIONS
↓ small intestine area	↓ Esophageal motility	↓ Rate of drug metabolism
↓ liver volume	↓ Acid secretion	↑ Aspiration risk
↓ Hepatic/Splanchnic flow	↓ Hepatic metabolism	↑ Constipation
	↓ Synthesis of coagulation factors	↑ Bleeding
	↑ Gastric emptying time	↑ Risk of drug toxicity

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Renal

STRUCTURE	FUNCTION	ANESTHETIC CONSIDERATIONS
↓ Renal mass	↓ GFR/creatinine clearance	↓ Drug clearance
↓ Nephrons	↓ Ability to clear Na	↑ Risk of dehydration
↓ Blood blow	↓ Ability to concentrate urine	↑ Electrolyte abnormalities
	↓ Thirst response	↑ Risk of AKI
	↑ Na retention	↑ Risk of drug toxicity

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Fluid Management

CRASH

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Body Composition/Pharmacology

STRUCTURE	FUNCTION	ANESTHETIC CONSIDERATIONS
↓ Skeletal Muscle Mass	↓ O2 consumption	↑ Hypothermia
↓ Total body water	↓ Heat production	↑ Serum drug concentration after bolus
↓ Lean body mass	↓ Renal/Hepatic drug clearance	↑ half-life fat soluble drugs
↓ Albumin	↓ Volume of distribution of water soluble drugs	↑ Risk of drug toxicity
↑ Percentage body fat	↑ Volume of distribution of lipid soluble drugs	Prolonged drug effect
↑ Distance between Schwann cells	↑Target organ drug sensitivity	Increased sensitivity to anesthetics

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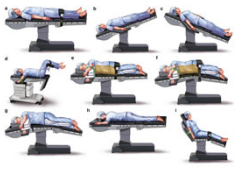
Patient Positioning



- Risk factors for positioning injuires:
  - Cardiopulmonary bypass
  - ASA status
  - Case length
  - Transfusion need
  - Hypotension and need for pressorsr
  - Hypotherrmia

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Intraoperative Management

- Geriatric Physiology
  - Structural
  - Functional
  - Anesthetic Considerations
- **Geriatric Pharmacology**
- Anesthetic Choice

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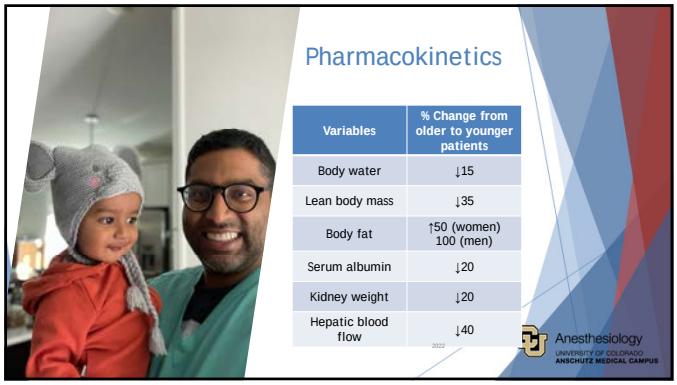

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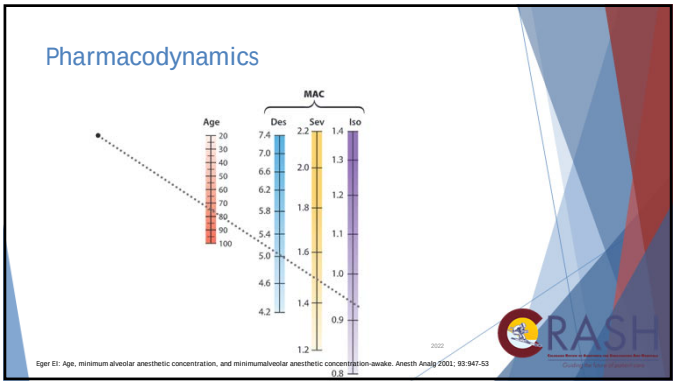

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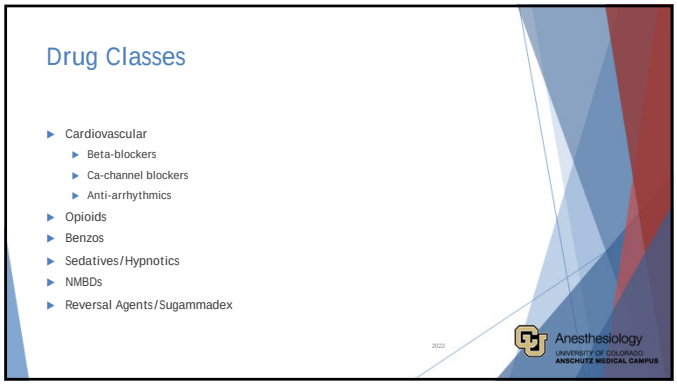

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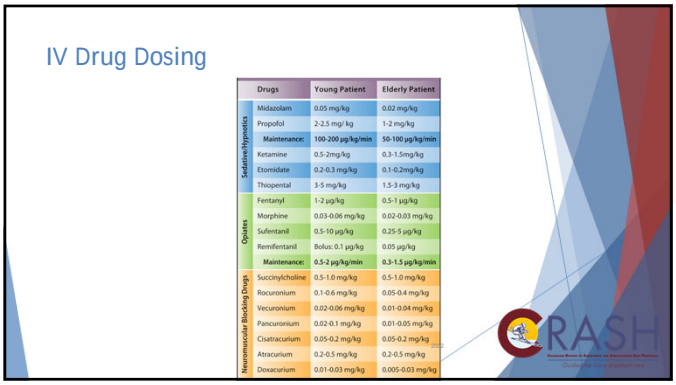

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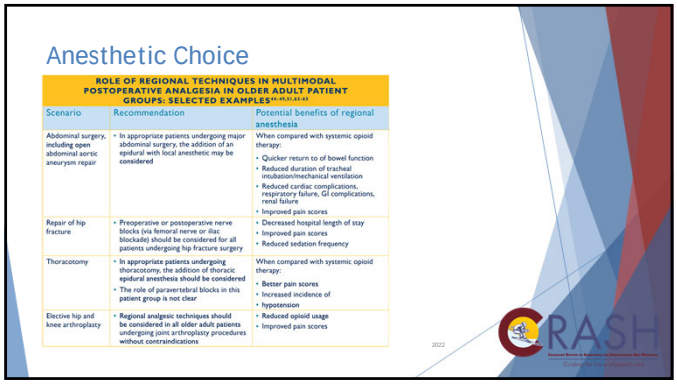

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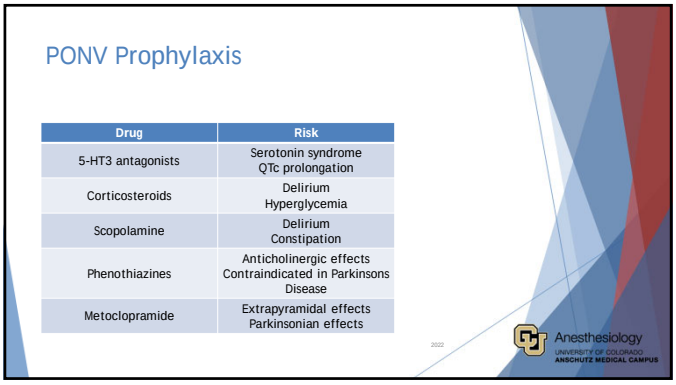

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Case Presentation

72 yo male with a history of Type 2 Diabetes Mellitus, CAD s/p stent in 2015, prior CVA without residual effect, PVD, paroxysmal afib, history of tobacco use (quit 5 years ago), and COPD requiring 2L O2 with activity, history of EtOH abuse. He has received 3 total COVID vaccine doses, with a booster in October, 2021. He tested positive for COVID on 1/6/2022 with dyspnea, cough and an increased oxygen requirement. He received outpatient therapy and believes he is now fully recovered. He uses a cane for ambulation and is able to perform activities of daily living.

The patient presents for preoperative evaluation prior to revision total hip arthroplasty scheduled in 2 months.

PMH:
DM Type 2 – c/b peripheral neuropathy
PVD
previous CVA
CAD s/p stent to LAD (2015)
paroxysmal afib
COPD on 2 L O2
CKD creat 1.2
Recent COVID infection (1/5/2022)
Anxiety

MEDS:
Metformin
Pregabalin
ASA 81 mg
Carvedilol 25 mg PO BID
Apixaban 5 mg PO BID
Furosemide 20 mg qday
Fluticasone/Salmeterol 1 puff BID
Albuterol PRN
Ativan 0.5 mg PRN

PSH:
previous right total hip arthroplasty
inguinal hernia repair

SH:
History of tobacco use - quit 2015
History of EtOH abuse - quit 2015
Cannabis use - "gummies daily"

FMH:
History of Alzheimer's in father

2022

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Perioperative Anesthetic Plan

- Comprehensive geriatric assessment to include cardiopulmonary risk, falls, frailty, nutritional and pre-habilitation needs, medication review, and cognitive assessment.
- Discuss increased risk of perioperative pulmonary complications.
- Continue his aspirin and beta-blockers, furosemide, and inhalers perioperatively given his previous coronary stenting and cardiac history and pulmonary history.
- Spinal anesthetic if he held his apixaban x 72 hours with propofol sedation. Adjust intraoperative dosing of medications appropriately for this age group and avoid polypharmacy.
- Adjust PONV strategy taking into account patient comorbidities
- Take extra precautions intraoperatively to help mitigate positioning injuries and pressure ulcers.

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Geriatric Anesthesia: Postoperative Concerns

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Rocky Mountain Regional VAMC
March 1 2022

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Disclosures

No financial disclosures

2

Learning Objectives

Discuss delirium and postoperative cognitive decline as major concerns in the postoperative care of the elderly.

Identify risk factors associated with delirium and POCD.

Identify prevention strategies for delirium and POCD.

3

Postoperative badness: The big players

Delirium

Post Operative Cognitive Dysfunction (POCD)

4

Delirium vs POCD

Delirium:

"Acute confusional state with alterations in attention and consciousness."

(*the* agreed upon definition)

POCD

"A decline in a variety of neuropsychological domains [including processing speed, memory, executive function, etc]"

(one of *many* definitions)

5

Delirium

Delirium is diagnosed by criteria set out in the DSM.

Stated succinctly as: "a disturbance in consciousness that is accompanied by a change in cognition that cannot be better accounted for by a preexisting or evolving dementia." (DSM)

Has 3 main "flavors" described as: hyperactive, hypoactive, and mixed.

The majority (68%) are hypoactive with a mixed presentation second most common at 31%. Isolated hyperactive delirium is rare (~1%).

CAM (confusion assessment method) is the most commonly used to score delirium.

6

Postoperative Delirium
A major concern in the elderly

- Prevalence 10% or more
  - Cardiac and hip surgery cary big risk
  - ICU care carries the biggest risk (up to 60-80%)
- Age is a big risk factor for postoperative delirium.
- Unsurprisingly, the greater the number of predisposing risk factors (called "vulnerability" factors) the smaller the stress needed to induce delirium.

7

Postoperative Delirium

- Major vulnerability factors are advanced age, visual impairment (visual acuity < 20/70), illness severity (APACHE score >16), cognitive impairment (MMSE <24), hearing impairment, dehydration, sleep deprivation, immobility, among others.
- Prevention is key
- Once delirium has begun there are few interventions that have much of a proven effect.

8

Clinical Interventions in Aging
Dovepress
open access to scientific and medical research
REVIEW

Prevention of postoperative delirium in elderly patients planned for elective surgery: systematic review and meta-analysis

Conclusion: Multicomponent interventions, the use of antipsychotics, BIS-guidance, and dexmedetomidine treatment can successfully reduce the incidence of postoperative delirium in elderly patients undergoing elective, non-cardiac surgery. However, present studies are heterogeneous, and high-quality studies are scarce. Future studies should add these preventive methods to already existing multimodal and multidisciplinary interventions to tackle as many precipitating factors as possible, starting in the pre-admission period.

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NEUROSCIENCE AND NEUROANAESTHESIA

Efficacy of perioperative dexmedetomidine on postoperative delirium: systematic review and meta-analysis with trial sequential analysis of randomised controlled trials

X. Duan[1,2], M. Coburn[2,*], R. Rossaint[2], R. D. Sanders[3], J. V. Waesberghe[2] and A. Kowark[2]

Conclusion: Dexmedetomidine can reduce POD incidence for adult cardiac and non-cardiac surgical patients. The optimal dose and timing of dexmedetomidine and influence on other outcomes or particular patient populations with risk factors warrants further studies.

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www.aging-us.com AGING 2020, Vol. 12, No. 2
Research Paper

Anesthesia and surgery induce age-dependent changes in behaviors and microbiota

Ning Liufu[1,2,*], Ling Liu[1,2,*], Shiqian Shen[3], Zengliang Jiang[4], Yuanlin Dong[2], Yanyan Wang[2,5], Deborah Culley[6], Gregory Crosby[6], Minghui Cao[1], Yuan Shen[7], Edward Marcantonio[8], Zhongcong Xie[2], Yiying Zhang[2]

ABSTRACT

The neuropathogenesis of postoperative delirium remains mostly unknown. The gut microbiota is implicated in the pathogenesis of neurological disorders. We, therefore, set out to determine whether anesthesia/surgery causes age-dependent gut microbiota dysbiosis, changes in brain IL-6 level and mitochondrial function, leading to postoperative delirium-like behavior in mice. Female 9 or 18 months old mice received abdominal surgery under 1.4% isoflurane for two hours. The postoperative delirium-like behavior, gut microbiota, levels of brain IL-6, PSD-95 and synaptophysin, and mitochondrial function were determined by a battery of behavioral tests, 16s rRNA sequencing, ELISA, Western blot and Seahorse XFp Extracellular Flux Analyzer. Intragastric administration of lactobacillus (10 days) and probiotic (20 days) were used to mitigate the anesthesia/surgery-induced changes. Anesthesia/surgery caused different alterations in gut microbiota, including change rate of reduction in the levels of gut lactobacillus, between the 18 and 9 months old mice. The anesthesia/surgery induced greater postoperative delirium-like behavior, increased brain IL-6 levels, decreased PSD-95 and synaptophysin levels, and mitochondrial dysfunction in 18 than 9 months old mice. Treatments with lactobacillus and probiotic mitigated the anesthesia/surgery-induced changes. These data suggest that microbiota dysbiosis may contribute to neuropathogenesis of postoperative delirium and treatment with lactobacillus or a probiotic could mitigate postoperative delirium.

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Preventing Postoperative Delirium

- Antipsychotics may help.
- Dexmedetomidine may also help.
- Probiotics?
- Intraoperative correction of metabolic derangements (electrolytes, volume status, etc.)
- Intraoperative and postoperative: decrease known trigger medications such as opioids, benzos, dihydropyridines CCBs, etc.
- TIVA vs volatile anesthetics?

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TIVA vs volatile maintenance
Delirium prevention? POCD prevention?

2018 Cochrane Review

28 RCTs and over 4500 participants.

There was heterogeneity in the data. Noted difficulty in blinding the anesthesia technique to the provider, some important variables (like intraoperative hypotension) could not be adequately controlled for.

Data reporting inconsistencies also made the analysis less reliable.

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Cochrane Library

Cochrane Database of Systematic Reviews

Intravenous versus inhalational maintenance of anaesthesia for postoperative cognitive outcomes in elderly people undergoing non-cardiac surgery (Review)

Miller D, Lewis SR, Pritchard MW, Schofield-Robinson OJ, Shelton CL, Alderson P, Smith AF

Authors' conclusions: We are uncertain whether maintenance with propofol-based TIVA or with inhalational agents affect incidences of postoperative delirium, mortality, or length of hospital stay because certainty of the evidence was very low. We found low-certainty evidence that maintenance with propofol-based TIVA may reduce POCD. We were unable to perform meta-analysis for intraoperative hypotension or length of stay in the PACU because of heterogeneity between studies. We identified 11 ongoing studies from clinical trials register searches; inclusion of these studies in future review updates may provide more certainty for the review outcomes.

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Original Contribution

Effect of propofol, sevoflurane, and isoflurane on postoperative cognitive dysfunction following laparoscopic cholecystectomy in elderly patients: A randomized controlled trial

Ying-jie Geng [a], Qing-hua Wu [b], Rui-qin Zhang [a,*]

[a] Department of Anesthesiology, Second Affiliated Hospital, Harbin Medical University, Nangang District of Harbin, Harbin, China
[b] Department of Anesthesiology, The First Hospital of Putian City, Putian, China

Main results: The incidence of POCD was significantly lower in the propofol group compared to the isoflurane group and the sevoflurane group at D1 and D3 (propofol vs. isoflurane: D1 and D3, $P < 0.001$; propofol vs. sevoflurane: D1, $P = 0.012$; D3, $P = 0.013$). The incidence of POCD was significantly lower in the sevoflurane group compared to the isoflurane group at D1 ($P = 0.041$), but not at D3. Postoperatively, plasma S-100β and $A\beta_{1-40}$ protein, IL-1β, IL-6, and TNF-α concentrations were significantly decreased in the propofol group compared to the isoflurane group.
Conclusions: Propofol anesthesia may be an option for elderly surgical patients.

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Preventing Postoperative Delirium
A wrinkle

Many advocate for use of neuraxial and regional techniques to avoid GA in the elderly.

Conflicting data

Recent study (2020) showed no benefit specifically in hip surgery, which is one of the higher risk surgeries for postoperative delirium.

114 patients, ages 65+, ASA 2-4 with hip fracture

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ORIGINAL ARTICLE

The effects of early femoral nerve block intervention on preoperative pain management and incidence of postoperative delirium geriatric patients undergoing trochanteric femur fracture surgery: A randomized controlled trial

Ali İhsan Uysal, M.D.,[1] Başak Altparmak, M.D.,[2] Eylem Yaşar, M.D.,[1] Mustafa Turan, M.D.,[3] Umut Canbek, M.D.,[2] Nigar Yılmaz, M.D.,[3] Semra Gümüş Demirbilek, M.D.[4]

[1]Department of Anesthesiology and Reanimation, Muğla Sıtkı Koçman University Training and Research Hospital, Muğla-Turkey
[2]Department of Orthopedics and Traumatology, Muğla Sıtkı Koçman University Faculty of Medicine, Muğla-Turkey
[3]Department of Biochemistry, Muğla Sıtkı Koçman University Faculty of Medicine, Muğla-Turkey
[4]Department of Anesthesiology and Reanimation, Muğla Sıtkı Koçman University Faculty of Medicine, Muğla-Turkey

RESULTS: VAS scores four hours after the first preoperative pain treatment and during the positioning for regional anesthesia were significantly lower in the femoral nerve block group. IL-8 levels are significantly lower in the femoral nerve block group but not in IL-6 levels. The incidence of delirium was less in the femoral nerve block group, but the difference was not statistically significant.

CONCLUSION: The femoral nerve block was more effective in preoperative pain management of trochanteric femur fracture and preventing pain during regional anesthesia application. The mean IL-8 level was lower in the femoral nerve block group when compared to the paracetamol group. There is no difference in the postoperative delirium incidence between groups.

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Post-Operative Cognitive Decline (POCD)

Not a single, specific diagnosis in the DSM

Inconsistent definitions, but here's one: "[a new] dysfunction in cognition, that is not explained by a preexisting neurocognitive disorder" (Ntalouka et al.)

Is gradual in onset, in contradistinction to delirium.

Requires neuropsychometric testing to track.

Usually self-limiting.

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POCD and Risk

Age is thought to be the most significant risk factor.

Some newer date point to possible biomarkers (neuron-specific enolase (NSE) and S100b), but as of now it's too early to know.

Cardiac surgery is, again, a higher risk surgery.

The label "POCD" may represent several different underlying problems.

Because of the possibility that several layers of etiology are possible…

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Promise for the future

Clinical Interventions in Aging — Dovepress

REVIEW

Postoperative cognitive dysfunction – current preventive strategies

exhibit undesired side effects. Interventions to reduce oxidative stress and neuroinflammation could prove beneficial. Preventive strategies, early recognition, and management of perioperative risk factors seems to be, by far, the best modality to deal with POCD till further progress in therapeutic interventions evolve.

20

Change in Nomenclature?

SPECIAL ARTICLE

Recommendations for the Nomenclature of Cognitive Change Associated with Anaesthesia and Surgery—2018

L. Evered, B. Silbert, D. S. Knopman, D. A. Scott, S. T. DeKosky, L. S. Rasmussen, E. S. Oh, G. Crosby, M. Berger, R. G. Eckenhoff, and The Nomenclature Consensus Working Group*

Anesthesiology, V 129 • No 5 872 November 2018

The working group recommends that 'perioperative neurocognitive disorders' be used as an overarching term for cognitive impairment identified in the preoperative or postoperative period. This includes cognitive decline diagnosed before operation (described as *neurocognitive disorder*); any form of acute event (*postoperative delirium*) and cognitive decline diagnosed up to 30 days after the procedure (*delayed neurocognitive recovery*) and up to 12 months (*postoperative neurocognitive disorder*).

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Is It the Anesthesia? (we don't know)

Clinical Interventions in Aging — Dovepress

REVIEW

General anesthetic and the risk of dementia in elderly patients: current insights

"Neither the route of anesthesia nor the type of anesthetic appears to be significantly associated with the development of postoperative delirium or postoperative cognitive dysfunction."

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REVIEW — Open Access

Anesthesiology and cognitive impairment: a narrative review of current clinical literature

Jillian C. Belrose* and Ruediger R. Noppens*

Abstract

Background: The impact of general anesthesia on cognitive impairment is controversial and complex. A large body of evidence supports the association between exposure to surgery under general anesthesia and development of delayed neurocognitive recovery in a subset of patients. Existing literature continues to debate whether these short-term effects on cognition can be attributed to anesthetic agents themselves, or whether other variables are causative of the observed changes in cognition. Furthermore, there is conflicting data on the relationship between anesthesia exposure and the development of long-term neurocognitive disorders, or development of incident dementia in the patient population with normal preoperative cognitive function. Patients with pre-existing cognitive impairment present a unique set of anesthetic considerations, including potential medication interactions, challenges with cooperation during assessment and non-general anesthesia techniques, and the possibility that pre-existing cognitive impairment may impart a susceptibility to further cognitive dysfunction.

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Is all POCD really POCD?

Is it possible that sometimes an acute event can cause greater scrutiny or reflection by a patient or family members?

Humans are excellent pattern-finders, so we sometimes pin changes that have been happening over months or years to a specific event thought to be sentinel.

Not all POCD research depends on clinical assessments of cognitive function.

Not every patient complaint of being "mentally different" after surgery is POCD or one of its kin.

Nevertheless, POCD remains common, and a problem of significant concern.

24

A great deal of research is needed

You saw that coming, didn't you?

This is an area of active research, and compared to what we need to know, very little has yet been discovered.

In the meantime, various multimodal approaches are the best we can do regarding preventing or ameliorating postoperative changes in cognition.

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Colorado Review of Anesthesia for Subscriptions And Hospitals
Guiding the future of patient care

Thank You!

References by following the link:

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Ambulatory Anesthesia: What Do You Need to Know?

Kim Strupp, MD
Alison Brainard, MD
Kyle Marshall, MD

Anesthesiology
University of Colorado Anschutz Medical Campus

1

Disclosures

- The presenters have no conflicts of interest to disclose

2

Objectives

- Discuss the required components of a preoperative evaluation for patients undergoing ambulatory surgery, including special considerations for patients with obesity, obstructive sleep apnea, and advanced age.
- Define screening criteria for patients presenting for ambulatory surgery.
- Identify patients who may benefit from prehabilitation prior to ambulatory surgery.
- Analyze the differences between prehabilitation and medical optimization in patients undergoing ambulatory surgery.
- Describe the critical components of the pathway for effective ambulatory anesthetic management.

3

History

Reed and Ford opened first free-standing ASC in 1970 in Phoenix, AZ
Strict patient selection (ASA I or II)
Low surgical acuity
Procedures < 1 hour
53 million ambulatory surgeries in the US in 2009 (CDC data)
More than 66% of all surgeries performed (American Hospital Association 2014)

https://www.ascassociation.org/50yearsofascs/home

4

Defining Risk

- Goal: predictable cases with defined risk
- Estimated mortality 1:50,000 to 1:100,000
- Serious complications < 1%
- Patient satisfaction
- Surrogate markers (admission/readmission)
  - Admission rate 1%

Keyes 2004, Keyes 2008, Mathis 2013, Walsh 2018

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Morbidity/Mortality

- NSQIP data 2005-2010
- 244,397 surgeries
- 232 (0.1%) cases experienced early perioperative morbidity or mortality

Mathis 2013

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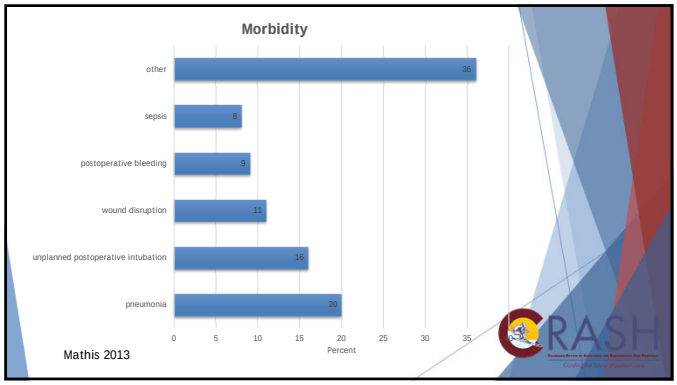
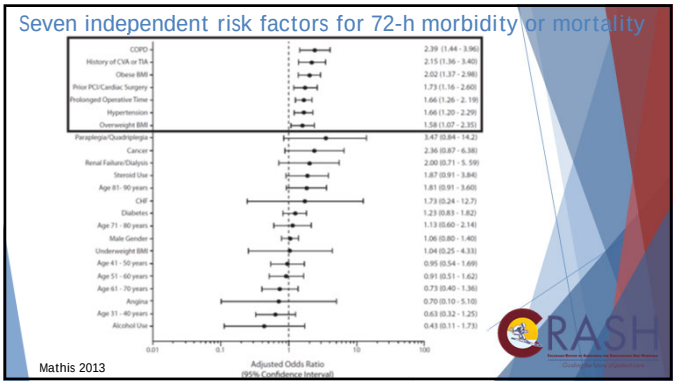

Morbidity
other
sepsis
postoperative bleeding
wound disruption
unplanned postoperative intubation
pneumonia
36
8
9
11
16
20
0
5
10
15
20
25
30
35
Percent
Mathis 2013

7


Seven independent risk factors for 72-h morbidity or mortality
Mathis 2013
Adjusted Odds Ratio
(95% Confidence Interval)

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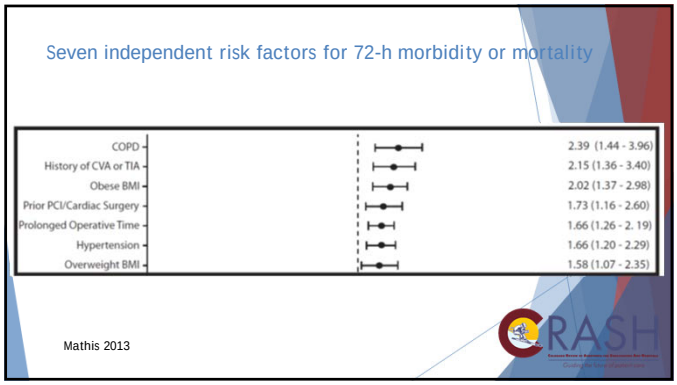
Seven independent risk factors for 72-h morbidity or mortality
COPD 2.39 (1.44 - 3.96)
History of CVA or TIA 2.15 (1.36 - 3.40)
Obese BMI 2.02 (1.37 - 2.98)
Prior PCI/Cardiac Surgery 1.73 (1.16 - 2.60)
Prolonged Operative Time 1.66 (1.26 - 2. 19)
Hypertension 1.66 (1.20 - 2.29)
Overweight BMI 1.58 (1.07 - 2.35)
Mathis 2013

9


Admission / Readmission
400 patients out of 20,657
200 required admission, 200 controls
Multiple logistic regression analysis
Length of surgery > 1 h
ASA III or IV
Age >80
BMI 30-35
Whippey 2013

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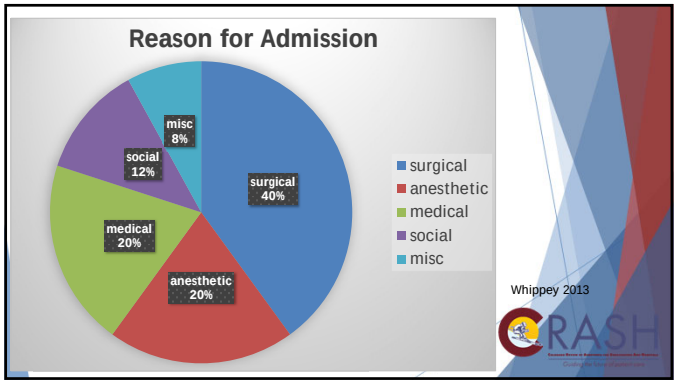

Reason for Admission
misc 8%
social 12%
surgical 40%
medical 20%
anesthetic 20%
surgical
anesthetic
medical
social
misc
Whippey 2013

11

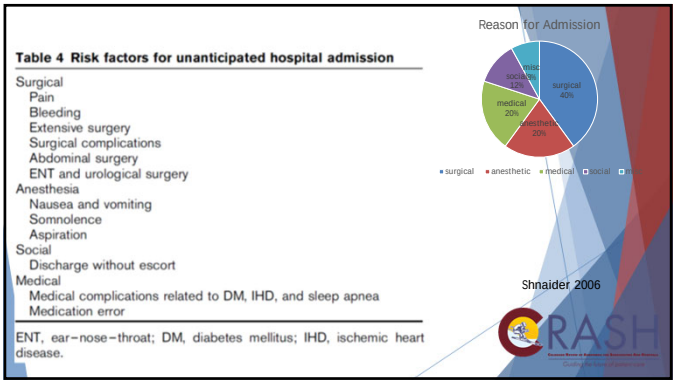
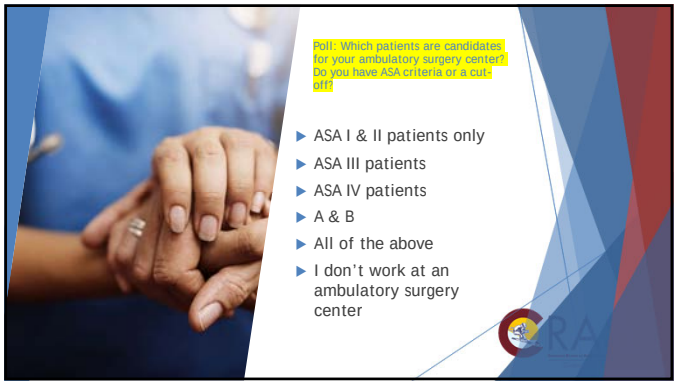


Table 4 Risk factors for unanticipated hospital admission
Surgical
Pain
Bleeding
Extensive surgery
Surgical complications
Abdominal surgery
ENT and urological surgery
Anesthesia
Nausea and vomiting
Somnolence
Aspiration
Social
Discharge without escort
Medical
Medical complications related to DM, IHD, and sleep apnea
Medication error
ENT, ear–nose–throat; DM, diabetes mellitus; IHD, ischemic heart disease.
Reason for Admission
surgical 40%
anesthetic 20%
medical 20%
social 12%
misc
Shnaider 2006

12



Poll: Which patients are candidates for your ambulatory surgery center? Do you have ASA criteria or a cut-off?

- ASA I & II patients only
- ASA III patients
- ASA IV patients
- A & B
- All of the above
- I don't work at an ambulatory surgery center

13

ASA Physical Status

ASA III patients commonplace

- European multicenter study 57,709 procedures (ASA I, II & III)
- Major complications were low
- No deaths definitively related to surgery

ASA IV patients starting

- Well equipped ASCs
- Low acuity procedures
- Local anesthesia with minimal sedation
- Higher rate of block failure
- Unplanned admission 7%

Majholm 2012, Walsh 2018

14

Age/frailty

- Variability with data
  - Increased mortality > 85 (Fleisher 2004)
  - Increased admission > 65 (De Oliveira 2015)
  - Pulmonary complications > 70 (De Oliveira 2017)
- Physiologic age vs chronologic age
  - Functionality matters
- Frailty = decreased physiologic reserves
  - 10-20% > 65
  - 40% > 80

Walsh 2018

15

Frailty Score
Age
Cancer diagnosis
Weight loss
Renal failure
Congestive heart failure
Shortness of breath
Cognitive deterioration
Functional status

Frailty and NSQiP

- **Shah 2018**
- 1 million patients assigned frailty score
- Complications: low scores (3.2%) versus high scores (36.4%)
- Higher failure to rescue

- **Seib 2018**
- 140,000 patients
- Overall complication rate of 1.7%
- Increased risk for intermediate (OR=2.0) and high (OR=3.95) frailty groups

16

Pre-Op Screening

Comorbidities	Surgery recommendation
Severe, unstable comorbidities that cannot be optimized further	No elective surgery Urgent surgery performed inpatient
Severe comorbidities likely to become unstable perioperatively	Elective surgery inpatient
Moderate to severe comorbidities that can be optimized	Optimize then outpatient
Mild, moderate or severe optimized comorbidities	Outpatient

Rajan 2020

17

Pre-op testing

- Only indicated if patient would need the test even if not having surgery
- Increases costs and delays
- Does not increase adverse outcomes in ASA I & II patients

Rajan 2020

18

Prehabilitation – an ounce of prevention is worth a pound of cure

- Goals: improve preoperative functional capabilities
  - nutritional status, physical activity levels, and mental state
- Nutritional supplementation
- Exercise programs
- Targeted activities to improve cognitive function
- Smoking cessation
- Stress-reduction strategies

Rajan 2020

19

Prehabilitation – Outcomes/Benefits

Clear expectation setting

Encourages patient participation and engagement in their recovery

Reduces anxiety

Increases patient satisfaction

Rajan 2020

20

Optimization of comorbidities

- Should start when surgery is **scheduled**
- Goal: avoid delays/cancellations & improve outcomes
- 3 categories of opportunity:
  - Shared (collaborative) decision-making
  - Comorbidity management
  - Collaborative behavioral change

Rajan 2020

21

Pre-op phone call

- 1-2 days before
- NPO instructions
- Arrival time
- Medication instructions
- What to bring: CPAP, home meds, ambulation assist devices, hearing aids, glasses

22

What BMI cut off do you use in your ambulatory practice?

- < 40
- < 50
- Other
- No cut off
- I do not provide ambulatory care

23

Obesity

- Complications increase significantly BMI > 50 → inpatient (Joshi 2013)
- BMI alone (<50) poor predictor of periop risk
- BMI > 40 strong association with OSA → periop risk (Grewal 2019)
- CV (cardiomyopathy), Respiratory (OSA), endocrine (DM)

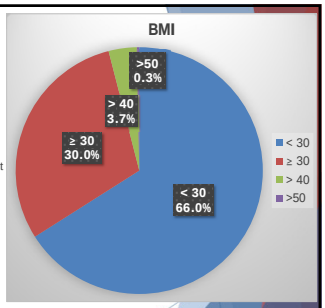
- Functional capacity, full H&P
- EKG for limited functional capacity plus 1 risk factor (hx heart disease, hx CHF, hx CVD, periop insulin, Cr >2)
  - LBBB, right heart hypertrophy

Walsh 2019, Grewal 2019

24

Outpatient Cancer Study

- 13,957 patients, 2016-2018
- Higher BMI → higher rate of transfer (p=0.014)
  - Mean risk 0.8% for BMI 25 vs 1.3% for BMI 40
  - 111 patients with BMI 40 would need to be treated at the main hospital to prevent one transfer
- No association (p=0.7 for all)
  - Urgent care visits or readmissions within 30 days
  - Outpatient LOS
- Operative time for outpatient procedures (p= <0.0001)
  - 59 vs 63 min for BMI 25 vs 40



Vertosick 2019

25

OSA

- Risk associated with postoperative respiratory events and need for postoperative narcotics
- Risk prolonged PACU stay
- STOP-BANG screening tool validated
  - No need to delay surgery for sleep study
- Need CPAP available

Walsh 2019

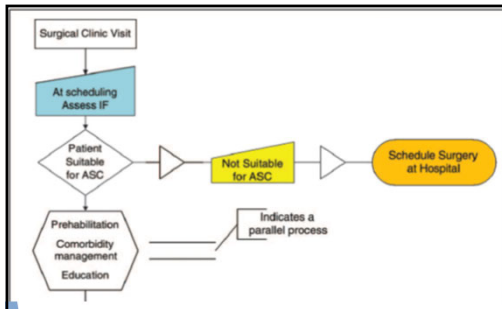
26

OSA/Obesity

- Benzodiazepines with caution due to respiratory depression
- Hypoxic events during procedural sedation with propofol→careful titration
- Ketamine (does not decrease upper airway muscle activity)
- REGIONAL ANESTHESIA

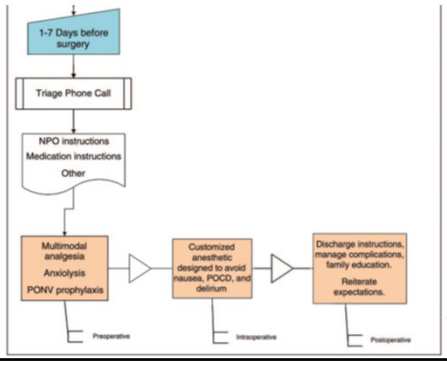
Walsh 2019

27



Rajan 2020

28



Rajan 2020

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- Images courtesy of Pixabay: https://pixabay.com/

31

Freestanding ASC's and COVID

Alison Brainard MD
Associate Professor
Director Cherry Creek North Ambulatory Surgery Center

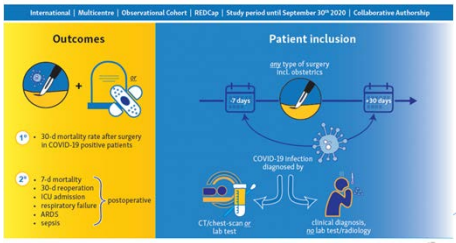
No financial disclosures, though Dr. Angela Selzer gave me 7 of the slides in this talk ☺

1

Timing of Surgery with COVID infection

CovidSurg – Study Protocol

Outcomes of Surgery in COVID-19 infection: international cohort study



2

Timing of Surgery with COVID infection

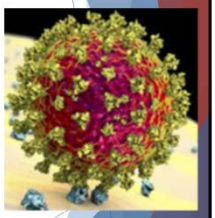
Anaesthesia 2021, 76, 748-758 doi:10.1111/anae.15458

Original Article

Timing of surgery following SARS-CoV-2 infection: an international prospective cohort study

COVIDSurg Collaborative* and **GlobalSurg Collaborative***

NIHR Global Health Research Unit on Global Surgery, Birmingham, UK



- 140,231 Patients from 116 countries
- Primary Outcome, 30-day mortality

3

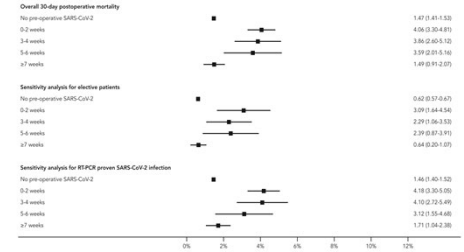
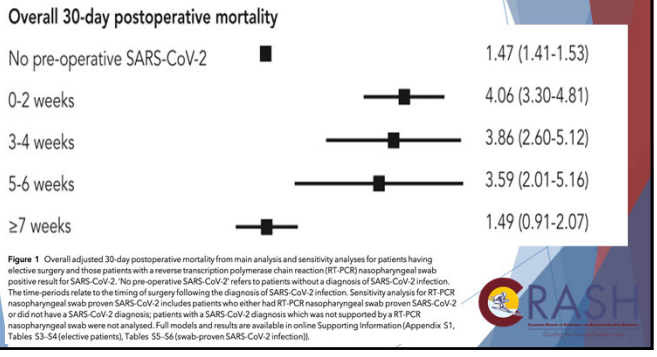


Figure 1 Overall adjusted 30-day postoperative mortality from main analysis and sensitivity analyses for patients having elective surgery and those patients with a reverse transcription polymerase chain reaction (RT-PCR) nasopharyngeal swab positive result for SARS-CoV-2. 'No pre-operative SARS-CoV-2' refers to patients without a diagnosis of SARS-CoV-2 infection. The time-periods relate to the timing of surgery following the diagnosis of SARS-CoV-2 infection. Sensitivity analysis for RT-PCR nasopharyngeal swab proven SARS-CoV-2 includes patients who either had RT-PCR nasopharyngeal swab proven SARS-CoV-2 or did not have a SARS-CoV-2 diagnosis; patients with a SARS-CoV-2 diagnosis which was not supported by a RT-PCR nasopharyngeal swab were not analysed. Full models and results are available in online Supporting Information (Appendix S1, Tables S3–S4 (elective patients), Tables S5–S6 (swab-proven SARS-CoV-2 infection)).

4



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5

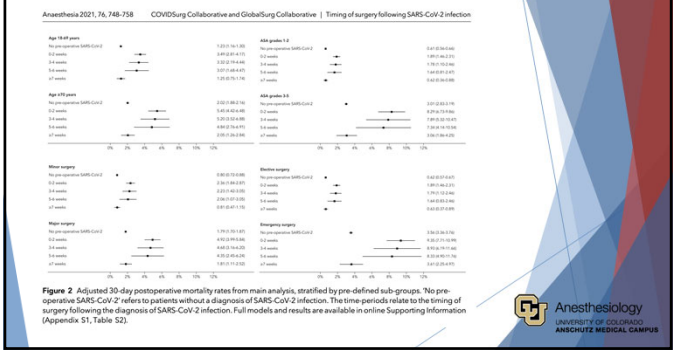

Figure 2 Adjusted 30-day postoperative mortality rates from main analysis, stratified by pre-defined sub-groups. 'No pre-operative SARS-CoV-2' refers to patients without a diagnosis of SARS-CoV-2 infection. The time-periods relate to the timing of surgery following the diagnosis of SARS-CoV-2 infection. Full models and results are available in online Supporting Information (Appendix S1, Table S2).

6

Timing of Surgery with COVID infection

- Conclusions of COVIDSurg Trial:
  - Asymptomatic COVID infections confer a higher mortality rate for 7 weeks after infection
  - Patients with continued symptoms after 7 weeks have an increased mortality rate
- Data were collected until Oct, 2020:
  - Unvaccinated patients
  - Predominantly Alpha, with Beta and Delta variants
- COVID Surg 3 trial: collecting data Feb, 2022
  - More vaccinated patients
  - Predominantly Omicron variant

"Decisions should be tailored for each patient since the possible advantages of delaying surgery for at least 7 weeks following SARS-COV-2 diagnosis must be balanced against the potential risks of delay"

Anesthesiology
UNIVERSITY OF COLORADO
ANSCHUTZ MEDICAL CAMPUS

7

Our current practice…

Why did the hipster refuse to undergo surgery?

The anesthesi… local.

YELLOWJOKES.

Patient- Can I use anesthesia on myself ?

Doctor- Sure, knock yourself out !

CRASH

8

uchealth

Scheduling Surgery in Patients with Prior COVID-19 Infection: Timing, Preoperative Testing & Assessment Guidelines[1]

COVID-19 HISTORY		Tier 0	Tier 1 Procedure Delay[2]	Tier 2/3 Procedures Delay[3]	PPS or PCP CONSULT[4]	Other Notes & Laboratory Testing Guidelines[5]
COVID (+) test (within the last 6 months)	Asymptomatic	Proceed with surgery under COVID-19 precautions	Four (4) WEEKS	Four (4) WEEKS	If PMH Indicates[5]	Consider: CBC, EKG[7]
	Mild Symptoms (loss of taste, fatigue, headache)		Four (4) WEEKS & symptom resolution	Four (4) WEEKS & symptom resolution	If PMH Indicates[5]	Preop CBC Consider: EKG[5]
	Moderate Symptoms (cough, dyspnea, without hospitalization)		Six (6) WEEKS & symptom resolution	Six (6) WEEKS & symptom resolution	YES[6]	Preop CBC & EKG Consider: CXR, D-Dimer[7]
	Severe Symptoms (requiring hospitalization)		Eight (8) WEEKS & symptom resolution	Eight (8) WEEKS & symptom resolution	YES[6]	Preop CBC, EKG, CXR Consider: D-Dimer & echocardiogram[7]
	Critical Symptoms (requiring ICU admission)		Twelve (12) WEEKS & symptom resolution	Twelve (12) WEEKS & symptom resolution	YES[6]	Preop CBC, EKG, CXR, Echocardiogram Consider: D-Dimer[7]
No Known History or COVID (+) test > 6 months prior			No Delay	No Delay	If PMH Indicates[5]	PCR Testing performed regardless of vaccination status

9

November 3, 2021

Angela Selzer, MD
Associate Professor
Department of Anesthesiology
University of Colorado
Medical Director | Pre-Procedure Services Clinic

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CRASH

10

UCHealth COVID guidelines (for now)

1. Guidelines in this table apply only to immunocompetent patients. In immunocompromised patients, consult Infectious Disease for recommendations for testing and surgical delay.
2. Obtain within 3-5 days of scheduled surgery. Only obtain a PCR test. Arrange testing at a UCHealth facility whenever possible
3. Following first positive (+) COVID test. These are minimum delays. More time may be necessary based on severity of symptoms and recovery from illness.
4. Refer to PPS as per table. For patients ineligible for a PPS appointment (out of state, e.g.) obtain evaluation by PCP to assess recovery from COVID and optimization for elective surgery.
5. Labs to be determined during preoperative assessment based on history, review of symptoms and physical exam.
6. Refer these patients to PPS according to medical history (For example, patients with complex medical histories, including cardiopulmonary disease and/or on anticoagulants).
7. Refer all patients with history of moderate, severe or critical symptoms to PPS for evaluation, regardless of other medical history. Place an MD required referral.

CRASH

11

CRASH

12

13

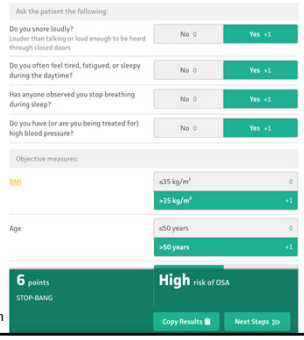
14

Would you do this case at a freestanding ASC….?

- 24 year old F presenting for tracheal dilation
  - PMHx: Idiopathic Tracheal Stenosis, RAD
- 46 year old M presenting for creation of AV fistula
  - PMHx: CRF on dialysis, IDDM, Obesity (BMI 40), OSA
- 31 year old F presenting for hysteroscopy
  - PMHx: RAD, Obesity (BMI 45)
- 19 year old F presenting for ORIF distal radius
  - PMHx: 18 weeks pregnant, otherwise healthy
- 78 year old M presenting for green light laser of prostate
  - Obesity (BMI 36), NIDDM, HTN, STOP-BANG score 6

15

STOP-BANG



www.MdCalc.com

16

STOP-Bang = Snoring, Tiredness, Observed apnea, High BP, BMI, Age, Neck circumference, and Male gender

STOP-Bang Score	Any OSA (AHI > 5)	Moderate/Severe OSA (AHI > 15)	Severe OSA (AHI > 30)
0-2	0.46 (0.39-0.53)	0.18 (0.13-0.24)	0.04 (0.02-0.08)
3	0.72 (0.65-0.78)	0.36 (0.29-0.43)	0.13 (0.09-0.19)
4	0.73 (0.66-0.79)	0.42 (0.34-0.49)	0.18 (0.13-0.25)
5	0.77 (0.69-0.84)	0.50 (0.42-0.59)	0.30 (0.23-0.39)
6	0.79 (0.68-0.87)	0.57 (0.45-0.69)	0.32 (0.22-0.44)
7 and 8	0.86 (0.72-0.93)	0.60 (0.44-0.73)	0.38 (0.29-0.53)

Data are given as probability (95% CI).

Frances Chung, Hairil R. Abdullah, Pu Liao, STOP-Bang Questionnaire: A Practical Approach to Screen for Obstructive Sleep Apnea, Chest, Volume 149, Issue 3, 2016, Pages 631-638,

17

Same Day Cancellation Policy

- **General:**
- Unstable vital Signs:
  - Symptomatic hypotension
  - Hypertensive crisis symptoms
  - BP > 220/110
  - O2 saturation less than 89%
- History of serious complications from anesthesia
- Personal/family history of MH
- Known Pregnancy
- DNR status that is not revoked for ENTIRE perioperative period (until patient is in their car)
- Emergent procedure
- Greater than 400 lbs
- BMI greater than 44
- Patients must be at least 12 years old AND > 40 kg
- ASA Status is NOT an exclusion criteria

18

- **Cardiac:**
  - Active chest pain
  - New onset arrythmia
  - New onset syncopal episodes
  - MI within last 6 months
  - Uncompensated or severe CHF
  - Critical Aortic Stenosis
  - DVT within last 3 months
  - PE within last 6 months
  - Implanted AICD
  - Pacemaker Dependent (>40% paced), surgery above umbilicus, and unable to place magnet
  - Severe Pulmonary HTN
  - Cardiac Stents with ASA therapy where surgeon wants ASA discontinued for procedure
  - Bare Metal stents placed less than 6 weeks ago
  - Angioplasty done less than 6 weeks ago

19

- **Pulmonary:**
  - Pneumonia less than 6 weeks from start of antibiotics
  - Known difficult airway
  - Tracheostomy in place without ENT surgeon operating
  - Patients with tracheal stenosis/tracheomalacia or other vocal cord dysfunction w/o ENT surgeon
- **Endocrine:**
  - Uncontrolled or "brittle" diabetics (Hgb A1C > 12)
  - Blood sugar preoperatively >300
  - Significant electrolyte abnormalities
- **Neurology:**
  - Active untreated seizure disorder
  - History of TIA/CVA within 9 months
  - Symptomatic or severe carotid stenosis

20

- **Renal:**
  - Skipping dialysis for surgery
- **Social:**
  - Patients MUST have a responsible caregiver/ride to and from CCN unless local only case
  - Acute Intoxication (alcohol or marijuana)
  - Active substance abuse (illicit drugs)
- **Mobility:**
  - Requires a Hoyer lift
- **Type of Procedure:**
  - Any procedure where there is an increased likelihood of blood transfusion
  - Need of invasive monitoring (arterial line)
  - Any patient requiring factor administration prior to surgery
- **Infectious Disease:**
  - COVID or other pandemic – follow current documents/guidelines

21

Ambulatory Total Joints

Kyle Marshall, MD
Associate Professor
University of Colorado

1

Same-Day Discharge Total Joints

2

Same-Day Discharge Hips/Knees

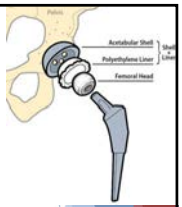
- It's coming to all…
  - Changes in Reimbursement
- It can be done safely
- Cost savings
- Beds can be used for something else…
  - Like COVID patients!

3

COVID-19 Update: Orthopods Suspend Bro Hugs for 60 Days

4

Same-Day Discharge Total Joints



- Perhaps you're thinking:
- Wait!? This isn't new!!
  - Correct!
  - Ambulatory THA/TKA have been around for years
    - Healthier patients
    - Orthopedic specialty hospitals
      - Strict criteria for eligibility

5

Same-Day Discharge Total Joints

- Healthy patients only?
  - Nope!
- How can it work for patients that would have been admitted in the past?
  - Patient education/preparation
  - Compliance with best-practices
  - Multi-disciplinary collaborative effort

6

Stakeholders

- Orthopedic Surgery
- Anesthesiology
- Pharmacy
- Physical & Occ Therapy/Rehab
- Pre/Intra/Post-op Nursing staff
- Pre/Post Clinic staff
- Social Work/Home Healthcare
- Internal Medicine

7

Lets break this down… *for Anesthesiology*

- Pre-operative
- Intra-operative
- Post-operative

8

Pre-operative - Anesthesiology

- **Pre-Hospital/Surgi-center**:
- Determine exclusion criteria
- Schedule these cases early in the Day!

- If we don't evaluate and clear the patients…
  - THEY WILL
  - All of us know what that means…

9

Pre-Operative – Anesthesiology

- **Day of Surgery**:

- Multimodal management starts in Pre-op!
  - Acetaminophen 1000mg
  - Meloxicam vs. Celecoxib
  - Adductor Canal for TKA – 20mL 0.5% Ropi or Bupi
  - Avoid opioids, gabapentinoids
  - Minimize/Avoid benzodiazepines

10

Intra-Operative - Anesthesiology

- Primary Anesthetic –

- **Spinal vs. General**
  - The age-old argument

11

Intra-operative - Primary Anesthetic SPINAL

- **PRO**
  - Opioid sparing
  - Nice wake-up
  - Less PONV
  - Less delirium
  - Less airway manipulation
- **CON**
  - Anticoagulation issues
  - Urinary retention
  - Obesity + Arthritis
  - Provider Dependent

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Intra-operative – Primary Anesthetic GENERAL

- PRO
  - Anticoagulation?!
    - Who cares!
  - Less provider dependent
  - Less surgeon dependent
  - No mid-case conversion
- CON
  - More PONV
  - More pain
  - More opioids
  - More delirium
  - Urinary retention

13

Spinal – Meds?

- **SHORT ACTING!**
- Mepivacaine 1.5% - administer ~3mL intrathecal @L2/3
  - 2-3hrs duration
  - Quick onset, surgical team ready to position/prep
- Avoid opioids – reduce urinary retention, PONV
- Avoid epinephrine!
  - We do straight local anesthetic
  - Our surgeons are predictable

14

Intra-Operative

SPINAL
- Propofol gtt
- Phenylephrine PRN
- Anti-emetics
- Light fluid ~1L
- No Foley

GENERAL
- Gas/TIVA/Mix
- Multimodal analgesia!
  - Ketamine – low dose
  - Fentanyl PRN – Avoid long actors
- Phenylephrine PRN
- Anti-emetics
- Light Fluid ~1L
- No Foley

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Post-operative - Anesthesiology

- Good news! We're mostly done…
- Oral pain meds > IV pain meds
- Ketorolac 15mg x1 (yes, on top of Meloxicam)
- If IV – stick to Fentanyl, avoid long actors
  - If you must, be judicious with dosing
- Anti-emetics

16

CRASH
Guiding the future of patient care

Breaking News: Orthopedic Surgeon Completes 1000th Surgery with EBL of 50 cc

17

References:

- Basques Bruce A., et al. Same-Day Discharge Compared with Inpatient Hospitalization Following Hip and Knee Arthroplasty, The Journal of Bone and Joint Surgery: December 06, 2017 - Volume 99 - Issue 23 - p 1969-1977.
- Nelson, Stephen J., et al. Is Outpatient Total Hip Arthroplasty Safe? The Journal of Arthroplasty: Volume 32, Issue 5, 2017, Pages 1439-1442.
- Hamilton, William G., et al. Protocol Development for Outpatient Total Joint Arthroplasty. J Arthroplasty. 2019 Jul;34(7S):S46-S47. doi: 10.1016/j.arth.2018.12.043. Epub 2019 Jan 7.
- Lombardi Jr, Adolph V., et al. "Outpatient Arthroplasty is Here Now." *Instructional Course Lectures* 65 (2016): 531-546.
- Gomerblog.com

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Wednesday, March 2nd

Pearls for Practice: Optimizing Patients for the OR

Angela Selzer, MD
Associate Professor of Anesthesiology
Medical Director of Pre-Procedure Services
University of Colorado

1

Disclosures

- I have no financial disclosures

2

Pearls for Practice: Optimizing Patients for the OR

- Why optimization matters
- Basics of a preop eval
- Beyond the basics: What's new in periop
  - Functional Status Assessment
  - Anemia Prehab
  - Glycemic Control
  - Penicillin Allergy Testing

QR Code with References & Resources

3

Making the Argument for Optimizati

- Decreased surgical delays and cancellat
- Decreased perioperative mo
- Reduction in exc
- Reduction
- Increased Pa
- Increased reg
- Improving info
- Improved patien
- Improved compli
- Implementing care isciplinary context

4

Basics of the

- A basic preoperati include:
  - List of current medical p
  - ROS
  - List of current medicatio
  - List of allergies and reac
  - Physical exam with vital
  - Necessary lab testing
  - A comment on whether r
  - Assessment of risk for sd
  - Results of any prior testi testing

IM JUST SAYIN' YOU COULD DO BETTER

5

IM JUST SAYIN'
WE COULD ALL DO
BETTER

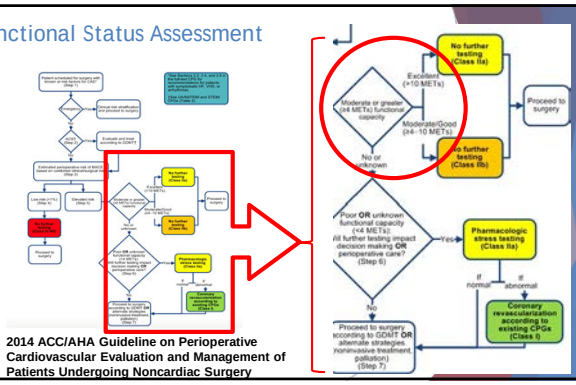
6

New Frontiers of Perioperative Medicine

- Functional Status Assessment
- Anemia Prehabilitation
- Diabetes Management
- Penicillin Allergy Testing

7

Functional Status Assessment



2014 ACC/AHA Guideline on Perioperative Cardiovascular Evaluation and Management of Patients Undergoing Noncardiac Surgery

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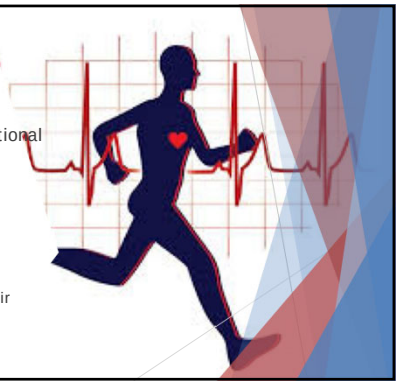
Functional Status Assessment



- Methods of assessing functional status
  - Ask questions
  - DASI survey
  - 6 minute walk test
  - Cardiopulmonary testing
- In General:
  - Patients OVERESTIMATE their function
  - Physicians UNDERESTIMATE function

9

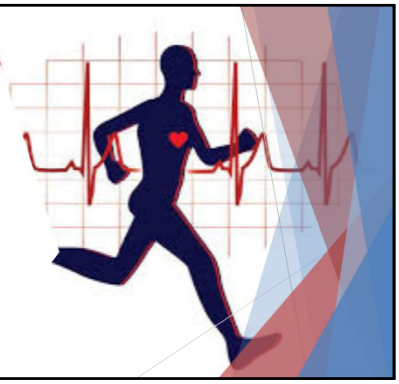
Functional Status Assessment

- Question:

How do you normally assess functional status in your patients?

10

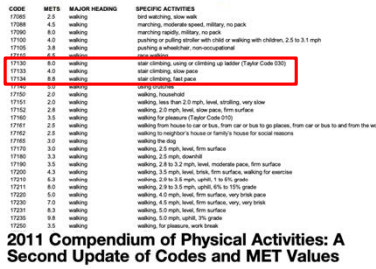
Functional Status Assessment



- Can you walk up two flights of stairs without chest pain or shortness of breath?
- Can you walk two city blocks without chest pain or shortness of breath?

11

Compendium of Physical Activities



CODE	METS	MAJOR HEADING	SPECIFIC ACTIVITIES
17065	2.5	walking	bird watching, slow walk
17068	4.5	walking	marching, moderate speed, military, no pack
17090	8.0	walking	marching rapidly, military, no pack
17100	4.0	walking	pushing or pulling stroller with child or walking with children, 2.5 to 3.1 mph
17105	3.8	walking	pushing a wheelchair, non-occupational
17130	8.0	walking	stair climbing, using or climbing up ladder (Taylor Code 030)
17133	4.0	walking	stair climbing, slow pace
17134	8.8	walking	stair climbing, fast pace
17140	9.0	walking	using crutches
17150	2.0	walking	walking, household
17151	2.0	walking	walking, less than 2.0 mph, level, strolling, very slow
17152	2.8	walking	walking, 2.0 mph, level, slow pace, firm surface
17160	3.5	walking	walking for pleasure (Taylor Code 010)
17161	2.5	walking	walking from house to car or bus, from car or bus to go places, from car or bus to and from the worksite
17162	2.5	walking	walking to neighbor's house or family's house for social reasons
17165	3.0	walking	walking the dog
17170	3.0	walking	walking, 2.5 mph, level, firm surface
17180	3.3	walking	walking, 2.5 mph, downhill
17190	3.5	walking	walking, 2.8 to 3.2 mph, level, moderate pace, firm surface
17200	4.3	walking	walking, 3.5 mph, level, brisk, firm surface, walking for exercise
17210	6.3	walking	walking, 2.9 to 3.5 mph, uphill, 1 to 6% grade
17211	8.0	walking	walking, 2.9 to 3.5 mph, uphill, 6% to 15% grade
17220	5.0	walking	walking, 4.0 mph, level, firm surface, very brisk pace
17230	7.0	walking	walking, 4.5 mph, level, firm surface, very, very brisk
17231	8.3	walking	walking, 5.0 mph, level, firm surface
17235	9.8	walking	walking, 5.0 mph, uphill, 3% grade
17250	3.5	walking	walking, for pleasure, work break

2011 Compendium of Physical Activities: A Second Update of Codes and MET Values

BARBARA E. AINSWORTH[1,2], WILLIAM L. HASKELL[3], STEPHEN D. HERRMANN[1,2], NATHANAEL MECKES[1,2], DAVID R. BASSETT JR.[4], CATRINE TUDOR-LOCKE[5], JENNIFER L. GREER[1,2], JESSE VEZINA[1,2], MELICIA C. WHITT-GLOVER[6], and ARTHUR S. LEON[7]

- Measured participant energy expenditure (VO2)
- Divides VO2 by 3.5mL/kg/min to calculate Standard METS

https://links.lww.com/MSS/A82

12

Measured METs vs Standard METs

- Measured METs: Used calorimeters and accelerometers to measure actual energy expenditure for standardized activities
- Concluded that standard MET values:
  - Generally, underestimate actual energy expenditure.
  - Especially in:
    - Women
    - Older ages
    - Overweight individuals

Medicine & Science in Sports & Exercise, September 2010

Accelerometer Output and MET Values of Common Physical Activities

	N	Measured METs Mean	SD	95% CI	Compendium MET Value
Ascend stairs	215	10.3*	1.89	10.00, 10.51	5
Shooting baskets	39	9.3*	1.96	8.70, 9.93	4.5
Moving a box	271	5.0*	1.05	4.88, 5.13	4
Descending stairs	231	4.4*	1.03	4.28, 4.54	3
Washing dishes	42	3.1	0.40	2.01, 2.26	2.3
Dusting	39	2.8*	0.66	2.62, 3.04	2.5
Gardening	38	4.0*	1.25	3.59, 4.39	4.5
2.23 m·s⁻¹, 2% grade	189	10.4	1.49	10.14, 10.56	N/A
1.56 m·s⁻¹, 2% grade	266	6.7*	0.94	6.07, 6.29	6
1.34 m·s⁻¹, 2% grade	268	5.2	0.79	5.11, 5.30	N/A
Folding laundry	39	2.4*	0.30	2.32, 2.51	2
2.23 m·s⁻¹, 0% grade	227	9.3*	1.36	9.03, 9.38	8
1.56 m·s⁻¹, 0% grade	267	5.0*	0.83	4.92, 5.12	3.8
1.34 m·s⁻¹, 0% grade	270	4.2*	0.69	4.13, 4.30	3.3
Mopping	38	3.9*	0.77	3.67, 4.16	3.5
Mowing	37	5.8	1.36	5.42, 6.29	5.5
Painting	38	3.3*	0.85	3.03, 3.58	4.5
Raking	39	4.7*	1.35	4.26, 5.11	4
Organizing a room	37	5.2*	1.11	4.87, 5.58	3
Sweeping	40	3.4	0.71	3.17, 3.61	3.3
Tennis	39	9.5*	1.61	9.04, 10.06	7
Trimming lawn	38	3.6	0.78	3.34, 3.83	3.5
Vacuuming	38	3.5	0.66	3.28, 3.70	3.5

Measured METs (measured VO_2/measured RMR).
* If the compendium MET value is outside the 95% confidence interval (CI) for the measured MET, the values are considered statistically different at $\alpha = 0.05$.
n = number of participants that completed that activity.
Measured MET values for study activities compared with the MET values from the compendium of physical activities.

13

Duke Activity Score Index

A Brief Self-Administered Questionnaire to Determine Functional Capacity (The Duke Activity Status Index)

Mark A. Hlatky, MD, Robin E. Boineau, MA, Michael B. Higginbotham, MB, Kerry L. Lee, PhD, Daniel B. Mark, MD, MPH, Robert M. Califf, MD, Frederick R. Cobb, MD, and David B. Pryor, MD

TABLE I The Duke Activity Status Index

Activity	Weight
Can You . . .	
1. take care of yourself, that is, eating, dressing, bathing or using the toilet?	2.75
2. walk indoors, such as around your house?	1.75
3. walk a block or 2 on level ground?	2.75
4. climb a flight of stairs or walk up a hill?	5.50
5. run a short distance?	8.00
6. do light work around the house like dusting or washing dishes?	2.70
7. do moderate work around the house like vacuuming, sweeping floors, or carrying in groceries?	3.50
8. do heavy work around the house like scrubbing floors, or lifting or moving heavy furniture?	8.00
9. do yardwork like raking leaves, weeding or pushing a power mower?	4.50
10. have sexual relations?	5.25
11. participate in moderate recreational activities like golf, bowling, dancing, doubles tennis, or throwing a baseball or football?	6.00
12. participate in strenuous sports like swimming, singles tennis, football, basketball or skiing?	7.50

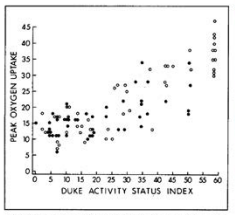


FIGURE 1. The Duke Activity Score (*horizontal axis*) is plotted against the peak oxygen uptake in ml/min (*vertical axis*) in the patients in the development sample (*open symbols*) and validation sample (*closed symbols*).

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Duke Activity Score Index

Table 3 Adjusted association of DASI score and other clinical risk factors with 30-day postoperative death or myocardial injury. Model was fit using 1417 observations with complete data. The multivariable regression model had a c-index of 0.66 and Hosmer–Lemeshow goodness-of-fit statistic P-value of 0.12. Revised Cardiac Risk Index scores were calculated using a modified definition of diabetes mellitus (i.e. any known diagnosis vs requirement for insulin). CI, confidence interval; DASI, Duke Activity Status Index; NT pro-BNP, N-terminal pro-B-type natriuretic peptide.

Preoperative risk factor	Odds ratio (95% CI) for 30-day death or myocardial injury	P-value
DASI score		
Expressed as transformed continuous variable		
Per 1 point increase above 34 points	0.97 (0.96–0.99)	0.002
Those not extrapolated from transformed variable		
≥34 points	1.97 (1.28–3.04)	
35 points	1.92 (1.26–2.90)	
40 points	1.67 (1.20–2.31)	
45 points	1.44 (1.14–1.81)	
50 points	1.26 (1.09–1.46)	
55 points	1.09 (1.03–1.16)	
58.2 points (maximum score)	Reference	
Revised Cardiac Risk Index		
Class 1	Reference	
Class 2	1.08 (0.74–1.59)	
Class 3	1.65 (1.02–2.68)	
Class 4	2.05 (0.97–4.35)	
Preoperative NT pro-BNP concentration <300 ng·L⁻¹	Reference	
≥300 ng·L⁻¹	2.43 (1.60–3.69)	

Integration of the Duke Activity Status Index into preoperative risk evaluation: a multicentre prospective cohort study

Duminda N. Wijeysundera[1,2,3,4,5,*], W. Scott Beattie[1,3], Graham S. Hillis[6,7], Tom E. F. Abbott[8,9], Mark A. Shulman[10,11], Gareth L. Ackland[8,9], C. David Mazer[1,3,5], Paul S. Myles[12,13], Rupert M. Pearse[8], Brian H. Cuthbertson[14,15] on behalf of the Measurement of Exercise Tolerance before Surgery Study Investigators

15

6 Minute Walk Test

- 6 minute walk test (6MWT)
  - Self paced
  - Easily accomplished
  - No special equipment
  - Variability in testing
  - Need designated area
  - Takes 6 minutes!
  - Weakly correlated with outcomes (DASI is better)

https://cpcclinicalresearch.org/six-minute-walk-test/

16

Using Devices to Assess Function

Perioperative Medicine
ORIGINAL CLINICAL RESEARCH REPORT

Development and Pilot Study of an iOS Smartphone Application for Perioperative Functional Capacity Assessment

Daniel S. Rubin, MD, MS,* Allison Dalton, MD,* Allyson Tank, BS,† Mark Berkowitz, BS,‡ David E. Arnolds, MD, PhD,* Chuanhong Liao, MS,§ and Rebecca M. Gerlach, MD, FRCPC*

A&A: September 2020 • Volume 131 • Number 3

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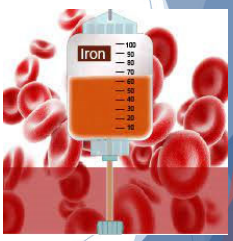
Functional Status: PEARLS

- Consider asking different questions to assess status
- Female, older and overweight patients expend more energy with less activity
- The DASI index is a great tool to guide testing in questionable patient
  - A DASI score less than 34 having moderate to high-risk surgery may benefit from pharmacologic stress testing
- Wearables and phones can provide more information on activity
- *Prehab through function tracking apps will be the next frontier*

18

Anemia Prehabilitation

- Anemia effects 25-75% of elective surgical patients
- Anemia is an independent risk factor for perioperative:
  - Morbidity & mortality
  - MACE
  - AKI
  - Transfusions
- Blood transfusions are:
  - Costly & poorly reimbursed
  - Associated with increased morbidity and mortality
  - Associated with increased ICU and hospital length of stays



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Iron Deficiency Anemia

ANESTHESIOLOGY

An Effective and Efficient Testing Protocol for Diagnosing Iron-deficiency Anemia Preoperatively

Obianuju Okocha, M.D., Hardik Dand, B.A., Michael J. Avram, Ph.D., BobbieJean Sweitzer, M.D., F.A.C.P.

Anesthesiology 2020; 133:109–18

- Over 1/3 of preoperative anemia is associated with iron deficiency
- Iron deficiency anemia is easily treatable with PO or IV Iron
- PO Iron is often poorly tolerated and takes
- Hemoglobin levels can be corrected in as little as two weeks preoperatively if IV iron is given
- Reticulocyte counts usually double within 48 hours following a single iron infusion

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INNOVATION

Implementation of a Preoperative Anemia Clinic Utilizing a Minimal Staffing Model

Christian Mabry, MD, Seth Perelman, MD, Jung T. Kim, MD, and Jeanna D. Blitz, MD

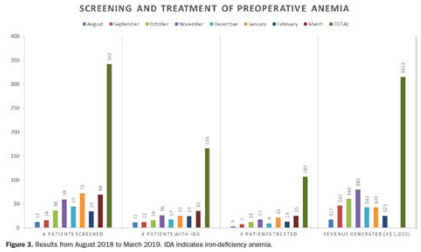

Figure 3. Results from August 2018 to March 2019. IDA indicates iron-deficiency anemia.

Anesthesia & Analgesia Practice, February 2020

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Perioperative Anemia: Prevention, Diagnosis, and Management Throughout the Spectrum of Perioperative Care

Matthew A. Warner, MD,*† Linda Shore-Lesserson, MD,†‡ Aryeh Shander, MD,†§ Sephalie Y. Patel, MD,†‖ Seth I. Perelman, MD,†¶ and Nicole R. Guinn, MD¶#

Anesthesia & Analgesia, May 2020

Hgb <12mg/dL
Iron Studies:
TSAT, Ferritin
If IDA→will need GI/PCP f/u
Also:
B12/Folate
ESA with Iron

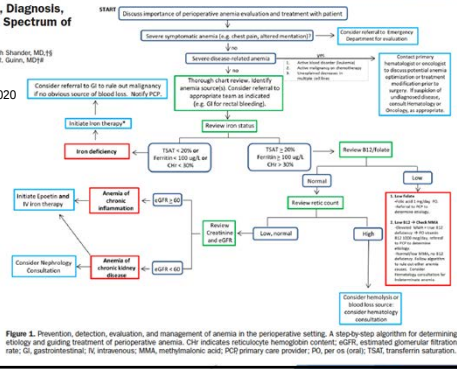

Figure 1. Prevention, detection, evaluation, and management of anemia in the perioperative setting. A step-by-step algorithm for determining etiology and guiding treatment of perioperative anemia. CHr indicates reticulocyte hemoglobin content; eGFR, estimated glomerular filtration rate; GI, gastrointestinal; IV, intravenous; MMA, methylmalonic acid; PCP, primary care provider; PO, per os (oral); TSAT, transferrin saturation.

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Iron Deficiency Anemia

- Calculate iron for treatment with the total Iron Deficit:
  - (Target Hemoglobin – Current Hemoglobin) x Body Weight (kg) x 2.4 + 500mg
- Replete with:
  - Ferric Carboxymaltose
    - More expensive
    - Requires fewer infusions
  - Iron Sucrose
  - Ferric Gluconate
- If no known cause of IDA, should have GI/PCP follow up

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Anemia Prehab: PEARLS

- Treatment of Anemia in the preoperative period is cost-effective
- Identifying and treating Iron Deficiency Anemia is a good place to start
- 3-4 weeks preop is an ideal time frame
- Patients benefit from repleting depleted iron stores in as little as 48 hours
- Preoperative clinics can successfully treat anemia due to kidney disease, chronic inflammation or B12/Folate deficiency
- More research is needed to establish improved outcomes with anemia prehab

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Diabetes Management


British Journal of Anaesthesia 112 (1): 79–88 (2014)
Advance Access publication 5 September 2013 · doi:10.1093/bja/aet297

BJA

Preoperative blood glucose concentrations and postoperative outcomes after elective non-cardiac surgery: an observational study

B. B. Abdelmalak[1,2*], J. Knittel[1], J. B. Abdelmalek[3], J. E. Dalton[1,2], E. Christiansen[4], J. Fess[1], M. Argalious[1], R. Zimmerman[4] and G. Van den Berghe[5]


Can J Anesth/J Can Anesth (2010) 57: 1058–1064
DOI 10.1007/s12630-010-9391-4

REPORTS OF ORIGINAL INVESTIGATIONS

The prevalence of undiagnosed diabetes in non-cardiac surgery patients, an observational study

La prévalence de diabète non diagnostiqué chez les patients subissant une chirurgie non cardiaque, une étude observationnelle

Basem Abdelmalak, MD · Joseph B. Abdelmalak, MD · Justin Knittel, MD · Eric Christiansen, MBA · Edward Mascha, PhD · Robert Zimmerman, MD · Maged Argalious, MD · Joseph Fess, MD

- It is estimated that 5-10% of patients having surgery are undiagnosed diabetics
- Hyperglycemia without a diagnosis of diabetes has a greater risk of worse perioperative outcomes than patients with a diagnosis of diabetes
- Increased risk of:
  - Prolonged hospital stay
  - Postoperative complications: including infection, prolonged intubation
  - Perioperative mortality

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Diabetes Management

Serum Fructosamine: A Simple and Inexpensive Test for Assessing Preoperative Glycemic Control

Noam Shohat, MD, Majd Tarabichi, MD, Eric H. Tischler, BA, Serge Jabbour, MD, and Javad Parvizi, MD, FRCS

Investigation performed at The Rothman Institute at Thomas Jefferson University, Philadelphia, Pennsylvania

- >30% of total joint arthroplasty patients have undiagnosed hyperglycemia
- In a prospective clinical trial examining the role of diabetes and pre-diabetes on complications after total joint surgery, of 829 patients:
  - 119 (14.4%) had a diagnosis of diabetes
  - 21 (2.5%) were undiagnosed diabetics
  - 308 (37.2%) were pre-diabetic
  - 448 (54.0%) of patients had a hyperglycemic disorder

J Bone Joint Surg Am. 2017;99:1900-7

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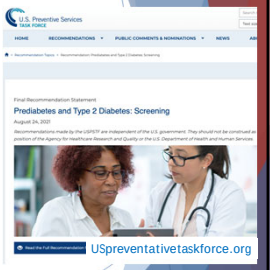
Screening for diabetes

- USPSTF recommends screening:
  - Every three years:
    - All overweight adults over 35
    - All adults over 45
    - Adults of any age with risk factors (FH, HTN, CVD, PCOS, HL, Low HDL, severe obesity, high risk racial/ethnic group)
  - Annually:
    - Patients with a diagnosis of pre-diabetes
    - Patients with a history of gestational diabetes
- Methods of screening for diabetes and pre-diabetes:
  - Fasting Glucose
  - Oral Glucose Tolerance Test
  - HgbA1c



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Diagnosing Diabetes: Glucose Testing

- Random Glucose (>200mg/dL):
  - Present on BMP
  - Specific but not sensitive
  - Non-diagnostic by itself
- Fasting Glucose (>126mg/dL):
  - Requires overnight fasting
- Oral Glucose Tolerance Test (>200mg/dL)
  - Requires overnight fasting
  - Most sensitive
  - Most cumbersome
  - Can be unpleasant for patients (nausea)
  - Rarely performed as part of a preoperative assessment

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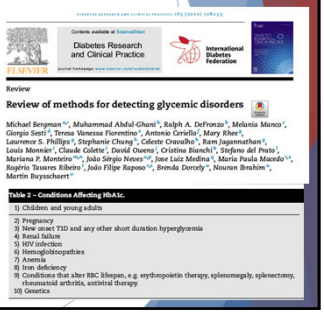
Diagnosing Diabetes: Hemoglobin A1c

- HgbA1c (>6.5%)
  - Reproducible/precise
  - Standardized
  - Does not require fasting
  - Lower sensitivity compared to glucose testing
  - Reflects daily averages (not reflective of swings)
  - Reduced accuracy with many medical conditions
  - Underdiagnosis of DM



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Improving Glycemic Control

- In general, ADA recommends HgbA1c<7% *and* Glucose between 70-180 for at least 70% of the day
- There is a clear association between increasing HgbA1c and perioperative complications
- *However, delaying surgery to lower HgbA1c has not been shown to alter outcomes*
- Interventions:
  - Lifestyle modifications
  - Diabetes educator
  - Assessment of current regimen
  - Addition/modification of medication
  - Glucose Log or Continuous Glucose Monitor
  - Referral to endocrinology/PCP
- Have a clear plan for follow-up: *What specific targets to achieve by what date using what support*

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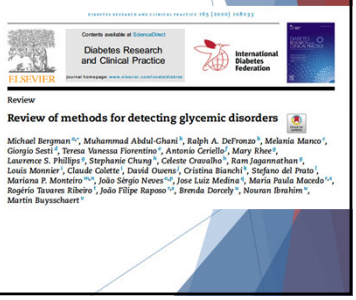
Measuring Improved Glycemic Control: Hemoglobin A1c

- Glucose binds to hemoglobin within the red blood cell
- Good indicator of overall glucose control
- Takes 3 months to reflect changes in glycemic control
- *Not particularly helpful to assess changes in diabetes management in the preoperative period*


Diabetes Research and Clinical Practice

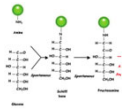
Review

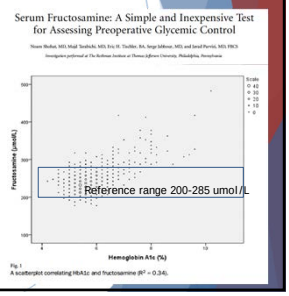
Review of methods for detecting glycemic disorders

31

Measuring Improved Glycemic Control: Fructosamine

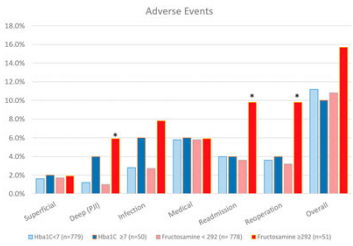
- Glucose + Protein = Fructosamine
- Turnover is around 10-21 days
- Fructosamine levels will improve in a number of weeks with improved glycemic control
- Usually a send-out test
- Unclear how to use it!





32

Measuring Improved Glycemic Control: Fructosamine




Serum Fructosamine: A Simple and Inexpensive Test for Assessing Preoperative Glycemic Control

High Fructosamine levels correlate with adverse hyperglcemic related outcomes

33

Measuring Improved Glycemic Control: Glucose Monitoring

- Reflects actual glucose levels throughout the day rather than an average
- Can use the estimated average glucose (eAG) to estimate a HgbA1c
- Techniques:
  - Self-Monitoring of Blood Glucose (SMBG)
    - Accurate if high patient compliance
    - Ask for different glucose levels at different times of the day
    - Can associate with a food log for education
  - Continuous Glucose Monitoring (CGM)
    - Better at capturing fluctuations
    - Does not require patient compliance

A1C	eAG	
%	mg/dl	mmol/l
6	126	7.0
6.5	140	7.8
7	154	8.6
7.5	169	9.4
8	183	10.1
8.5	197	10.9
9	212	11.8
9.5	226	12.6
10	240	13.4

Formula: 28.7 X A1C – 46.7 = eAG

1-800-DIABETES
diabetes.org/professional/eAG

34

Continuous Glucose Monitoring

- Intersitial glucose measured every 1-5 minutes
- Subcutaneously implanted enzyme electrodes
- Can be coupled with an insulin pump to create a "closed-loop control" of glucose
- Less accurate in prediabetics
- Not approved for diagnosis of diabetes
- Allows for ability to assess "Time in Range" for optimal adjustment of medical management
- Can be set with alarms to treat hyper and hypoglycemia early

35

Diabetes Management: PEARLS

- The majority of our presurgical patients should have screening for diabetes and pre-diabetes at least every three years
- Be especially mindful of the undiagnosed hyperglycemics
- HgbA1c levels are the best indicator for glycemic control
  - →but takes months to reflect changes in glycemic control
- Fructosamine levels adjust more rapidly, needing only a few weeks to reflect changes in glycemic control
  - →early research is promising, but more research is needed
- Continuous Glucose Monitoring may be the best way to assess glycemic control in the preoperative period
  - →but requires special equipment and staffing to interpret data and educate patients
- It is not clear that improving glycemic control in the short term improves outcomes, it is inarguably better for patients in the long term

36

Penicillin "Allergies"

- Less than 2% of patients with a listed penicillin "allergy" will have a positive penicillin allergy test
- 1st and 2nd generation cephalosporins are often avoided in patients with a penicillin allergy
- Flouroquinolones, clindamycin and 3rd gen cephalosporins are favored in penicillin allergic patients but have an increased risk of C Diff
- Having a listed penicillin allergy is an independent risk factor for:
  - VRE & MRSA
  - Increased hospital length of stay
  - Surgical Site Infection
  - Need for reoperation

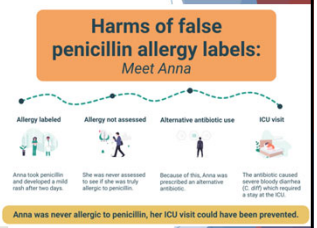
Food, drug, insect sting allergy, and anaphylaxis

Health care use and serious infection prevalence associated with penicillin "allergy" in hospitalized patients: A cohort study

Eric Macy, MD, MS,[a] and Richard Contreras, MS[b] *San Diego and Pasadena, Calif*

37

Penicillin Allergy Delabeling

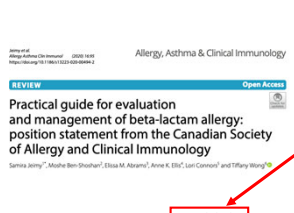


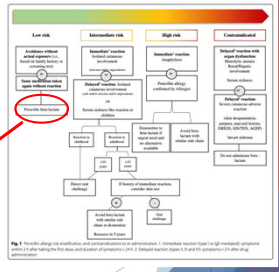
Droptheabel.ca

https://app.firstline.org/en/clients/39-bc-womens-hospital/pathways

38

Penicillin Allergy Delabeling

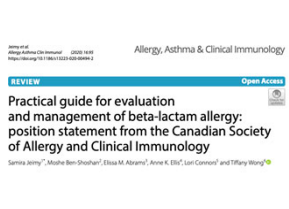


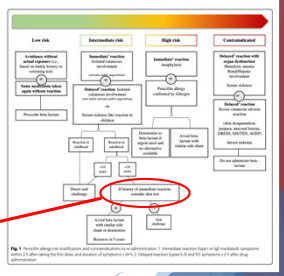


De-label during preop assessment

39

Penicillin Allergy Delabeling

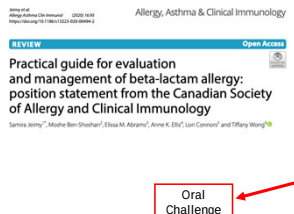


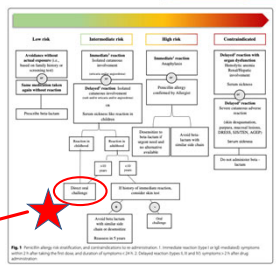


Refer to allergy for skin testing

40

Penicillin Allergy Delabeling





Oral Challenge in Preop Clinic!

41

Penicillin Allergy Testi

BJA

- Screened surgical patients
- Low risk patients offered testin
- Of 56 patients tested in clinic, were de-labeled
- The majority of patients (70%) prefer to have delabeling occur in conjunction with supervised testing
- The majority of patients would prefer to have testing performed during the presurgical visit

42

Penicillin Allergy Testing: CU Experience

- 2018: launched referral process to Allergy clinic→100% delabelled
- 2020: Allergists begins direct to oral challenge testing in select patients
- Scheduling limited due to presurgical timeframe, patient willingness and appointment availability
- 2021: Developed a process to perform testing in low/intermediate risk patients in our clinic (rxn>10yrs ago)
- Launching in March, 2022!


uchealth

Doctors Specialties Locations

About 90% of patients reporting a penicillin allergy are wrong

Penicillin allergies are widely reported but often inaccurate. Two UCHealth clinics are protecting patient safety with allergy testing before surgery.

By Tyler Smith | April 1, 2019

A necessary step for providers in preparing for upcoming surgeries is checking their prospective patients' list of medication allergies, like a penicillin allergy. Antibiotics, a key component of any surgical procedure, come under close scrutiny, as a patient's allergic reaction to them on the operating table can be a potentially life-threatening event or lead to post-surgical problems.

At UCHealth University of Colorado Hospital on the Anschutz Medical Campus, the concern with antibiotic allergies has taken a new twist. Medical professionals have increased their attention on identifying patients who believe they are allergic to a well-known antibiotic, but actually are not. It's an approach that could have surprisingly powerful and positive results for both patients and the hospital.

https://www.uchealth.org/today/clinics-put-penicillin-allergies-to-the-test/

43

Penicillin Allergy: PEARLS

- 10% of surgical patients have a penicillin "allergy" listed in their EMR
- 98% of these "allergies" are not true allergies
- Having a beta-lactam allergy listed in a patient's EMR worsens perioperative outcomes and increases overall hospital costs
- **Low Risk Patients** with a listed beta-lactam allergy can be safely de-labeled after a careful history
- **Intermediate and High Risk Patients** can be delabeled through allergy testing in allergy, Primary care or preoperative clinics

44

Optimizing Patients for the OR: Take Home Points

- Preoperative clinics are cost effective models of care which improve perioperative outcomes
- We aren't great at assessing functional status: The DASI tool, 6MWT, compendium of physical activities, and wearable devices can provide a better picture of our patient's fitness for surgery
- Treating iron deficiency anemia in the preoperative period is cost effective but more research is needed to show improved outcomes
- All patients should be screened for diabetes as the undiagnosed diabetics have the worst perioperative outcomes
- While poorly controlled diabetes is clearly associated with worse outcomes, more research is needed to show that outcomes are improved with better preoperative glycemic control
- Delabeling patients' penicillin "allergy" improves perioperative outcomes
- Direct to oral challenge allergy testing is cost and time efficient in intermediate risk patients

45

Questions?

References:

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CRASH
Colorado Review of Anesthesia for Subcutaneous And Hospitals
Guiding the future of patient care

Basics of TEG and ROTEM

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

Anesthesiology
University of Colorado
Anschutz Medical Campus

1

- Everything You Need to Know About TEG/ROTEM For Your Practice
- Tran: Basics of TEG vs ROTEM
- Wilkey: TEG/ROTEM in cardiac surgery, cardiopulmonary bypass
- Stewart: TEG/ROTEM in liver disease/general cases
-
- Learn the differences between TEG and ROTEM
- How to apply whole blood global viscoelastic studies to in coagulopathy in cardiac surgery
- How to apply whole blood global viscoelastic studies to manage coagulopathy in general surgery, trauma, and other cases
-
-

2

Disclosures

- None

3

Objectives

- What are viscoelastic studies?
  - Thromboelastography
  - Rotational thromboelastometry
- What are the differences between TEG and ROTEM?
- How do I interpret abnormalities in these studies?

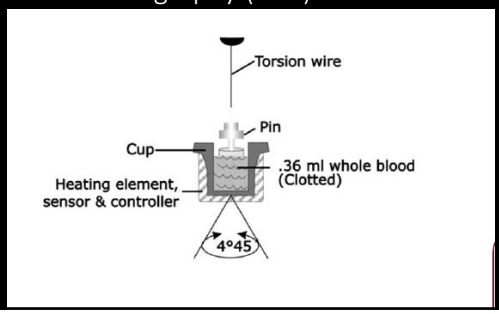
4

Viscoelastic Hemostatic Assays

- Most commonly used TEG and ROTEM
- Allows for assessment of the function of the coagulation balance
- Limitations

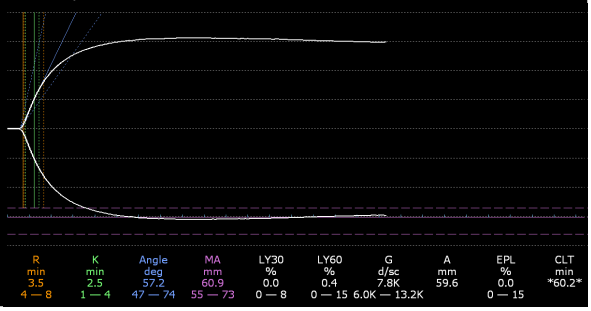
5

Thromboelastography (TEG)



6

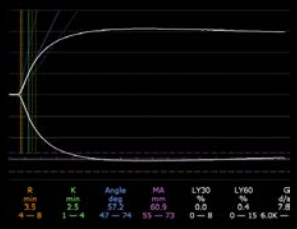
TEG Output



7

TEG Basics

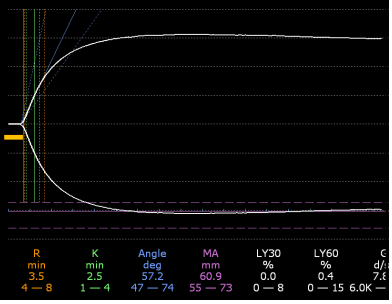
- R Time: Start to formation at 2mm
- K Time: Time to 20mm
- Angle: Between R and K
- Maximum Amplitude
- Lysis 60



8

R Time

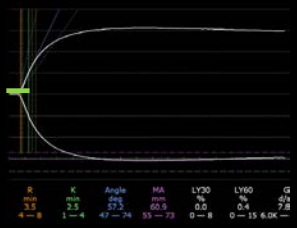
- Start of test to formation at Amplitude 2mm
- Intrinsic coagulation factors
- Factors 2, 5, 8, 9 10, Fibrinogen



9

TEG Basics

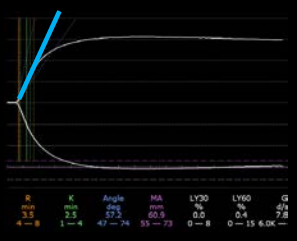
- K Time: Start of clot to 20mm
- Fibrin/Platelets/Coagulation Factors



10

TEG Basics

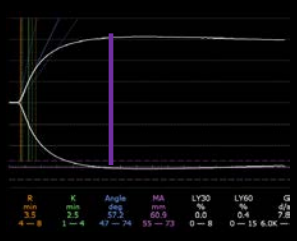
- Angle: Angle Between Between R and K
- "Rate of clot formation"
- Fibrinogen, Platelet Dependent



11

TEG Basics

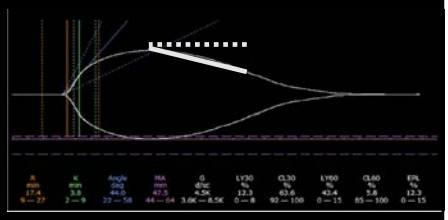
- Maximum Amplitude
- Platelets



12

TEG Basics

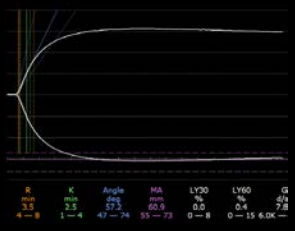
- Lysis 30 60
- Amount of lysis at 30 min/60min



13

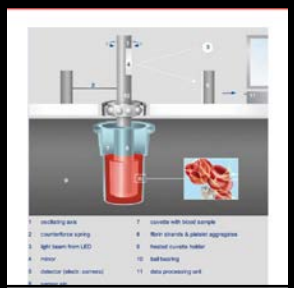
TEG Basics

- R Time: Start to formation at 2mm
- K Time: Time to 20mm
- Angle: Between R and K
- Maximum Amplitude
- Lysis 60



14

Rotational Thromboelastometry



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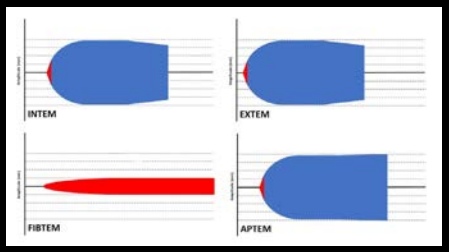
16

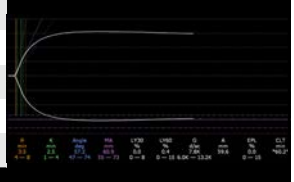
ROTEM Output



17

ROTEM Variables

TEG	ROTEM
R Time	Clotting Time (CT)
K Time	Clot Formation Time (CFT)
Alpha Angle	Alpha Angle
Maximum Amplitude	Maximum Clot Firmness
Ly30, Ly60	Clot Lysis



18

IN-TEM/EX-TEM/Fib-TEM/Hep-TEM

Component Assay	Comparable Lab Test	Purpose	Pathologies that affect the assay
INTEM	aPTT	Tests intrinsic pathway	↓PLT,↓ fibrinogen
EXTEM	PT/ INR	Tests extrinsic pathway	↓PLT,↓ fibrinogen
APTEM	-	Tests fibrinolysis (compared to EXTEM)	↓PLT ,Hyperfibrinolysis
FIBTEM	Fibrinogen, INR	Eliminates PLTs in clot to test fibrinogen function	↓fibrinogen
HEPTEM	-	Eliminates heparin effect (compared to INTEM)	Heparin effect

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ROTEM Variables

TEG	ROTEM	Considerations for Treatment
R Time	Clotting Time (CT)	FFP
K Time	Clot Formation Time (CFT)	Fibrinogen
Alpha Angle	Alpha Angle	Fibrinogen
Maximum Amplitude	Maximum Clot Firmness	Platelets
Ly30, Ly60	Clot Lysis	Anti-Fibrinolytic

20

Limitations

- The addition of the antiplatelet agent reduces the platelet-mediated clot activation signal to selectively evaluate the fibrinogen component of clot strength. In turn, platelet contribution is calculated by the difference between the viscoelastic amplitude of the tissue factor–activated ROTEM and fibrinogen ROTEM.10
- First, there are convincing data showing that there
- is residual platelet noise in the fibrinogen assays caused by
- incomplete inhibition of platelet aggregation.8,9 This is more
- pronounced when a platelet glycoprotein IIb/IIIa receptor
- inhibitor is used and less pronounced when cytochalasin D is
- used.The combination of the agents leads to complete inhi-
- bition of platelet aggregation and thereby prevents any resid-
- ual “platelet noise.”8,

21

References

- Am. J. Hematol. 89:228–232, 2014.
- Erdoes G, Koster A, Levy JH. Viscoelastic Coagulation Testing: Use and Current Limitations in Perioperative Decision-making. Anesthesiology. 2021 Aug 1;135(2):342-349. doi: 10.1097/ALN.0000000000003814. PMID: 33979438.

22

TEG & ROTEM IN CARDIAC SURGERY

Barbara Wilkey, MD
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1

I have no disclosures.

2

What We Will Cover

- Can viscoelastic testing predict bleeding in cardiac surgery?
- Do Viscoelastic tests convey more benefit than standard lab testing?
- What are current recommendations in cardiac surgery related to viscoelastic testing?

3

Can viscoelastic testing predict bleeding in cardiac surgery?

- The rate of change of A10 in ROTEM has been correlated with bleeding. The faster the rate of change the more bleeding. This is true across all A10 channels. (General Thoracic and Cardiovascular Surgery 2021 https://doi.org/10.1007/s11748-021-01688-0)
- No correlation between R-TEG preop and massive transfusion for CABG patients. However, there was a correlation between R-TEG ACT and bleeding. For every 10-minute increase in R-TEG ACT there was a 1.5 times increased risk for perioperative massive transfusion. (Lin et al. Medicine (2020) 99:37).

4

Do viscoelastic tests convey more benefit than standard lab testing?

Deppe et al. Point-of-care thromboelastography/thromboelastometry-based coagulation management in cardiac surgery: a meta-analysis of 8332 patients. J Surg Res. 2016; 203: 424-33.

- 17 studies. 15 of the 17 published between 2001 and 2012.
- All studies compared viscoelastic testing with standard of care.
- TEG/ROTEM guided transfusion management :
  - significantly decreased the odds for patients to receive allogeneic blood products
  - significantly decreased the re-exploration rate due to postoperative bleeding
  - resulted in less postoperative AKI and thromboembolic events
  - no statistical differences stroke, length of stay in ICU or hospital, or in-hospital mortality

5

Do viscoelastic tests convey more benefit than standard lab testing?

Serraino and Murphey. Routine use of viscoelastic blood tests for diagnosis and treatment of coagulopathic bleeding in cardiac surgery: updated systematic review and meta-analysis. Br J Anaesth. 2107: 118 (6): 823-33.

- TEG, ROTEM And Sonoclot.
- 15 trials; included 9 from the previously mentioned meta-analysis.
- 8,737 patients.
- One trial had 7,402 patients. The other trials ranged from 22-228.
- Analysis showed that viscoelastic testing did decrease transfusion of red blood cells and platelets.
- There was no decrease in emergency reoperation, length of intubation, ICU or hospital length of stay, stroke or mortality.
- There were 4 studies that reported on AKI and the incidence of this was significantly decreased.

6

Do viscoelastic tests convey more benefit than standard lab testing?

Meco et al. Viscoelastic Blood Tests Use in Adult Cardiac Surgery: Meta-Analysis, Meta-Regression, and Trial Sequential Analysis. J Cardiothorac Vasc Anesth 34 (2020) 119-127.

- A more recent metanalysis
- 8 trials, 1035 patients
- Viscoelastic testing results in less RBC, Plasma, and Platelet transfusion as well as decreased bleeding at 12 and 24 hours.
- Also, less re-exploration for non-surgical bleeding.

7

What are current recommendations in cardiac surgery related to viscoelastic testing?

8

What do our guidelines say?

SCA Blood Conservation Working Group. SCA Clinical Practice Improvement Advisory for the Management of Perioperative Bleeding and Hemostasis in Cardiac Surgery Patients. Anesth and Analg Nov 2019:129 (5): 1209-21.

- The SCA endorses creation of a multidisciplinary blood management team.
- The SCA endorses the creation of transfusion algorithms with defined triggers "measured by POC or other rapid turnaround coagulation test".
- "It is the working group's opinion that viscoelastic coagulation tests are superior to conventional coagulation laboratory studies in guiding transfusion therapy in patients undergoing cardiovascular surgical procedures".
- They do recognize that everybody does not have access to these testing methods, so they provide an algorithm for non viscoelastic testing transfusion.

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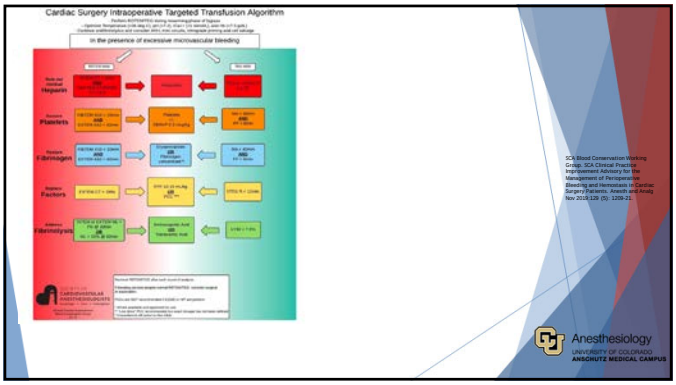

10

RASH
Colorado Review of Anesthesia for Subscriptees And Hospitals
Guiding the future of patient care

- Perform ROTEM/TEG during rewarming phase of bypass
- Optimize Temperature (>36 deg C), pH (>7.2), iCa++ (>1 mmol/L), and Hb (>7.5 g/dL)
- Continue antifibrinolytics and consider ANH, mini circuits, retrograde priming and cell salvage

SCA Blood Conservation Working Group. SCA Clinical Practice Improvement Advisory for the Management of Perioperative Bleeding and Hemostasis in Cardiac Surgery Patients. Anesth and Analg Nov 2019:129 (5): 1209-21.

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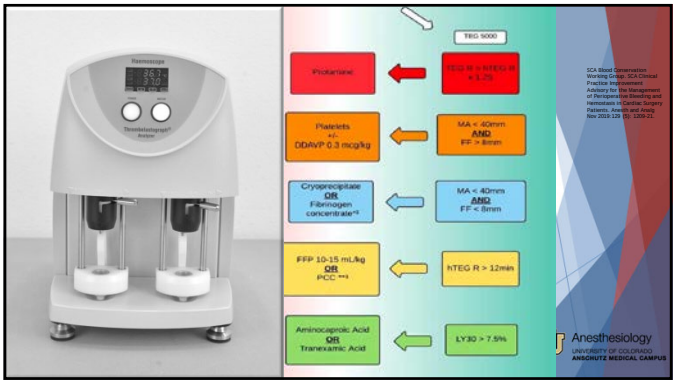

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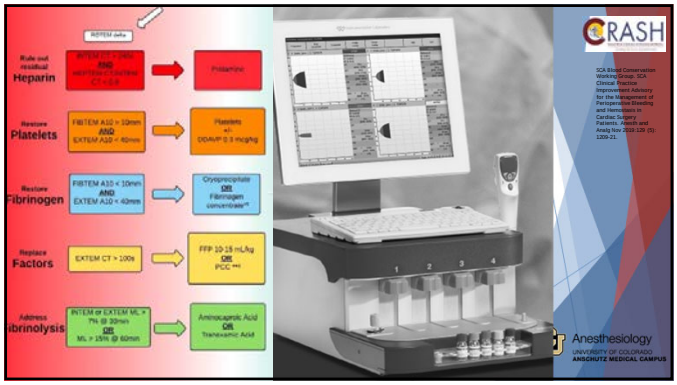


13

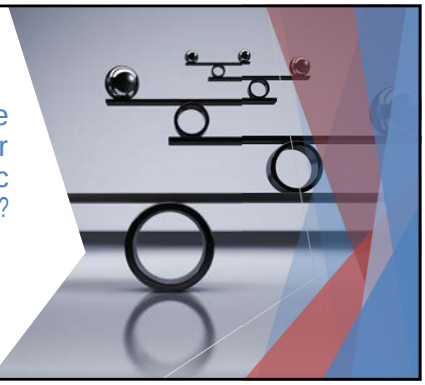
What do the European guidelines say?

The Task Force on Patient Blood Management for Adult Cardiac Surgery of the European Association for Cardio-Thoracic Surgery (EACTS) and the European Association of Cardiothoracic Anaesthesiology (EACTA). 2017 EACTS/EACTA Guidelines on patient blood management for adult cardiac surgery. J Cardiothorac Vasc Anesth. 31(2018)88-120.

- "Perioperative treatment algorithms for the bleeding patient based on viscoelastic POC tests should be considered to reduce the number of transfusions. "
- Unlike the SCA, they do not give treatment recommendations based upon viscoelastic values.

14

What are some other viscoelastic algorithms?



15

Haensig et al. Thrombelastometry guided blood component therapy after cardiac surgery: a randomized study. BMC Anesthesiology (2019) 19:201

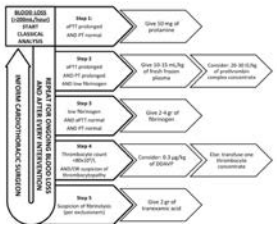
1. 4-chamber TEM (1 INTEM, 2 HEPTEM, 3 FIBTEM, 4 APTEM), Quick, AT3
2. CT-INTEM/CT-HEPTEM> 1.5 = > **5000 IE Protamin**
3. CT-HEPTEM> 260 s = > **FFP units** (kg body weight)[2]
4. a: MCF-HEPTEM 35–45 mm and MCF-FIBTEM > 8 mm = > **1 platelet concentrate**
   b: MCF-HEPTEM< 35 mm = > **1 platelet concentrate**
5. MCF-FIBTEM < 8 mm = > **2 g Fibrinogen**
6. MCF-APTEM/MCF-HEPTEM > 1.5 or Aprotinin effective optically = > **2 Mio IE Aprotinin / 2 g Tranexamic acid**

- In case of persistent bleeding -> re-testing according to (1) and further therapy as suggested by the protocol.
- 2000 IE FPSB if INR > 2.0 and known liver dysfunction or previous Coumadin therapy.
- 2000 IE AT3 if an increase > 50% (prothrombin time) is not to be expected via FFP-substitution.

Transfusion of RBCs according to the haemoglobin level of the blood-gas-analysis. Target value >8.0 g/dl
FFP (15 ml / kg KG; < 58 kg body weight -> 3 FFP, 58–75 kg body weight -> 4 FFP, 75–92 kg body weight -> 5 FFP, > 92 kg body weight -> 6 FFP
The entries in boldface represent the administered blood-components

16

Kuiper et al. Shifts of Transfusion Demand in Cardiac Surgery After Implementation of Rotational Thromboelastometry Guided Transfusion Protocols: Analysis of the HEROES-CS (HEmostasis Registry of patiEntS in Cardiac Surgery) Observational, Prospective Open Cohort Database. J Cardiothorac Vasc Anesth33 (2019) 307-317.



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Refern et al. Thromboelastography-Directed Transfusion in Cardiac Surgery: Impact on Postoperative Outcomes. Ann Thorac Surg 2019;107:1313-8

Table 1. Clinical Interpretation of TEG Results as Recommended by Manufacturer

TEG Result	Hemostasis State	Recommended Treatment
Angle		
<45°	Low fibrinogen level	0.06 U/kg cryoprecipitate
Reaction time (R value)		
<4 minutes	Enzymatic hypercoagulability	Anticoagulant
11–14 minutes	Low clotting factors	2 U of FFP
>14 minutes	Very low clotting factors	4 U of FFP
Maximal amplitude		
46–54 mm	Low platelet function	0.3 µg/kg DDAVP
41–45 mm	Very low platelet function	1 U of platelet pheresis
≤40 mm	Extremely low platelet function	2 U of platelet pheresis
>73 mm	Platelet hypercoagulability	Antiplatelet therapy

DDAVP = 1-deamino-8-D-arginine vasopressin; FFP = fresh frozen plasma; TEG = thromboelastography.

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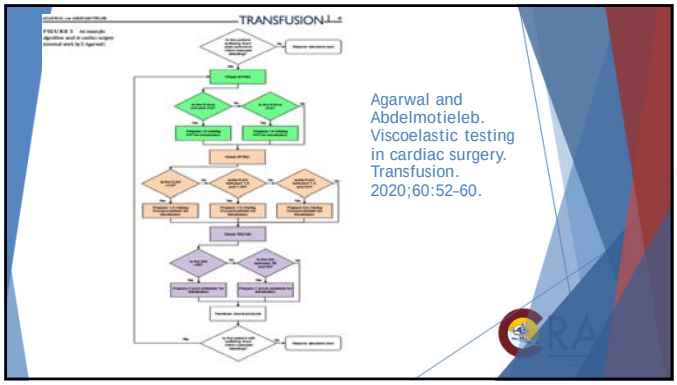

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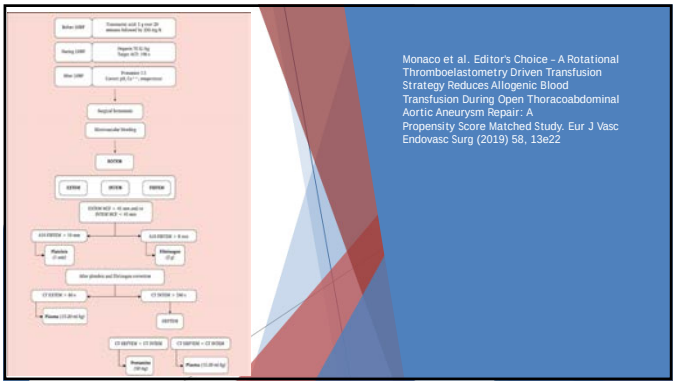

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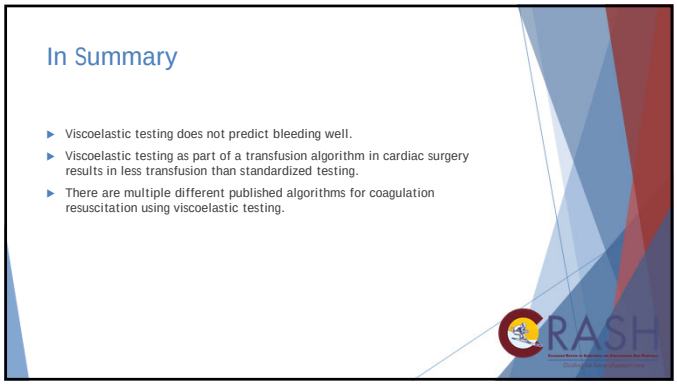

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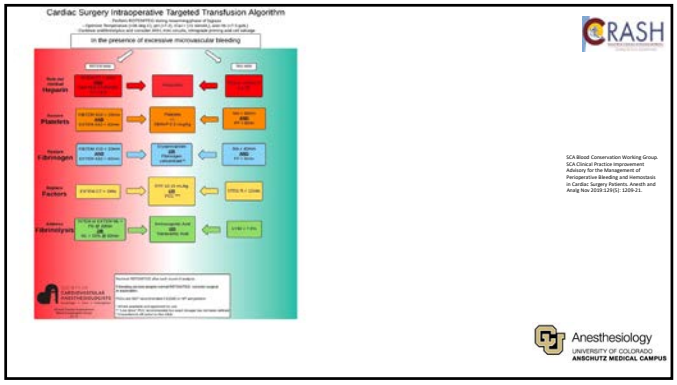

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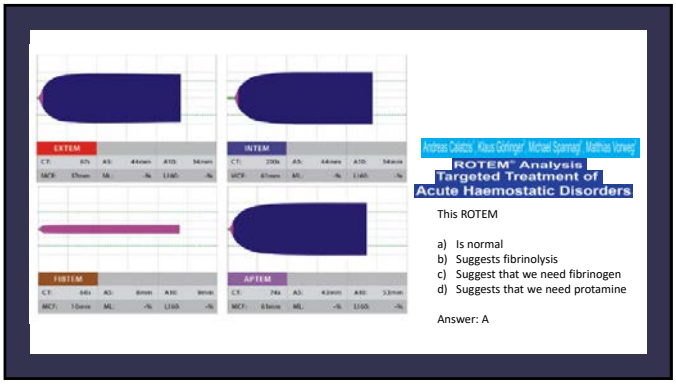

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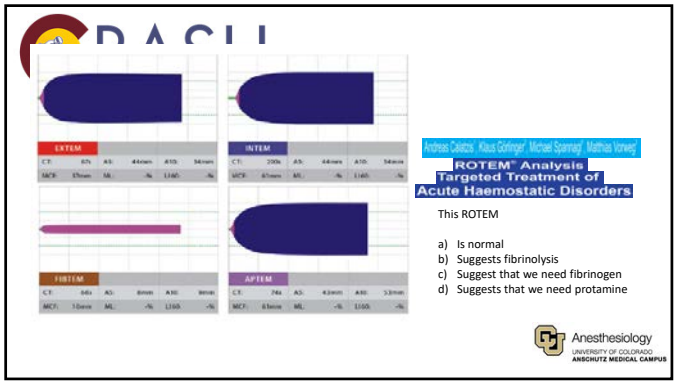

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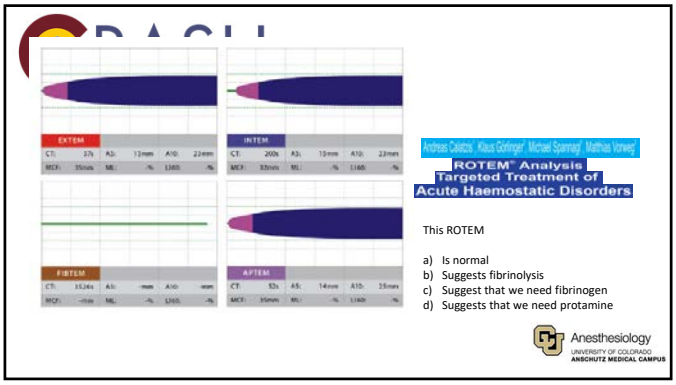

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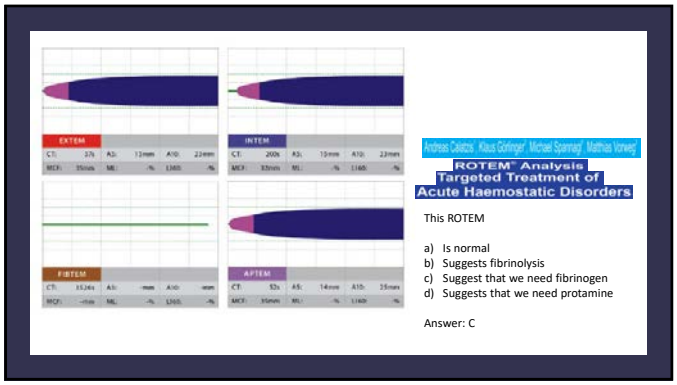

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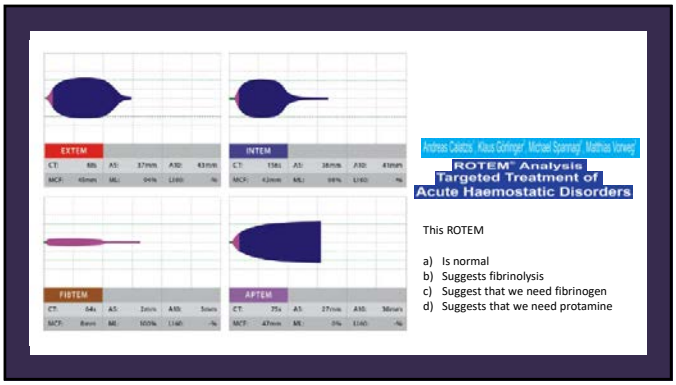

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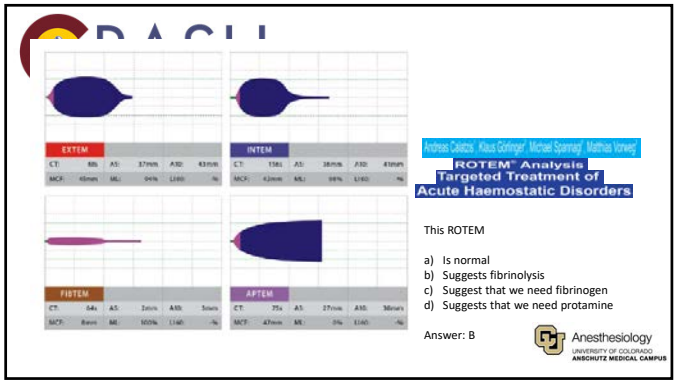

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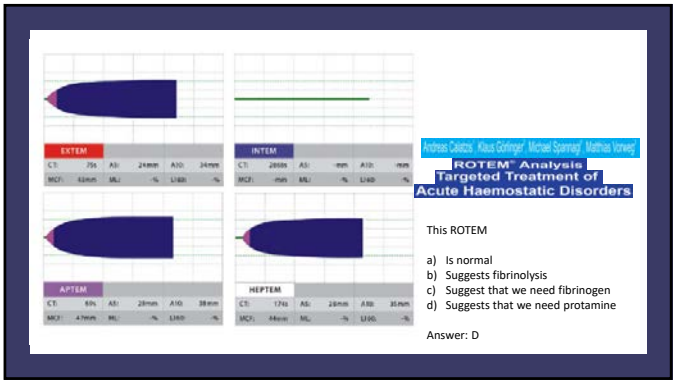

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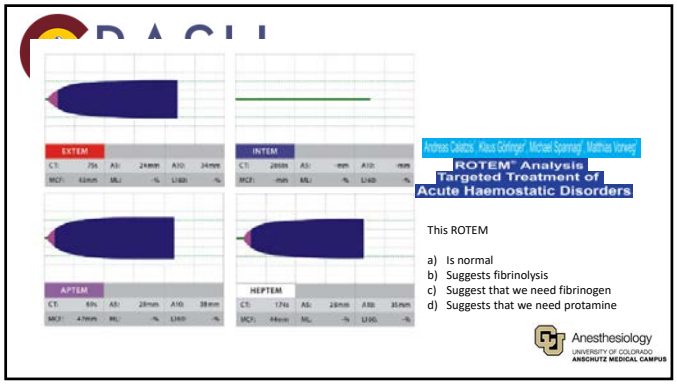
EXTEM
INTEM
APTEM
HEPTEM
Andreas Calatzis · Klaus Görlinger · Michael Spannagl · Matthias Vorweg
ROTEM® Analysis
Targeted Treatment of
Acute Haemostatic Disorders
This ROTEM
a) Is normal
b) Suggests fibrinolysis
c) Suggest that we need fibrinogen
d) Suggests that we need protamine
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31

Perioperative use of viscoelastic testing in non-cardiac surgery

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Dept of Anesthesiology/CUSOM

1

No disclosures

2

Objectives

- Consider the advantages and limitations of using viscoelastic testing to manage coagulopathy in perioperative patients
- Review coagulopathies found commonly in patients undergoing non-cardiac procedures and discuss expected findings in viscoelastic testing
- Examine the literature supporting the use of viscoelastic testing in guiding the management of these coagulopathies
- Interpret viscoelastic test tracings for a variety of coagulopathic states

3

Perioperative use of viscoelastic testing (VET)

- Provides a visual representation of the cell-based model of hemostasis by providing measures of clot kinetics, strength, stability and dissolution
- Faster turn around time as compared to standard laboratory coagulation studies (aPTT, PT/INR, platelet count, fibrinogen, etc) and can be used as "point of care" testing in the operating room
- Can help to distinguish between a wide variety of coagulopathies whereas a single standard coagulation study cannot
- May avoid inappropriate transfusion thereby decreasing the utilization of blood products and reducing transfusion-related complications
- May portend a clinical benefit in terms of patient outcomes in specific settings but this is yet to be fully elucidated in use for all non-cardiac procedures.

4

Limitations of VETs

- Cannot accurately assess the contribution of endothelium to coagulation so cannot be used to evaluate conditions that effect adherence to the endothelium (i.e. vWD)
- VETs bypass primary hemostasis using reagents that activate coagulation – cannot be used to evaluate anti-platelet agents or disorders of primary hemostasis.
- Cannot quantify coagulation effects of external factors such as hypothermia, acidosis, etc

5

Coagulopathy in trauma

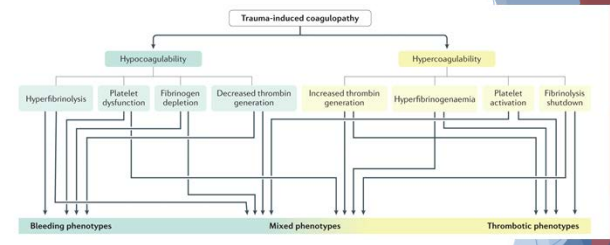
- Hypothermia
- Acidosis
- Disseminated intravascular coagulation
- Dilutional coagulopathy
- Trauma-induced coagulopathy

6

Use of viscoelastic testing in trauma

- TEG parameters such as MA have been shown to better correlate with transfusion requirements than standard coagulation studies in the first 24 hours after admission[17]
- TEG parameters are more closely associated with survival as compared to INR[13]
- Use of TEG parameters in goal-directed resuscitation has been shown to improve mortality and decrease utilization of blood products[7,11,17]

7

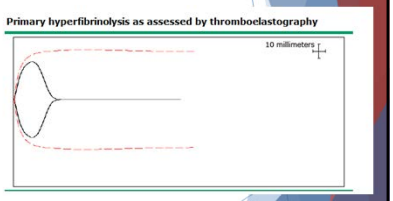


Moore, E.E., Moore, H.B., Kornblith, L.Z. *et al.* Trauma-induced coagulopathy. *Nat Rev Dis Primers* **7**, 30 (2021

8

Dysregulation of fibrinolysis in trauma

- Hyperfibrinolysis
  - Reduced clot formation due to excessive breakdown of mature fibrin defined by an LY30 greater than 3%[16]
  - Related to release of tissue plasminogen activator (tPA) with out an appropriate increase in anti-fibrinolytic plasminogen activator inhibitor-1 (PAI-1) in shock and tissue injury[18]
  - Associated with increased mortality in trauma patients, most commonly associated with exsanguination[16]



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Dysregulation of fibrinolysis in trauma

- Fibrinolysis shut down
  - State of inhibited fibrinolysis defined by an LY30 of 0.8% or less on VET (Moore) which results in a pro-thrombotic state
  - Most common phenotype of fibrinolysis seen in initial presentation of trauma patients[16]
  - Physiologic mechanism is less clear
  - Associated with increased mortality in trauma patients however more associated with multi-organ failure[12,16]

10

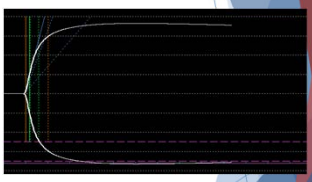
Management of dysregulated fibrinolysis

- Clinical Randomization of Antifibrinolytic in Significant Hemorrhage (CRASH-2)
  - 2010: TXA improves survival when administered early in trauma with known or suspected hemorrhage
- Military Application of Tranexamic Acid in Trauma Emergency Resuscitation (MATTERs)
  - 2012: Concordant with results to the CRASH-2 trial
- Study of Tranexamic Acid During Air and Ground Medical Prehospital Transport (STAAMP)
  - 2020: TXA may be of benefit when given early to patients in severe shock
- Patients who present with more common "fibrinolytic shutdown" may be at higher risk of VTE. Utilizing VETs to determine early fibrinolytic phenotypes may help differentiate those who may benefit from early TXA administration.

11

Obstetrics

- Hypercoagulability of normal pregnancy
  - VET parameters of hypercoagulability increase as pregnancy progresses[8]
  - Slowly normalizes over about 4 weeks post-partum[20]
  - TEG has been used to determine anticoagulant effect but further investigation into best dosing for anticoagulation or VTE ppx in pregnancy is needed



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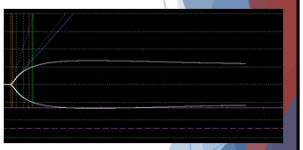
Obstetrics

- Post-partum hemorrhage
  - ROTEM may be helpful in detecting hypofibrinogenemia in PPH and guiding resuscitation with fibrinogen
    - FIBTEM is an independent early predictor of progression to severe hemorrhage[2]
    - May consider administration of fibrinogen concentrate with FIBTEM A5 less than 12 mm in women with PPH[3]
    - Using ROTEM to guide resuscitation may lead to reduced utilization of blood products, reduced incidence of circulatory overload, lower c-section rates, reduced rates of ICU admission and hospital LOS[14,15,21]



13

Obstetrics

- Assessing platelet function in thrombocytopenia
  - Data is limited
  - One prospective case series suggest that neuraxial anesthesia may be safely performed in pregnant patients with a platelet count greater than 56K and a normal TEG[10]
  - Standard TEG is unable to detect platelet dysfunction in severe pre-eclampsia[4]

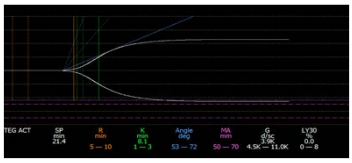
14

End-stage liver disease

- Quantity and function of liver-dependent coagulation factors as well as platelets are disturbed in ELSD resulting in a propensity for both bleeding and thrombosis
- Correlation of prolonged INR with bleeding risk has not been established[9]
- Studies of VET in cirrhotic patients have shown relatively preserved hemostasis even in the context of abnormal standard coagulation studies (INR, low platelet count)[5,19,22]
- Use of VET has been shown to reduce transfusion when incorporated into resuscitation protocols during liver transplantation however a clear survival benefit has not been demonstrated to date[1,6,23]

15

POST-TEST



This VET tracing most closely represents a deficiency in which of the following?

A. Platelets

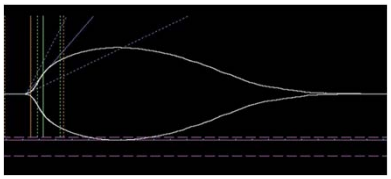
B. Fibrinogen

C. RBCs

D. Factors

16

POST-TEST



Which of the following therapies should be considered in a trauma patient presenting with this VET tracing?

A. Aminocaproic acid

B. Tranexamic acid

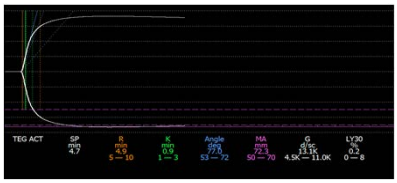
C. Aprotinin

D. Platelets

E. Fibrinogen

17

POST-TEST



This VET tracing would be expected in which of the following clinical scenarios:

A. Within the first 24 of a resuscitation for massive hemorrhage.

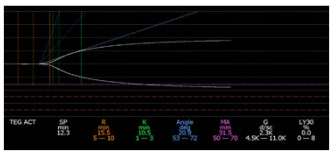
B. Dilutional coagulopathy during a liver transplantation.

C. A patient with metastatic cancer

D. A patient on warfarin therapy.

18

POST-TEST



This VET profile is most consistent with which of the following:

A. COVID-19 infection causing critical illness

B. Hemophilia A

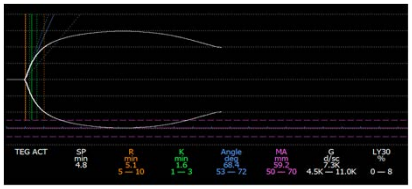
C. Early DIC

D. Late DIC

E. Antiplatelet therapy

19

POST-TEST



This VET tracing reflects which of the following clinical states:

A. Platelet dysfunction

B. Anticoagulation

C. Secondary fibrinolysis

A. Fibrinolysis shut-down

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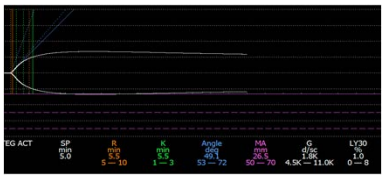
POST-TEST



In a patient experiencing ongoing hemorrhage, which interventions should be considered for resuscitation?

A. Platelets

B. Plasma

C. Whole blood

D. Cryoprecipitate

E. Anti-fibrinolytics

21

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Neuroanesthesia Panel
The Toolbox for Providing the Best Clinical Care

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1

Delirium and Postoperative Cognitive Dysfunction

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2

No conflict of interest to disclose

3

Learning Objectives

- Define Delirium and postoperative cognitive dysfunction (POCD)
- Review risk factors for delirium and POCD
- Understand possible mechanisms
- Summarize anesthetic considerations
- Review current recommendations for the prevention of delirium and POCD

4

What is Delirium/POCD?

Why is this important?

5

Delirium

- A set of fluctuating changes in attention, mental status and level of consciousness
- Common after surgery/anesthesia

POCD

- Cognitive impairment present after full recovery of consciousness that persists beyond the expected pharmacological and physiological effects of anesthetic drugs

6

CRASH

Colorado Review of Anesthesia for Subscriptees And Hospitals

Guiding the future of patient care

Recommendations for the Nomenclature of Cognitive Change Associated with Anaesthesia and Surgery—2018

L. Evered, B. Silbert, D. S. Knopman, D. A. Scott, S. T. DeKosky, L. S. Rasmussen, E. S. Oh, G. Crosby, M. Berger, R. G. Eckenhoff, and The Nomenclature Consensus Working Group*

Anesthesiology November 2018, Vol. 129, 872–879.

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Table 1 Nomenclature used for cognitive impairment at different perio-operative time periods

Time Period	Nomenclature	Definition
Preoperative	Mild Neurocognitive Disorder (NCD)	DSM-5 definition: (1) cognitive concern from the individual/informant/clinician + (2) objective evidence of decline of 1–2 SD compared to normative group + (3) maintained iADLs &/or ADLs
	Major NCD	DSM-5 definition: (1) cognitive concern from the individual/informant/clinician + (2) objective evidence of decline of ≥2 SD + (3) impaired iADLs &/or ADLs
Emergence	Emergence excitation or delirium	
After operation to postoperative day 30	Postoperative delirium	Fluctuating changes in attention, mental status, or level of consciousness which occur in hospital up to 1 week following surgery
	Delayed neurocognitive recovery	Cognitive decline meeting DSM-5 criteria for mild or major NCD, diagnosed within the 30 day recovery period
From expected recovery (30 days) to 12 months	Postoperative mild neurocognitive disorder (POCD) Postoperative major NCD (POCD)	Criteria as per DSM-5 for mild and major NCD Assumes decline cannot be accounted for by any other condition. Postoperative specifier implies temporal relationship. It does not imply causation. POCD is included as a specifier in parentheses while transitioning to the new nomenclature
Greater than 12 months postoperatively	Routine DSM-5 nomenclature	Postoperative specifier is NO LONGER attached if neurocognitive disorder is first diagnosed after this time.

The above nomenclature has been recently proposed to further define neurocognitive disorders associated with the perioperative period. Abbreviations: *DSM-5* diagnostic and statistical manual of mental disorders, *NCD* neurocognitive disorder, *SD* standard deviation, *iADL* instrumental activities of daily living, *ADL* activities of daily living; Objective evidence: tests of complex attention, executive function, learning and memory, language, perceptual-motor, or social cognition. Objective evidence cannot be limited to screening tools. This table is adapted from Evered et al. (2018) [7]

8

Importance

- Cognitive changes after surgery/anesthesia have been identified for >100 years
- More than 250 M major surgical procedures worldwide per year
- Implications of anesthesia in patients with preoperative CD
- Age >65 undergoing surgery is 30%
- Incidence 50-80 % discharge, 20-50% at 6 weeks and 10-30% at 6 months.
- Longer life expectancy
- Prevalence of Dementia 46.8 M in 2015 and 113 M in 2050
- Impact of CD on morbidity, mortality, LOS, economic burden
- Characterization of role of anesthetics and other perioperative factors is needed

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Risks Factors

- **Advance age**
- **Preexisting cognitive impairment (poor memory and attention)**
- Lower level of education
- Lower IQ
- Duration of surgery
- Respiratory complications
- Infection
- Reoperation
- Health/pain status

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Mechanisms

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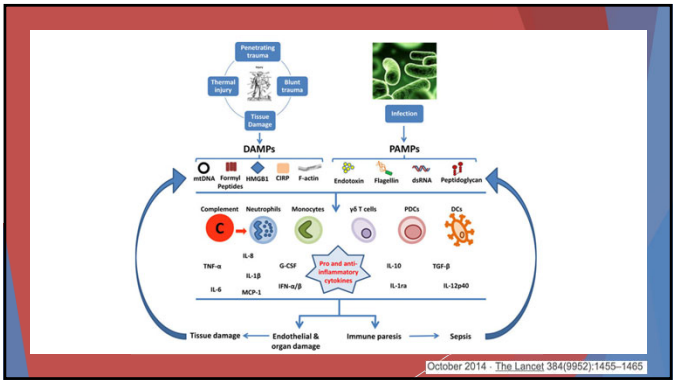

October 2014 · The Lancet 384(9952):1455–1465

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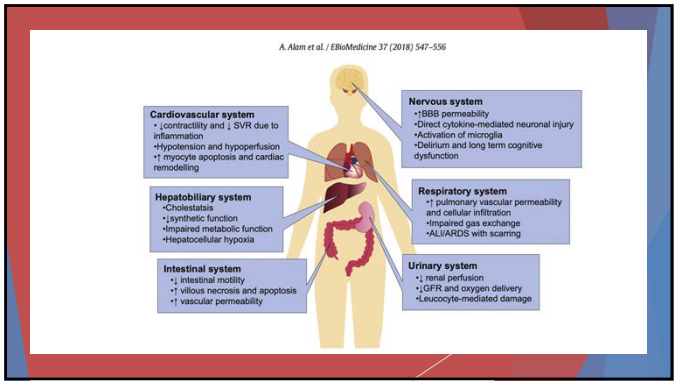

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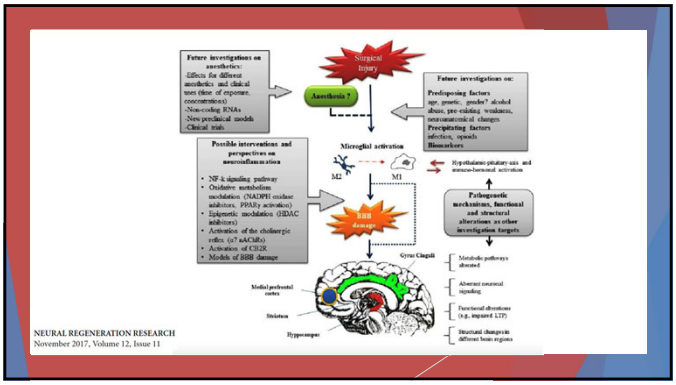

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Role of anesthetic agents and techniques

- General vs other (regional, neuraxial, local, sedation)
- TIVA vs inhalational anesthesia
- Anesthesia depth
- Hypotension
- Hypoxemia
- Hypothermia
- Cerebral perfusion
- Cerebral oxygenation
- Glucose control

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Possible treatments

- Dexmedetomidine
- Ketamine
- Anti-inflammatories (Parecoxib/COX-II inhibitors)
- Minocycline
- Statins
- Pregabalin
- Lidocaine

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16

Efficacy of perioperative dexmedetomidine on postoperative delirium: systematic review and meta-analysis with trial sequential analysis of randomised controlled trials

Conclusion: Dexmedetomidine can reduce POD incidence for adult cardiac and non-cardiac surgical patients. The optimal dose and timing of dexmedetomidine and influence on other outcomes or particular patient populations with risk factors warrants further studies.

British Journal of Anaesthesia, 121 (2): 384e397 (2018)

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Randomized Controlled Trial > JAMA Surg. 2017 Aug 16;152(8):e171505.
doi: 10.1001/jamasurg.2017.1505. Epub 2017 Aug 16.

Intraoperative Infusion of Dexmedetomidine for Prevention of Postoperative Delirium and Cognitive Dysfunction in Elderly Patients Undergoing Major Elective Noncardiac Surgery: A Randomized Clinical Trial

Intraoperative infusion of dexmedetomidine does not decrease postoperative delirium or affect postoperative cognition in elderly patients undergoing major elective noncardiac surgery. Specifically, we did not observe the reduction in delirium demonstrated previously in numerous surgical ICU studies. This result may be due to the short-acting nature of

18

Intraoperative ketamine for prevention of postoperative delirium or pain after major surgery in older adults: an international, multicentre, double-blind, randomised clinical trial

*Michael S Avidan, Hannah R Maybrier, Arbi Ben Abdallah, Eric Jacobsohn, Phillip E Vlisides, Kane O Pryor, Robert A Veselis, Hilary P Grocott, Daniel A Emmert, Emma M Rogers, Robert J Downey, Heidi Yulico, Gyu-Jeong Noh, Yonghun H Lee, Christine M Waszynski, Virendra K Arya, Paul S Pagel, Judith A Hudetz, Maxwell R Muench, Bradley A Fritz, Witold Waberski, Sharon K Inouye, George A Mashour, on behalf of the PODCAST Research Group**

There was no difference in delirium incidence between patients in the combined ketamine groups and the placebo group (19·45% *vs* 19·82%, respectively; absolute difference 0·36%, 95% CI –6·07 to 7·38, p=0·92). There were more postoperative hallucinations (p=0·01) and nightmares (p=0·03) with increasing ketamine doses compared with placebo.

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What can we do?

20

NEUROSCIENCE AND NEUROANESTHESIOLOGY

Best Practices for Postoperative Brain Health

Recommendations From the Fifth International Perioperative Neurotoxicity Working Group

Berger, Miles MD, PhD*; Schenning, Katie J. MD, MPH†; Brown, Charles H. IV MD, MHS‡; Deiner, Stacie G. MD§; Whittington, Robert A. MD‖; Eckenhoff, Roderic G. MD¶; for the Perioperative Neurotoxicity Working Group **Author Information**

Anesthesia & Analgesia: December 2018 - Volume 127 - Issue 6 - p 1406-1413
doi: 10.1213/ANE.0000000000003841

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Recommendations

1. Consent

Consensus Statement

"All patients over age 65 should be informed of the risks of PND including confusion, inattention, and memory problems after having an operation."

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Recommendations

2. Screening

Consensus Statement

"Baseline cognition should be objectively evaluated with a brief screening tool during preoperative evaluation in all patients over the age of 65 and in any patient with risk factors for preexisting cognitive impairment."

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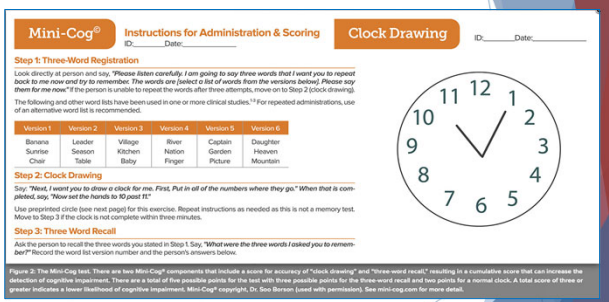

Mini-Cog© Instructions for Administration & Scoring ID:_____Date:_____

Clock Drawing ID:_____Date:_____

Step 1: Three-Word Registration

Look directly at person and say, *"Please listen carefully. I am going to say three words that I want you to repeat back to me now and try to remember. The words are [select a list of words from the versions below]. Please say them for me now."* If the person is unable to repeat the words after three attempts, move on to Step 2 (clock drawing).

The following and other word lists have been used in one or more clinical studies.[1-3] For repeated administrations, use of an alternative word list is recommended.

Version 1	Version 2	Version 3	Version 4	Version 5	Version 6
Banana	Leader	Village	River	Captain	Daughter
Sunrise	Season	Kitchen	Nation	Garden	Heaven
Chair	Table	Baby	Finger	Picture	Mountain

Step 2: Clock Drawing

Say: *"Next, I want you to draw a clock for me. First, Put in all of the numbers where they go." When that is completed, say, "Now set the hands to 10 past 11."*

Use preprinted circle (see next page) for this exercise. Repeat instructions as needed as this is not a memory test. Move to Step 3 if the clock is not complete within three minutes.

Step 3: Three Word Recall

Ask the person to recall the three words you stated in Step 1. Say, *"What were the three words I asked you to remember?"* Record the word list version number and the person's answers below.

Figure 2: The Mini-Cog test. There are two Mini-Cog© components that include a score for accuracy of "clock drawing" and "three-word recall," resulting in a cumulative score that can increase the detection of cognitive impairment. There are a total of five possible points for the test with three possible points for the three-word recall and two points for a normal clock. A total score of three or greater indicates a lower likelihood of cognitive impairment. Mini-Cog© copyright, Dr. Soo Borson (used with permission). See mini-cog.com for more detail.

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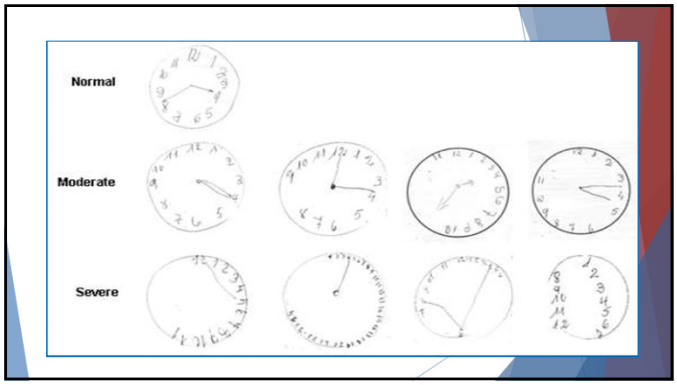

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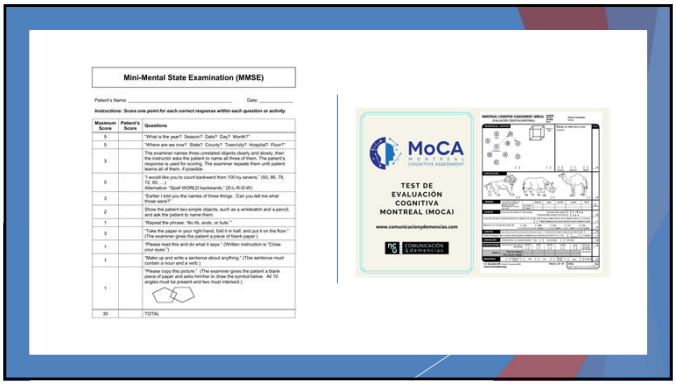

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Recommendations

3. Intraoperative

Table 4. Intraoperative Recommendations to Promote Postoperative Brain Health

- Avoid centrally acting anticholinergics, benzodiazepines, meperidine, and other drugs listed in Table 3
- Avoid relative hypotension
- Maintain normothermia
- Monitor age-adjusted end-tidal MAC fraction
- Use EEG-based intraoperative brain monitoring to titrate anesthetic administration

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Table 3. Medications Commonly Given by Anesthesiologists That Should Be Avoided or Used With Caution in Patients Over 65 Years of Age[23]

Medication or Class of Medication	Examples	Rationale for Avoiding
First-generation antihistamines	Diphenhydramine	Central anticholinergic effects
Phenothiazine-type antiemetics	Prochlorperazine, promethazine	Central anticholinergic effects
Antispasmodics/anticholinergics	Atropine, scopolamine	Central anticholinergic effects
Antipsychotics (first and second generation)	Haloperidol	Risk of cognitive impairment, delirium, neuroleptic malignant syndrome, tardive dyskinesia
Benzodiazepines	Midazolam, diazepam	Risk of cognitive impairment, delirium
Corticosteroids	Hydrocortisone, methylprednisolone	Risk of cognitive impairment, delirium, psychosis
H_2-receptor antagonists	Ranitidine	Risk of cognitive impairment, delirium
Metoclopramide		Extrapyramidal effects
Meperidine		Neurotoxic effects
Skeletal muscle relaxants	Cyclobenzaprine	Anticholinergic effects

Abbreviation: H_2, histamine 2 receptor.

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Recommendations

3. Intraoperative

"There was widespread agreement among the participants that anesthesiologists should use age-adjusted MAC fraction in older adults to adjust end-tidal volatile anesthetic concentration during surgery, which at least provides a population-derived starting point for dosing inhaled anesthetics".

"The current literature does not support the recommendation that a regional anesthetic technique should be used in place of (or in addition to) general anesthesia to reduce delirium or PND rates".

"A number of studies have examined whether using specific drugs to maintain general anesthesia affect the rates of various types of PND, but no clear consensus recommendations have emerged from these studies"

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Recommendations

4. Follow up

Table 1: Proposed Interventions To Mitigate Cognitive & Functional Decline

Intervention	Description
Core Intervention	
Daily visitor/orientation	Orientation board with names of care team members and schedule
Therapeutic activities	Cognitive stimulation three times daily
Early mobilization	Ambulation or active range-of-motion exercises three times daily
Vision protocol	Visual aids and adaptive equipment
Hearing protocol	Portable amplifying devices and special communication techniques
Oral volume repletion	Feeding and drinking assistance and encouragement
Sleep enhancement	Nonpharmacologic sleep protocols
Program Interventions	
Geriatric nursing assessment	Nursing assessment and intervention for cognitive and functional impairment
Interdisciplinary rounds	Twice-weekly rounds to discuss patients and set goals
Provider education	Formal didactic sessions, one-on-one interactions
Community linkages	Referrals and communication with community agencies to optimize transition to home
Geriatrician consultation	Targeted consultation referred by program staff
Interdisciplinary consultation	As needed consultation upon referral by staff

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Conclusions

- Potential association between surgery/anesthesia and POCD
- Patients with dementia (Alzheimer's) are at increased risk
- High quality studies are needed prioritizing pts with preexisting CD
- True effect of anesthesia
- Anesthetics with protective profile
- High priority in neuroscience
- Current recommendations to prevent/decrease are available

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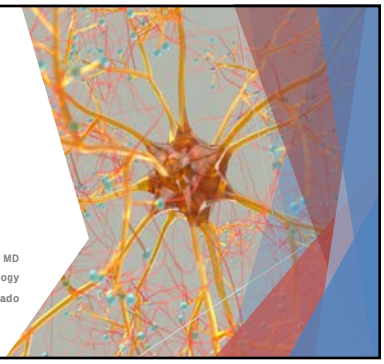
Colorado Review of Anesthesia for Subcutaneous Area Hospitals
Guiding the future of patient care

Awake Craniotomy Invasive & Minimally Invasive Procedures

Leslie C Jameson, MD
Clinical Professor Anesthesiology
Denver Colorado



1

The AWAKE Brain during surgery.

- Goal:
  - Maintain patients with neurologic disorders
    - Invasive Low Grade Glioma
    - Degenerative Movement Disorders (e.g., Parkinson's)
  - During awake or minimal anesthesia care!

Audacious

synonyms for audacious:
bold, brazen, daring, insolent, brave, impudent, fearless, adventurous, intrepid, venturesome

2

Medical Diagnosis that most frequently are scheduled for Awake Craniotomy -- 2022

Low Grade Glioma (LGG)

- Grade 1-2 for growth and infiltration rate
- 20% of all brain tumors
- New diagnosis/year est. 20,000
- All are ultimately fatal

Intractable Seizure Disorders

- Minimally invasive craniotomy—
- MRI and Computer technology
- (ROSA™) with general anesthesia
  - *Numbers Unknown --- Millions*

Movement Disorders (MD)

- Parkinson's disease (*930,000 to 1.3 million* ***US***) (Parkinson's Foundation)
- Essential Tremor (*10 million or 4% population age over 40 years*) (Rare Diseases Database)
- Tourette's Syndrome - childhood diagnosis estimate *138,000* (CDC)

Other

- Obsessive Compulsive Disorder
- Schizophrenia (Europe)

https://jamanetwork.com/collections/5759/movement-disorders

REVIEW

3

TABLE 1. Neurologic disease and suggested therapeutic DBS targets.

MEDICAL CONDITION	TARGETED NUCLEUS
Movement Disorders[3,5,6,22,33,34]	
Parkinson's Disease[5,22,33,34]	Subthalamic nucleus (STN), Globus pallidus internus (GPi), Ventral intermediate thalamus (Vim)
Essential Tremor	
Dystonia	
Tourette Syndrome[33]	Basal Ganglia
Neurologic Injury	
Intractable Epilepsy[6,22]	Centromedian thalamic nucleus (CMN), STN
Minimally Conscious State[33]	Hippocampus, Cerebellum
Chronic Pain[33]	Mesencephalic reticular formation, Centromedian–Parafascicular nucleus (CM-Pf) of Thalamus
	Suggested locations Periaqueductal grey and Periventricular grey (PAG/PVG), Centromedian intra-laminar parafascicular complex[33] (CMPf)
Psychiatric Diagnosis[5,6,8]	
Obsessive Compulsive Disorder[6,33]	STN, Ventral capsule/striatum, Inferior thalamic peduncle, Anterior limb of internal capsule
Medically Refractory Depression[8]	Ventral capsule, Ventral striatum, Brodmann area 25, Subgenual cingulate, Nucleus accumbens
Schizophrenia[8]	Hippocampus, Mediodorsal thalamus, nucleus accumbens, areas of prefrontal cortex

^ DBS a FDA approved therapy.

Uses DBS AWAKE or ASLEEP Technique

REVIEW

Discussion primarily uses *DBS for Parkinson's Disease and Essential Tremor comparable.*

4

Awake Craniotomy— Management Dilemmas

- *Anesthesiology practices vary with what "Awake" requires.*
  - *Patient Characteristics*
  - *Surgical Location and Technique*
    - ***Invasive*** *- Craniotomy--Supratentorial Tumor (LGG)*
    - **Minimally Invasive** *– "Electrodes" Placement (e.g., Deep Brain Stimulation)*
  - *BOTH have significant risk of severe permanent injury and death.*

Depiction of the "first" awake craniotomy.
Performed London UK 1886 by Sir Victor Horsley
Can J Anesth 2017 DOI 10.1007/s12630-017-0804-1

Language Testing during craniotomy

https://hum.hse.ru/en/news/225033213.html

5

Why should an intracranial procedure be awake?

Neurosurgeon

AWAKE Procedures MUST *allow neurologic function to immediately be identified, evaluated, and next action assessed.*

YOU KNOW WHEN TO STOP!

Issues: neurologic injury
patient resilience

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6

Surgical & Anesthesia's Team View

Even if patient can almost maybe follow directions (not necessarily perform the required activity —GO!!!!!!)

Why the total surgical commitment to an awake procedure?

Better patient outcomes!!!

7

Surgeon's and Neurologist's View- GO!!

Time for the Anesthesia Plan anyone?

8

Anesthesiologist View

1. **Absolute NO, NYET, FORGET IT, NEVER!!**
2. **Pretty close to NO-**
   Cannot/will not lay in position requested
3. **Not a good idea- Significant risk even with COLLABORATIVE plans**
   Significant medical illness that will make supine and unable to move a problem

9

Anesthesiologist during any AWAKE anesthetic.

- Entertainer
- Comedian
- Friend
- Student-Learn how to run a cattle ranch even when you have never seen one.
- Perform miracles
- Talk for hours about *anything*
- Learn to count-again and again and again and again then do nursery rhymes.
- Give drugs
- Discuss how to teach a 3rd grader to improve his reading skills when you don't have children.
- Restrain the patient
- Occasionally give DRUGS

REVIEW

10

Patient Evaluation For Awake Craniotomy

11

Low Grade Glioma - Patient Characteristics

- **young adults (mean age 37-41 years)**
- **good health**
- ***presenting symptom is seizure in 85%***
- medical complaints—headache, nausea/vomiting, diminished consciousness, weakness or numbness,
- **cognitive & emotional function irregularities**
  - "forgetting" words, *issues* at work--judgement
  - ***mood disorder—anger, anxiety, emotionally labile difficulty with working memory, attention***
- diagnosis requires imaging and **complete neuropsychologic evaluation** often obtained after first seizure.
- *Patient often appear to be using drugs*

International Review of Neurobiology http://dx.doi.org/10.1016/bs.irn.2017.04.006

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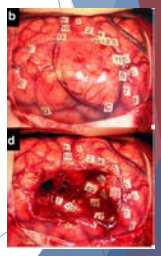
Glioma– Testing during procedure

- **Memory test:** Repeat language exercises
- **Cognition test:** Explain how two items are like. For instance, if you see a picture of a dog and a cat, you might answer that they're both animals or that they are both pets.
- **Verbal communication test:**
  - Identification-communication-Name items, given a letter of the alphabet and told to list words that start with that letter.
  - Spontaneous communication –Teach me to run a farm tractor
- **Motor tests:** Show fingers, wiggle feet, squeeze hand

Subjective: When have neuro deficit CAN remain calm!

REVIEW



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Low Grade Glioma-- Awake

Psychological Resilience

Can they tolerate RAGE, stress, PTSD symptoms, disorientation, anxiety yet remain *functional* and *calm*.

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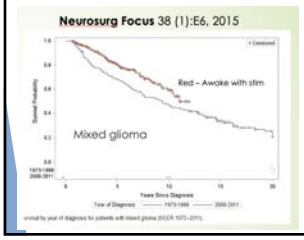
Surgeon's and Anesthesiologist view in Low Grade Glioma
We must !!!!



- Overall Survival about ***6 years*** in case of single biopsy
- Survival now is around ***14-15 years*** when **extensive tumor removal (Awake + Mapping) has been achieved at diagnosis**.

Neurosurgical Review https://doi.org/10.1007/s10143-020-01418-9 2020

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Low Grade GLIOMA

Awake surgery is currently the gold standard for cerebral mapping,because this is the sole technique enabling a direct identification of neural networks crucial for brain functions.

Neurosurgical Review https://doi.org/10.1007/s10143-020-01418-9 2020

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Patient Evaluation

Awake Deep Brain Stimulator Placement

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NEURO	**Depression, Dementia, Cognitive change, Hallucination/Delusions Vertigo, Visual changes**
	DOI 10.1007/s40265-016-0600-5 DRUGS 2016
Airway, Head & Neck	**Pharyngeal muscle weakness**, Chronic aspiration
Cardiovascular	***Autonomic instability*** Orthostatic Hypotension, Hypertension/Hypovolemia CAD, Vascular Disease
Respiratory	***Chest wall rigidity*** causing restrictive lung disease, Poor cough to chronic cough, COPD, Asthma, OSA
Gastrointestinal	Obesity to morbid obesity **Gastroparesis**, **Dysphagia**,
Endocrine	Diabetes, Type II Additional abnormal glucose metabolism (selegiline)
Pain	**PAIN–Chronic, Mild To Severe Need to think adjunct drugs**

https://www.parkinson.org/understanding-parkinsons

Movement Disorders

Primarily Parkinsons' Disease

Common Medical Conditions & Risks PRESENT for any surgical procedure.

REVIEW

18

Common Medications (Standard in Parkinson Disease)

- Artane, Azilect, Cogentin, Comtan, Dopar, Larodopa, Mirapex, Neupro, Requip, Sinemet, Tasmar (just some)

Common drug regimen includes 3-7 drugs often as every 3 hours 24/7

- As Meds fail—cycling—"break through events"
- (Symptoms so severe place NG tube during long routine surgical cases to give meds)

- Newer surgical philosophy has shifted DBS treatment to early not rescue end stage treatment
- *Moving toward an "offer" when start medications before severe disability*

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REVIEW CONCEPT

Whenever Drugs are withheld

- **Dopamine Agonist Withdrawal Syndrome (DAWS)** include
  - anxiety, *PANIC ATTACK*, dysphoria, obsessive, restlessness hallucinations (often mistaken for confusion)
  - fatigue, DYSAUTONOMIA, sleep disturbance,
  - generalized pain, ***SEVERE RIGIDITY***, *dyskinesia*
  - *INCREASED CV LABILITY (HR, BP)*
  - Urgent Periop Treatment TREATMENT: **APOMORPHINE** sublingual (FDA release 5-2020)
- PAIN increased by psychostimulant withdrawal syndromes

MOVEMENT DISORDERS

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Reported success with DBS

MEDICAL CONDITION	EFFICACY
Parkinson's Disease Essential Tremor Dystonia	47-98%, average 88% Awake 78%, Asleep 69.7% (NS-all)
Tourette Syndrome-	52%
Obsessive Compulsive Disorder	40-70%
Medically Refractory Depression (Asleep)	40-70% (Europe)

Credible Evidence-- Better outcomes today

21

There are Times to say LATER or NO

- Patient must have reasonable control of the medical issues
- Primary issue is autonomic instability

Prior to entering OR if have

- extreme hypertension
- Poorly controlled ominous cardiac rhythm
- PSTD – usually cannot do MRI without anesthesia/drug assistance

- Fix it first or do it anesthetized with the right drugs!

ALL or NOTHING

WHY?

- Overall, 67% improvement (p=0.003)
  - Medication reduction
  - Motor exam improved
  - Reduction in off-cycle
  - Motor activity fluctuation
- Change in symptoms *equivalent* if procedure awake or asleep with DBS placed in
  - STN, Globus Pallidus, Ventral Intermedius Nuclei
- ***Specific*** Surgeon—have the same results whether the patient is Asleep or Awake.
- Neuromodulation: Technology at the Neural Interface DOI: 10.1111/ner.13061, *2020*

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CRASH
Colorado Review of Anesthesia for Subcutaneous And Hospitals
Guiding the future of patient care

How do we manage the anesthetic?

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23

Anesthesia Decisions

Cannabinoids

They are commonly used to self medicate particularly emotional disorders in

ALL AGES

PLEASE READ!

Cannabis Use Disorder (CUD*) RX Marinol, Casamet

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Cannabis Use Disorder (CUD*) and Awake Craniotomy

- Baseline use: daily with 2-9 joints/day in studies
- up to 40% of regular cannabis users develop moderate-severe CUD*
- Withdrawal symptoms: (DSM10, 2015) --Three or more symptoms within a week
  - Irritability, anger, aggression,
  - Nervousness or anxiety or depressed mood, restlessness, vivid dreams
  - Physical Symptoms: abdominal discomfort Pain, tremor, sweating, fever, chills, headache
  - Increased appetite, weight loss, insomnia

*Neuropsychopharmacology Reviews (2018) 43, 173-194; doi:10.1038/npp.2017.212;

*CNS DRUGS 2018 HTTPS://DOI.ORG/10.1007/S40363-018-0577-6.

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FDA approved Synthetic Cannabinoids

Possibly Useful—Rescue drugs for NV

Dronabinol (**Marinol**)-- activates cannabinoid receptors

- Schedule III, 1985 for Chemotherapy Nausea and Vomiting (5-15mg/m² to 6X/day)
- EFFECTS: Decrease *symptoms of withdrawal at 40mg to 90mg doses* (N=41 multiple studies)

Nabilone (**Casamet**)

- Schedule II, 2006 for Nausea and Vomiting, 1-2 mg q8-12 hours ca
- Effects: Decrease *symptoms of withdrawal at 1 to 10 mg* (N=30)

CNS DRUGS 2018 HTTPS://DOI.ORG/10.1007/S40363-018-0577-6.

Neuropsychopharmacology REVIEWS (2018) 43, 173-194

26

Awake Craniotomy In the Operating Room

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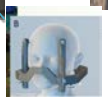
Low Grade Glioma AND DBS

Can I rescue this airway? NO?

Then Awake means AWAKE!!!!

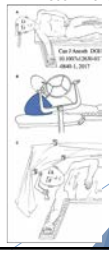
- Supratentorial Glioma—Position

NO!! Who could do cognitive assessment anyway?



LMA vs Tracheal Tube

Recommended



Must be able to ventilate and interview!!!!

28

FOOLHARDY

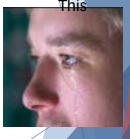
To prescribe an anesthetic technique to this learned group.

This is more of a remember moment!

29

Anesthesia Care

This



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Glioma

Resilience

30

Anesthetic Choices -Low Grade Glioma (LGG)

- **Awake + Charm+ Field Blocks* *Sedation*
- Asleep ➔ Awake ➔ Asleep
  With or without breathing device (56%)
- *Sedation* ➔ *Awake* ➔ *finish Awake* or
  ➔ finish Asleep +_Airway (15%)

Asleep Group: 82% LMA to start and finish with 71% LMA/29% tube to finish

Determined by Neurosurgical desires & Anesthesia skills = Choice

Acta Neurochirurgica (2020) doi.org/10.1007/s00701-020-04274-0, CAN J Anesth (2017) DOI 10.1007.s12630-0840-1

31

Fantasy Anesthetic Goal (MY Organization's)

How awake are they????

Must be awake enough to read Brave New World while doing a quadratic equation and teaching you how to become an Olympic Skier or fix a car motor or…….

Language – No delays
- Speech-spontaneous without word salad
- Judgement: Identifying objects and use
- Memory- show word-pick word
- Attention
- Emotional control

Blood Pressure is below 140 systolic --Period

32

ANY GLIOMA "Awake" scenario

- **Blood Pressure Below 140 mmHg**:
  - Intravenous **calcium channel blockers**
  - (Nicardipine, Clevipprex (has rebound hypertension associated with it's use))
  - **Beta Blockers NO!, NO!, NO! if DBS**
  - Direct vasodilator, **hydralazine,** *nitroprusside, nitroglycerine*
  - TINY tiny tiny doses of fentanyl OR remifentanil
- Sedation until "done" then ***let the airway be your guide***.
  - Consider LMA when positioning
  - USUALLY narcotic & propofol or dexmedetomidine or Maybe both
- ***Calm***
  - On the operating room table
  - **NEVER HAVE MENTAL STATUS CHANGE (FOR VERY LONG) FROM DRUGS ADMINISTERED during mapping and resection.**

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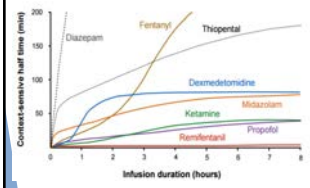
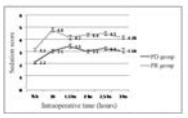
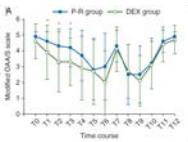
Procedural Management - Drug Action Technique & Procedural Goals





Minerva Anestesiologica 2017 DOI: 10.23736/S0375-9393.17.11873-0



British Journal of Anaesthesia, 116 (6): 811-21 (2016) DOI:10.1093/BJA/AEW024

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Common Drug Combos that Work

Propofol-remifentanil
- **May have airway issue, Short duration**

Dexmedetomidine
- **Less arousable, better airway**

Low dose Ketamine INFUSION only.
(doi: 10.1097/ALN.0000000000003529)

	Onset	Peak effect Minutes	Half life Minutes	Duration Minutes	Conclusion
Propofol+ Remi	15-30 sec	6	30-40	5-10	Short
Dexmedetomidine	5 min	15	120	120 to 180	Long-very long

35

Universal Surgical Advantages of Awake Craniotomy

OVERALL BENEFITS—SURGICAL

Tumor--Better *overall* preservation of motor, speech, executive and emotional functions

IMMEDIATE detection of pending injury (damage to eloquent areas, hemorrhage, seizure, stimulation complications

Reduced postoperative neurologic deficits

Shorter hospitalization

?Less physiological disturbance in medically frail or emotionally labile patients leading to rapid recovery?

CNS DRUGS 2018 HTTPS://DOI.ORG/10.1007/S40363-018-0577-6
Can J Anesth (2017) 64:517-529 DOI 10.1007/s12630-017-0840-1

REVIEW

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DBS -- How awake?

15,42/106,120/206,228/323-342

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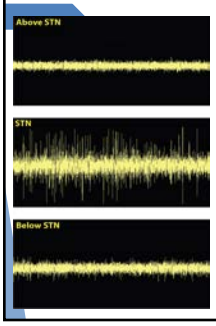
MER—MicroElectrode Recording



End Goal for STN placement

The subjective grading and *objective* change (program calculations)

- tremor
- paresthesia
- dysarthria
- Reduction in rigidity (bradykinesia)

with stimulation

38

Requirements in My Practice—Deep Brain Stimulation

- Blood Pressure Below 140 mmHg:
  - Intravenous **calcium channel blockers**
  - (Nicardipine, Cleviprex (has rebound hypertension associated with it's use)) ***NO BETA BLOCKER -movement disorder primarily***
  - Direct vasodilator, **hydralazine,** *nitroprusside, nitroglycerine*
  - TINY tiny tiny doses of fentanyl OR remifentanil
- NEVER HAVE MENTAL STATUS CHANGE (FOR VERY LONG) FROM DRUGS ADMINISTERED.
- Patient with Rigidity symptoms –
  - NEVER Remi with symptoms of rigidity, tardive dyskinesis, myotonia
  - NEVER use a beta blocker in movement disorders—ends MER testing

39

Any Patient taking Levodopa
DRUGS TO AVOID—*Period!!!*

Triggers DAWS

NEVER DRUGS

- **Droperidol**
- **Metoclopramide**
- **Compazine**
- ***Haldol***
- **Psychiatric Drugs which Deplete Dopamine**
  - **(e.g. tetrabenazine)**

- OK AT LOW DOSE
  - **Ondansetron**

Another excuse for Marinol, Casamet

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Effect on MER Activity
HYPNOTICS

REVIEW

DRUG	ADVANTAGES	DISADVANTAGES
Hypnotic Drugs		
~~Benzodiazepines##~~	~~Anxiolysis~~ ~~**Single dose.**~~	~~*Abolishes MER.*~~ ~~Alters stimulation threshold.~~
Propofol##	Predictable, short acting **EASY TO TITRATE!!!** **CONSISTANT EFFECT,** **RAPID RECOVERY**	Abolishes tremor Decease MER firing Respiratory depression RAPID RECOVERY
Dexmedetomidine	**Selective α2-adrenoceptor agonist** ~~low dosage small MER effect.~~ ~~Anxiolytic and analgesic.~~ ~~Maintain spontaneous respiration.~~	Attenuates MER at high doses. *(0.7mcg/kg/hr.)* ~~Long-acting~~ ~~Hypotension, bradycardia.~~ ~~**DURATION**~~ ~~**LOCKED IN SYNDROME**~~
Etomidate##	~~Minimal BP, HR effects.~~ ~~Predictable **Single dose.**~~	~~***Abolishes MER***~~ ~~Adrenal Suppression.~~

41

Effect on MER Activity
Analgesia

REVIEW

DRUG	ADVANTAGES	DISADVANTAGES
Analgesic and Opioids		
Fentanyl	**Minimal effect on MER**	*Rigidity*, hypoventilation, apnea
Remifentanil	**Minimal effect on MER** Rapid acting	Suppression of tremors ***Rigidity exacerbated in tardive dyskinesia*** (potent, fast)
Sufentanil	**Minimal effect on MER**	*Rigidity*
Ketamine** INFUSION only 5-15 mg/hour	NMDA receptor antagonist Maintenance of spontaneous respiration Analgesic **Preservation of MER**	~~Transient increase in ICP.~~ ~~Hypersalivation.~~ ~~Hyperreflexia.~~ ~~Muscle hypertonicity.~~ Hemodynamic variability? Agitation?

Caution with rigidity. Slow and Small doses but effective for hypertension.
Rigidity can be reversed by Narcan, NARCAN NOT EFFECTIVE WITH REMIFENTANIL

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Effect on PARKINSONS SYMPTOMS
Anything that decreases MER

DRUG	ADVANTAGES	DISADVANTAGES
Anti-hypertensive		
Beta Blockers	Attenuation of tremor for symptom control	**Attenuates tremor, MER**
Nicardipine	Fast, Titratable intravenous	Uses infusion pump
Hydralazine	Direct vasodilating drug, bolus administration	Intermediate acting Intravenous formulation
Antiemetic/Psychiatric		
Ondansetron	antiemetic	**Extrapyramidal side effects**
MARINOL/ CASMET	RESCUE ANTIEMETIC CHEMO-- EFFECTIVE	**NONE REPORTED**
Dexamethasone	Best antiemetic	None

REVIEW

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D O N E

44

A Multidisciplinary Approach to Preoperative Assessment of Complex Surgical Spine Patients

Julio Montejano MD
Neuroanesthesia Fellow
University of Colorado School of Medicine Dept. Anesthesiology

1

Disclosures

- None

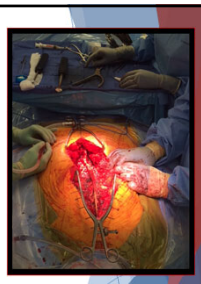
2

Learning Objective

- Describe preoperative evaluation and intraoperative goals in patients undergoing spine surgery with complex medical and surgical features.

3

What is Complex Spine Surgery?



- Surgery involving 2 or more levels of the spine
  - Associated with cardiac and pulmonary events, stroke, wound complications, prolonged hospitalization, high readmission rates, and often discharge to rehab facilities
  - Surgery to correct deformity in patients often includes 5 or more levels with major instrumentation
  - Patients with pre-existing hardware that will be removed or is infected should also be considered complex
- >400,000 patients undergoing spinal fusions each year in the US Lumbar fusion is the most common procedure followed by cervical and thoracic spinal fusions

4

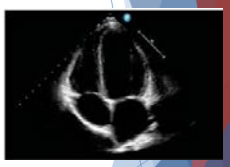
Preoperative Evaluation

- Reduced case-delays and cancellations
- Decreased hospital length-of-stays and lower in-hospital mortality rates

- Physical exam, review of medical history, risk assessment, indicated laboratory testing and imaging
- High risk surgeries will need preoperative testing
  - Hemoglobin, platelet count, electrolyte panel including baseline glucose, coagulation studies and a type and screen
  - Screening for osteoporosis and nutritional testing
  - Other testing per patient history

5

Cardiac Assessment



- EKG is not routinely indicated unless prompted by the patient's history
- In patients in whom functional status cannot be accurately assessed TTE and other non-invasive testing may be indicated, such as pharmacologic stress testing
- The Gupta Index is one tool to assess risk for perioperative myocardial infarction (MI) and cardiac arrest (CA)
- The American College of Surgeons (ACS) developed an online Surgical Risk Calculator (SRC) which assesses individual risk for twelve different adverse events
  - The result is a visual representation of relative risk including death or discharge to nursing or rehab facility

6

Pulmonary Assessment

- Baseline spO2 should be obtained in clinic and day of surgery
- PFTs are not routinely performed unless indicated by the patient's history
- ARISCAT pulmonary risk calculator predicts the likelihood of pulmonary complications
  - Pneumonia, respiratory failure requiring intervention such as reintubation or prolonged intubation
  - Highest risk group have a 44% risk of pulmonary complications throughout the perioperative period
  - Age, preoperative SpO2, respiratory infection within one month, anemia, surgical incision site, duration of surgery and emergency surgery are considered

7

Functional Status Assessment

- If ≥4 Metabolic Equivalents of Task (METs) are reported without symptoms no further cardiopulmonary testing is indicated
  - Examples include strenuous housework, mowing the lawn or walking up a flight of stairs
- This patient population is often limited in their functional status either due to pain, deformity or weakness
- If functional status cannot be satisfactorily assessed pharmacologic stress testing would then be indicated

8

Identifying Patients at risk of DVT/PE

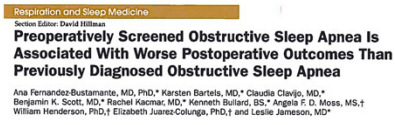
- The most commonly used calculator is the Caprini Score and it is available on-line
- Lowest risk score (0) need only early ambulation
- Patients with the highest risk scores (≥8) are recommended to have compression boots and prophylactic anticoagulation for 30 days total.

9

Obstructive Sleep Apnea Risk Assessment

- Patients with untreated OSA have a significantly higher rate of postoperative pulmonary complications, longer hospitalizations and higher risk of mortality
- Complications can be reduced by preoperative diagnosis and implementation CPAP therapy
- The STOP-Bang assessment tool is sensitive for OSA
  - Patients with a positive STOP-Bang identified Mild OSA (AHI>5) in 84% of cases, 93% of moderate OSA (AHI>15) and 100% of severe OSA cases (AHI>30)
  - Low specificity(37-56%), patients with high scores should proceed with formal testing

10


Respiration and Sleep Medicine

Section Editor: David Hillman

Preoperatively Screened Obstructive Sleep Apnea Is Associated With Worse Postoperative Outcomes Than Previously Diagnosed Obstructive Sleep Apnea

Ana Fernandez-Bustamante, MD, PhD,* Karsten Bartels, MD,* Claudia Clavijo, MD,* Benjamin K. Scott, MD,* Rachel Kacmar, MD,* Kenneth Bullard, BS,* Angela F. D. Moss, MS,† William Henderson, PhD,† Elizabeth Juarez-Colunga, PhD,† and Leslie Jameson, MD*

11

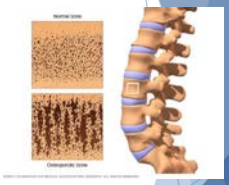
Frailty as a Predictor for Surgical Outcomes

- Poorly defined high-risk state portends negative surgical outcomes across all patients
  - It has been described as a pre-existing pro-inflammatory state characterized by increased levels of cytokines such as IL-6, TNF-alpha and CRP as well as hormonal derangements including elevated cortisol and insulin resistance
- Frail patients have increased rates of mortality (18% vs 3%), readmissions, falls and disability
- There are dozens of calculators aimed at identifying frail patients
  - Modified FI (mFI) 5 has been shown to be predictive of postoperative complications

12

Nutrition and Osteoporosis

- Vitamin D levels, albumin and pre-albumin can be obtained
- DEXA scans will be routinely obtained by the surgical team
- The Nutritional Risk Index (NRI) takes into account a patient's albumin, pre-albumin and BMI
  - A modified index exists for elderly patients (GNRI) and takes into account the changes in lean body mass
- The use of high protein oral nutritional supplements has been associated with decreased post-operative complications, decreased length of hospitalization and decreased admission costs
- High dose vitamin D supplementation is usually indicated
  - Referral to endocrinology should be considered in severe cases



2022

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Glycemic Control

- Baseline blood glucose should be obtained
- Patients at risk for diabetes are screened with a HgbA1c
  - Risk factors include age >45, sedentary lifestyle and obesity
- Hyperglycemia (glucose >180mg/dL) and poorly controlled diabetes mellitus (DM) have been shown to increase the morbidity and mortality of spine surgical patients
  - Poorly controlled or uncontrolled DM Hgb A1c >7 and >9 increases risk of surgical site infections (SSI)

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Identifying and Treating Anemia

- Screening patients for anemia, thrombocytopenia and coagulopathies is recommended
- Patients with preoperative anemia (in men Hgb<13 and women Hgb<12) have increased need for transfusions, perioperative mortality, morbidity and cost
- Iron studies should be performed to identify iron deficiency
- Iron supplementation should be implemented
  - The effects of oral iron supplementation are delayed
  - Presurgical patients typically qualify for IV iron therapy
- Iron supplementation should be administered weeks in advance

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Smoking Cessation

- Nicotine testing is indicated in patients with a history of smoking to assure cessation
- Patients are more likely to quit in the perioperative period
- Smokers have an increased 30-day mortality and major morbidity including pulmonary complications, infection, ICU admissions, wound complications, neurologic complications and septic shock
  - Following spine surgery, smoking is a significant predictor for postoperative infections and non-unions after fusion
  - Increased post-operative pain scores and opioid consumption
- Cessation can decrease these effects to near non-smoker levels
- Even brief periods of cessation can be beneficial in reducing wound and pulmonary complications

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Pre-habiliation Programs: PREPARE

- Presurgery physiotherapy can decrease pain, risk of avoidance behavior, and worsening of psychological well-being, and can improve quality of life and physical activity levels before surgery
- PREhabilitation, Physical Activity and exercise Trial
  - a physiotherapeutic person-centered prehabilitation program based on a cognitive behavioral approach
  - The prehabilitation phase should start 8 to 12 weeks before surgery
  - Even "conventional care" shows a positive effect in improving outcomes

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Complex Plus

RED CASES (Complex)
Examples of red cases based on surgical complexity: EBL > 1000 cc

- Any case crossing a spine segment junction (Occiput – Cervical, Cervical – Thoracic, Thoracic – Lumbar; i.e. C2 – T2 posterior fusion, T4 – Ilium posterior fusion, T10 – Ilium posterior fusion)
- Any cases where a pedicle subtraction osteotomy is planned
- Any cases where multiple Smith-Peterson (or Ponte, Chevron, etc) ostomies are planned
- Any case where a corpectomy is planned (cervical, thoracic, or lumbar)
- Multilevel (more than 2 levels) anterior posterior cervical spine
- Lateral approach for a thoracic spine surgery with or without a double-lumen tube
- Tumor resection surgery (Separation surgery with stabilization, tumor resection, tumor stabilization with RFA)
- Secondary Cancer Procedures: Large tumor resection involving spine infiltration performed with other services (eg. Thoracic, Urology, GYN)
- Infection cases where extensive debridement/bone resection work will be done with concern for sepsis and/or high blood loss
- Any case deemed "complex" or "deformity correction" by the surgeon

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Our Model: Complex Spine Conference

- Using EPIC Procedure Pass to identify patients
- Patients are discussed weeks to months in advance to allow ample time for interventions to be performed if needed
- Weekly to Bi-Monthly Meetings to discuss upcoming cases
- Representatives from all ortho spine clinics are present
- Representatives from the Neuroanesthesia team are present and discuss patients from a medical perspective
- Preprocedure services, Social work and chronic pain also involved
- Pre-Anesthesia Clinic Visit is compulsory
- Labs, testing and Imaging are reviewed
- Follow up and coordination of repeat labs, indicated testing and referrals
- Surgery team then performs in depth planning for the surgery
- Patients are then stamped with a seal of approval if no other interventions are needed

19

Improvements, Challenges and Future Directions

- Procedure Pass identifying patients and missing urgent cases
- Challenges
  - COVID-19 pandemic
    - Patients with stable deformity may deteriorate due to postponement of surgical intervention
  - Coordinating out of state care
    - Referral center
    - Difficulty coordinating care or having patients travel to be seen at UCH
- Involvement of other ancillary services such as nutrition, PT and OT, chronic pain, and pain psychiatry

20

Question

- How is the preoperative evaluation of Complex Spine surgery patients different than that of patients undergoing other major surgery?

21

CRASH
Colorado Review of Anesthesia for Subscriptions And Hospitals
Guiding the future of patient care

Questions?

Anesthesiology
University of Colorado
Anschutz Medical Campus

22

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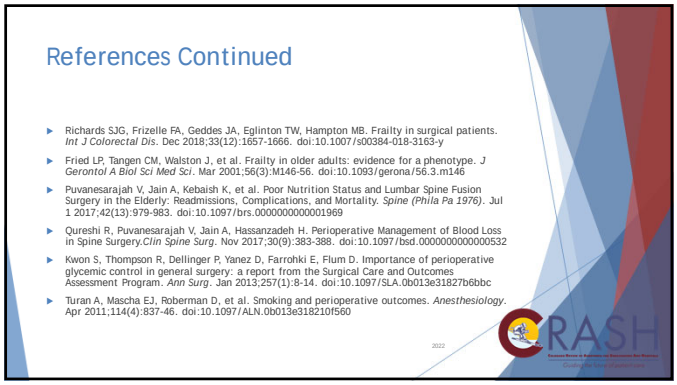
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2022
CRASH

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Trauma Panel 2022

Drs. Bethany Benish, Ryan Laterza and Steve Bourland

1

No financial disclosures

2

Trauma Anesthesiologist Panel:

Dr. Bethany Benish

Dr. Ryan Laterza

Dr. Steve Bourland

3

Panel Objectives:

- Discuss some hot topics & controversies in Trauma Anesthesia
- Review volume resuscitation principles and techniques in trauma care
- Discuss some principles/techniques of pain control/regional anesthesia in trauma population

4

What's New in Trauma Anesthesiology?

Bethany Benish MD
Associate Professor CUSOM
Associate Director, Director of Trauma
Denver Health Medical Center

5

Trauma Anesthesia Update

Objectives of my talk:

- Brief review of Acute Coagulopathy of Trauma & Damage Control Resuscitation
- Discuss transfusion strategies, including component ratios & Whole Blood
- Discuss the controversial role of TXA in trauma
- Review the role of ECMO in trauma

6

Trauma Epidemiology

- Trauma remains the 4th leading cause of mortality in the U.S.
- Major cause of mortality worldwide, responsible for nearly 5 million deaths annually
- Leading cause of years of potential life lost prior to age 65 years, exceeding heart disease and cancer

7

Challenges in Trauma

- Prehospital care
- Prompt Recognition of need for surgery
- Airway Management
- Safe Induction
- Hypoxia/lung injury
- Cardiac injury (tamponade, contusions, failure)
- Neurologic injury—TBI, SCI
- Postop complications….MOF, long term M&M, pain

Exsanguination due to uncontrolled bleeding is the leading cause of potentially preventable deaths among trauma patients

8

Acute Coagulopathy of Trauma

- Massive hemorrhage accounts for over 30% of trauma deaths
  - Outcomes have improved for bleeding trauma patients in the last 20 years (MTP, Ratios, Damage Control Resuscitation) but not for those who arrive in severe shock
- 1/3 of trauma patients are coagulopathic on arrival to Emergency Department
- Acute Coagulopathy of Trauma
  - Develops very rapidly following tissue trauma and hemorrhagic shock → hypocoagulation and hyperfibrinolysis
- Independent predictor of transfusion, multi-organ failure and mortality
  - In patients with the same Injury Severity Score, the presence of coagulopathy nearly doubles mortality

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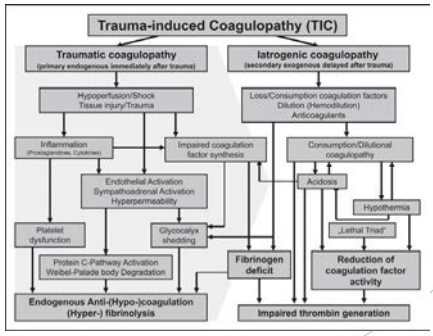

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Management of Bleeding Trauma Patients

Damage Control Resuscitation:

- Permissive hypotension
- Correction of both endogenous & iatrogenic causes of coagulopathy
  - Minimizing crystalloid
  - Early & high ratio FFP, Platelets
  - TEG/ROTEM goal directed management of traumatic coagulopathy

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Hemostatic Resuscitation & MTP

Massive Transfusion Protocols

- Predefined ratios delivered by blood bank
- Reduces provider variability, facilitates staff communication and compliance
- MTPs are effective in decreasing mortality in trauma
- Best if blood is readily available (thawed) in trauma bay when patient arrived
- Faster blood product delivery, better outcome (duh!)
  - Every minute from MTP activation to arrival of 1st cooler → increases odds of mortality by 5%

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Let's talk Ratios…

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Transfusion Ratio Studies:

Borgman & Holcomb et al '07: Retrospective Review

- High Plasma to RBC ratio (1:1.4)→ independently associated with survival, decreased death from hemorrhage

PROMMTT Study Holcomb et al. '13

- The PRospective, Observational, Multicenter, Major Trauma Transfusion Study (PROMMTT)
- First 6 hours, patients receiving ratios of less than 1:2 (FFP: RBC) were 3-4 times more likely to die than those receiving 1:1 or higher

J-OCTET '16 (Japanese Observation Study for Coagulation and Thrombolysis in Early Trauma)

- Transfusion of FFP/RBC ratio 1:1 or higher within first 6 hours reduces death by 60%

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PROPPR Trial

Holcomb et al '15: PROPPR Trial

- RCT, 480 Pts. 1:1:1 vs 1:1:2 (Plasma:Platelet: pRBC)

Conclusions:

- No significant mortality difference at 24 hour or 30 days (significantly underpowered for mortality differences)

But:

- In 1:1:1, faster hemostasis and decreased death due to exsanguination in first 24hrs, similar complications rates to lower ratio protocol

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Conclusions on Ratios…

- Sufficient evidence to support **high ratios of plasma and platelet** transfusion to improve survival and decreased hemorrhagic death
- MTP should utilized between 1:1:1 and 1:1:2 ratios (Plasma: Platelet : RBCs)

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What about whole blood?

Better than the sum of its parts?

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What does "whole blood," reconstituted in a 1:1:1 ratio of pRBC, PLT, FFP, actually contain?

A. **680 mL, HCT=29%, PLT= 80K, Coag Factors=65% (of original)**
B. **800 mL, HCT=32%, PLT= 100K, Coag=75%**
C. **600 mL, HCT=37%, PLT=140K, Coag=85%**
D. **500 ml, HCT=43%, PLTs=150-400K Coag Factors=100%**

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History of Whole blood

- **Whole Blood (WB)** was the traditional transfusion product in military trauma since WWII
- **Component therapy** was introduced in 1960s. By 1990—only component therapy in civilian hospitals
- WB resurfaced in global war on terror in the form of "*walking blood bank*"
- Source of platelets in a field expedient fashion

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WB studies:

- **Spinella et al '09**. Retrospective Military study, 354 pts
  - Warm Fresh Whole Blood (WFWB) group: (100 pts; 28%)
  - Component Therapy (CT) group: RBC, plasma, aPLT no WFWB (254 patients; 72%)
  - Primary outcomes: 24 hr. and 30 day mortality

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Spinella, et. al. WFWB: Results

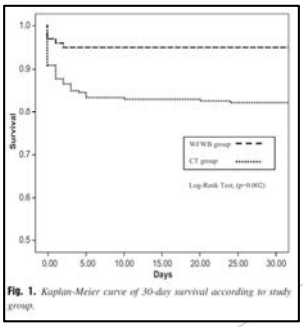

Fig. 1. *Kaplan-Meier curve of 30-day survival according to study group.*

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Spinella et al Conclusions:

- "It is our belief that WFWB is more efficient than stored CT at correcting coagulopathy and shock in [trauma patients]…"
- WFWB is a more concentrated product than CT to prevent/correct shock and O2 debt in critically ill patient
- Minimizes adverse effects of transfusion of "storage lesion" of older RBCs.
  - WFWB group received less anticoagulants and additives than CT group.

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Civilian Literature:

- Civilian study, Single Center (Houston), RCT, modified Whole Blood, '13
  - 55 Cold Whole blood vs 52 Component Therapy

Conclusions:

- No significant survival advantage
- Compared with CT, WB significantly reduce transfusion volumes (11 vs 16 units) in severely injured patients predicted to receive massive transfusion

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Cold-stored WB vs CT

- Two center, Case matched, Retrospective Study comparing CWB to CT ('19)
  - Endpoints:
    - Trauma bay mortality
    - 30-day mortality
    - Lab values at 4 hours and 24 hours
    - Overall blood product utilization
  - 91 Patients CWB vs 182 CT
    - Significantly lower death in trauma bay vs CT (2.2% vs 8.8%), higher mean Hgb at 24hrs
    - No difference at 24hr or 30-day, no difference in transfusion requirement

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Outcomes in WB National Trauma Database

- Nationwide Analysis, Retrospective Review Civilian trauma
  - 280 (WB +CT) vs 8214 (CT only)
    - WB group: significantly lower 24hr Mortality (17% vs 25%)

Authors' Conclusions:

- "The use of WB as an adjunct to CT is associated with improved outcomes in resuscitation of severely injured civilian trauma patients. Further studies are required to evaluate the role of adding WB to massive transfusion protocols"

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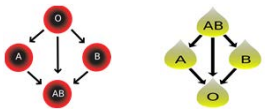
What about risks?



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Myths/Challenges with WB:

- **WB (both cellular and AB components) needs to be ABO matched to its recipient**
  - **Solution: Low Titer O WB (male O donors with low AB titers)**
- **WB must be leuko-reduced, which destroys platelets**
  - New platelet-sparing leukoreduction filters preserve platelets
- **Cold storage of WB destroys platelets**
  - Platelet lifespan is reduced from 7days to 2-4 days with cold storage
  - "Cold activated platelets"
    - Cold storage (4°C) **better pro-thrombotic product** than room temperature storage

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Initial safety and feasibility of cold-stored uncrossmatched whole blood transfusion in civilian trauma patients

Mark H. Yazer, MD, Byron Jackson, MD, Jason L. Sperry, MD, Louis Alarcon, MD, Darrell J. Triulzi, MD, *and* Alan D. Murdock, MD. *Pittsburgh, Pennsylvania*

BACKGROUND: The transfusion of cold-stored uncrossmatched whole blood (WB) has not been extensively used in civilian trauma resuscitation. This report details the initial experience with the safety and feasibility of using WB in this setting after a change of practice at a Level 1 trauma center was instituted.

METHODS: Up to two units of uncrossmatched group O positive WB that was leukoreduced using a platelet-sparing filter from male donors were transfused to male trauma patients with hypotension secondary to bleeding. Hemolytic marker haptoglobin and reports of transfusion reactions in these patients were followed. Additionally, transfusion volumes and outcomes were compared to a historical cohort of male trauma patients who received at least one red blood cell (RBC) unit, but not WB, during the first 24 hours of admission.

RESULTS: There were 47 WB patients who were transfused with a mean (SD) of 1.74 (0.61) WB units. The median haptoglobin concentration on post-WB transfusion Day 1 was 25.1 (9.3) mg/dL in 7 of 30 non-group O recipients. No adverse reactions in temporal relation to the WB transfusions were reported. There were 145 male historical control patients identified who were resuscitated with component therapy; the median volume of inconspicuous plasma transfused to the WB versus component therapy group was not significantly different (1,000 vs. 800 mL, respectively; $p = 0.38$); the mean plasma:RBC (0.99[0.47] vs. 0.77[0.73], respectively; $p = 0.006$) and platelet:RBC (0.72[0.40] vs. 0.51[0.754], respectively; $p < 0.0001$) ratios were significantly higher in the WB group.

CONCLUSION: Transfusion of two units of cold-stored uncrossmatched WB is feasible and seems to be safe in civilian trauma resuscitation. Determining the efficacy of WB with regard to reducing the number of blood products transfused in the first 24 hours or improving recipient survival will require a larger randomized trial. *J Trauma Acute Care Surg.* 2016;81: 21–26. Copyright © 2016 Wolters Kluwer Health, Inc. All rights reserved.)

LEVEL OF EVIDENCE: Therapeutic study, level IV.

KEY WORDS: Whole blood; transfusion; trauma; resuscitation; hemorrhage.

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Whole blood therapy

- storage at 1-6 °C
- Up to 35 days
- LTOWB—Low levels of anti-A and anti-B IgM
  - O pos male donors for all males and females over 50
  - O neg WB for females of child-bearing age
- Content WB 500mL
  - HCT 38-50
  - Plt 150-400K
  - 100% of plasma coagulation factors
  - 1g Fibrinogen

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Conclusion on WB:

- **Promising studies using cold stored LTOWB as well as Warm WB**
- **WB is better than the sum of its parts**
  - **Lower transfusion requirements**
  - **More concentrated than components**
  - **Survival advantage**
- **Safe (decades of evidence)**
- **Stored up to 35days (platelet function diminishes over time)**
- **Role in Prehospital care**
  - minimizes product/factor delays in critical first hour of trauma
- **Minimized delays in transfusion**

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Whole Blood at Denver Health

- 4 bags of Whole Blood on arrival (in ED fridge)
- Followed by balanced component resuscitation

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Next controversy: TXA in trauma patients

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Tranexamic Acid (TXA)

- Synthetic derivative of Lysine, irreversibly inhibits the proteolytic action of plasmin on fibrin clot and platelet receptors
- Inhibits fibrinolysis

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What is Hyperfibrinolysis?

- Incidence varies widely in trauma literature
  - 2-15% of trauma patients on arrival
  - 34% of trauma patients requiring massive transfusion (DHMC study)
- Hyperfibrinolysis *independently and significantly* predicts mortality in trauma patients
- Associated with very high mortality (70-100%)
  - Even low levels of hyperfibrinolysis predicts poor outcome in trauma

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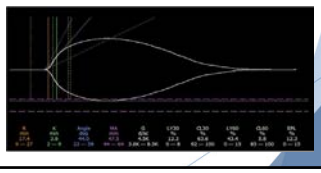
Diagnosing Hyperfibrinolysis

- Most studies use TEG/ROTEM for diagnosis
  - On rapid TEG: **LY30>7.5%** or EPL >15%
  - **LY30>3%** is associated with initial significant increase in mortality



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The CRASH 2 Trial

- **Largest randomized placebo-controlled trial reporting effect of early TXA (20,211 Pts)**
  - Significant reduction in all-cause mortality with TXA
    - 14.5% vs 16% (p=0.035)
  - Significant reduction in risk of death due to bleeding with TXA
    - 4.9% vs 5.7% (p=0.0077)
  - No increase in fatal or non-fatal vascular occlusive effects
  - Early treatment (<1hr from injury) had the greatest reduction in mortality; after 3hrs from injury had increased mortality

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Problems with CRASH 2

- Only 5% patients had bleeding as cause of death
- Only 50% patients received a transfusion, and TXA did not reduce blood transfusions
- Majority of patients enrolled were in low-income or developing countries where massive transfusion protocols and hemostatic resuscitation are not routinely used
- No data on lab values, injury severity & subtypes of transfused products (pRBC,FFP) were reported

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TXA trials in developed countries

- **Miami Ryder Trauma Center-**
  - Trauma patients arrived sooner after injury (<1hr vs 2.8hrs), earlier operative intervention and earlier use of fluid & blood products
  - RESULTS: In highest injury acuity patients, TXA was associated with **increased** mortality, regardless of time it was administered.
- Compared to CRASH2, Miami patients were more hypotensive, had more penetrating injuries, 97% transfused, 78% required surgery

Authors Concluded: Lack of benefit from TXA, may be attributable to rapid availability of fluid/blood and emergency OR.

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More TXA trials in Developed countries:

- **Swendsen et al. '13-** Retrospective multiple cohort, 126 trauma patients US Level 1 trauma center
  - Confirmed early TXA survival benefit

BUT:

- Increased DVT/PE
- Increased Acute kidney injury
- No difference in transfusion

17, 29

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Fibrinolysis in Trauma is complex

- Trauma patients have both promoters and inhibitors of fibrinolysis
  - Shock promotes tPA-mediated fibrinolysis
  - Tissue injury inhibits fibrinolysis
- Spectrum of fibrinolysis in severe trauma has been described with hyperfibrinolysis at one end to "fibrinolytic shut down" at the other end

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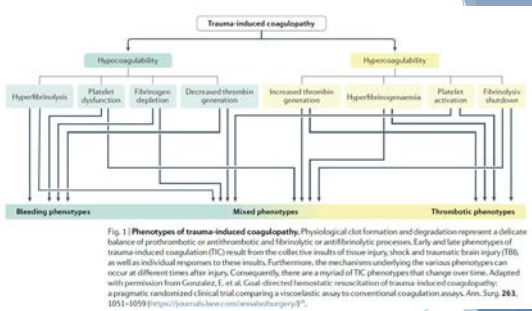

Fig. 1 | **Phenotypes of trauma-induced coagulopathy.** Physiological clot formation and degradation represent a delicate balance of prothrombotic or antithrombotic and fibrinolytic or antifibrinolytic processes. Early and late phenotypes of trauma-induced coagulation (TIC) result from the collective insults of tissue injury, shock and traumatic brain injury (TBI), as well as individual responses to these insults. Furthermore, the mechanisms underlying the various phenotypes can occur at different times after injury. Consequently, there are a myriad of TIC phenotypes that change over time. Adapted with permission from Gonzalez, E. et al. Goal-directed hemostatic resuscitation of trauma-induced coagulopathy: a pragmatic randomized clinical trial comparing a viscoelastic assay to conventional coagulation assays. Ann. Surg. **263**, 1051–1059 (https://journals.lww.com/annalsofsurgery/).

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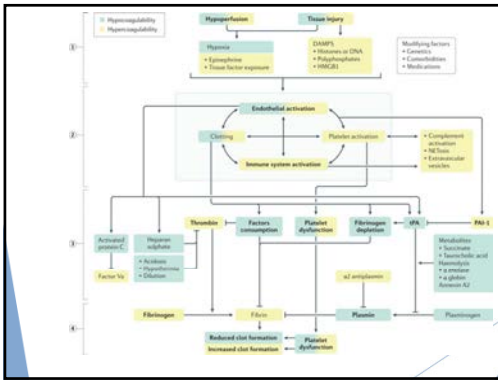

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TXA and thrombotic events in trauma patients

- Trauma patients are prone to thrombotic events (approaching 60% with surveillance)
  - Majority of severely injured patients have low VHA-measured fibrinolysis at 12hrs
  - Low rate of clot degradation (by VHA) is associated with increased mortality
- Observational have shown an association between fibrinolysis shutdown, and ROTEM/TEG hypofibrinolysis, TXA and venous thrombotic events
- TXA → increased mortality in patients with physiologic levels of fibrinolysis and no benefit when given to patients in fibrinolytic shutdown
- TXA use is associated with persistent fibrinolysis shutdown (microvascular thrombosis, MOF)

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Goal directed TXA use (AKA VHA directed)

- Even Goal Directed TXA has NOT been associated with improved overall survival in trauma
- PROPPR Database: Admission Ly30>3% on TEG→ increased survival at 6hrs but did not improve long-term outcomes in severely injured
- Meta-analysis 2018 of RCTs TXA use→ reduction in 24h mortality, NOT 30d mortality
- Recent Review Anesthesia & Analgesia on this:
  - 2 interpretations:
    - TXA reduces early bleeding, but increases risk of delayed death from subsequent fibrinolysis shutdown
    - VHA are insensitive to the identify which patient that are hyperfibrinolytic

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My Conclusions on TXA:

- In populations represented by CRASH-2, early use of TXA is recommended
- Other patients, consider more judicious & selective TXA administration, ROTEM/TEG guided
  - If no TEG, consider TXA in those who are likely to have the highest mortality reduction (SBP <75, severe hemorrhagic shock, less than 3hrs from injury)
- More studies needed to predict which patients benefit from TXA
- Fibrinolytic shutdown phenotype is an independent risk factor for increased mortality (up to 5 fold)
  - Associated with high plasminogen activator inhibitor-1 (PAI-1) activity
  - t-PA TEG Assay may differentiate between these phenotypes and determine which patients will benefit from TXA

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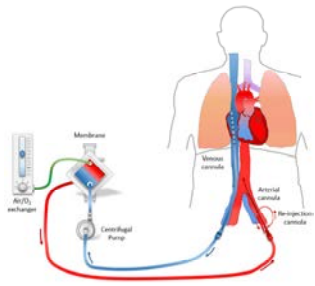
Role of ECMO in Trauma



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Posttraumatic ARDS

- Twenty-three studies between 1 January 1980 and 30 June 2018 were included in the analysis (486,861 patients, 52,561 with posttraumatic ARDS)
  - No change in the mortality of trauma-induced ARDS over the last several decades, and the mortality ranges from 20.6 to 25.8%

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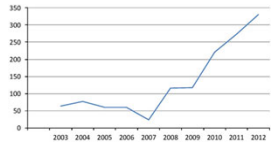
Increasing use of ECMO in trauma:



Overall increase in the use of extracorporeal membrane oxygenation in trauma patients from 2003 to 2012

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Roles for ECMO in trauma

- Most common injuries:
  1. Thoracic Trauma
  2. Spine Fracture
  3. Abdominal injury
  4. Ortho fracture
  5. Burn
- Most common indication: ARDS
- Most placed on V-V ECMO

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ECMO in Trauma

- V-V ECMO for Chest trauma
  - Traumatic Pneumonectomy—VV ECMO in OR
  - Bronchopulmonary fistula – allow injury to heal
- Intractable ARDS/Severe pulmonary contusion (similar to other indications for ECMO MICU setting—PaO2/FiO2 ratio
  - Improve PaO2/FiO2 ratio
  - Decrease barotrauma of ventilation
  - Decrease hyperoxia/free radical damage
  - Option after maxed ventilator support

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V-A ECMO?

- V-A ECMO for Massive trauma with hemodynamic compromise
  - Traumatic cardiac contusion (rare indication)
  - Sepsis post trauma
  - Massive PE with HD compromise
  - Severe polytrauma at time of arrival or in ED (?)

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V-A ECMO

Advantages of V-A ECMO

- Support the heart/Augment C.O.
- Decreases acidemia/shock/reperfusion time
- Warms the blood
- Massive cannula for transfusion

Directly reverses lethal triad of trauma

- Corrects pH, Base deficit, hypothermia (warms)
- Correct platelet function, INR, fibrinogen by restoring perfusion
- Restores the microscopic mucosal integrity by reversing shock physiology
- Decreases end cellular damage of multi-organ failure (AKI, Cardiac)-animal models

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What about bleeding risk?

Literature review of bleeding risk:

- If no systemic heparin (only ECMO circuit)-→no increased risk of bleeding
- Small study (Italian, 375 Pts, 30 on ECMO)
  - Quicker Lactate correction
  - Better pH
  - Decreased Inotropic support
  - No increase in bleeding risk
- Scandinavian study
  - No increase in bleeding
  - Even included Burn injuries and Ortho traumas with fat emboli

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Anticoagulation strategies

- **High risk of bleeding**: Initiate heparin free for several days (esp if severe TBI), heparin bonded circuit only
- **Moderate risk of bleeding**: heparin infusion with lower ACT goal (150)

Our institution:

- Institutional therapeutic and "subtherapeutic" anticoagulation protocols with differing PTT targets
- Routinely hold heparin until bleeding resolves
- Pay close attention to oxygenator and circuit; preparation for urgent circuit change

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ECMO induced Coagulopathy

- Multifactorial
  - Heparin to counteract the increase in procoagulant factors due to biomaterial exposure
  - ECMO induces acquired vWF disease
- Specific to the patient and the disease process

Balance of anticoagulation in ECMO needs to be individualized and reassessed regularly by trauma team

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2020 Systemic Review of ECMO in Trauma

Table 3 The summary of other ECMO-related complications in trauma

From: Extracorporeal membrane oxygenation in trauma patients: a systematic review

Complications	Size
Ischemia of lower extremity (fasciotomy 3)	9
Abdominal compartment syndrome	2
Brain swelling	2
Acute lung edema	1
Acute pancreatitis	1
Accidental removal of a cannula	1
Pseudoaneurysm developed on the site of cannula	1
SSC-CIP	1
Non-record	7
Total	25

Notes: *ECMO* Extracorporeal membrane oxygenation, *SSC-CIP* Secondary sclerosing cholangitis in critically ill patients

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ECMO outcomes in trauma

- CESAR Trial (2010):
  - UK, VV ECMO for Resp Failure, less than 7days
  - >60% survival (not just trauma)
  - Rec: Mortality benefit of VV ECMO, led to resurgence of ECMO use in Adults

Small studies in trauma:

- Guirand et al: VV ECMO 26Pts propensity matched for age and PaO2/FiO2
  - Survival 64% vs 23%
- ECLS Registry: ARDS/Postop/Trauma

6000 cases, 56% survival (similar to non-trauma)

  - Average run 11days, longest run 83days
- Germany Trauma Study Registry
  - 85% came off ECMO, >80% survival

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Survival in trauma

Table 2 Survival rates of trauma patients compared with patients placed on extracorporeal membrane oxygenation for nontrauma indications.3

Diagnosis	n	Average Run Duration, d	Survival to Hospital Discharge (%)
Trauma—total cohort	279	8.8±9.5	61
Trauma—respiratory support	247	9.3±9.3	63
ARDS, not postoperative/trauma*	837	13.0	54
Acute respiratory failure, non-ARDS*	1408	11.5	55
Viral pneumonia*	926	13.5	65
Bacterial pneumonia*	1362	10.9	61
Trauma—cardiac support	20	4.1±4.5	50
Adult cardiac support*	9025	6.5	41
Trauma—eCPR	12	6.5±16.8	25%
Adult eCPR*	2885	Not available	29%

*Data from ELSO

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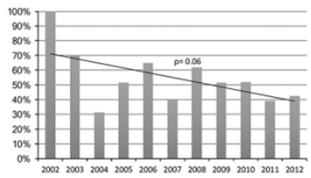
Trend toward improved mortality in trauma ECMO



Overall decrease in mortality in extracorporeal membrane oxygenation patients

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ECMO in traumatic cardiac arrest

- Predictors of survival:
  - Penetrating injury
  - Signs of life Prehospital or in ED
  - Short length of prehospital CPR
  - Cardiac movement on POCUS
  - Pediatric patient
  - Reversible causes (Tamponade or Tension PTX)

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Any Contraindications to ECMO?

- "Elderly" some institutions have age cut off
- Oxygen requirement prior to injury
- Jehovah's Witness (not accepting blood)
- Cirrhotic liver
- Abdominal compartment syndrome

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American Association for the Surgery of Trauma
Critical Care Clinical Consensus on ECMO in 2019

- ECMO can be considered for partial or full support in cases of potentially reversible posttraumatic cardiopulmonary failure
- No specific diagnoses are absolute indications or contraindications to ECMO therapy, other than irreversible injury
- Traumatic brain injury (TBI) should no longer be an automatic exclusion to ECMO

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Summary of ECMO in Trauma

- Based on small studies and initial view of National Trauma Database
  - Role of ECMO (VV & VA) in Trauma
  - ECMO Service/Team available
- Time to cannulation/Expertise likely improves outcome in massive trauma patients
- Complications: bleeding, limb ischemia (add distal antegrade perfusion cannula to minimize
- Weening off? Patient specific—longer runs if limited to lung injury

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CRASH
Colorado Review of Anesthesia for Subcutaneous And Hospitals
Guiding the future of patient care

Volume Resuscitation and Assessment in Trauma

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Disclosure Statement: I have no commercial, financial, or any other conflict of interest pertaining to the content of this presentation.

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Learning Objectives

- Review the history pertinent to volume resuscitation
- Review the harm caused by excessive crystalloid administration in the setting of trauma
- Discuss the concept of permissive hypotension and how it pertains to volume resuscitation
- Review the basic physiology governing volume homeostasis
- Review the evidence for various volume assessment modalities
  - Static Modalities: Physical Examination, Shock Index, Base Deficit
  - Dynamic Modalities: A-line Variability, Pulse Contour Analysis, Pleth Variability, Esophageal Doppler

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History

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History: Intravenous Saline

- First reported use of intravenous saline for the treatment of disease:
  - Dr. Latta's letter to the Lancet on the success of saline for a patient with cholera

May 23, 1832

She had apparently reached the last moments of her earthly existence.... ounce after ounce [of saline] was injected...soon the sharpened features, and sunken eye, and fallen jaw, pale and cold, bearing the manifest impress of death's signet, began to glow with returning animation; the pulse, which had long ceased, returned to the wrist.

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History: Intravenous Saline

The quantity to be injected depends on the effect produced, and the repetition on the demands of the system, which generally vary according to the violence of the diarrhoea; the greater the degree of collapse, the greater will be the quantity needed.

The syringe must be quite perfect, so as to avoid the risk of injecting air...

Your most obedient servant,

Thomas Latta, M.D.

Malignant cholera. Documents communicated by the Central Board of Health, London, relative to the treatment of cholera by the copious injection of aqueous and saline fluids into the veins. Lancet 1832;18:274-80.

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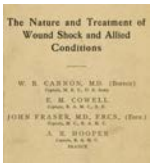
History: Permissive Hypotension in Trauma

- In August, 1917, the Medical Research Committee (Great Britain) appointed a Special Investigation Committee to undertake the coordination of inquiries into surgical shock and allied conditions [during World War I].


The Nature and Treatment of Wound Shock and Allied Conditions

W. B. CANNON, M.D. (Boston)
E. M. COWELL
JOHN FRASER, M.D., F.R.C.S., (Edin.)
A. E. HOOPER

Injection of a fluid that will increase blood pressure has dangers in itself. Hemorrhage in a case of shock may not have occurred to a marked degree because blood pressure has been too low and the flow too scant to overcome the obstacle offered by a clot. If the pressure is raised [with fluid] blood that is sorely needed may be lost.

Cannon W, et al. The nature and treatment of wound shock and allied conditions. Chicago: American Medical Association; 1918.

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6

Volume and Complications

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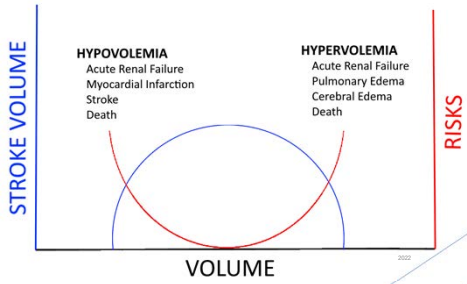
Ideal Volume



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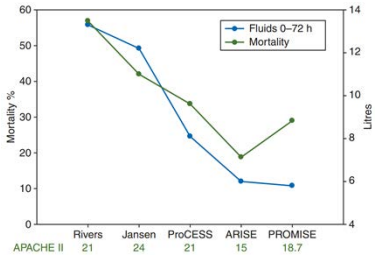
EGDT Studies (Sepsis) 2001 – 2016



Marik P, et al. A rational approach to fluid therapy in sepsis. Br J Anaesth. 2016 Mar;116(3):339-49.

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9

Harm from crystalloid (Trauma)

- **Increase Mortality (HR 2.5) and Coagulopathy (OR 2.2)**
  - Brown J, et al. Inflammation and the Host Response to Injury Investigators. Goal-directed resuscitation in the prehospital setting: a propensity-adjusted analysis. J Trauma Acute Care Surg. 2013 May;74(5):1207-12.
- **Increase Mortality (OR 1.11)**
  - Haut E, et al. Prehospital intravenous fluid administration is associated with higher mortality in trauma patients: A National Trauma Data Bank analysis . Ann Surg. 2010 Dec.
- **Increased Mortality (19% vs 7%)**
  - Driessen A, et al. Prehospital volume resuscitation--Did evidence defeat the crystalloid dogma? An analysis of the TraumaRegister DGU® 2002-2012. Scand J Trauma Resusc Emerg Med. 2016 Apr 6;24:42.
- **Increased Mortality (OR 1.11)**
  - Haut E, et al. Prehospital intravenous fluid administration is associated with higher mortality in trauma patients: a National Trauma Data Bank analysis . Ann Surg. 2011 Feb;253(2):371-7.
- **Increased Mortality (OR 1.1)**
  - Joseph B, et al. Improving mortality in trauma laparotomy through the evolution of damage control resuscitation: Analysis of 1,030 consecutive trauma laparotomies. J Trauma Acute Care Surg. 2017 Feb;82(2):328-333.
- **Increased Risk of ARDS (OR 3.4), Multiple Organ Failure (OR 2.9), and Surgical Site Infection (OR 2.8)**
  - Kasotakis G, et al. Inflammation and Host Response to Injury Investigators. Aggressive early crystalloid resuscitation adversely affects outcomes in adult blunt trauma patients: an analysis of the Glue Grant database. J Trauma Acute Care Surg. 2013 May;74(5):1215-21; discussion 1221-2.
- **Increased Risk of Abdominal Compartment Syndrome (9.9 L vs. 2.7 L, p < 0.001)**
  - Madigan M, et al. Secondary abdominal compartment syndrome after severe extremity injury: are early, aggressive fluid resuscitation strategies to blame? J Trauma. 2008 Feb;64(2):280-5.
- **Increase Mortality (HR 1.1) and Coagulopathy (PTT 56 vs 39.1, INR 2.2 vs 1.4)**
  - Morrison C, et al. Hypotensive resuscitation strategy reduces transfusion requirements and severe postoperative coagulopathy in trauma patients with hemorrhagic shock: preliminary results of a randomized controlled trial. J Trauma. 2011 Mar;70(3):652-63.

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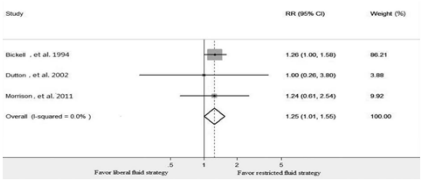
10

Restrictive vs Liberal Fluid Resuscitation in Trauma Patients

- Meta-analysis of RCT trials



Wang C, et al. Liberal versus restricted fluid resuscitation strategies in trauma patients: a systematic review and meta-analysis of randomized controlled trials and observational studies. Crit Care Med. 2014 Apr;42(4):954-61.

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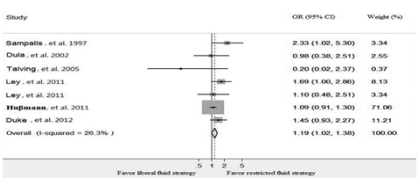
Restrictive vs Liberal Fluid Resuscitation in Trauma Patients

- Meta-analysis of observational trials



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Permissive Hypotension in Trauma

- Permissive hypotension is **permitting** the blood pressure to be low by **deliberately** giving **less crystalloid** in active bleeding trauma patients
- The intervention is restrictive volume resuscitation not deliberate hypotension
- This is analogous to permissive hypercapnia for ARDS whereby the intervention is low tidal volumes and permitting hypercapnia

Disease State	Intervention	Permissive	Goal
Hemorrhagic Shock	Restrictive Fluid Resuscitation	Hypotension	Limit harm due to crystalloids
ARDS	Low Tidal Volume	Hypercapnia	Limit harm due to VILI

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Permissive Hypotension

- Crystalloids cause harm in hemorrhagic shock
  - Hypothermia
  - Dilutional coagulopathy
  - Acidosis (Normal Saline)
  - Higher BP can worsen bleeding
- Recall "Trauma Triad of Death"
  - Hypothermia
  - Coagulopathy
  - Acidosis

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Permissive Hypotension

- European Trauma Guidelines 5th Ed, 2019
  - We recommend permissive hypotension with a target systolic blood pressure of 80-90 mmHg (mean arterial pressure 50-60 mmHg) until major bleeding has been stopped in the initial phase following trauma without brain injury. (Grade 1C)
  - In patients with severe TBI (GCS ≤ 8), we recommend that a mean arterial pressure ≥ 80 mmHg be maintained. (Grade 1C)
    - Note, patients with spinal cord injury should also have higher BP goals (MAP > 85)
- Advanced Trauma Life Support 10th Ed, 2018
  - Does not endorse specific blood pressure goals
  - "Administering excessive crystalloid solution can be harmful"
  - "Early administration of pRBCs, plasma, and platelets in a balanced ratio to minimize excessive crystalloid administration may improve patient survival"
  - "Delaying aggressive fluid resuscitation until definitive control of hemorrhage is achieved may prevent additional bleeding"

Spahn D, et al. The European guideline on management of major bleeding and coagulopathy following trauma: fifth edition. Crit Care. 2019 Mar 27;23(1):98.

Advanced Trauma Life Support Student Course Manual: tenth edition. Chicago (IL): American College of Surgeons; 2018.

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Blood Volume Homeostasis

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Volume: What regulates it?

- Kidneys
  - SLOWEST
  - Governed by RAAS and ADH
- Interstitial space
  - SLOWER
  - Governed by starling forces
    - Can take 1-2 hours to restore intravascular volume during hemorrhage
- Venous system
  - FAST
  - Governed by **stress** vs **unstressed volume**
    - Immediate source of intravascular volume during hemorrhage

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Venous Function

- Veins contain 70% of blood volume
- Serve as a reservoir for blood
- 30 times more compliant than arteries
  - $C = \Delta V / \Delta P$
- Veins contain a high population of alpha-1 receptors
- Clinically, this pertains mostly to the **splanchnic vasculature** (highly compliant vessels) and to a lesser degree the **cutaneous vasculature** (compliant, but less than splanchnic veins)

Gelman S, et al. Venous Function and Central Venous Pressure: A Physiologic Story. Anesthesiology 2008; 108:735-748

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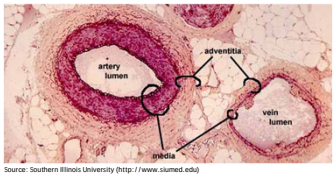
Dualities: Artery vs Vein

- **Arteries** function as **large resistors** and small capacitors
- **Veins** function as **large capacitors** and small resistors



Source: Southern Illinois University (http://www.siumed.edu)

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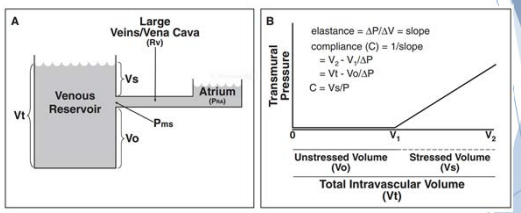
Stress vs. Unstressed Volume



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Funk D, et al. The role of venous return in critical illness and shock-part I: physiology. *Crit Care Med*. 2013 Jan;41(1):255-62.

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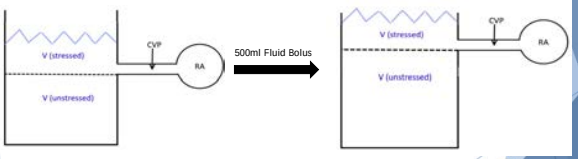
Example: Fluid Bolus

- Healthy patient with high vascular compliance
  - Volume bolus expands unstressed volume
  - Stressed volume stays the same and CVP is **unchanged**



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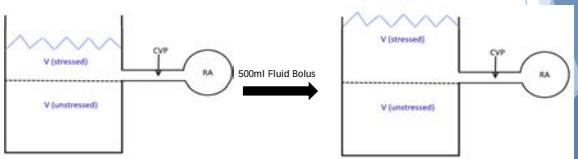
Example: Fluid Bolus

- CHF patient with low vascular compliance (arteriosclerosis)
  - Arteriosclerosis and high catecholamine state decrease vascular compliance
  - Volume bolus expands stressed volume
  - Unstressed volume stays the same and CVP increases



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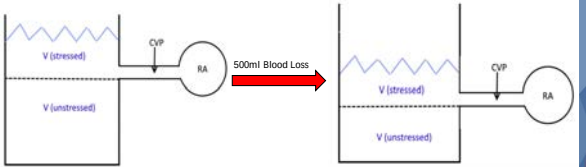
Example: Hemorrhage

- Healthy patient
  - Catecholamines increase causing venoconstriction (decrease venous compliance)
  - Volume moves from unstressed to stress volume to **maintain** CVP



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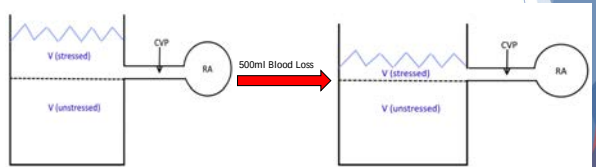
23

Example: Hemorrhage

- CHF patient with low vascular compliance (arteriosclerosis)
  - Venoconstriction in response to catecholamines is blunted
  - Stress volume decreases and CVP decreases



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Stress vs Unstress Volume Clinical Implications

- Explains why CVP is not an accurate modality to assess volume status
- Explains why young, healthy patients may lose a significant amount of blood with little change in vitals
  - Studies show that maternal vitals signs may initially be normal in PPH despite losing up to 1000 mL of blood[1]
- Explains how vasopressors may be a useful temporary adjunct to maintain pre-load in a variety of clinical scenarios: spinal anesthesia, neurogenic or septic shock
- Explains why more sophisticated measures to assess volume status should be utilized instead of relying on vitals alone to guide volume resuscitation

[1] Pacagnella R, et al. A systematic review of the relationship between blood loss and clinical signs. PLoS One. 2013;8(3)

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Volume Status Assessment Modalities

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Modalities to Assess Volume Status

- Static Modalities
  - Shock Index, Base Deficit, Capillary Refill Time, etc.
- Dynamic Modalities
  - Arterial Line Variability, ΔCO with Fluid Bolus, Pleth Variability Index, etc.

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Shock Index

- $Shock\ Index = \frac{HR}{sBP}$
- SI $\geq$ 1.0 is highly predictive of massive transfusion (MT) in trauma patients
  - SI $\geq$ 1.0 RR of 9.67 (95% CI 6.09-15.36) for MT (>10 units in 24 hours)
  - SI also highly predictive of post part partum hemorrhage (SI > 1.4, sensitivity 100%, specificity 70%)
- Heart rate is not predictive of MT in the geriatric (>65 years) trauma patient population.
  - MT and non-MT groups (HR of 92.6 vs 87.4, P > 0.05).
  - SI in this demographic is still predictive of MT (SI 1.3 in MT vs 0.67 in non-MT, P <0.001)

Olaussen A, et al. Review article: shock index for prediction of critical bleeding post-trauma: a systematic review. Emerg Med Australas. 2014;26(3):223-8.

Ayadi A, et al. Vital Sign Prediction of Adverse Maternal Outcomes in Women with Hypovolemic Shock: The Role of Shock Indidex. PLoS One. 2016 Feb 22;11(2)

Figor SC, et al. Vital Signs Strongly Predict Massive Transfusion Need in Geriatric Trauma Patients. Am Surg. 2016 Jul;82(7):632-6.

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Base Deficit

- Base Deficit (BD) or Base Excess (BE) measures the metabolic component of the acid/base disturbance
- BD is calculated in the following manner:
  - 1) Calculate what the pH would be if the CO2 was 40 mm Hg
  - 2) Calculate the amount of HCO3- (mmol/L) that would then be required to normalize this pH to 7.4
- Formal Definition
  - Base excess is the amount of strong acid (in millimoles per liter) that needs to be added in vitro to 1 liter of fully oxygenated whole blood to return the sample to standard conditions (pH of 7.40, Pco2 of 40 mm Hg, and temperature of 37 C)

Berend K. Diagnostic Use of Base Excess in Acid-Base Disorders. N Engl J Med. 2018 Apr 12;378(15):1419-1428.

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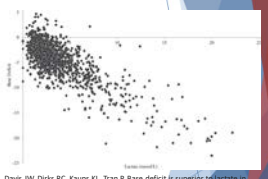
Base Deficit

- BD is not an accurate modality to assess volume status
- BD is highly correlated to lactate levels
  - Lactate kinetics are sluggish
  - Lactate $T_{1/2}$ is 20 minutes assuming normal liver function
- BD may not reflect hypovolemic shock in the following situations
  - Administration of normal saline or HCO3-
  - Renal Failure
  - DKA
  - Prolonged CO2 retention (e.g., COPD)
  - Toxins (methanol, ASA, ethylene glycol)
  - Cardiogenic, Septic, or Neurogenic Shock



Davis JW, Dirks RC, Kaups KL, Tran P. Base deficit is superior to lactate in trauma. Am J Surg. 2018 Apr;215(4):682-685

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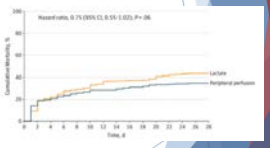
Capillary Refill Time

- Apply firm pressure for 10 seconds to the distal tip of the finger or toe until the nailbed is blanched then release pressure
- Color should return to normal within 3 seconds if perfusion is normal

- ANDROMEDA-SHOCK Trial
  - RCT comparing CRT to lactate based resuscitation for septic shock
  - 28 hospitals, 5 countries, 424 patients
  - Mortality was 34.9% (CRT) vs 43.4% (Lactate), P=.06



Hernández G, et al. Effect of a Resuscitation Strategy Targeting Peripheral Perfusion Status vs Serum Lactate Levels on 28-Day Mortality Among Patients With Septic Shock: The ANDROMEDA-SHOCK Randomized Clinical Trial. JAMA. 2019 Feb 19;321(7):654-664.

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Dynamic Modalities

- Dynamic tests
  - Physiological basis, optimize frank-starling curve
- Gold standard
  - $\Delta CO > 10\%$ with 250ml fluid challenge or passive leg raise
    - Other indices such as ΔSV, ΔSVI, $\Delta CI > 10\%$ may also be used
    - Requires use of PAC, Esophageal Doppler, Pulse Contour Analysis (FloTrac, PiCCO, LiDCO), Echocardiography, or Bioreactance
- Other tests
  - Arterial Line Variability
  - Esophageal Doppler
  - Pulse Contour Analysis
  - Pleth Variability Index

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Volume Optimization Goals

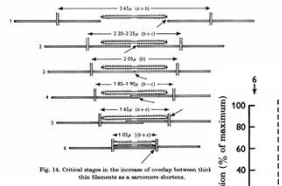
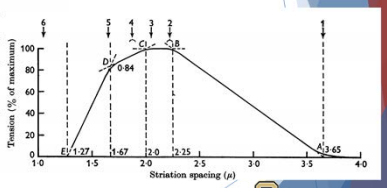


Fig. 14. Critical stages in the increase of overlap between thick and thin filaments as a sarcomere shortens.



Gordon A, et al. The variation in isometric tension with sarcomere length in vertebrate muscle fibres. *J Physiol*. 1966 May; 184(1): 170-192.

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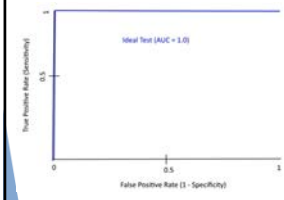
Receiver Operating Curve (Review)



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Arterial Line Variability

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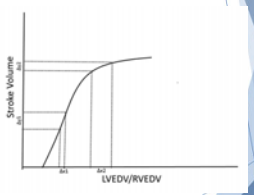
Arterial Line Variability

- ΔSV is a function of Δpreload/afterload
- Positive pressure ventilation
  - Decreases RV preload
  - Increases RV afterload
  - Decreases SV
- Requires
  - **TV > 8ml/kg**
  - **No dysrhythmias**
  - **No spontaneous breathing**



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Arterial Line Variability: Calculation

- Systolic Pressure Variation
  - $SPV = \left(\frac{SBP_{max} - SBP_{min}}{SBP_{mean}}\right) \cdot 100\%$
- Pulse Pressure Variation
  - $PPV = \left(\frac{PP_{max} - PP_{min}}{PP_{mean}}\right) \cdot 100\%$
- Interpretation
  - Volume responsive: SPV or PPV > 12%
  - Indeterminate: SPV or PPV 8-12%
  - Not Volume Responsive: SPV or PPV < 8%

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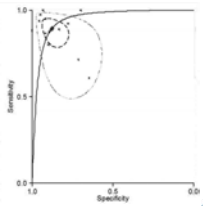
Arterial Line Variability: Evidence

- Meta-analysis of 29 studies
  - 9 MICU
  - 16 Cardiac ICU
  - 4 Intra-operative
- SPV
  - **ROC: 0.86**
- PPV
  - **ROC: 0.94**



Marik P, et al. Dynamic changes in arterial waveform derived variables and fluid responsiveness in mechanically ventilated patients: A systematic review of the literature. *Crit Care Med*. 2009 Sep;37(9):2642-7.

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Arterial Line Variability: Eyeball Technique

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

- Methods
  - 50 Anesthesia Providers (30 residents and 20 attendings)
  - Asked to give volume or not based on visually observed arterial line variability
- Results
  - **3% elected to treat when (SPV < 8%)**
  - **60% elected to treat when (SPV 8 – 12%)**
  - **37% elected to treat when (SPV > 12%)**

Thiele R, et al. The ability of anesthesia providers to visually estimate systolic pressure variability using the "eyeball" technique. Anesth Analg. 2012 Jul;115(1):176-81.

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Pulse Contour Analysis

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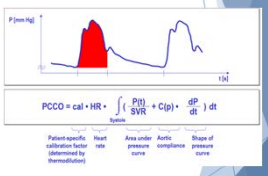
Pulse Contour Analysis

- Analysis of arterial waveform to calculate stroke volume
  - $Pulse\ Pressure \propto Stroke\ Volume$
  - $Pulse\ Pressure \propto \frac{1}{Compliance}$
- Calibrated
  - PiCCO, LiDCO
  - Uses thermodilution to calculate compliance for calibration
- Uncalibrated
  - FloTrac
  - Uses patient demographic data to calculate compliance



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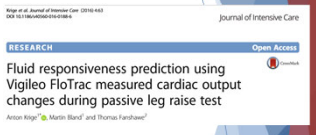
Pulse Contour Analysis: Evidence

- 2nd Generation Flotrac Software
  - Volume Responsive: Δ CO > 15% with 500ml fluid
  - **ROC: 0.92** with **Δ SV > 15% with PLR**[†]
- 3rd Generation Flotrac Software
  - Volume Responsive: Δ CO > 15% with 250ml fluid
  - **ROC: 0.85** with **Δ CO > 9% with PLR**[‡]


Journal of Intensive Care

RESEARCH

Open Access

Fluid responsiveness prediction using Vigileo FloTrac measured cardiac output changes during passive leg raise test

Anton Krige[‡], Martin Bland[†] and Thomas Fanshawe[†]

†Briais M, et al. Changes in stroke volume induced by passive leg raising in spontaneously breathing patients: comparison between echocardiography and Vigileo/FloTrac device. Crit Care. 2009;13(6):R195.

‡Krige A, et al. Fluid responsiveness prediction using Vigileo FloTrac measured cardiac output changes during passive leg raise test. J Intensive Care. 2016 Oct 6;4:63

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Esophageal Doppler Monitor

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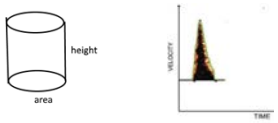
Esophageal Doppler

- Esophageal probe measuring blood velocity in the **descending aorta**
- Aortic area can be approximated by demographics (age, height, weight)
- **Stroke Volume = Aortic Area X VTI**
  - VTI (height) = distance column of blood moved during systole
  - $VTI = \int_{systole\_start}^{systole\_end} Velocity \cdot dt$



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Esophageal Doppler: Evidence

- Stroke Volume Variation (i.e. ΔrespSV)
  - $SVV = \left(\frac{SV_{max} - SV_{min}}{SV_{mean}}\right) \cdot 100\%$
  - **SVV > 14% predictor of fluid responsive**
- FTc – Systolic ejection time corrected for heart rate
- **SVV ROC: 0.91**
- **FTc ROC: 0.49**

Guinot P, et al. Ability of stroke volume variation measured by oesophageal Doppler monitoring to predict fluid responsiveness during surgery. *Br J Anaesth*. 2013 Jan;110(1):28-33.

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Esophageal Doppler: Pitfalls

- Descending aorta receives approximately 70% of total blood flow
  - EDM does 70:30 correction to calculate total CO
  - Shock states divert blood away from mesenteric circulation
  - Lowering percentage of blood flow in the descending aorta
- Velocity Calculation
  - EDM assumes 45 or 60º correction of doppler signal
- Blood flow is laminar and not uniform
- EDM assumes aortic area using patient demographics

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Pleth Variability Index

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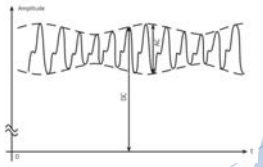
Pleth Variability Index

- Perfusion Index (PI) is calculated as the pulsatile infrared signal (AC) indexed against the non-pulsatile infrared signal (DC). The AC and DC signals reflect the absorption of infrared light.
  - $PI = \frac{AC}{DC} \times 100\%$
- The Pleth Variability Index (PVI)
  - $PVI = \frac{PI_{max} - PI_{min}}{PI_{max}} \times 100\%$
- Requires
  - TV > 8ml/kg
  - No dysrhythmias
  - No spontaneous breathing



Pleth Variability Index: A Dynamic Measurement to Help Assess Physiology and Fluid Responsiveness. Masimo Technical Bulletin. 2013.

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Pleth Variability Index: Evidence

- Advantages
  - Non-invasive
  - Large meta-analysis of 25 studies both in the operating room and the intensive care unit showed a ROC of 0.82[1]
- Disadvantages
  - Proprietary technology from Massimo
  - Qualitative analysis of the waveform is not accurate due to automatic gain adjustment to maximize the appearance of the signal
  - Unclear cut-off value
    - Studies utilize a range of cut-off values from 7-20%
  - PVI is inaccurate in the setting of large volume resuscitation
    - A study in patients undergoing orthotopic liver transplant found a ROC of 0.55[2]

[1]Liu T, et al. Reliability of pleth variability index in predicting preload responsiveness of mechanically ventilated patients under various conditions: a systematic review and meta-analysis. BMC Anesthesiol. 2019 May 8;19(1):67.

[2]Konur H, et al. Evaluation of pleth variability index as a predictor of fluid responsiveness during orthotopic liver transplantation. Kaohsiung J Med Sci. 2016 Jul;32(7):373-80.

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Questions

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Thoracic Wall Analgesia

Steven Bourland DO, MS
Pediatric Anesthesiologist
Denver Health Medical Center
Children's Hospital of Colorado

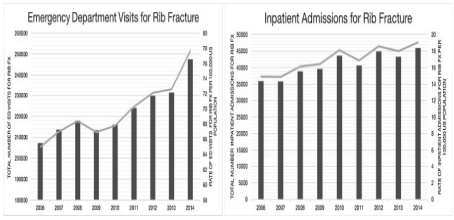
1

Objectives

- Rib fractures and the problems they cause
- Introduce fascial plane blocks
  - Mechanisms
  - Anatomy
- Analyze which plane blocks to use for rib fractures
  - Technique
  - Complications

2

Rib Fractures



- Most common type of clinically significant blunt traumatic injury to thorax
  - MVC, MVC vs pedestrian, falling & crush injuries
- Estimated 248,000 ED encounters, 46,000 inpatient admissions

3

Pulmonary Complications Associated With Rib Fractures

- A 2005 analysis of 64,750 patients entered into National Trauma Data Bank
  - 1 or more rib fractures
- 13% (n=8,473) developed 13,086 complications, of which 6,292 (48%) were related to chest wall injury
- Overall mortality for pts with rib fractures was 10%
- Incidence of the following increased with each additional rib fracture
  - Pneumonia
  - Pneumothorax
  - Acute Respiratory Distress Syndrome
  - Empyema
  - Aspiration Pneumonia

4

ANALGESIA PMG FOR INPATIENTS WITH RIB FRACTURES

BEGIN (Tier I)

Ice and heat to soft tissues
Ketorolac 15 mg IV q6H x 48 HR then ibuprophen 600 mg PO q6H
Acetaminophen 650 mg PO q6H
Diazepam 5 mg PO TID PRN (if age < 65 years)
Oxycodone 5-10 mg PO Q4HR PRN
IV narcotic push x 2 (if ≥ 2 doses required, move to Tier II

Tier II

Loco-regional modalities
Thoracic epidural catheter
or Pain pump (bupivacaine infusion)
or Liposomal bupivacaine intercostal nerve blocks
or **erector spinae (ESP) catheter**

Tier III

Narcotic PCA
Ketamine infusion (as per PAD order set)
Lidocaine infusion**

Advance to next tier if SCARF score remains ≥ 2 after intervention(s)

SCARF Score

Parameter	Points
Numeric pain score ≥ 5	1
Incentive spirometry < 50% predicted	1
Respiratory rate ≥ 20	1
Poor cough	1

SCARF=Sequential Clinical Assessment of Respiratory Function

5

Background

- Rib fractures associated with significant morbidity and mortality
  - M/M increases with age and number of fractures
- Hypoventilation (poor incentive spirometry) leads to atelectasis, pneumonia, respiratory failure
  - Invasive ventilation strategies
- Trauma centers develop protocols focused on early pain management to assist with rapid mobilization, improves respiratory care and decreases length of stay in ICU
  - Multi-modal opioid sparing regimen

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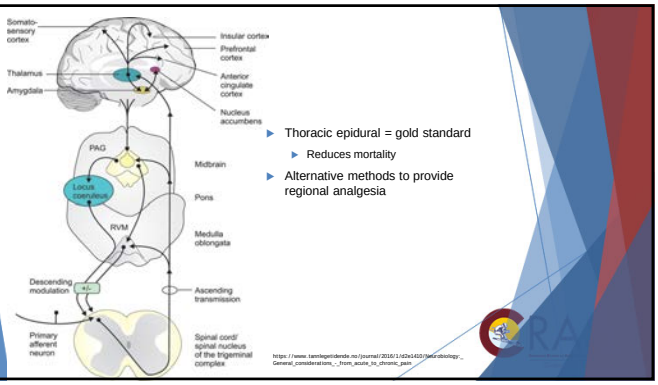

- Thoracic epidural = gold standard
  - Reduces mortality
- Alternative methods to provide regional analgesia

https://www.tamlegetidende.no/journal/2016/1/d2e1410/Neurobiology:_General_considerations_-_from_acute_to_chronic_pain

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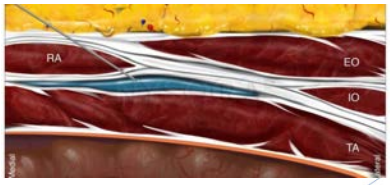
Fascial Plane Blocks

- Placement of local anesthetic between two fascial layers, muscle and/or bone
- Local anesthetic bathes nerves coursing through these planes to provide analgesia
- Depending on location of injection, mechanisms vary



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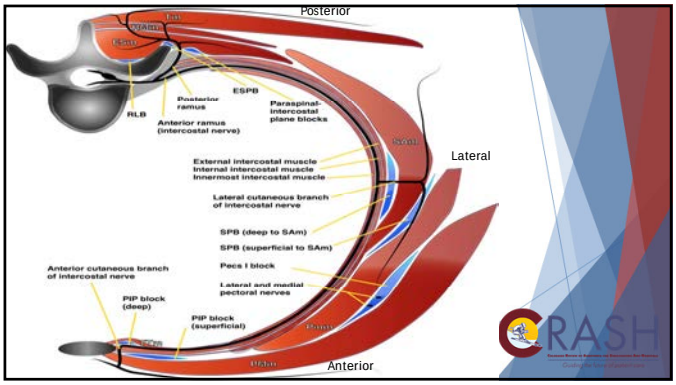
Location: Posterior, Lateral, Anterior

9



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Indications

- Targeted regional anesthesia
  - Provides unilateral analgesia
    - Thoracotomy, rib fractures
- Favorable physiology
  - Reduces episodes of hypotension secondary to sympathectomy caused by thoracic epidural
    - Reduces interruptions in analgesia
- Fewer contraindications
  - Safe when anticoagulated: LMWH, systemic heparinization
  - Can be placed when patient is intubated

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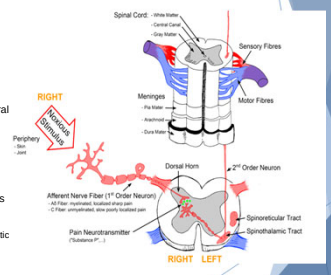
Mechanism of Action

- Local dispersion via injection between layers of the plane
  - May spread to adjacent tissues/planes through porous communications in the plane
  - Spread into neuraxium if close to vertebral column
    - Paravertebral by proxy
- Vascular uptake
  - Local anesthetic acts on site of injury in periphery and also in central pain centers of neuraxium (dorsal horn of spinal cord, thalamus)
    - Systemic effect of elevated local anesthetic plasma concentrations



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Posterior Rib Fractures

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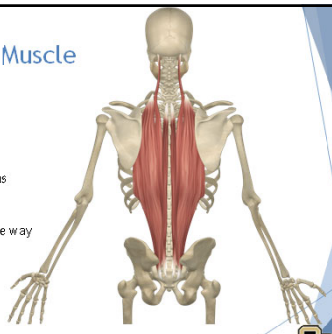
Erector Spinae Muscle

- Paraspinal muscle group
  - Iliocostalis
  - Longissimus
  - Spinalis
- Originate medially from spinous processes and transverse processes
- Insert along angle of ribs all the way down to sacrum



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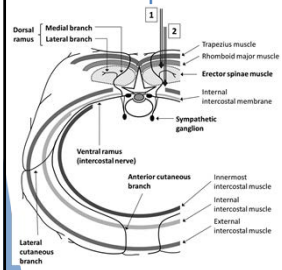
Erector Spinae Plane Block



- First described in 2016
- Used to manage thoracic neuropathic pain caused by metastatic disease
  - Rib fractures
- Complications
  - LAST
  - Pneumothorax
  - Infection
  - Epidural puncture/injection

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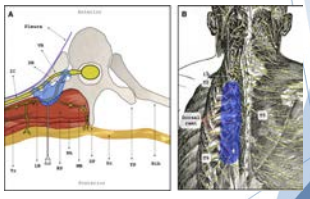
Erector Spinae Plane Block

- Perforations in intertransverse connective tissue allow anterior spread providing analgesia in cephalocaudal direction
  - LA reaches up to 3 vertebral levels and 7 intercostal levels
- Analgesia similar to that of paravertebral block
- Retrospective studies show improved IS values
  - Pain scores, morphine equivalents difficult in polytrauma
- Prospective studies needed in isolated rib fractures



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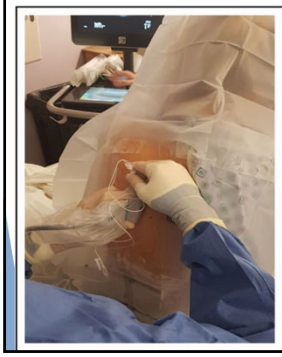
Technique



- High frequency linear US probe
- In plane approach
  - Parasagittal craniocaudal orientation
- 3 cms lateral to midline, needle deep to ESM on transverse process
  - ESM should lift and injectate spread cranio-caudally

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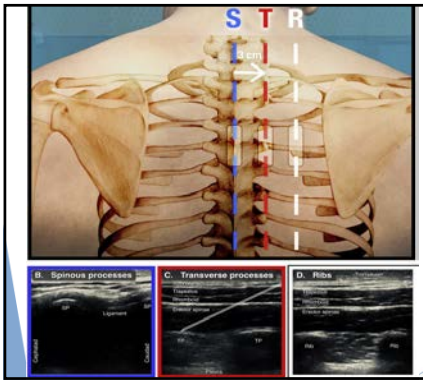

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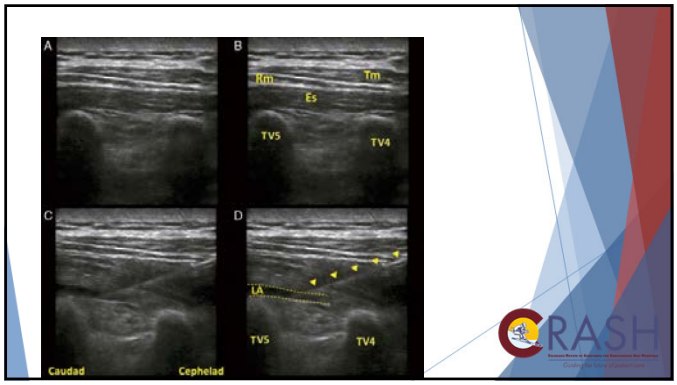

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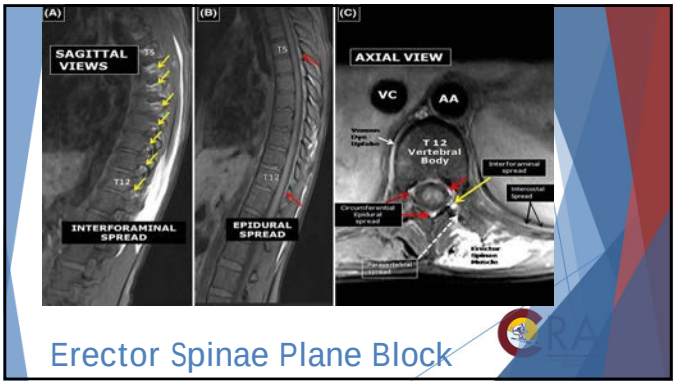

Erector Spinae Plane Block

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Infusions

- Duration of action single bolus of 0.4mg/kg bupivicaine
  - Acute rib fracture analgesia ~ 3 hours
- Programmed intermittent bolus
  - 15-20mL 0.1-0.2% bupivicaine every 4-6 hours
- Continuous infusion
  - 0.1-0.2% @ 8-12/hr

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Antero-Lateral Rib Fractures

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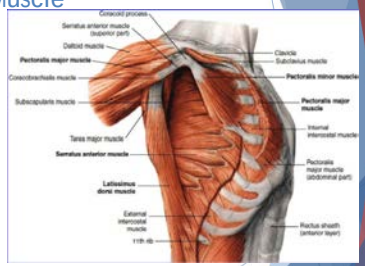
Serratus Anterior Muscle

- Fan like muscle originating from lateral thorax, ribs1-9
- Inserts on underside of medial scapula
- Innervated by long thoracic nerve
- Accessory inspiratory muscle



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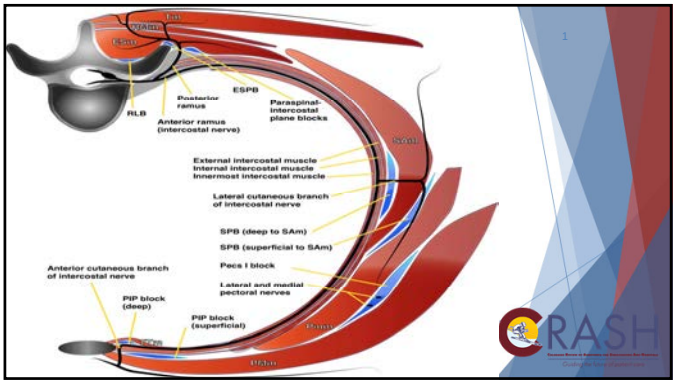

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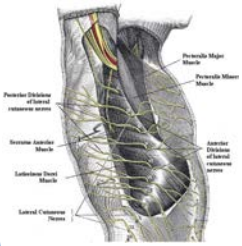
Serratus Anterior Plane Block



Reprinted from Gray H, Lewis WH. Anatomy of the Human Body. 20th ed. Philadelphia, PA: Lea & Febiger; 1918.

- First described in 2013 in volunteer study
- Complications
  - LAST
  - Infection
  - Pneumothorax
  - Hemothorax

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Serratus Anterior Plane Block: Technique

- High frequency linear US probe
- Patient remains supine with abduction of arm to expose anterior axilla
- Target rib in middle of the fractured ribs for optimal spread
  - Rib fxs 4-8, target rib 6
- Evidence for both superficial and deep catheter placement
  - Superficial to SAM appears to have increased duration and greater spread
    - T2-T9, single injection duration ~730mins
  - Deep to SAM can be easier if trauma to area obscures superficial plane
    - T2-T7, single injection duration ~330mins

RASH

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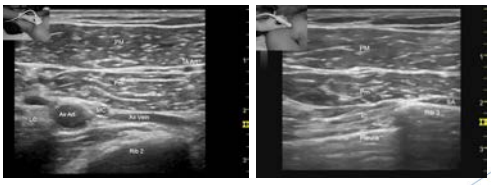
Serratus Anterior Plane Technique



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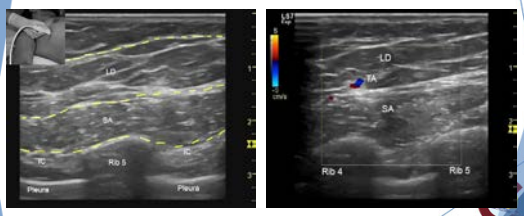
Serratus Anterior Plane Technique



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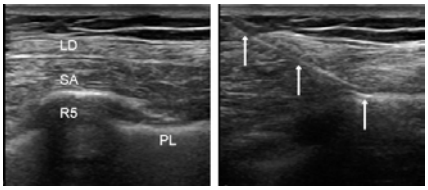
Serratus Anterior Plane Technique



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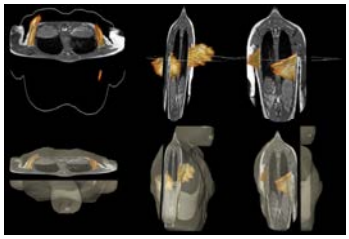
Serratus Anterior Plane Block



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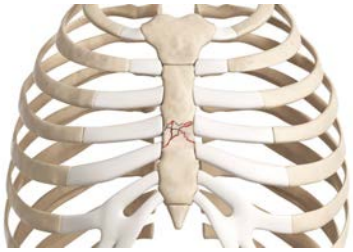
Anterior Fractures



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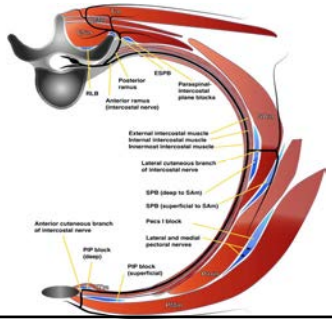
Parasternal
Pecto-Intercostal Plane Block



- Sternal fractures
- Sternotomy
- Anterior Rib fractures

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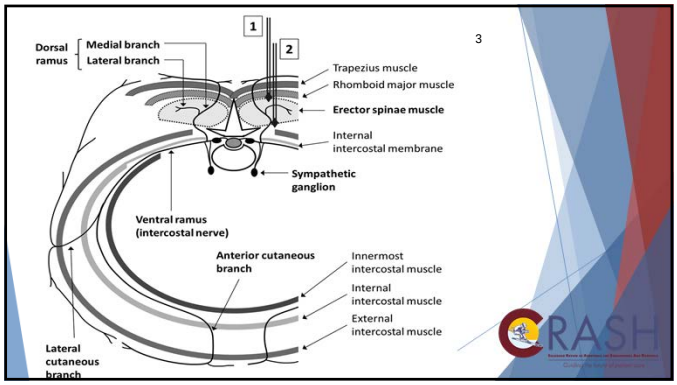

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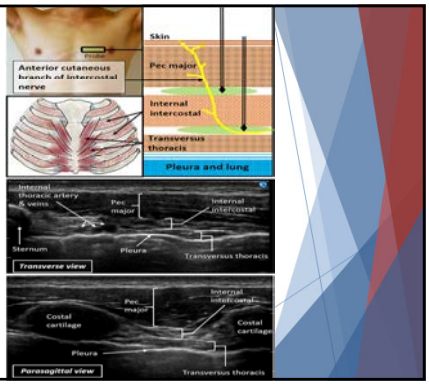
Pecto-Intercostal Planes

- Targets anterior cutaneous branch T2-T6 to provide anterior chest wall analgesia
  - Intercostal nerve (ventral ramus)
- Superficial Plane
  - Between pec major & internal intercostal muscle
- Deep Plane
  - Between internal intercostal and transversus thoracic muscle
- Planes difficult to visualize in patients s/p CABG especially if Internal Mammary artery used
- Complications:
  - LAST
  - Pneumothorax/Hemothorax
  - Arterial Punture & Hematoma
  - Pericardial puncture/Injection
  - Infection



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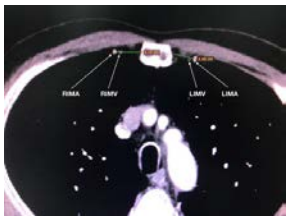
Pecto-Intercostal Plane Block



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Pecto-Intercostal Plane Block

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Pecto-Intercostal Plane Block

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Pecto-Intercostal Plane Block

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Pecto-Intercostal Plane Block Superficial & Deep

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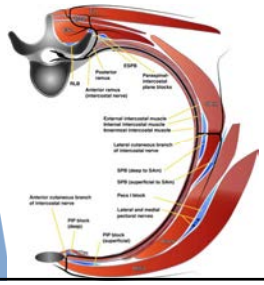
Thoracic Wall Analgesia



- Provide alternative to thoracic epidural
- Similar analgesic profile to paravertebral block
- Can be performed while patients intubated and/or anticoagulated

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Moving Forward

- High variability amongst studies
- Small sample sizes
- Studies with isolated thoracic wall injuries
- Inter-individual variability

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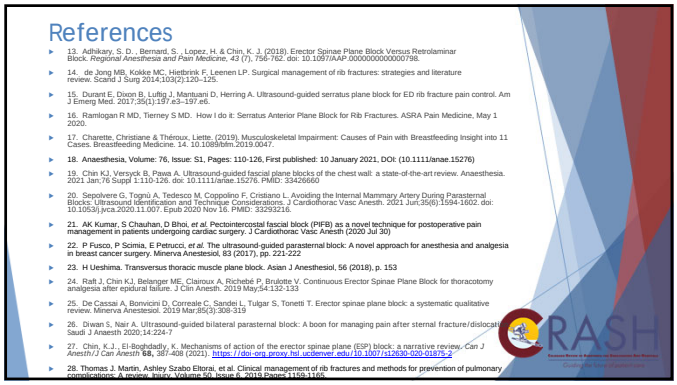
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CRASH

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Thursday, March 3rd

CRASH
Colorado Review of Anesthesia for Subcutaneous and Hospitals
Guiding the future of patient care

Minimally Invasive Pain Procedures

Justin Merkow, MD
Interventional Pain Physician

MD PAIN
SPORT, SPINE, AND PAIN MANAGEMENT

Anesthesiology
UNIVERSITY OF COLORADO
ANSCHUTZ MEDICAL CAMPUS

1

No Disclosures

2

Objectives

- Discuss minimally invasive pain procedures including newer options that are becoming more common
  - Intrathecal drug deliver systems (IDDS) or intrathecal pumps (ITPs)
  - Spinal cord and dorsal root ganglion stimulation
  - ReActiv8
  - Peripheral nerve stimulation
  - Vertiflex - Superion Interspinous Spacer
  - MILD (minimally invasive lumbar decompression)
  - Intracept Relievant
  - Others
- Highlight procedural aspects important for the anesthesiologist

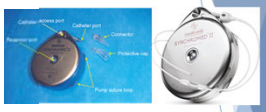
3

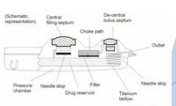
ITPs

- Basics
  - ITP is a method of delivering medications directly to the spinal cord
  - Medications in the reservoir are programmed to be delivered through a catheter that sits in the intrathecal space
  - Since medication is delivered directly to spinal cord, much lower doses and volume needed
  - Less systemic and less cerebral effects

4

- 20 cc- 40 cc titanium reservoir
- Access (side) port and reservoir port
- Flexible catheter w splicer
- Pump ~7 cm in diameter and 2 cm thick





5

Placing The Device

- Most commonly lateral position but prone if placing in back/buttock
- General or MAC
- Incision/wet tap/catheter
- +/- spinal dose for surgical analgesia
- Abdominal pocket
- Tunneling


6

Indications for ITP Therapy

- Cancer pain
- Non-cancer chronic pain
- Spasticity
- Overlap

7

Intrathecal Medications

- FDA approved
  - Morphine
  - Baclofen
  - Ziconotide
- Non-FDA approved
  - **Bupivacaine**
  - **Dilaudid**
  - Clonidine
  - Fentanyl
  - Sufentanil
  - Ketamine*
  - Ropivacaine*
  - Midazolam*
  - Buprenorphine*

*very little information in literature and use recommended with caution

8

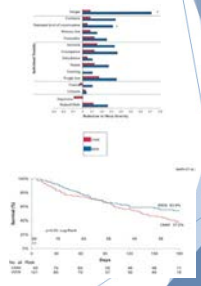
Complications

- Loss of analgesia or spasticity control
- Infection
- CSF leak
- Pump or catheter issues
- Drug side effects
- Drug overdose/underdose
- Seroma
- Granuloma
- *Intra-op catastrophes (spinal cord injury, epidural hematoma..)*
- *Intra-op ITP med related issues (hypotension, high spinal)*

9

Improved pain and QOL

- Smith et al, J Clin Oncol, 2002
  - RCT, ITP compared to conventional medical treatment in 143 patients with cancer and VAS >5
    - Follow up 4 weeks post treatment/randomization
    - IDDS group with more successful pain relief
    - More patients reporting >20% reduction in pain and drug toxicity (58% vs. 37.5%, p = 0.02)
    - IDDS group primary benefits - decreased fatigue and depressed level of consciousness



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Case Presentation

- JU: 40 yo male with a h/o metastatic (chest, abdomen, pelvis) colorectal cancer s/p right hemicolectomy 3/2016 and multiple rounds of chemo/radiation
  - Large metastatic superficial abdominal mass eroding through skin
  - Continued severe abdominal pain despite mod/high dose opioids
    - MME =304 (Methadone, dilaudid PO)

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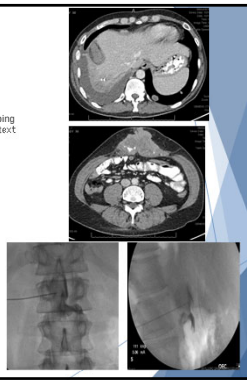
- Underwent retrolaminar block, CPBs x2
  - Blocks provided relief but pt hoping for more long-term relief in context of worsening dz and decrease in opioid use
- Decided to go forward with ITP



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- ITP pump placed in OR under MAC
  - Due to large abdominal mass, reservoir placed in flank
  - Catheter to T6
  - Observed for 24 hours then discharged
  - Pump with Dilaudid and Bupivacaine
- Started ITP 0.25 mg/day Dilaudid
  - Small adjustments as outpt and gave PTM function (self bolus)
- Patient weaned off methadone in 2 weeks, rarely takes oxycodone 5 mg prn
- Pain down to 1-2/10, improved sleep, function, ability to play with son, took trip to Disney World prior to passing away

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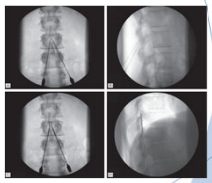
Spinal Cord Stimulation

- Dorsal Column Stimulation
  - Electrical energy near spinal cord to control pain
  - Percutaneous vs. paddle leads placed in epidural space
  - Leads commonly placed at thoracic or cervical level
  - Trial vs. permanent
  - Paresthesia vs. non-paresthesia
  - Stimulation variables = frequency, amplitude and pulse width



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Spinal Cord Stimulation

- Indications (expanding)
  - **Failed back surgery syndrome (FBSS)**
  - **CRPS**
  - **Arachnoiditis**
  - Painful peripheral neuropathy
  - *Diabetic peripheral neuropathy*
  - PHN
  - Ischemic limb pain/angina
  - Intractable angina
  - Chronic pancreatitis pain
  - Inguinal neuralgias
  - Restless leg syndrome
  - Trigeminal neuralgia
  - Chronic headaches
  - Spinal cord injury

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Spinal Cord Stimulation

- Mechanism of Action
  - Gate control theory (Melzack and Wall, 1965(6))
  - Supraspinal effects/descending pain pathway
  - Increasing inhibitory and decreasing excitatory pathways (WDR neurons, interneurons)
    - Increase GABA and serotonin (inhibitory)
    - Decrease glutamate and aspartate (excitatory)
  - Sympathetic effects, improving blood flow
  - Glial Cell effects
- Last 5 years years explosion in technology for SCS centered around types of stimulation, MRI compatibility, battery size and life

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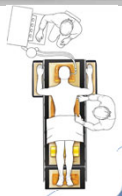
Spinal Cord Stimulation

- Complications
  - Infection (<5%)
    - Superficial vs. deep, pocket vs. back
  - *Epidural hematoma*
  - *Spinal cord injury*
  - Dural puncture
  - Pocket hematoma vs. seroma
  - Wound dehiscence
  - Lead migration or fracture

17

Spinal Cord Stimulation

- Placing the device
  - Prone position
  - MAC anesthesia for percutaneous leads
    - Often need wake up during case for testing
  - General with neuromonitoring for paddle leads
  - Midline back incision + pocket incision (usually flank/buttock)
  - Accessing epidural space, advancing leads, tunneling are parts of case that can be stimulating



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Advancements in SCS

- Boston Scientific – Combination therapy, FAST
- Medtronic – Differential target multiplexed therapy (DTM)
- Nevro – HF10 high frequency stimulation
- Abbot – Burst therapy, DRG

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Spinal Cord Stimulation 50 Years Later

Clinical Outcomes of Spinal Cord Stimulation Based on Randomized Clinical Trials—A Systematic Review

Nagy Mekhail, MD, PhD, Ojel Vinjiruca, MD, Gergos Azer, MD, Diana Sue Mekhaeil, MD, Priya Agrawal, DO, and Victor Pearson, MD

- Systematic review of RCTs, 2018
- Strong (1A-2B) evidence for SCS for FBSS, ischemic pain, and neuropathic pain
- Improvement in function, QOL, and analgesic use
- Dorsal root ganglion stimulation also effective compared to dorsal column stimulation for neuropathic pain

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Case Presentation

- CV: 68 yo male with a h/o AAA, HTN, multiple lumbar spine surgeries (including L3-5 fusion), and arachnoiditis with continued 8/10 mostly bilateral low back pain
  - Tried extensive PT, medications (neuropathic, MRs, NSAIDS, antidepressants), injections, massage, acupuncture, chiropractor prior to seeing me
  - I did one caudal ESI which provided 60% relief for 1 month
  - Patient wanting longer term solutions, not a candidate for repeat surgery

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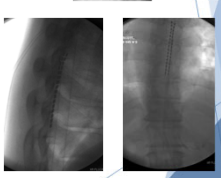
- Great results from trial, >90% relief
- Permanent implant placed
- >80% relief now at 1 year post op
- Significantly improved QOL – able to walk, bike ride, exercise which he was unable to do prior
- Very happy patient



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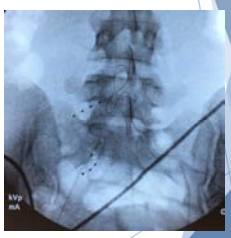
Spinal Cord Stimulation

- Dorsal Root Ganglion (DRG) Stimulation
  - Similar concept to dorsal column but leads are placed specifically over DRG of nerve involved in pain
  - For neuropathies in limited areas
    - Groin - T12, L1, L2
    - Knee – L3, L4
    - Foot – L4, L5, S1
    - Pelvis – L1/L2, S2
  - Trial often done in OR as more stimulating than dorsal column
  - Will sometimes need to wake patient up for testing but less common



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Case presentation

- DS: 35 yo male w h/o chronic left groin pain for >5 years after inguinal hernia surgery
- Pain refractory to all treatments
- Limited duration relief from blocks, radiofrequency ablation
- DRG leads x2 placed left L1 and L2
- Great relief from DRG trial
- 75% relief from permeant implant, sustained now ~2 years

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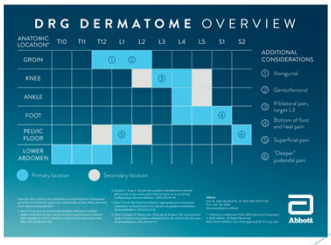

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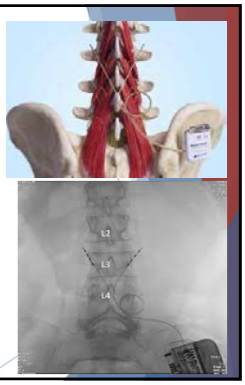
Reactiv8 – Multifidus dysfunction

- Instead of modulating pain like with SCS, goal is to stabilize the spine
  - Activate the multifidus muscle which is which is involved in stabilizing the spine and is inhibited in chronic low back pain
- Candidates
  - Chronic low back pain
  - Failed conservative treatments (PT, medications, injections including MBBs/radiofreqency ablation)
  - MRI findings of multifidus atrophy +/- positive prone instability test



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PAIN

OPEN

An implantable restorative-neurostimulator for refractory mechanical chronic low back pain: a randomized sham-controlled clinical trial

Christopher Gilligan[a,*], Willem Volcheck[b], Marc Russo[c], Matthew Green[d], Christopher Gilmore[e], Vivek Mehta[f], Kristiaan Deckers[g], Kris De Smedt[h], Usman Latif[i], Peter Georgius[j], Jonathan Gentile[k], Bruce Mitchell[l], Meredith Langhorst[l], Frank Huygen[m,n], Ganesan Baranidharan[o], Vikas Patel[p], Eugene Mironer[q], Edgar Rose[r], Alexios Caraiannoudoulos[s], Salim Hayek[t], Ashish Gulve[u], Jean-Pierre Van Buyten[v], Antoine Tohmeh[w], Jeffrey Fischgrund[x], Shivanand Lad[y], Farshad Khadivi[z], Timothy Deer[a], William Klemme[a], Richard Rauck[aa], James Rathmell[ab], Robert Levy[ac], Jan Pieter Haemels[ad], Sam Eldabe[ae], for the ReActiv8-B investigators

- International, double-blind, sham-controlled trial
- 204 patients with mechanical low back pain and positive prone instability test +/- multifidus muscle atrophy on MRI
- Sham stimulation vs. therapeutic stimulation
- Unblinded at 120 days, patients in sham group switched to therapeutic stimulation
- Followed for 1 year
- Primary endpoint inconclusive at 120 days but benefits accrued out to 1 year end point and were clinically meaningful

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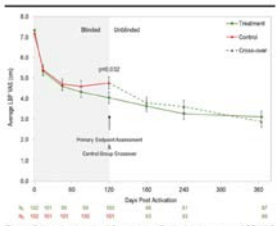

Figure 3. Low back pain-VAS trajectory. Reduction in average LBP-VAS shows a significant mean group difference at 120 days ($P = 0.032$) and improvements in CLBP continue to accrue through 1 year. CLBP, chronic low back pain; VAS, visual analogue scale.

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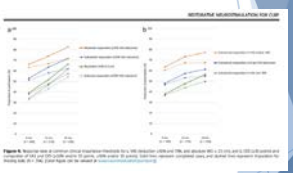
2 year data

- 71% participants with >50% improvement in low back pain, 65% resolution
- 61% with ODI reduction >20 points
- 87% continued device use at 2 years



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Peripheral Nerve Stimulation

- Electrical stimulation applied directly to peripheral nerves
- Increasingly being utilized
- Indications
  - CRPS
  - Neuralgias
  - Amputee pain
  - Low back pain

30

Peripheral Nerve Stimulation

- Trial of diagnostic injections often precede placement although but not necessary
- Pain must be along identifiable nerve distribution
- Newer devices with no internal battery or very small battery
- Can also use traditional SCS leads and place peripherally (internal generator with pocket needed)
- Done in OR vs. procedure room (newer devices)

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Peripheral Nerve Stimulation

- Advantages
  - Less invasive than SCS
    - No needles near the spinal cord
    - No internal battery for some devices
  - Can be done with limited (if any) sedation and local
  - Longer lasting than injections and radiofrequency ablation
  - Recovery faster than SCS as no incision for the newer devices
- Complications
  - Lead migration, fracture
  - Nerve, vascular injury
  - Hematoma, seroma, skin erosion
  - Infection
  - Increased pain/discomfort, numbness
  - Reaction to external battery adhesive

32

Peripheral Nerve Stimulation

- Placing the device
  - Theoretically any accessible peripheral nerve can be targeted
    - Ilioinguinal/iliohypogastric G
    - Genicular
    - Saphenous
    - Superficial peroneal, S
    - Suprascapular
    - Tibial
    - Cluneal
    - Occipital
  - Ultrasound and/or Xray guidance
  - Percutaneous placement
  - Testing is done around nerve to confirm placement

33

Temporary PNS – SPRINT

- PNS lead left in for 60 days, then removed
- Typical PNS indications
- Low back pain – targeting medial branch nerve
- Phantom limb pain
- Acute post op pain

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ANESTHESIOLOGY

Percutaneous Peripheral Nerve Stimulation (Neuromodulation) for Postoperative Pain: A Randomized, Sham-controlled Pilot Study

Brian M. Ilfeld, M.D., M.S., Anthony Plunkett, M.D., Alicia M. Vijenwaraju, M.S., Robert Hackworth, M.D., Sandeep Dhangal, M.D., Alparslan Turan, M.D., Steven P. Cohen, M.D., James C. Eisenach, M.D., Scott Griffith, M.D., Steven Hanling, M.D., Daniel I. Sessler, M.D., Edward J. Mascha, Ph.D., Dongsheng Yang, M.S., Joseph W. Boggs, Ph.D., Ariaro Wongsarnpigoon, Ph.D., Harold Gelfand, M.D., on behalf of the PAINFREE Investigators*

Anesthesiology 2021; XXX:00–00

Percutaneous peripheral nerve stimulation for the treatment of chronic neuropathic postamputation pain: a multicenter, randomized, placebo-controlled trial

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Treatment of chronic axial back pain with 60-day percutaneous medial branch PNS: Primary end point results from a prospective, multicenter study

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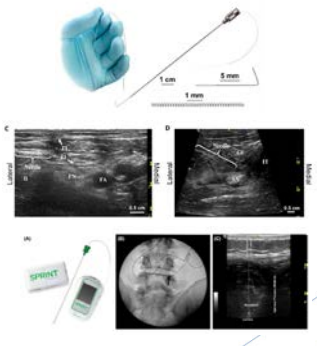

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Case presentation

- JU
  - 34 yo male w h/o left ankle CRPS related to ankle surgery in 2016
    - Tried multiple medications (Gabapentin, Cymbalta, Nortriptyline, topicals, Lyrica, NSAIDS), PT, CAMs
    - Left saphenous nerve block performed, great relief for ~1 week
    - Left saphenous RFA performed with good but again temporary relief
    - Decided to perform left saphenous peripheral nerve stimulation

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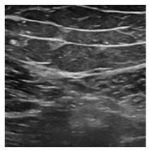
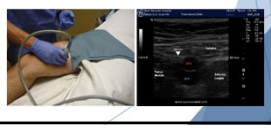
- Pain went from 8/10→2/10 post PNS placement, ongoing
- 80-90% improvement overall with improved function
- "life changing relief"





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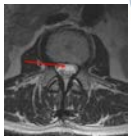
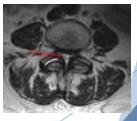
Lumbar Spinal Stenosis (LSS)/Neurogenic Claudication

- Symptoms of LSS/neurogenic claudication
  - Walking intolerance
  - Standing intolerance
  - Pain in back, buttock, legs
  - Improved with rest, sitting down
  - Improved with back flexion ("shopping cart sign")
- Causes
  - Listhesis, hypertrophic facets, short pedicles, disc bulge, foraminal stenosis, ligamentum flavum hypertrophy





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LSS Epidemiology

- Most commonly seen in patients >50
- Growing prevalence due to aging population
- 250,000-500,000 US residents with LSS
- Most common reason for spine surgery in elderly patients
- By 2029, 20% of US population expected to be > 65 yo

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Treatment– Conservative therapy

- Physical therapy
- Medications
- Epidural steroid injections
- Less than 40% of patients with moderate to severe LSS with claudication improve long-term with conservative treatment
- May improve but many pts want longer periods of non-treatment

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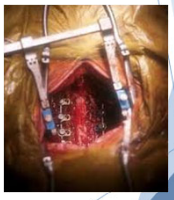
Treatment - Surgery

- Effective but side effects/complication profile should be considered
  - Nerve root damage (1 in 1000) or bowel/bladder incontinence (1 in 10,000)
  - CSF leak (1-3%)
  - Infections
  - Postop operative instability of operated on level (5-10% of cases)
  - No improvement in pain (10-40%)
  - Pseudoarthrosis (5-40%)
  - Continued/worsening pain



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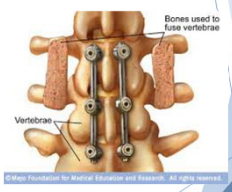
Treatment - Surgery

- Poor operative candidates
  - COPD
  - CHF
  - Uncontrolled HTN
  - Osteoporosis
  - Obesity
  - High dose opioids use
  - Low BMI
- Do not want surgery



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Minimally Invasive Lumbar Decompression (MILD)

- MILD = PILD
  - PILD: percutaneous image guided lumbar decompression
  - MILD: minimally invasive lumbar decompression
    - Mild is a decompression tool kit by Vertos medical

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MILD

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Mild Indications

- Symptoms of neurogenic claudication (walking, standing)
- Improved with rest (sitting), leaning forward
- Ligamentum flavum hypertrophy (LFH) >2.5 mm
- DDD, disc bulge, facet hypertrophy ok to co-exist if not severe or primary cause of symptoms

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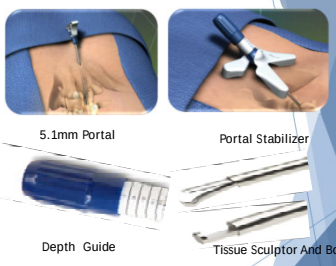
MILD Instruments

- Portal
- Portal Stabilizer
- Depth Guide
- Bone Rongeur
- Tissue Sculptor



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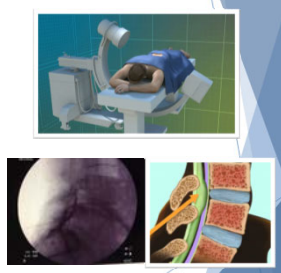
Procedure

- Prone position
- Eliminate lumbar lordosis
- MAC/sedation
- Epidural needle at or below working level
- Contrast into epidural space to create epidurogram at working space



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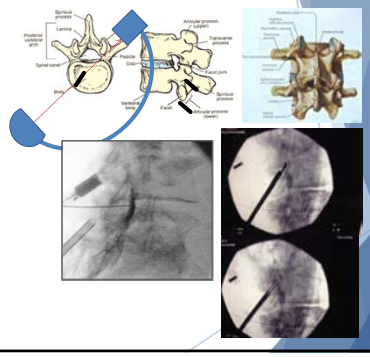
Procedure

- Contralateral Oblique View
- Remove superior and inferior parts of lamina using bone rongeur
- Using tissue sculptor, remove components of ligamentum flavum
- Assess post decompression contrast flow



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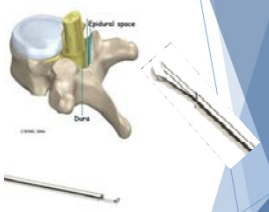
MILD Complications

- Adverse events within clinical trials:
  - None (Dural tear, Hematoma, Neural avulsions, Blood loss-transfusions)
- Adverse events outside of clinical trials:
  - Dural tear reported
  - Epidural hematoma in patient with "low platelets" requiring evacuation. No long-term sequela
  - Report of foot drop and numbness in patient post procedure who had severe stenosis
  - Demo kit tray used instead of sterile kit. Patient sent home with IV abx`
  - Risk similar to epidural steroid injection



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MiDAS ENCORE

- 2018
- Randomized, multi-center, comparative outcomes study of MILD vs. ESI
- Medicare patients, 65+ years, suffering from lumbar spinal stenosis (LSS) with neurogenic claudication and ligamentum flavum hypertrophy
- Primary Endpoint:
  - Oswestry Disability Index (ODI)
    Statistical superiority of the proportion of ODI responders from Baseline to 1 Year. (Responder = ODI change ≥10)
- Secondary Endpoints:
  - Zurich Claudication Questionnaire (ZCQ)
  - Numeric Pain Rating Scale (NPRS)
- Timeframes: 6 Months & 1 Year Required +2 year follow up of MILD arm

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MIDAS ENCORE

Table 5. *Primary and secondary efficacy outcomes—Proportion of responders.*

Outcome Measure	6 Months				1 Year			
	MILD % (n/N)	ESI % (n/N)	Difference (95% CI)	*P* Value	MILD % (n/N)	ESI % (n/N)	Difference (95% CI)	*P* Value
Primary Efficacy: ODI[a]	62.2% (89/143)	35.7% (46/129)	26.4% (14.4%, 38.8%)	<0.001 *	58.0% (83/143)	27.1% (35/129)	30.9% (18.0%, 42.8%)	<0.001 *
Secondary Efficacy: NPRS[b]	55.9% (80/143)	33.3% (43/129)	22.6% (10.4%, 34.9%)	<0.001 *	57.3% (82/143)	27.1% (35/129)	30.2% (18.3%, 42.1%)	<0.001 *
ZCQ[c] Symptom Severity domain	52.8% (75/142)	28.7% (37/129)	24.1% (12.1%, 36.2%)	<0.001 *	51.7% (74/143)	31.8% (41/129)	20.0% (7.8%, 32.2%)	0.001 *
Physical Function domain	52.8% (75/143)	14.0% (18/129)	38.7% (27.6%, 49.8%)	<0.001 *	44.1% (63/143)	17.8% (23/129)	26.2% (15.0%, 37.4%)	<0.001 *
Patient Satisfaction[d]	64.8% (92/142)	30.2% (39/129)	34.6% (22.7%, 46.5%)	<0.001 *	61.5% (88/143)	33.3% (43/129)	28.2% (16.1%, 40.3%)	<0.001 *

a. Significant difference between groups
b. ODI responder definition: ≥ 10 point improvement
c. NPRS responder definition: ≥ 2.0 point improvement
d. ZCQ domain responder definition: ≥ 0.5 point improvement in each domain
e. ZCQ Patient Satisfaction responder definition: ≤ 2.5. Lower scores indicate a higher level of satisfaction with the procedure.

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MiDAS 2 year follow up

- Followed the MILD group for another year
- Did not follow control group
- At 2 years, ODI improved by 22.7 points, VAS by 3.6 points, ZCQ symptom severity and physical function by 1.0 and 0.8, respectively
- No serious device/procedure related AEs, 1.3% non serious AE (intra-op oozing, post op pain)
- No Mild patient underwent repeat Mild
- 5.6% underwent surgical procedure at index level
- 15.4% underwent ESI or block at same level
  - Including 1 SCS, 1 rhizotomy, 1 ITP

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Vertiflex – Superion Interspinous Spacer

Neurogenic Intermittent Claudication (NIC)

NIC Secondary to LSS

- Canal and foraminal space for nerve decrease in **extension**

- Canal and foraminal space increase in **flexion**

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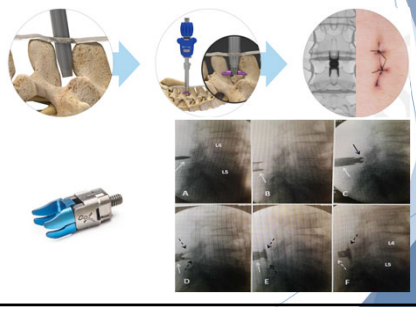
Vertiflex – Superion Interspinous Spacer



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Vertiflex – Superion Interspinous Spacer

- Indications
  - NIC secondary to moderate lumbar stenosis = 25-50% reduction in central canal, lateral recess or foramen
  - Relief in flexion
- Contraindications
  - Instability, > grade 1 spondylolisthesis, fracture, cauda equina syndrome, osteoporosis, infection, fusion at target level, BMI> 40

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Vertiflex – Superion Interspinous Spacer

- Complications
  - Spinous process fracture
  - Migration/dislodgement
  - Infection
  - Bleeding
  - Dural injury

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Superion Interspinous Process Spacer for Intermittent Neurogenic Claudication Secondary to Moderate Lumbar Spinal Stenosis

Two Year Results From a Randomized Controlled FDA-IDE Pivotal Trial

Vikas V. Patel, MD,* Peter G. Whang, MD,† Thomas R. Haley, DO,‡ W. Daniel Bradley, MD,§ Pierce D. Hunley, MD,¶ Raphael P. Davis, MD,‖ Larry E. Miller, PhD,** †† Jon L. Block, PhD,†† and Fred H. Geisler, MD, PhD‡‡

- Prospective, multicenter, randomized controlled IDE trial
- 391 NIC patients w moderate LSS randomized to Vertiflex (n=190) vs. X-stop (n=201) device
- Initial study 2 year follow up, then followed for 5 years
- Evaluated pain scores, disability, claudication index

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Results – Primary Outcomes

Primary Efficacy Outcomes % of Subjects Meeting Success Criteria	24 mo (n=183)	36 mo (n=167)	48 mo (n=155)	60 mo (n=157)
Success in 2 of 3 ZCQ domains Symptoms, function, satisfaction	81.7%	88.0%	85.6%	84.1%
Other Observations				
No re-operations/revisions Any surgical intervention at treated level(s)	80.0%	78.4%	75.3%	74.7%
No major related complications Infection, fracture, migration/dislodgement	86.3%	87.4%	85.8%	86.8%
No confounding additional treatments Stimulators, an ESI or nerve root block	86.8%	84.2%	83.7%	82.6%

Results – Secondary Outcomes

Secondary Endpoint Components % of Subjects Meeting Success Criteria	24 mo	36 mo	48 mo	60 mo
ZCQ Physical Function domain	72.5%	79.6%	80.0%	80.7%
ZCQ Symptom Severity domain	77.1%	84.3%	83.4%	75.0%
ZCQ Patient Satisfaction domain	84.0%	91.7%	86.7%	89.8%
VAS (Leg Pain)	75.6%	82.2%	78.2%	80.0%
VAS (Back Pain)	67.2%	76.6%	66.7%	64.7%
ODI	63.4%	67.6%	61.1%	64.8%

Individual Outcomes Positive at 2 years, Durable Through 5 years

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Results – Secondary Outcomes - VAS

- 60 month Outcomes

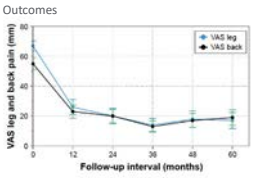

Figure 2 Time course of results for leg and back pain severity by VAS.
Note: Results reported as mean (95% CI).
Abbreviation: VAS, visual analog scale.

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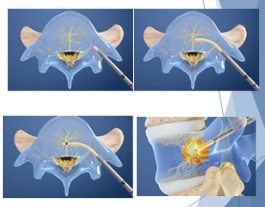
Intracept Relievent

- For patients with vertebrogenic back pain
- Patients with DDD often have evidence of vertebral endplate damage
  - On MRI = modic 1 and modic 2 changes
- Strongly correlated with low back pain
- Basal vertebral nerve (BVN) innervates the endplates and proliferates with endplate damage
- Procedure entails ablation of the BVN in the posterior middle aspect of VB
- Performed commonly under MAC



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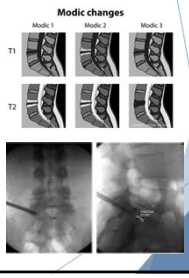
Long-term outcomes following intraosseous basivertebral nerve ablation for the treatment of chronic low back pain: 5-year treatment arm results from a prospective randomized double-blind sham-controlled multi-center study

Jeffrey S. Fischgrund[1,2] · Alfred Rhyne[3] · Kevin Macadaeg[4] · Gregory Moore[5] · Evtich Kamrava[6] · Christopher Yeung[7] · Eerk Truumees[8] · Michael Schuchele[9] · Phillip Yuan[10] · Michael DePalma[11] · David Greg Anderson[12] · Douglas Beutner[13] · James Reynolds[14] · Michael Sikorsky[15]

- Double-blind randomized sham-controlled trial
- 117 patients
- Type 1 or 2 modic changes
- >6 months conservative therapy
- VAS >4



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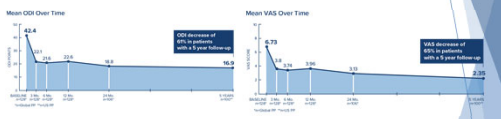
Does it work?



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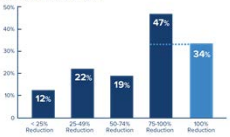
Proportion of Patients by % VAS Reduction

(Baseline to 5 Years, N=100)



Opioids?
Baseline: 30% on opioids
5 years: 8% on opioids (73% reduction)

Further injections?
Baseline: 59% injections within past year
5 years: 4% getting injections within past year

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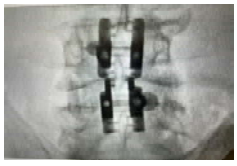
Other minimally invasive procedures to look out for

- Percutaneous SIJ fusion
- Minimally invasive lumbar fusion
- Percutaneous discectomy



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Conclusion

- Interventional pain is an exciting and technology driven field with constant innovation
- Existing devices with significant technological advancements in recent years
- New devices gaining popularity and evidence
  - Expect to see more and more in ORs
- Familiarity of basics of these procedures can be helpful for Anesthesiologists and proceduralists

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Contact Info

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CRASH
Colorado Review of Anesthesia for Simultaneous And Hospitals
Guiding the future of patient care

Pediatric Cardiac Patients Presenting for Non-Cardiac Surgery: Decision-making and Management

Megan Albertz, MD
Pediatric Cardiac Anesthesiologist, Children's Hospital Colorado
Assistant Professor, University of Colorado

Anesthesiology
UNIVERSITY OF COLORADO
ANSCHUTZ MEDICAL CAMPUS

1

No Disclosures

2

Learning Objectives

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

1. Assess which patients with congenital heart disease are at greatest risk of intraoperative complications
2. Identify common problems that are likely to be encountered when treating children with congenital heart disease
3. Demonstrate analytic thinking approaches to clinical scenarios associated with congenital heart disease.

3

Why is this topic important?

4

Also…

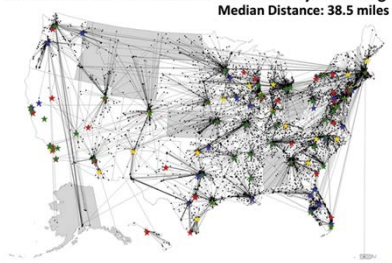
5

Ortho vs Anesthesia

6

Distance to Care

Current Patient Travel Patterns Where They Are Going
Median Distance: 38.5 miles



Welke et al. *Ann Thorac Surg* (2019).

7

Defining the Risk

8

Anesthesia-Related Cardiac Arrest in Children with Heart Disease: Data from the Pediatric Perioperative Cardiac Arrest (POCA) Registry (2010)

Mortality is higher in patients with heart disease (33%) compared with to those without (23%, P = 0.048).

Lesion	No. of Cardiac Arrests	Mortality
Single Ventricle	24	6 (25%)
Left to right shunts	23	4 (17%)
Obstructive	20	9 (45%)
Aortic Stenosis	13	8 (62%)
Cardiomyopathy	16	8 (50%)
Tetralogy of Fallot	15	3 (20%)
Truncus Arteriosus	6	2 (33%)

Ramamoorthy *et al. Anesth Analg* (2010).

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Anesthesia-Related Cardiac Arrest in Children with Heart Disease: Data from the Pediatric Perioperative Cardiac Arrest (POCA) Registry (2010)

- Patient risk factors
  - Young age < 2 years of age
  - Single ventricle patients
  - Aortic stenosis
  - Cardiomyopathy
- Location of Arrests
  - General operating room (54%)
    - Gastrointestinal procedures, ENT, and placement of central venous catheters
    - Maintenance > Presurgical > postsurgical
  - Cardiac OR (26%)
  - Cardiac catheterization lab (17%)

Ramamoorthy *et al. Anesth Analg* (2010).

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Post-operative Outcomes in Children with and without Congenital Heart Disease Undergoing Noncardiac Surgery

Classification	Definition
Minor CHD	• Cardiac condition with or without medication and maintenance (eg, ASD, small to moderate VSD without symptoms) • Repair of CHD with normal cardiovascular function
Major CHD	• Repair of CHD with residual hemodynamic abnormality with or without medications (eg, TOF with free pulmonary regurgitation, HLHS including Stage 1 repair)
Severe CHD	• Uncorrected cyanotic CHD • Patients with documented pulmonary hypertension • Patients with ventricular dysfunction requiring medication • Listed for heart transplant

Faraoni D et al. *J Am Coll Cardiol* (2016).

11

Post-operative Outcomes in Children with and without Congenital Heart Disease Undergoing Noncardiac Surgery

- 4520 children with CHD who underwent noncardiac surgery
  - 2805 with minor CHD
  - 1272 with major CHD
  - 417 with severe CHD
- Propensity matched with controls without CHD
- Overall mortality was significantly higher for patients with major (3.9% vs 1.7%, p < 0.001) and severe (8.2% vs 1.2%, p = 0.001) CHD compared with their controls
- No difference between children with minor CHD and their matched controls

12

Dilated Cardiomyopathy (DCM)

- Annual incidence of 0.58 per 100,000 children
- Most common type of cardiomyopathy (60%)
- Etiologies
  - Idiopathic
  - Familial
  - Associated with neuromuscular disorders
    - Duchenne and Becker muscular dystrophy
    - Limb girdle muscular dystrophy
    - Freidrich Ataxia
  - Associated with mitochondrial disease
  - Inflammatory
    - Viral myocarditis

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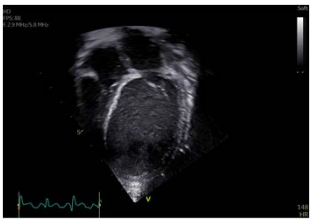
Preoperative Assessment



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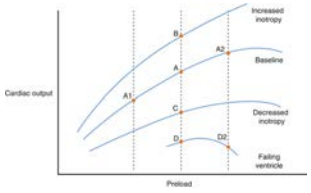
Frank Starling Curve



15

Intraoperative Anesthetic Management

- Maintain normal blood pressure to optimize coronary perfusion
- Maintenance of preload
- Avoidance of tachycardia
- Avoidance of decreased myocardial contractility
- Avoid increases in systemic vascular resistance

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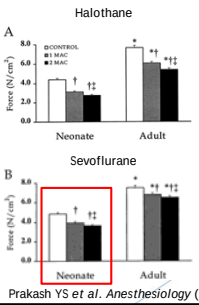
16

Volatile Anesthetics

- Volatile anesthetics depress myocardial contraction
  - Mechanism: Interfere with calcium channels in the myocardium decreasing available calcium for myocyte contraction
- Neonatal myocardium is more susceptible than the adult myocardium to the reduction in myocardial contraction



Prakash YS *et al. Anesthesiology* (2000).

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17

Propofol

- Quick onset and quick offset
- No change in CO, HR and mean PAP
- Significantly decreases MAP and SVR

	Group	Awake	T1	T1+5	(T vs P)
HR (beat min^{-1})	T	139 (20)	144 (21)	135 (20)	ns
	P	141 (23)	131 (15)	130 (17)	
SAP (mm Hg)	T	114 (21)	123 (13)	110 (18)	P<0.001
	P	109 (15)	105 (10)	93 (10)*	
MAP (mm Hg)	T	79 (14)	89 (12)	72 (17)	P< 0.001
	P	80 (19)	68 (9)	58 (6)*	
LVDD (cm)	T	2.4 (0.2)	2.4 (0.2)	2.3 (0.2)	ns
	P	2.4 (0.3)	2.5 (0.2)	2.4 (0.2)	
SF (%)	T	38 (6)	32 (4)*	33 (6)*	ns
	P	36 (4)	35 (6)	35 (3)	
VCFc (circ s^{-1})	T	1.03 (0.20)	0.81 (0.12)	0.87 (0.18)	ns
	P	0.94 (0.14)	0.89 (0.21)	0.91 (0.10)	
ESWS (g cm^{-2})	T	40.5 (10.2)	53.9 (18.5)	42.4 (10.6)	P< 0.05
	P	47.9 (21.0)	40.0 (12.0)	32.0 (5.1)*	
SVR (dyn s cm^{-5})	T	1262 (238)	1449 (319)	1250 (299)	P< 0.05
	P	1366 (385)	1171 (273)	1001 (166)*	

Wodey E *et al. Br J Anaesth* (1999).

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Dilated Cardiomyopathy

- 10yo F with a history of DCM presents for central line placement for continuous milrinone infusion
- No prior problems with anesthesia
- Ejection fraction 14% on most recent echo

- How would you induce this patient?

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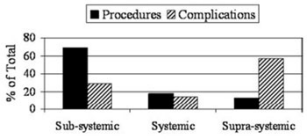
Pulmonary Hypertension

- Diagnosis
  - Resting mean pulmonary artery pressure (mPAP) ≥ 25 mmHg
  - Pulmonary vascular resistance index (PVRI) > 3 Woods units X m^2
- Etiologies
  - Idiopathic
  - Congenital Heart Disease

20

Risk Assessment

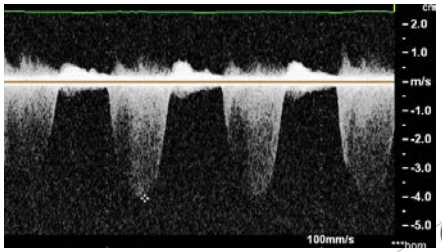
- Systemic (70-100% MAP) to suprasystemic (> 100% MAP) mPAP
- Decreased right ventricular function
- Elevated mPAP
- Home oxygen use
- Presence of syncope



Carmosino et al. *Anesth Analg* (2007).

21

Pulmonary Hypertension



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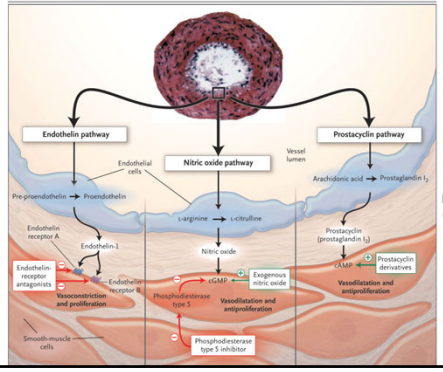
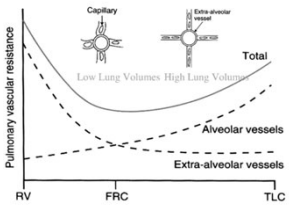


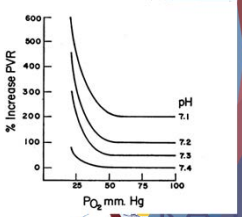
Humbert et al. *NEJM* (2004).

23

Ventilation



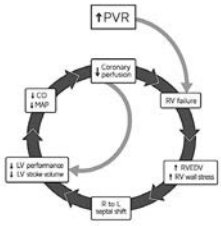
Iliopoulos and Nelson. *Prog Pediatr Cardiol* (2015)



Rudolph and Yuan. *J Clin Invest* (1966)

24

Pulmonary Hypertensive Crisis



Treatment	Rationale
Administer 100% O_2	↑ P_AO_2 and P_aO_2 can ↓ PVR
Hyperventilate	PVR is directly related to P_aCO_2
Exclude pneumothorax	Optimize ventilation
↓ mean airway pressure	Avoid $P_{alv} > P_{art}$
Correct metabolic acidosis	PVR is directly related to H^+ level
Administer pulmonary vasodilators	iNO
Support cardiac output	Adequate preload and inotropic support, ECMO
Support coronary perfusion	Maintain SVR with epinephrine, NE or Vaso
Analgesia	Decrease sensory/sympathetic mediated ↑ PVR

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Case

- 8-year-old M with a history of severe idiopathic pulmonary hypertension presents for cardiac catheterization for right heart and pulmonary hypertension evaluation
- PMHx includes developmental delay and genetics of unknown consequence
- Medications include sildenafil and bosentan
- How would you manage the airway?

26

Left Ventricular Outflow Tract Obstruction

- Williams Syndrome
- Critical aortic stenosis
- Subaortic membrane

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Williams Syndrome

- Genetic disorder related to deletion of several genes on chromosome 7, including the elastin gene
- Characteristics
  - "Elfin" facies
  - Lack social inhibition
  - Endocrine abnormalities
    - HYPERcalcemia
  - Developmental delay
  - Genitourinary abnormalities
    - Renal artery stenosis

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Cardiac Abnormalities

- Supravalvular aortic stenosis (SAS)
- Pulmonary artery stenosis (PAS)
- Coronary arteriopathy
- Left ventricular hypertrophy (LVH)
- Systemic hypertension
- Prolonged QT

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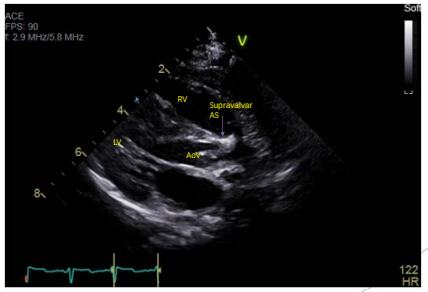
Williams Syndrome



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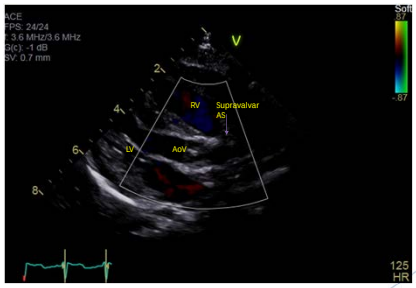
Williams Syndrome



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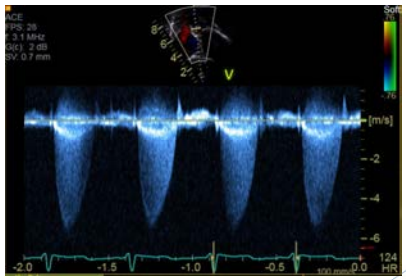
Williams Syndrome



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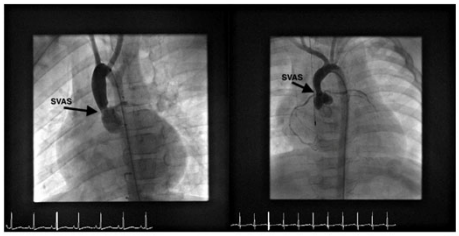
Supravalvar Aortic Stenosis



Staudt et al. *JCVA* (2021).

33

Classification of Williams Syndrome

Low Risk	Moderate Risk	High Risk
Normal ECG	Mild stenosis of a branch of the pulmonary artery	Severe SVAS (> 40mmHg)
Normal echocardiogram	Hypertension	Symptoms or ECG signs consistent with ischemia
Minimal extracardiac anomalies	Mild-to-moderate SVAS (<40mmHg)	Coronary disease demonstrated in imaging
	Other mild cardiac anomalies (VSD)	Severe left ventricular hypertrophy
	Repaired SVAS or SVPS without residual gradients	Biventricular outflow tract disease
	Mild to moderate SVPS in isolation	Prolonged QTc on ECG
	Significant extracardiac disease such as difficult airway or severe GERD	

Matisoff *et al. Paediatr Anaesth* (2015).

34

Anesthetic Management

- Preservation of sinus rhythm
- Maintenance of preload, contractility and SVR
- Avoidance of anesthetic drugs that cause physiologic changes that may worsen ischemia

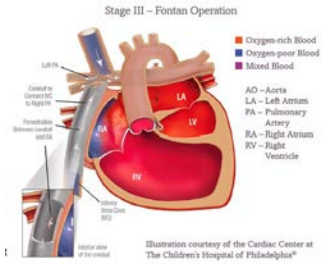
35

Case

- 6-year-old patient presents for a preoperative evaluation for tympanotomy and tube insertion
- PMHx includes Williams Syndrome, recurrent otitis media
- No prior anesthetics
- Last echocardiogram was done 6 months ago
- Would you proceed with the anesthetic at an ambulatory surgery center?

36

Total Cavopulmonary Anastamosis(Fontan)



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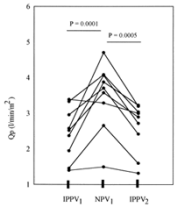
Long Term Complications

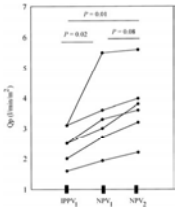
- Cardiac
  - Arrhythmias
  - Heart failure
- Pulmonary
  - Pulmonary arteriovenous malformations
  - Plastic bronchitis
  - Pulmonary Hypertension
- Hepatic
  - Liver dysfunction
- Gastrointestinal
  - Protein-Losing Enteropathy (PLE)

38

Ventilation



40% increase in PBF
Decrease with return of PPV



PBF continues to increase with NPV

Fontan circulation prefers spontaneous ventilation/negative intrathoracic pressure

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Case

- 15-year-old with a history of Fontan completion who presents for laparoscopic appendectomy
- Doing well clinically
- During the procedure, oxygen saturations decrease to 89%. They come up to 91% on
- Would you extubate at the end of the case? Where would you put the patient postoperatively?

40

Anesthetic Management

- Advocate for the first case of the day
- Consider fluid bolus before induction of anesthesia
- When using positive pressure ventilation consider the following:
  - Strive for normocapnia
  - Avoid acidosis
  - Long I:E ratio
  - Extubate early
- If a healthy Fontan, they can be discharged home

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Thank you

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CRASH
Colorado Review of Anesthesia for Subsequent Ambulatory Hospitals
Guiding the future of patient care

Quality Improvement and Change Management

Alma Juels, MD; Samuel Gilliland, MD; Tyler Morrissey, MD

Anesthesiology
University of Colorado
Anschutz Medical Campus

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Panel Breakdown

- Tyler Morrissey, MD – Assistant Professor, Pediatric Anesthesiology - CHCO
  - Quality Improvement Overview; "Anatomy of a QI Project"
- Sam Gilliland, MD – Assistant Professor, Anesthesiology and Critical Care – UCH
  - Perioperative Glycemic Management
- Alma Juels, MD – Associate Professor, Anesthesiology – Denver Health
  - Change Through Communication

2

Faculty Disclosure

- None

3

Learning Objectives

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

- Describe the anatomy of a QI project using IHI's Model for Improvement (MFI).
- Demonstrate how the MFI can be systematically applied to create improvement in many aspects of health care.
- Compare quality improvement data with research data.

4

What is QI?

5

Why QI?

Traced back to Institute of Medicine *Quality of Health Care in America* reports:

- *To Err is Human* (1999)
- *Crossing the Quality Chasm* (2001)

Current climate: growing emphasis on outcomes and costs.

Provost L, Lloyd R, Murray M. *QI Modules 101-104*. J. Roessner and L. Fink (Eds). Retrieved from www.ihi.org; 2015.

6

Once we have a project idea, **where do we start?**

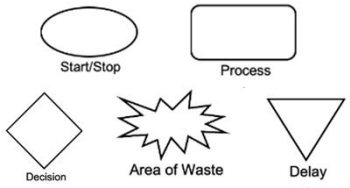
Engage and involve key stakeholders

This includes frontline workers

7

SC1

Process mapping basics



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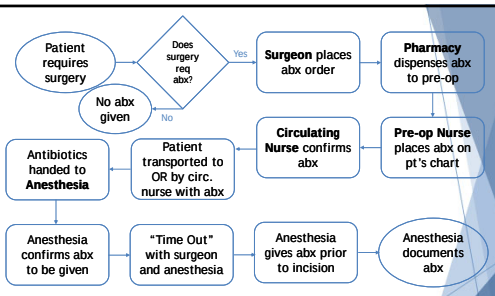

Example Process Map

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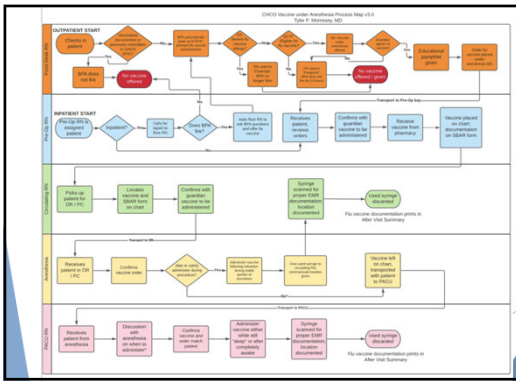

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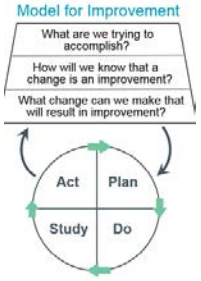

The Model for Improvement

- What are we trying to accomplish?
- How will we know that a change is an improvement?
- What change can we make that will result in improvement?

Provost L, Lloyd R, Murray M. *QI Modules 101-104*. J. Roessner and L. Fink (Eds). Retrieved from www.ihi.org; 2015.

11

Six Sigma's DMAIC

Define	Define the problem in detail
Measure	Measure defects (dpm, sigma level)
Analyze	Analyze under what conditions defects occur
Improve	Improve by defining and testing changes
Control	Control your results and maintain performance

12

Q1: What are we trying to accomplish?

- The answer to this question will become your "SMART" Aim Statement.
  - Specific, measurable, answers these questions:
    - How good?
    - By when?
    - For whom?

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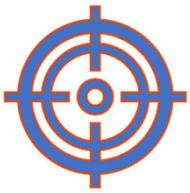
AIM statement pointers



- Make one.
- Make sure it's meaningful to you.
- Make sure it's trackable.
- Set a reasonable scope.

14

Q2: How will we know if a change is an improvement?

QI measures are different than formal research

Types of measures:

Outcome	Process	Balancing

Provost L, Lloyd R, Murray M. *QI Modules 101-104*. J. Roessner and L. Fink (Eds). Retrieved from www.ihi.org; 2015.

15

	Research	QI
Purpose	Determine effectiveness	Sustain improvement
Data Collection	Authoritatively study for effect; Control for confounders	Just enough data to inform improvement; confounders as needed (balancing measures)
Method	One test, control bias	Sequential tests, don't control bias
Hypothesis	Fixed	Changing as learning takes place
Evaluation	Post-assessment	Regular assessment with run or control charts

Research vs QI

Provost L, Lloyd R, Murray M. *QI Modules 101-104*. J. Roessner and L. Fink (Eds). Retrieved from www.ihi.org; 2015.

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Q3: What change can we make that will result in an improvement?

Ideas for change come from several places…..

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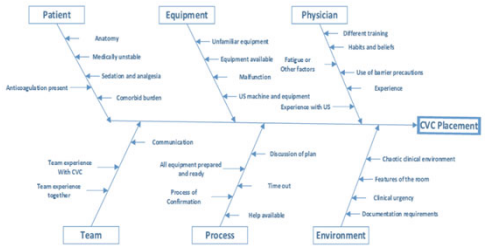
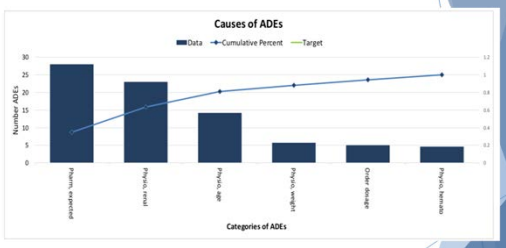


Fishbone Diagram. American Society for Quality. Excerpted from The Quality Toolbox, Second Edition, ASQ Quality Press. https://asq.org/quality-resources/fishbone

18

Pareto



Classen DC, Pestotknik SL, Evans RS, Burke JP. Computerized Surveillance of Adverse Drug Events in Hospital Patients. JAMA. 1991; 266(20): 2847

19

PDSA

Image: Provost L, Lloyd R, Murray M. *QI Modules 101-104*. J. Roessner and L. Fink (Eds). Retrieved from www.ihi.org; 2015.

20

Plan

- Test and Data Collection

Try to answer:

- What information is important to collect? Why?
- Who will collect the data?
- Where and when (and how) will data be collected?

21

Do

- Perform the test!

22

Study

- Complete, as a team, analysis of the data
- Compare to your prediction
- Summarize what you've learned

23

What is a Run Chart?

- Line graph of data plotted over time
- Allows user to find trends or patterns in a process
- Allows user to track changes in a process from an intervention

Perla R, Provost L, Murray S. The run chart: a simple analytical tool for learning from variation in healthcare processes. BMJ Qual Saf 2011; 20: 46-51.

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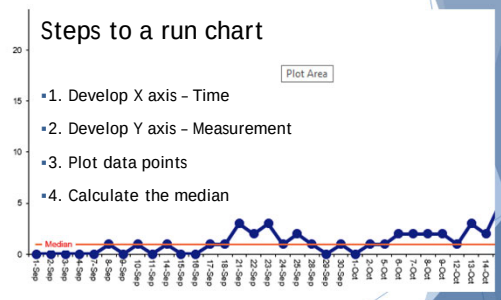
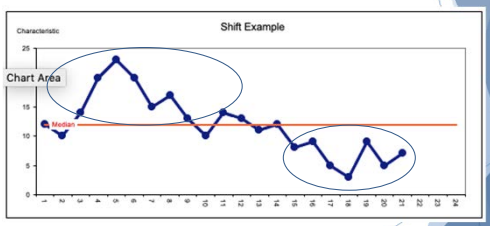
Steps to a run chart



- 1. Develop X axis – Time
- 2. Develop Y axis – Measurement
- 3. Plot data points
- 4. Calculate the median

25

Shift



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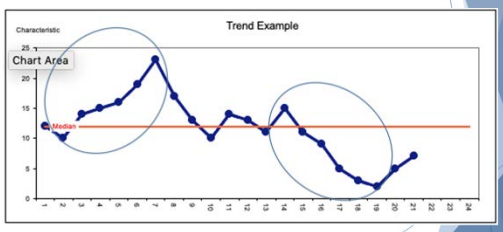
Trend



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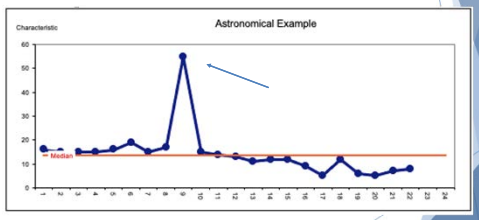
Astronomical data points



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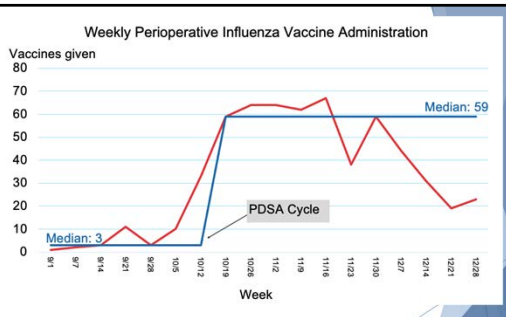

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Goal:
associate non-random variation (i.e. shifts and trends) with your intervention

30

You are here!

Act

- The 3 A's:
  - Adapt
  - Adopt
  - Abandon

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Summary – a return to objectives

We have…

- Described the anatomy of a QI project using IHI's Model for Improvement (MFI).
- Demonstrated how the MFI can be systematically applied to create improvement in many aspects of health care.
- Compared quality improvement data with research data and illustrate common methods of displaying quality improvement data, including run charts and control charts.

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CRASH

Colorado Review of Anesthesia for Surgeries And Hospitals

Guiding the future of patient care

Perioperative Glycemic Management

Sam Gilliland, MD

Assistant Professor, Anesthesiology and Critical Care

Anesthesiology
University of Colorado
Anschutz Medical Campus

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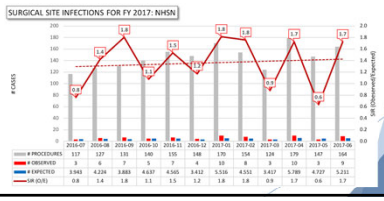
Problem Statement

BROAD PROBLEM:
Surgical site infection rates at the University of Colorado exceed the national average when compared to risk-adjusted controls.



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CDC Guidelines

- Appropriate antimicrobial prophylaxis
- Alcohol-based skin prep
- Normothermia
- ~~Oxygen administration~~
- *Perioperative blood glucose <200mg/dL*

DEPARTMENT OF HEALTH & HUMAN SERVICES-USA
CDC

Berrios-Torres SI, Umscheid CA, Bratzler DW, Leas B, Stone EC, Kelz RR, et al. Centers for Disease Control and Prevention Guideline for the Prevention of Surgical Site Infection, 2017. JAMA Surg. 2017;152(8):784-91.

35

The Problem Statement

BROAD PROBLEM:
Surgical site infection rates at the University of Colorado exceed the national average when compared to risk-adjusted controls.

OUR PROBLEM:
Patients receiving inpatient surgery at the University of Colorado Hospital have inadequate glucose management in the perioperative period.

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Our Team

Gina Whitney, MD – Vice Chair, Quality
Sam Gilliland, MD – Physician Lead
Kristen Vandevelde, CRNA – APP Lead, Superuser
Shelby Badani, MD – Resident Lead, Superuser
Jen Locker, RN – PreOp RN Supervisor
Randi Strom, RN – PACU RN Supervisor
Clark Lyda, PharmD – Lead Pharmacist
Agnes Tatarka – Data Analysis
Derek Hawes - Data Analysis
Cecilia Low-Wang – Director, GMT

37

Aim Statement

We aim to increase the proportion of hyperglycemic patients treated intraoperatively by 20% over 6 months by standardizing testing intervals and providing pathways for treatment of hyperglycemia in the inpatient surgery setting.

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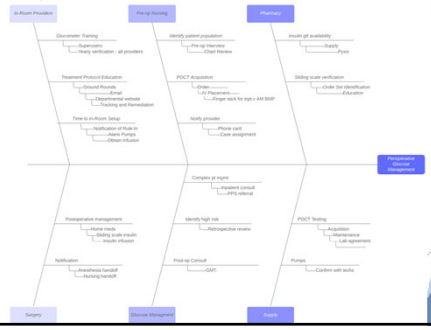
The Conceptual Model of the Problem



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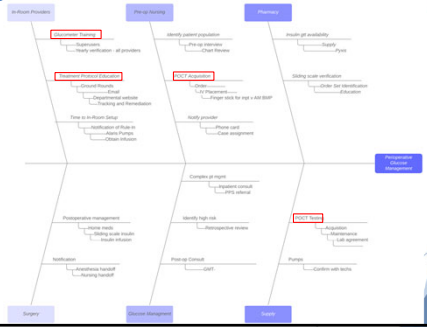
Leverage Points



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Leverage Points

POCT License – low complexity testing
POCT Acquisition – 2 units for ~40 ORs
POCT Training – all providers, yearly certification
Reliable data extraction and monitoring for compliance
Protocol Development

Data Element - %hyperglycemic patients receiving insulin intraop

41

Change Hypotheses

- Acquiring point of care testing credentials and testing units will give us the tools necessary to monitor our patients appropriately.
- Training all frontline providers and providing an infrastructure for yearly maintenance certification will empower them to manage perioperative hyperglycemia
- Thoughtful protocol development for intraoperative glycemic control will allow for appropriate monitoring and treatment without dramatically altering workflow
- Monitoring of provider adherence to the protocol will allow us to identify deficiencies in the process.

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Perioperative Management Protocol

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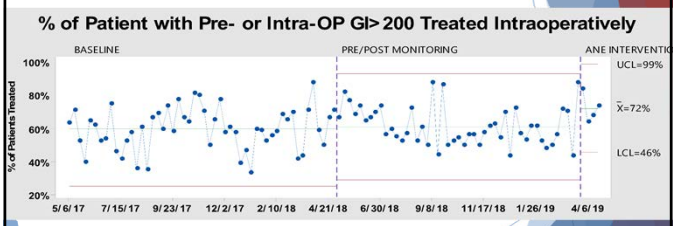
Baseline Data / Results



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Lessons Learned

- Given the appropriate tools and training, we can move the needle on intraoperative glucose management
- Communication between phases of care is vital to the success of a complex process
- Development of a "source of truth" monitoring system is complex
- Nurses are far more organized that physicians

45

Next Steps

- Migration of protocols / new trainees and staff training
- 3 months post-intervention initiate follow-up with non-compliant providers to identify barriers
- Identify patients whose first hyperglycemic event is postoperative, review chart for risk factors
- Develop a more robust post-operative management protocol with the assistance of our glucose management team
- Develop an analogous treatment pathway for outpatient surgery

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The End

47

CRASH
Colorado Review of Anesthesia for Subscriptions And Hospitals
Guiding the future of patient care

Change through Communication

Alma Juels, M.D
Associate Professor of Anesthesiology
University of Colorado School of Medicine
Attending Physician
Denver Health and Hospital

Anesthesiology
University of Colorado
Anschutz Medical Campus

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No Disclosures

49

Operating Room Errors

- 10% of surgical patients
- Almost half of those can be prevented
- The majority are due to human errors

. Zegers M, de Bruijne MC, de Keizer B, et al. The incidence, root- causes, and outcomes of adverse events in surgical units: implication for potential prevention strategies. Patient Saf Surg 2011; 5: 13

50

- 98,000 patient deaths per year due to medical errors, 72% from communication errors To ERR Human, IOM 1999

51

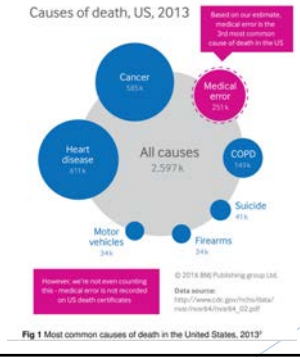


Fig 1 Most common causes of death in the United States, 2013[1]

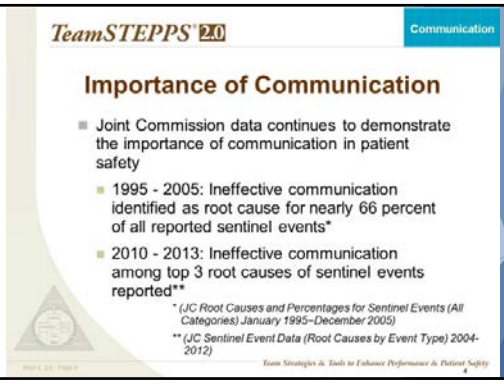
52

Communication Failures

- Errors
- Adverse events
- Malpractice claims

Hu YY, Arriaga AF, Peyre SE, et al. Deconstructing intraoperative communication failures. J Surg Res 2012; 177: 37-42

53



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- Wrong side/site procedures
- Wrong implant
- Retained foreign objects
- Wrong procedure

55

- One simulation study showed team members did not share clinical relevant information 48% of the time

Cumin D, Skilton C, Weller J. Information transfer in multidisciplinary operating room teams: a simulation-based observational study. BMJ Qual Saf 2016; 26: 209-16

56

- Communication failures occur frequently-every 7 to 8 minutes
- Usually between professions not within professions
- 90% of the time this causes an issue such as delays, procedure error, waste of resources, near misses and other adverse events.

Kripalani S, LeFevre F, Phillips CO, William MV, Basaviah P. Baker DW. Deficits in communication and information transfer between hospital-based and primary care physicians: implications for patient safety and continuity of care. JAMA 2007; 297: 831-41.

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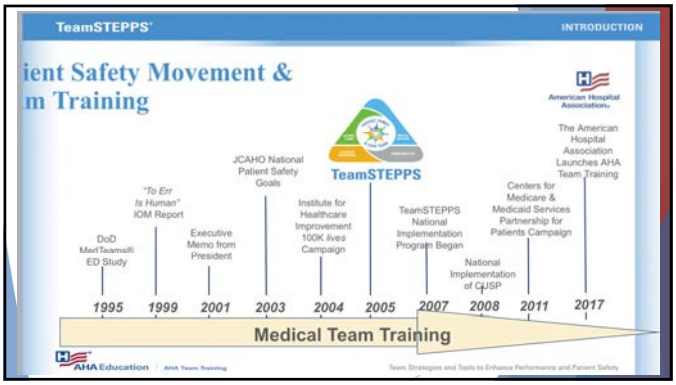

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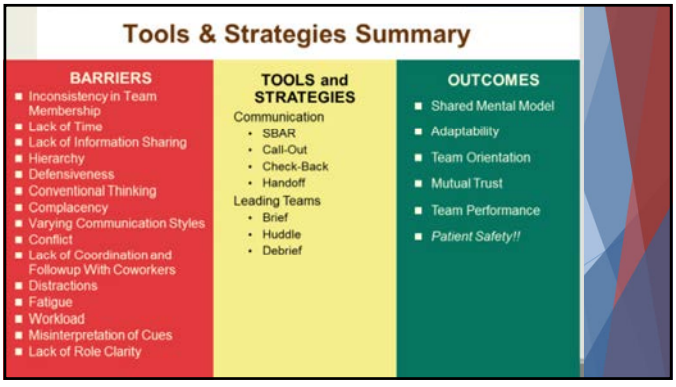
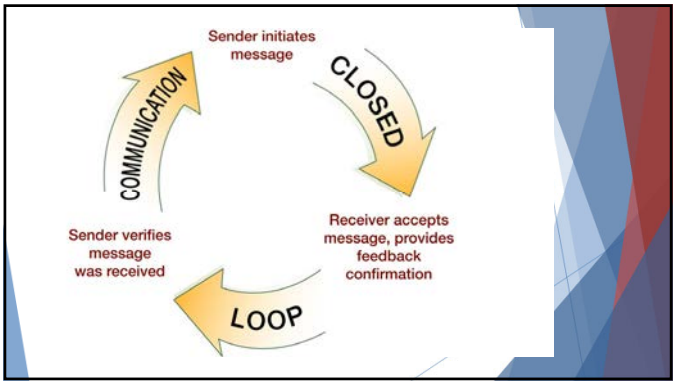


60

Standardized Structured Communication

- Checklist/Briefings-timeout
- Closed loop communication
- Situation Background Assessment Recommendation (SBAR)
- Critical Language
- Common Language
- Active Listening

61



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SBAR

Standardized framework to communicate about a patient

63

Successful Communication in the OR

- Structure
- Standardization
- Team integration
- Team stability
- Culture that allows anyone to speak up

64

How to Improve Communication

- Standardize communication
- Assertive Language
- Education

65

Education

- Teamwork training
- Crisis Resource Management training
- TeamSTEPPS-Team Strategies and Tools to Enhance Performance

66

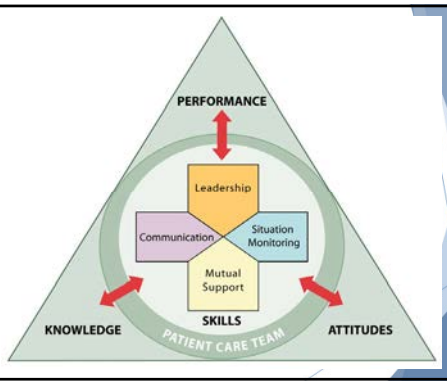
- Based on more than 30 years of research and evidence
- Improve attitudes
- Increase knowledge
- Improve behavioral skills
- Meta-analysis has shown evidence of moderate to positive effect on team outcomes

67

TeamSTEPPS

- Team Structure
- Communication
- Leadership
- Situation Monitoring
- Mutual Support

68



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Communication Skills

100 Level Skills	200 Level Skills	300 Level Skills
Request	Huddle	CUS
Call-Out	Debrief	Two-Challenge Rule
Cross-Check	Handoff	DESC
Check-Back	Cross- Monitoring	I'M SAFE
SBAR	STEP	
Brief	Task Assistance	
	Shared Mental Model	

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Tools

- Briefs-Planning, prior to start, roles, expectation, outcomes
- Huddles-problem solve, changing plans
- Debriefs-after event
- Mutual support

71

Assertive Phrases

- "I am concerned"
- "I am uncomfortable"
- "I feel this is a safety issue"
- CUS-Technique-Concerned, Uncomfortable, Safety issue
- May need to reach out to other resources to maintain patient safety-another provider

72

- Shared Mental Models
- Clear Roles laid out
- Shared Vision
- Optimize Resources
- Strong team leadership
- Regular feedback
- Collective Trust and Confidence
- Enable Cooperation and Coordination

73

- Good understanding of roles and responsibilities
- Sharing information in a timely fashion
- Improve efficiency
- Holding staff accountable for their actions

74

Surgical Checklist

- Discuss cases for the day, what is needed-concerns, equipment, anesthetic care, medication, recovery issues-first thing in the morning
- Before induction of anesthesia
- Before skin incision/start of procedure
- Before patient leaves the room

75

Timeouts/Briefing

- Helps with clear and good communication
- Gets everyone on the same page
- Teamwork and collaboration
- Allows team members to address an concerns/problems-everyone participates
- Sets the tone for the procedure
- Improves patient safety

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All team members introduce themselves

Team confirms-Patient identification and procedure/surgical site and side

Surgeon shares operative plan and possible difficulties

Anesthesia team shares anesthetic plan and/or concerns

Nurse and scrub tech share equipment available, issues, concerns

Nurse and scrub tech confirm medications are correct and labeled and implant is the correct type and size

Surgeon sets the tone with a statement-asking if anyone has any concerns/questions

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Debriefing

- Verification of sponge/needle count
- Review procedure that was performed
- Confirmation of any specimens labeling
- Discuss any issues or concerns with equipment or patient recovery
- Discuss actions for next case

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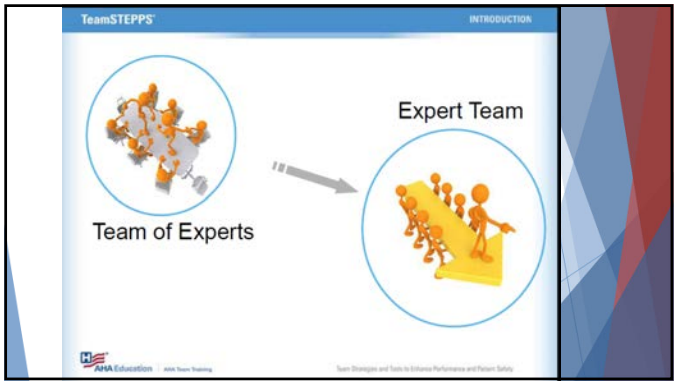
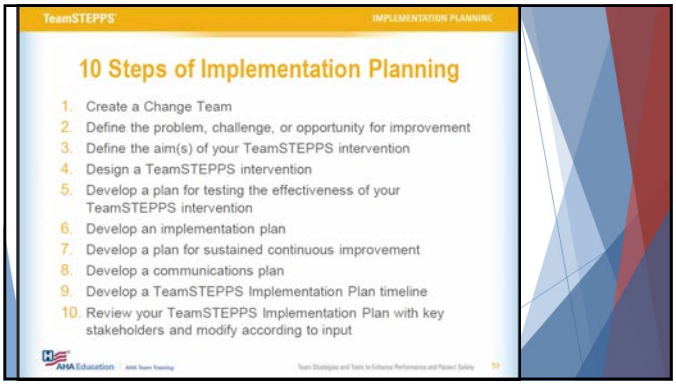
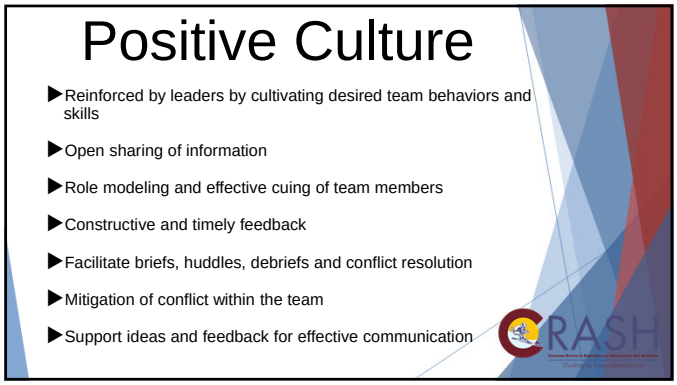

TeamSTEPPS
INTRODUCTION
Expert Team
Team of Experts
AHA Education

79


TeamSTEPPS
IMPLEMENTATION PLANNING
10 Steps of Implementation Planning
1. Create a Change Team
2. Define the problem, challenge, or opportunity for improvement
3. Define the aim(s) of your TeamSTEPPS intervention
4. Design a TeamSTEPPS intervention
5. Develop a plan for testing the effectiveness of your TeamSTEPPS intervention
6. Develop an implementation plan
7. Develop a plan for sustained continuous improvement
8. Develop a communications plan
9. Develop a TeamSTEPPS Implementation Plan timeline
10. Review your TeamSTEPPS Implementation Plan with key stakeholders and modify according to input
AHA Education

80


Positive Culture
Reinforced by leaders by cultivating desired team behaviors and skills
Open sharing of information
Role modeling and effective cuing of team members
Constructive and timely feedback
Facilitate briefs, huddles, debriefs and conflict resolution
Mitigation of conflict within the team
Support ideas and feedback for effective communication
CRASH

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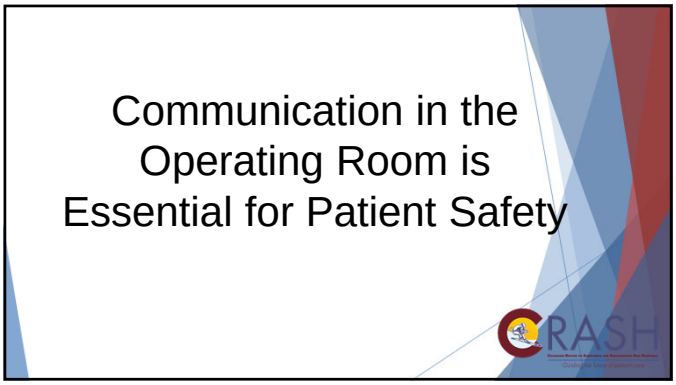
Communication in the Operating Room is Essential for Patient Safety
CRASH

82

Pediatric Anesthesia Conundrums

Megan Albertz, MD
Christopher Ciarallo, MD
Debnath Chatterjee, MD

1

Conflicts of Interest

- None

2

Scenario 1: Fasting Guidelines for Pediatric Procedural Sedation?

3

9-year-old, otherwise healthy female, with a closed distal radius fracture after a fall from the swing. Needs closed reduction under moderate/deep sedation. Drank milk in the ED waiting room.

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Poll #1

How long should you wait prior to propofol/ketamine sedation?

1. No waiting
2. 2 hours from milk
3. 4 hours from milk
4. 6 hours from milk

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Table 3. Summary of American Society of Anesthesiologists Recommendations for Preoperative Fasting and Use of Pharmacologic Agents to Reduce the Risk of Pulmonary Aspiration: Application to Healthy Patients Undergoing Elective Procedures

	Recommendation
Ingested material	
Clear liquids†	2-h minimum fasting period*
Breast milk	4-h minimum fasting period*
Infant formula	6-h minimum fasting period*
Nonhuman milk‡	6-h minimum fasting period*
Light meal§	6-h minimum fasting period*
Fried foods, fatty foods, or meat	Additional fasting time (*e.g.*, 8 h or more) may be needed

Anesthesiology 2018; 128:437-79

6

TABLE 3. NPO Status Requirement Before Conducting PPS for Solids, Milk and Clear Liquids

	Solids	Milk	Clear Liquids
No NPO	14.6%	21.1%	29.8%
NPO < 2 h	7.8%	22.9%	36.2%
NPO 2–4 h	35.2%	38.1%	24.8%
NPO 4–6 h	28.3%	9.2%	3.2%
NPO 8 h	3.2%	0%	0%
NPO 4 h	3.2%	1.8%	0.9%
NPO 2 h	0%	0%	0.9%
NPO situationally	7.8%	7.0%	4.4%

Pediatric Emergency Care 2022;38(1):e321-8.

- National survey of Pediatric Emergency Medicine physicians (n=211)
- Ketamine / Nitrous Oxide / Midazolam / Fentanyl / Propofol

7

Table 6. Adverse Sedation Events

Complications of Sedation	Group 1*	Group 2†	Group 3‡	*p* Value
Adverse event	12	13	19	0.254
Agitation	1	0	1	0.632
Apnea	1	3	0	0.020
Aspiration	0	0	0	–
Bradycardia	0	0	0	–
Apnea requiring BVM, oral airway, positive pressure ventilation, jaw thrust	2	2	2	0.576
Hypotension	0	0	1	0.655
Hypoxia	2	2	6	0.919
Intubation	0	0	0	–
Laryngospasm	0	0	0	–
Seizure-like activity	1	2	2	0.568
Emesis	4	4	9	0.959

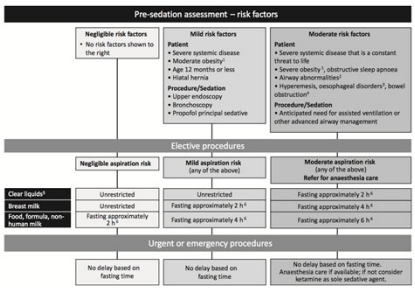
Three-way comparison for each adverse event category statistically significant $\alpha = 0.017$ using Bonferroni correction.
BVM = bag-valve mask.
* Group 1: met fasting guidelines at presentation.
† Group 2: sedated without meeting fasting guidelines.
‡ Group 3: fasted in pediatric emergency department.

J Emerg Med 2021;60(4):436-443.

- 2674 pediatric patients in level 1 pediatric ED
- Procedural sedation for orthopedic procedures
- Propofol / Ketamine

8

ICAPS



Anaesthesia 2020; 75: 374–385

9

Pediatric Preoperative Fasting
(European Society of Anaesthesiology)

Substance	Fasting Time Prior to Induction
Solid Food	6 hr
Light Breakfast Non-clear Liquids	4 hr
Formula Non-human Milk	4 hr
Breast Milk	3 hr
Clear Fluids	1 hr
Chewing Gum	Removed prior to induction

Eur J Anaesthesiol 2022; 39:4–25

10

11

A colleague is proficient in POCUS and specifically gastric ultrasound. She tells you that the gastric antrum appears empty.

12

Poll #2

Does this information change your NPO time prior to administering sedation?

1. YES – perform sedation immediately
2. YES – 2 hours NPO is adequate
3. YES – 4 hours NPO is adequate
4. NO – wait for 6 hours NPO

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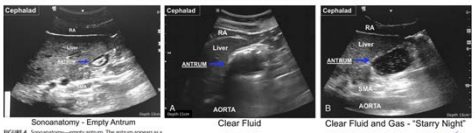
Gastric Ultrasound Imaging to Direct Perioperative Care in Pediatric Patients: A Report of 2 Cases

Karen R. Boretsky, MD,* and Anahi Perlas, MD, FRCPC†

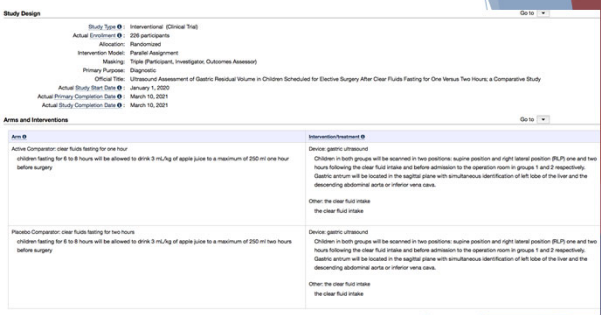
Pulmonary aspiration of gastric contents carries significant risk in children in the perioperative period. Ultrasound imaging of the gastric antrum has been validated to predict gastric content and volume in both pediatric and adult patients, and yet clinical applications in pediatric patients are sparse. We report 2 cases of children presenting for elective surgery with uncertain volume of gastric contents. Bedside gastric imaging successfully identified "full stomachs," and the information was used to direct care. (A&A Practice. 2019;13:443–5.)



Sonoanatomy - Empty Antrum | Clear Fluid | Clear Fluid and Gas - "Starry Night"

Regional Anesthesia and Pain Medicine 2018;43(7):689-98

14



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Your hospital is considering a 1-hour NPO policy for clear liquids prior to anesthesia.

16

Poll #3

Does the volume of clear liquids matter?

1. NO – gastric emptying time for clear liquids is independent of volume
2. YES – only a small sip is appropriate
3. YES – up to 5 ml/kg is appropriate
4. YES – up to 7 ml/kg is appropriate

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RESEARCH REPORT

Pediatric Anesthesia WILEY

Ultrasound assessment of gastric emptying time after intake of clear fluids in children scheduled for general anesthesia—A prospective observational study

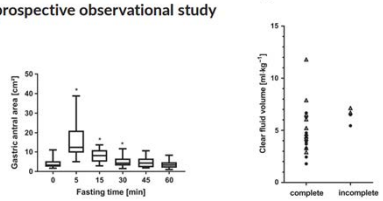

FIGURE 1 Box plots of the gastric antral area before and after intake of water or juice (5-60). Data are expressed as median values and 25/75 percentiles. The whiskers represent the highest and lowest values that are not outliers (*P < .05 vs fasted (0))

FIGURE 2 Volume of ingested clear fluids and gastric emptying after 1 h classified as complete (gastric antral area ≤baseline level after overnight fasting) or incomplete (gastric antral area >baseline level after overnight fasting)

Pediatric Anesthesia 2020;30:1384-1389

18

Pearls

ASA Practice Guidelines for fasting before procedural sedation are the same recommendations as for general anesthesia. (8:6:4:2)

- ACEP does not accept these guidelines
- ICAPS recommends individual patient risk assessment
- European Guidelines are now more liberal than ASA (6:4:3:1)

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Pearls

- Clear liquids **should not exceed 5 mL/kg to meet 1 hour recommendation**
- Gastric Ultrasound may demonstrate value
  - Re-evaluate population gastric volumes at various fasting times?
  - Individual patient risk stratification?

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Scenario 2: Succinylcholine for Pediatric Rapid Sequence Intubation

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A 7-year-old, otherwise healthy female is struck in the face by a swing causing a near-amputation of the anterior 1/3 of the tongue. NPO is appropriate but swallowed a moderate amount of blood. She needs surgical exploration and repair under general anesthesia.

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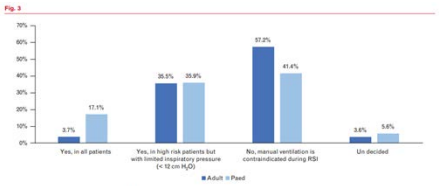
Poll #4

How would you induce general anesthesia?

1. Rapid sequence induction using succinylcholine
2. Rapid sequence induction using rocuronium
3. Modified rapid sequence induction using rocuronium

23

Mask Ventilation During RSI?



Eur J Anaesthesiol 2020; **37**:435–442

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Pediatric Anesthesia

Pediatric Anesthesia ISSN 1155-5645

ORIGINAL ARTICLE

Controlled rapid sequence induction and intubation – an analysis of 1001 children

Diego Neuhaus, Achim Schmitz, Andreas Gerber & Markus Weiss

Department of Anesthesia, University Children's Hospital, Zurich, Switzerland

In conclusion, we analyzed the complications in a large cohort of pediatric patients who underwent controlled RSII. Our data demonstrate that controlled RSII using gentle facemask ventilation and omitting cricoid pressure allows safe intubation in children with expected or suspected full stomach. By applying this technique, hypoxemic episodes with related cardiorespiratory adverse events proved avoidable without an increased risk of pulmonary aspiration. Infants, toddlers, and sick pediatric patients in particular seem to benefit from this approach.

25

ANECTINE® (Succinylcholine Chloride Injection, USP)

A short-acting depolarizing skeletal muscle relaxant.

WARNING

RISK OF CARDIAC ARREST FROM HYPERKALEMIC RHABDOMYOLYSIS

There have been rare reports of acute rhabdomyolysis with hyperkalemia followed by ventricular dysrhythmias, cardiac arrest, and death after the administration of succinylcholine to apparently healthy pediatric patients who were subsequently found to have undiagnosed skeletal muscle myopathy, most frequently Duchenne's muscular dystrophy.

This syndrome often presents as peaked T-waves and sudden cardiac arrest within minutes after the administration of the drug in healthy appearing pediatric patients (usually, but not exclusively, males, and most frequently 8 years of age or younger). There have also been reports in adolescents.

Therefore, when a healthy appearing infant or child develops cardiac arrest soon after administration of succinylcholine not felt to be due to inadequate ventilation, oxygenation, or anesthetic overdose, immediate treatment for hyperkalemia should be instituted. This should include administration of intravenous calcium, bicarbonate, and glucose with insulin, with hyperventilation. Due to the abrupt onset of this syndrome, routine resuscitative measures are likely to be unsuccessful. However, extraordinary and prolonged resuscitative efforts have resulted in successful resuscitation in some reported cases. In addition, in the presence of signs of malignant hyperthermia, appropriate treatment should be instituted concurrently.

Since there may be no signs or symptoms to alert the practitioner to which patients are at risk, it is recommended that the use of succinylcholine in pediatric patients should be reserved for emergency intubation or instances where immediate securing of the airway is necessary, e.g. laryngospasm, difficult airway, full stomach, or for intramuscular use when a suitable vein is inaccessible (see PRECAUTIONS: Pediatric Use and DOSAGE AND ADMINISTRATION).

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Pediatric Anesthesia

Pediatric Anesthesia 2010 **20**: 982–986 doi:10.1111/j.1460-9592.2010.03426.x

Anesthetic management of the pediatric bleeding tonsil

RYAN G. FIELDS DO, MBA* FRANK J. GENCORELLI MD† AND RONALD S. LITMAN DO‡

*Jersey Shore University Medical Center, Neptune, NJ, †Department of Anesthesiology, Hospital of the University of Pennsylvania School of Medicine, Philadelphia, PA and ‡Department of Anesthesiology and Pediatrics, University of Pennsylvania School of Medicine, The Children's Hospital of Philadelphia, Philadelphia, PA, USA

Results: Four hundred and seventy-five patients required surgery for exploration of post-tonsillectomy hemorrhage (incidence 2.9%). Intravenous rapid sequence induction was used in 401 (84.4%) patients. Succinylcholine was used in 420 (88%) patients. The most

27

Key reasons why Suxamethonium should continue to be used in pediatric anesthesia

1. There is no other drug that can provide both rapid and ultra-short muscle relaxation.
2. The neuromuscular block produced by suxamethonium does not require reversal.
3. Metabolism of suxamethonium is organ independent.
4. Suxamethonium can be a life-saving drug in case of severe larygospasm.
5. In the vast majority of patients, suxamethonium-associated side effects are not observed or are of minimal clinical significance.

Key reasons why suxamethonium should be abandoned in pediatric anesthesia:

1. Suxamethonium increases muscle stiffness.
2. Nondepolarizing neuromuscular blockers can produce better intubating conditions.
3. Suxamethonium produces muscle pain.
4. Suxamethonium can produce myoglobinuria which can be a threat to renal function.
5. Evaluation of the causes of myoglobinuria can be costly.
6. Diagnosis of occult myopathy can be difficult.
7. Suxamethonium has caused fatal hyperkalemic cardiac arrests in infants and children.
8. Suxamethonium can increase intracranial pressure.

Pediatric Anesthesia 2009;19:561-70

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Poll #5

You decide to use succinylcholine as part of a rapid sequence induction in this 7-year-old child. What dose of intravenous succinylcholine is indicated?

1. 1.0 mg/kg
2. 1.5-2 mg/kg
3. 3 mg/kg
4. 4 mg/kg

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TABLE II. *Ratio of paediatric to adult ED_{90} values; calculated equipotent doses of suxamethonium*

	Suxamethonium ED_{90} (mg kg^{-1})	ED_{90} ratio	Calculated equipotent doses (mg kg^{-1})
Neonates	0.517	1.8	1.8–2.7
Infants	0.608	2.1	2.1–3.2
Children	0.352	1.2	1.2–1.8
Adults [11]	0.290	1.0	1.0–1.5

Br J Anaesth 1989;62:655-658

30

Poll #6

A colleague suggests pre-treatment with atropine prior to succinylcholine to prevent bradycardia. What dose of atropine is indicated?

1. Zero – atropine is not empirically indicated with succinylcholine
2. 10 mcg/kg
3. 20 mcg/kg
4. 100 mcg (0.1mg) regardless of weight

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Atropine with Succinylcholine?

carinic receptors. In nonatropinized children (three months to seven years), well-ventilated and anaesthetized with halothane (H), 2.5% in oxygen, or isoflurane (I), 3.5% in oxygen, a bolus of succinylcholine *iv* (1.5 mg · kg^{-1}) elicits three different and unpredictable responses in the heart rate: (a) increase (incidence of 66% with H, 88% with I), (b) no change (0–7%, I–H), or (c) decrease (12–27%, I–H); bradycardia (<60 beats · min^{-1}) is observed in 0–14% (I–H) of the patients.

Atropine elicits two opposite cardiac effects, according to the dose used: (a) slowing of the heart rate, following 1.8 μg · kg^{-1} *iv* in adults, or 3.6 μg · kg^{-1} *iv* in infants and children; and (b) acceleration of the heart rate, following a minimum of 7.2–14.3 μg · kg^{-1} *iv* in infants, children, and adults.[4] It was thought that atropine and

Can J Anaesthesia 1995;42(1):1-7

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These data lead to a conclusion that the single dose suxamethonium-related bradycardia is an accidental event and probably caused by pharyngeal reflexes during intubation rather than from the use of the drug itself. On the other hand, other older data would suggest that a second dose of suxamethonium can be associated with unpleasant bradyarrhythmia and should be avoided if possible (7).

Pediatric Anesthesia 2009;19:561-70

33

Intramuscular Rocuronium?

Table 3. Pharmacodynamic Response of Infants and Children Given Rocuronium

	Infants		Children	
	Intramuscular	Intravenous	Intramuscular	Intravenous
Dose (mg/kg)	1.0 (n = 19)	0.45 (n = 18)	1.8 (n = 19)	0.45 (n = 19)
Peak effect–% twitch depression				
Mean	100 ± 0	99 ± 2	100 ± 0	98 ± 5
Range	98–100	91–100	99–100	80–100
Onset (min)	7.4 ± 3.4	2.5 ± 2.1	8.9 ± 6.3	2.4 ± 1.5
Range (min)	(3.3–11.5)	(0.7–3.7)	(4.0–31)	(0.4–5.3)
80% twitch depression range (min)	5.3 ± 2.9	1.4 ± 0.8	6.3 ± 3.5	1.6 ± 1.4
	(1.6–8.7)	(0.6–4.0)	(3.7–18)	(0.5–5.1)
Spontaneous recovery				
25% recovery (min)	79 ± 26	27 ± 6	86 ± 22	18 ± 8
Range (min)	(47–139)	(15–38)	(55–129)	(3–26)
	(n = 18)	(n = 15)	(n = 16)	(n = 19)
50% recovery (min)	91 ± 30	34 ± 7	98 ± 25	21 ± 9
Range (min)	(53–160)	(18–48)	(61–146)	(11–36)
	(n = 18)	(n = 14)	(n = 14)	(n = 18)
90% recovery (min)	112 ± 36	52 ± 20	120 ± 29	32 ± 13
Range (min)	(66–187)	(21–93)	(83–182)	(8–60)
	(n = 15)	(n = 12)	(n = 12)	(n = 16)

Anesthesiology 1999;91:633-8

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Pearls

- "Controlled" Rapid Sequence Intubation is preferred in infants and children
  - Peak inspiratory pressure MAX 10-12 cmH2O
  - Cricoid pressure NOT beneficial
- Succinylcholine not contraindicated in laryngospasm, "full stomach," difficult airway, IV access unavailable
- EVALUATE FOR MYOPATHY FIRST

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Pearls

- IM succinylcholine has ALMOST ZERO incidence of bradycardia (IN THE ABSENCE OF CONCURRENT HYPOXEMIA)
- Co-administration of atropine should be reserved for neonates and infants or multiple doses of succinylcholine - doses 7-14 mcg/kg with NO MINIMUM
- IM rocuronium has longer onset and MUCH LONGER DURATION

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Scenario 3: Use of Nitrous Oxide

- 5-year-old, 20kg male presents for circumcision
- No significant past medical history
- He appears stoic in pre-op, but parents think he can go back to the OR without any premedication

37

Poll #7

For an inhalational induction, would you use nitrous oxide?

1. Yes
2. No

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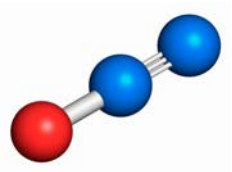
Nitrous Oxide



- First recorded discovery in 1772
- Used as an anesthetic by Horace Wells in 1884
- Colorless, non-pungent gas

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Hemodynamic Effects of Nitrous

Variable	(1) 50% N_2	(2) 50% N_2O	(3) 50% N_2	(4) 50% N_2O
Heart rate (beats/min)	125 ± 20	114 ± 18†	117 ± 17	109 ± 14*
MAP (mmHg)	76 ± 10	66 ± 11†	77 ± 10	68 ± 10†
RAP (mmHg)	9 ± 2	9 ± 2	10 ± 2	9 ± 3
MPAP (mmHg)	16 ± 2	15 ± 3	16 ± 2	16 ± 4
LAP (mmHg)	12 ± 4	12 ± 4	12 ± 4	13 ± 5
CI ($l \cdot min^{-1} \cdot m^{-2}$)	3.2 ± 0.7	2.7 ± 0.5†	3.1 ± 0.5	2.8 ± 0.6*
SVI ($ml \cdot beat^{-1} \cdot m^{-2}$)	27 ± 10	25 ± 9	27 ± 7	27 ± 10
SVRI (Wood units)	22 ± 5	22 ± 4	23 ± 4	22 ± 5
PVRI (Wood units)	1.4 ± 0.5	1.4 ± 0.2	1.4 ± 0.4	1.3 ± 0.4

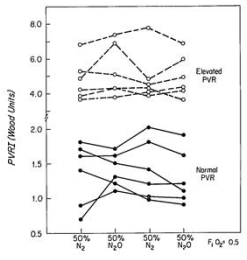
See text for abbreviations.
Wood units = $mmHg \cdot l^{-1} \cdot min \cdot m^2$.

* $P < 0.05$ compared with preceding 50% N_2 measurement.
† $P < 0.01$ compared with preceding 50% N_2 measurement.

Hickey et al. *Anesthesiology* (1986).

40

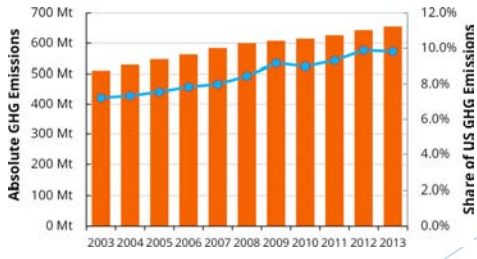
Hemodynamic Effects of Nitrous Oxide



Hickey et al. *Anesthesiology* (1986).

41

Environmental Impacts



Eckelman et al. PLoS One (2016).

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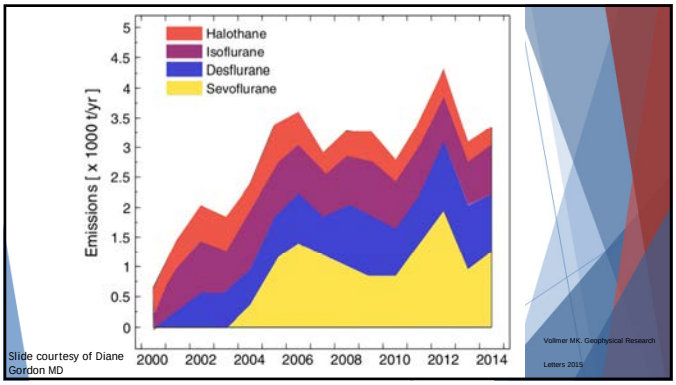

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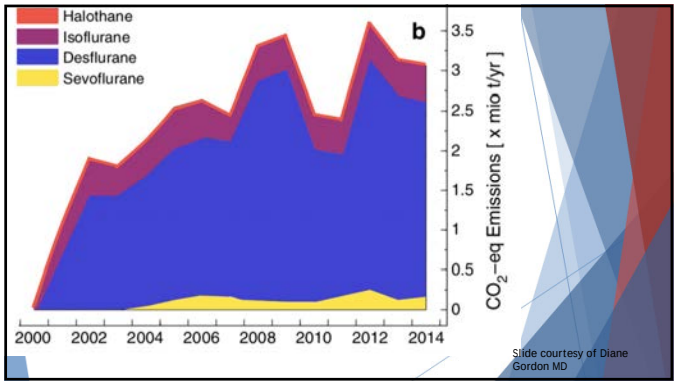

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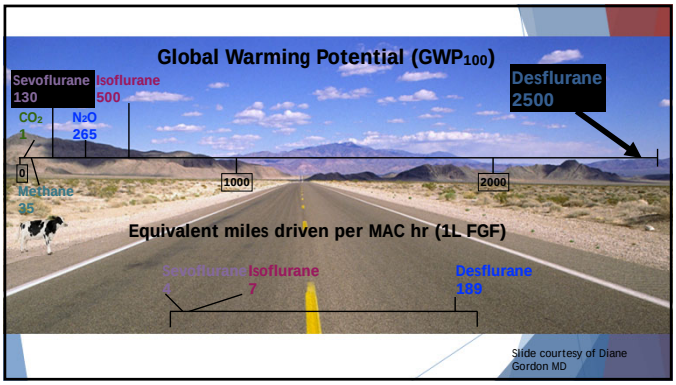

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Nitrous Oxide

- Advantages
  - Euphoria and ambivalence to presence
  - Stable hemodynamics overall
- Disadvantages
  - Prohibits preoxygenation
  - Increases carbon footprint of anesthetic
  - Dysphoria common in high inspiratory fraction
  - Increases risk of nausea (maintenance)
  - Does not speed mask induction

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ANSCHUTZ MEDICAL CAMPUS

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Pearls

- Healthcare is a significant contributor to green house gas emissions
- We can reduce our emissions by decreasing the use of nitrous oxide and desflurane
- Consider TIVA when appropriate
- Use low flow anesthesia when possible

CRASH

48

Scenario 4: Uncooperative Child

- 15-year-old, 90kg male who presents for dental restoration
- His past medical history is significant for autism spectrum disorder
- He is nonverbal, and has a history of being combative in unfamiliar situations

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Poll #8

For anxiolysis, what premedication would you MOST likely administer?

1. Oral midazolam
2. Intranasal midazolam
3. Intranasal dexmedetomidine
4. Intramuscular ketamine

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Autism Spectrum Disorder

- Diagnosed 1 in 68 children
- Generally, affects boys more than girls
- Often on medications that can have interactions with anesthesia

51

Pharmacological Options for Preoperative Anxiolysis

Midazolam → Dexmedetomidine → Ketamine

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Oral Midazolam vs. Midazolam & Ketamine

	Group M (n = 48) (%)	*Group MK (n = 49) (%)*	*P-value*
Sedation score			
1	19 (39.52)	9 (18.36)	0.01[a]
2	17 (35.41)	16 (32.65)	
3	10 (20.83)	23 (46.93)	
4	2 (4.16)	1 (2.04)	
Parental separation score			
1	23 (47.91)	10 (20.4)	0.031[a]
2	20 (41.66)	36 (73.46)	
3	4 (8.33)	3 (6.12)	
4	1 (2.08)	0 (0)	
Induction score			
1	25 (52.08)	28 (57.14)	0.501
2	11 (22.9)	11 (24.44)	
3	8 (16.66)	9 (18.36)	
4	4 (8.3)	1 (2.04)	

Ghai et al. *Paediatr Anaesth* (2005).

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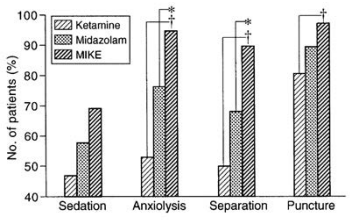
Oral Midazolam vs. Ketamine vs. Midazolam & Ketamine



Funk et al. BJA (2000).

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Comparison of Oral Midazolam vs. Intranasal Dexmedetomidine

	Group M	Group $D_{0.5}$	Group D_1	P
Successful parental separation				
Yes	31 (96.9%)	30 (93.7%)	32 (100%)	0.771
No	1 (3.1%)	2 (6.3%)	0 (0%)	
Sedation at separation from parent				
Satisfactory	7 (21.9%)	19 (59.4%)	24 (75%)	<.001*†
Unsatisfactory	25 (78.1%)	13 (40.6%)	8 (25%)	
Behavior at induction				
Satisfactory	31 (96.9%)	29 (90.6%)	26 (81.3%)	0.148
Unsatisfactory	1 (3.1%)	3 (9.4%)	6 (18.8%)	
Sedation at induction				
Satisfactory	6 (18.8%)	13 (40.6%)	17 (53.1%)	0.016*
Unsatisfactory	26 (81.3%)	19 (59.4%)	15 (46.9%)	
Change of behavior at induction from satisfactory to unsatisfactory				
n/total (%)	0/31 (0)	1/30 (3.3)	6/32 (18.8%)	0.012
Change of sedation at induction from Satisfactory to Unsatisfactory				
n/total (%)	1/7 (14.3)	6/19 (31.6)	7/24 (29.2)	0.828

Yuen et al. Anesth Analg (2008).

55

Patients with Autism Perioperative Experience

- Patients with autism are more likely to receive a premedication other than oral midazolam, but there was no difference in the overall experience.

Characteristic	Autism Spectrum disorders (*N* = 121) *n* (%) or mean ± SD	Nonautism spectrum disorders (*N* = 881) *n* (%) or mean ± SD	*P*-value
Nausea	6 (4.9)	79 (9.0)	0.14
Agitation	4 (3.3)	36 (4.1)	0.68
Total PACU time (min)	45.21 ± 27.1	42.2 ± 23.8	0.20
Time to discharge (min)	116.26 ± 134.5	114.98 ± 108.8	0.91

Arnold et al. Paediatr Anaesth (2015).

56

Combination of oral ketamine and midazolam as a premedication for a severely autistic and combative patient

Shailesh Shah, Sonia Shah, Jesus Apuya, Senthil Gopalakrishnan, and Timothy Martin

- "The unique flavor of Dr Pepper is well suited to increase the palatability and the acceptability of medications in children and patients with developmental delay"

57

Poll #9

What if the patient doesn't want to leave the car?

Would you consider prescribing an anxiolytic like lorazepam for the patient prior to coming to the hospital?

1. Yes
2. No

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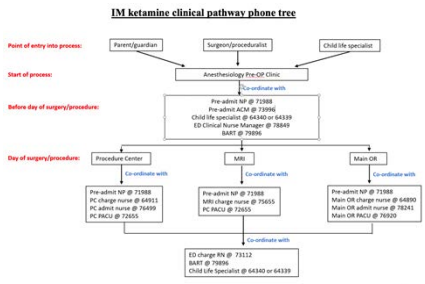
Children's Hospital Colorado Clinical Pathway



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Pearls

- There are multiple options for premedication in children
- No single premedication is superior
- Preoperative planning is required for patients with severe and uncooperative autism

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Scenario 5:Tonsillectomy and OSA

- 7-year-old obese girl with sleep-disordered breathing scheduled for tonsillectomy and adenoidectomy.
- h/o ADHD and poor school performance.
- Sleep study- Apnea Hypopnea Index -28 events/h

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Preoperative Evaluation

- How is pediatric OSA different from adult OSA?
- What are you looking for in the sleep study?

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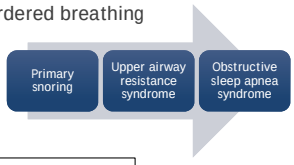
Pediatric Obstructive Sleep Apnea

Sleep disordered breathing



Recurrent episodes of partial or complete obstruction during sleep → Hypoxemia, Hypercapnia, Sleep disruption

1-4% of all children have OSA
Snoring is not synonymous with OSA

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Pediatric vs. Adult OSA

	Children	Adults
Presentation		
Age	2-6 yrs peak	Increased elderly
Gender	M = F	M > F
Obesity	Few	Most
Tonsils& adenoids	Often enlarged	Rarely enlarged
Daytime sleepiness	Less common	More common

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Pediatric vs. Adult OSA

	Children	Adults
Sleep		
Sleep architecture	Usually normal	Decreased delta & REM
Arousals	May not be seen	At end of each apnea
Treatment		
Surgical	Definitive	Minority
Medical (CPAP)	Selected patients	Most common

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Pediatric OSA Grading

Severity	AHI Scores	Descriptors	O_2 nadir
Mild	1-5	SpO_2 < 90% for 2-5% of sleep time	> 92
Moderate	5-9	SpO_2 < 90% for 5-10% of sleep time	
Severe	>10	SpO_2 < 90% for > 10% of sleep time	< 80

Schwengel DA. Anesthesiology Clin 2014

66

Indications for PSG in Children

- Obesity
- Down's syndrome
- Craniofacial abnormalities
- Neuromuscular disorders
- Sickle cell disease
- Mucopolysaccharidoses

AAO-HNS CPG on Tonsillectomy in Children. 2019

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Poll #10

Following inhalational induction and intubation, patient is maintained with sevoflurane, O_2 & air. What are your options for pain control?

1. Acetaminophen + fentanyl + dexmedetomidine
2. Acetaminophen + hydromorphone or morphine

68

Intraoperative Analgesia

- Fentanyl - 0.5- 1 mcg/kg, titrated to RR
- Dexmedetomidine - 0.5-1 mcg/kg
- Dexamethasone - 0.5 mg/kg, up to max 10 mg IV
- Acetaminophen- PO vs. IV

69

Post Discharge Medications

- Alternating Acetaminophen & ibuprofen q 3 hours
- Acetaminophen 10-15 mg/kg q 4-6 hours
  - max- 75 mg/kg/day or 4 grams
- Ibuprofen 5-10 mg/kg q 6-8 hours
  - After **3 hours post op**
- Oxycodone 0.05 mg/kg q 6 h for **patients > 5 years**

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Post Discharge Medications

- NO CODEINE, tramadol and hydrocodone
- Ultra-rapid metabolizers CYP450 2D6 pathway

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Overnight Admission Criteria

- Children < 3 years of age
- Severe OSA
- Comorbidities
  - Down syndrome
  - Cardiac complications of OSA
  - Neuromuscular disorders
  - Failure to thrive
  - Craniofacial anomalies
  - Obese children

AAO-HNS CPG on Tonsillectomy in Children. 2019

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PACU Discharge Criteria

- What are your PACU discharge criteria?
- Does she need to void/tolerate PO?
- How long does she need to be monitored after PACU oxycodone dose?
- What is a room air sleep challenge?

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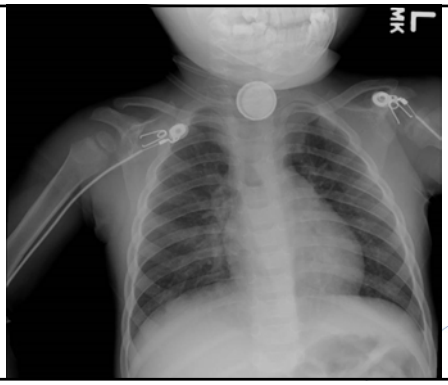
Scenario 6: Foreign body in esophagus

- A 2-year-old boy presents to ED with irritability, drooling, and refusing to eat. He was playing with his brother's toy car remote earlier today.

74



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Poll #11

What does the CXR show?

1. Coin
2. Button battery
3. Magnet

76

Two Changes

Larger diameter batteries (20-25 mm)

Stronger lithium batteries

- 3 volt (vs 1.5 volt)
- Longer shelf life
- Better stability at cool temperature
- Lighter weight

77

Poll #12

What is the mechanism of injury following button battery ingestion?

1. Leakage of chemicals
2. Mechanical obstruction
3. Caustic alkaline injury

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Mechanism of Injury

It's not leakage!

Entrapped BB → Mucosa bridges + & - terminals → Circuit completed → Generation of hydroxide radicals → Alkaline caustic injury

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Mechanism of Injury

Higher the voltage, faster the process

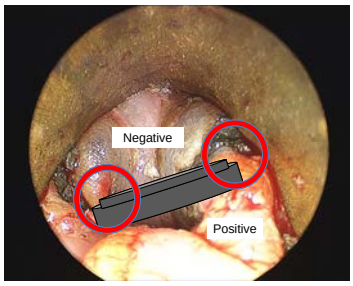
Visible injury within 15 minutes

Serious injury as soon as 2 hours

New vs. spent - 3.2 times higher risk

80

Orientation of Button Battery



Three Ns

Negative

Narrow

Necrotic

81

Extent of Damage

- Size
- Duration
- Location
- Orientation
- Voltage
- Esophageal pathology

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If a Child Swallows a Button Battery

Call the National Battery Ingestion Hotline 800-498-8666

Proceed immediately to hospital

Do not induce vomiting

1. Patient ≥12 months old
2. Suspected lithium battery
3. Ingested within 12 hours

10 mL of honey every 10 minutes

Max 6 doses

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National Capital Poison Control Treatment Algorithm

Button Battery in esophagus

Goal: endoscopic removal within 2 hours of ingestion

Consider **Sucralfate** 10 mL every 10 mins (max 3 doses)

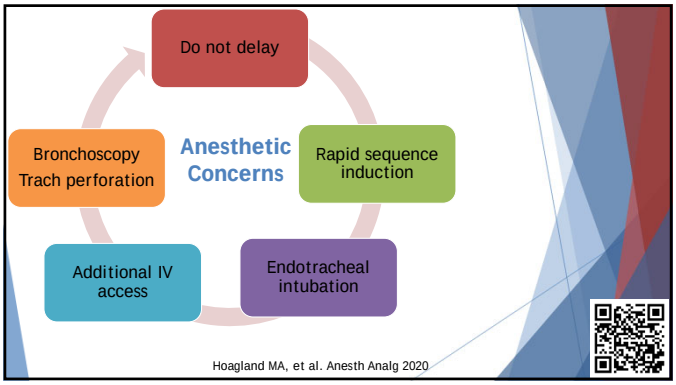
84

Poll #13

Would you delay the case for honey or carafate?

1. Yes
2. No

85



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After BB Removal

Inspect esophageal mucosa for extent of damage

Note orientation of negative pole

If no evidence of perforation, irrigate esophagus with **0.25% acetic acid** (50-150 mL)

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Scenario 6: Elective Surgery after COVID

- When to schedule elective surgery after recent COVID infection?

88

ASA and APSF Joint Statement on Elective Surgery and Anesthesia for Patients after COVID-19 Infection

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- 4 weeks- Asymptomatic patient
- 4 weeks- Recovery from mild, non-respiratory symptoms
- 6 weeks- Symptomatic patient, didn't require hospitalization
- 8-10 weeks- Symptomatic patient who is diabetic, immunocompromised, or hospitalized
- 12 weeks- Patient admitted to ICU due to COVID infection

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