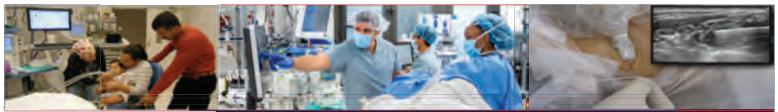
CRASH

Colorado Review of Anesthesia for Surgicenters And Hospitals

Guiding the future of patient care

Sunday, February 26th



Update on Anesthetic Neurotoxicity in Children: Clinical Challenges

Texas Children's Hospital

Baylor College of Medicine

Pediatric Anesthesiology, Perioperative and Pain Medicine

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CRASH 2023: February 26, 2023

Disclosures

- No financial disclosures
- Member of the SmartTots Scientific Advisory Board
- Dexmedetomidine is not labeled for pediatric use by the U.S. Food and Drug Administration and will be discussed

Learning Objectives

- Summarize the up to date animal and human neurotoxicity evidence
- Discuss the 2016 FDA Warning about prolonged or repeated anesthetics in young children
- Determine whether certain elective surgeries could be postponed until after 3 years of age
- Answer the question: Should the FDA Warning Affect My Practice?

FDA U.S. Food and Drug Administration Protecting and Promoting Your Health

Drug Safety Communications

FDA Drug Safety Communication: FDA review results in new warnings about using general anesthetics and sedation drugs in young children and pregnant women

[12-14-2016]

Safety Announcement

The U.S. Food and Drug Administration (FDA) is warning that repeated or lengthy use of general anesthetic and sedation drugs during surgeries or procedures in children younger than 3 years or in pregnant women during their third trimester may affect the development of children's brains.

"Lengthy" = >3 hours
"Deficits in cognition, learning, and behavior….."

http://www.fda.gov/Drugs/DrugSafety/ucm532356.htm

Warning Label Requirement

- FDA warning has been added to the labels of general anesthetic and sedation drugs

Generic Name	Brand Name
desflurane	Suprane
etomidate	Amidate
halothane	Only generic is available
isoflurane	Forane
ketamine	Ketalar
lorazepam injection	Ativan
methohexital	Brevital
midazolam injection, syrup	Only generic is available
pentobarbital	Nembutal
propofol	Diprivan
sevoflurane	Ultane, Sojourn

*This list includes anesthetic and sedation drugs that block N-methyl-D-aspartate (NMDA) receptors and/or potentiate gamma-aminobutyric acid (GABA) activity. No specific medications have been shown to be safer than any other.

http://www.fda.gov/Drugs/DrugSafety/ucm532356.htm

Recommendations for Health Providers and Parents

- Health Providers:
  - Balance benefits of appropriate anesthesia against potential risks
  - Discuss benefits, risks, and appropriate timing of surgery or procedure
- Parents:
  - Discuss potential adverse effects of anesthesia on brain development
  - Understand the appropriate timing of procedures that can be delayed without jeopardizing health

http://www.fda.gov/Drugs/DrugSafety/ucm532356.htm

FDA U.S. Food and Drug Administration — Protecting and Promoting Your Health

Drug Safety Communications

Similarly, surgeries or procedures in children younger than 3 years should not be delayed or avoided when medically necessary. Consideration should be given to delaying potentially elective surgery in young children where medically appropriate.

Evidence for the FDA Warning

- Adverse effects on brain development following use of general anesthetic and sedation drugs have been demonstrated in multiple animal species ranging from flatworm to nonhuman primates.
- Consistent with animal studies, recent human data suggest that a single, relatively short exposure to general anesthetic and sedation drugs in infants or toddlers is unlikely to have negative effects on behavior or learning. However, further research is needed to fully characterize how early life anesthetic exposure might affect children's brain development, particularly for more lengthy or repeated exposures and in more vulnerable children.
- No specific anesthetic or sedation drug has been shown to be safer than any other.

Evidence for the FDA Warning (cont'd)

- Based on comparisons across species, the window of vulnerability to these changes in the brain is believed to correlate with exposures in the third trimester of pregnancy through the first year of life, but may extend out to approximately 3 years in humans. The clinical significance of these nonclinical findings is not clear.
- Some published studies suggest that similar deficits in cognition and behavior may occur in children, particularly after repeated or prolonged exposures to anesthetic drugs early in life. These studies have limitations, and it is not clear if the effects reported are due to the anesthetic/sedation drugs, or to other factors such as the surgery or underlying illness.

CURRENT KNOWLEDGE:
POSSIBLE NEGATIVE EFFECTS OF ANESTHETICS ON THE DEVELOPING BRAIN IN ANIMALS AND HUMANS

Anesthetics/Sedatives/Analgesics and Receptors

Agent	GABA	NMDA	μ-opioid	α2-adrenergic
Halogenated anesthetics (sevoflurane, isoflurane, desflurane)	+			
Nitrous oxide		−		
Benzodiazepines	+			
Propofol	+			
Barbiturates	+			
Etomidate	+			
Chloral hydrate	+			
Ketamine		−		
Opioids			+	
Dexmedetomidine				+

GABA = gamma-aminobutyric acid; NMDA = N-meythl-D-aspartate

Best Pract Res Clin Anaesthesiol 2010;24:433

Early Exposure to Common Anesthetic Agents Causes Widespread Neurodegeneration in the Developing Rat Brain and Persistent Learning Deficits

Vesna

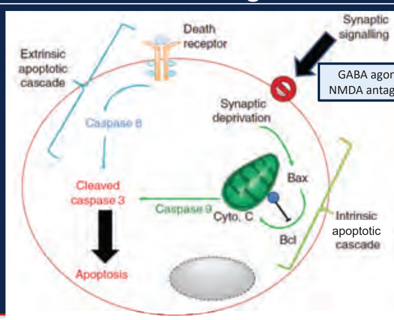
Charle

- P7 … nd is…
- Hi…
  - …
- M…

  M…
  - Significant deficits in long term learning, memory, spatial discrimination

THIS STUDY GAINED THE ATTENTION OF THE PEDIATRIC ANESTHESIA COMMUNITY AND IS CREDITED WITH INITIATING THE CONCERN ABOUT ANESTHETIC AND SEDATIVE NEUROTOXICITY

Proposed Mechanism of Anesthetic-Induced Neurodegeneration



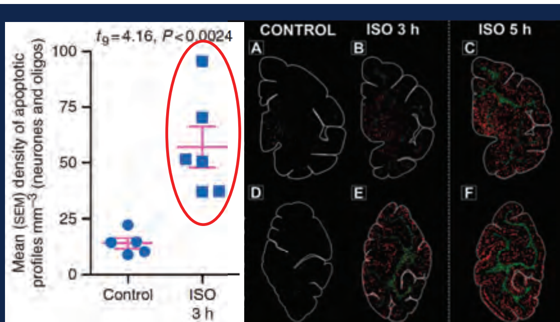
Br J Anaesth 2013; 110 Suppl 1:i53-72

Isoflurane exposure for three hours triggers apoptotic cell death in neonatal macaque brain

British Journal of Anaesthesia, 119 (3): 524–31 (2017)

K. K. Noguchi[1,*], S. A. Johnson[2], G. A. Dissen[3], L. D. Martin[4], F. M. Manzella[1], K. J. Schenning[5], J. W. Olney[1,†] and A. M. Brambrink[6,*]

- 6-day old rhesus monkeys (n= 6) exposed to deep plane of isoflurane anesthesia for 3h
  - Controlled endotracheal ventilation, extensive physiological monitoring
  - Compared with unexposed controls (n=5)
- ISO treatment increased neuroapoptosis of neurons and oligodendrocytes >4-fold (p<0.024)
  - Oligodendrocyte injury throughout white matter; neuronal injury in cortex, caudate, putamen, thalamus



British Journal of Anaesthesia, 119 (3): 524–31 (2017)

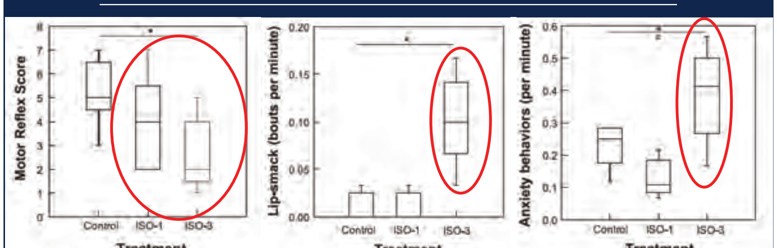
Isoflurane Anesthesia Has Long-term Consequences on Motor and Behavioral Development in Infant Rhesus Macaques

ANESTHESIOLOGY 2017; 126:74-84

Kristine Coleman, Ph.D., Nicola D. Robertson, M.S., Gregory A. Dissen, Ph.D., Martha D. Neuringer, Ph.D., L. Drew Martin, D.V.M., Verginia C. Cuzon Carlson, Ph.D., Christopher Kroenke, Ph.D., Damien Fair, Ph.D., Ansgar M. Brambrink, M.D., Ph.D.

- 24 neonatal rhesus monkeys exposed to anesthetic starting on DOL 6
  - Isoflurane 0.7-1.5% end-tidal for 5 hours
  - 8 animals with single exposure, 8 with 2 additional exposures on DOL 9 and 12, 8 control animals
- Behavioral and motor testing at DOL 14, 30, 3 months, 12 months

Neurobehavioral Outcomes

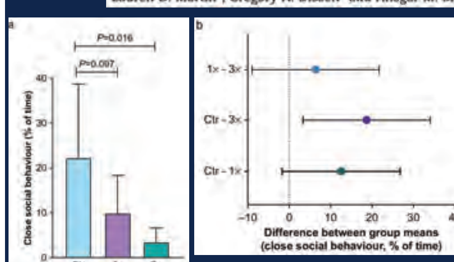


30 days | 12 months | 12 months

ANESTHESIOLOGY 2017; 126:74-84

Infant isoflurane exposure affects social behaviours, but does not impair specific cognitive domains in juvenile non-human primates

Viola Neudecker[1,*], Jose F. Perez-Zoghbi[1,*], Kristine Coleman[2,3], Martha Neuringer[2], Nicola Robertson[2], Alexandra Bemis[2], Bess Glickman[2], Katie J. Schenning[4], Damien A. Fair[5], Lauren D. Martin[3], Gregory A. Dissen[3] and Ansgar M. Brambrink[1,*]



Conclusions

Our study in 2-yr-old juvenile NHPs provides novel evidence for alterations in social behaviour assessed in the home environment after single and multiple isoflurane exposures during infancy. These NHPs model the developmental stage of children at 6–8 yr of age. Disturbances in social behaviour at this age could have serious long-term effects in children starting to attend school or other new environments, and could result in difficulties in adapting to new social settings. We found that neither single nor multiple 5 h exposures to isoflurane during infancy impaired the cognitive functions tested, but these exposures were associated with reduced close social behaviour. In addition, single exposed NHPs showed increased anxiety-related behaviours and inhibition towards novel objects. These findings in NHPs resemble the outcomes of most recent clinical studies that found no effects on general intelligence, but reported alterations in social behaviours in children exposed to anaesthesia during infancy.

British Journal of Anaesthesia, 126 (2): 486–499 (2021)

Summary of Animal Data

- GABA and NMDA binding agents cause neuroapoptosis in animal models of the developing brain
  - Volatile anesthetic agents, N_2O, benzodiazepines, propofol, ketamine
  - *In vitro*, rodents to primates
  - Reproducible effects, long lasting neurobehavioral sequelae
  - Mechanisms being elucidated
    - Interference with neurotransmission➔failure of neurons to connect/communicate➔🡅neuroapoptosis➔🡇dendrite/spine formation and 🡇neuronal migration

Br J Anaesth 2013; 110 Suppl 1:i53-72

Anesthesia and Sedation in Infants and Children

- ≈6 million children undergo anesthesia or sedation annually in the U.S.
- ≈1.5 million are less than 12 months, and 2-3 million less than 36 months of age
- The question of possible anesthetic and sedative neurotoxicity has major public health implications
- Exponential growth of sedation procedures in young children, e.g. MRI, is of significant concern
- Untreated or undertreated pain definitely causes neurodegeneration and long term neurobehavioral consequences

Br J Anaesth 2010;105 Suppl 1:i61-8

Is There a Clinical Problem in Children?

- This "disease" is the inverse of most pathology in that the animal model was first and gave rise to clinical concern
- Phenotype of neurodevelopmental-behavioral problems has not been observed clinically
  - Not obvious from the millions of children undergoing anesthesia and sedation annually in U.S.
  - Pre-existing medical conditions, and significant prevalence of neurobehavioral problems
- What is the clinical evidence to date?

Sanders R, et al. Br J Anaesth 2013; 110 Suppl 1:i53-72

Original Investigation

Association Between a Single General Anesthesia Exposure Before Age 36 Months and Neurocognitive Outcomes in Later Childhood

JAMA June 7, 2016 Volume 315, Number 21

Lena S. Sun, MD; Guohua Li, MD, DrPH; Tonya L. K. Miller, MD; Cynthia Salorio, PhD; Mary W. Byrne, PhD, MPH; David C. Bellinger, PhD, MSc; Caleb Ing, MD, MS; Raymond Park, MD; Jerilynn Radcliffe, PhD; Stephen R. Hays, MD, MS; Charles J. DiMaggio, PhD; Timothy J. Cooper, PsyD; Virginia Rauh, ScD; Lynne G. Maxwell, MD; Ahrim Youn, PhD; Francis X. McGowan, MD

- PANDA Study (***P***ediatric ***A***nesthesia ***N***euro***D***evelopment ***A***ssessment)
- 105 sibling pairs
  - One sibling exposed to GA for herniorrhaphy at <36 months
- Median anesthetic time 80 minutes (range 20-240 min)
  - Control unexposed sibling within 3 years in age
- Neuropsychological testing battery at age 8 to 15 years
- Primary outcome: full scale, performance, verbal IQ

Domains | Global cog function | xposed | (108-113) | (105-110) | (109-114)

No difference in Full Scale, Performance, or Verbal IQ

No difference in directly measured tests of memory, language, attention, executive function

Minor differences in behavior by parental questionnaire

Neuropsychological and Behavioral Outcomes after Exposure of Young Children to Procedures Requiring General Anesthesia

Anesthesiology 2018; 129:89-105

The Mayo Anesthesia Safety in Kids (MASK) Study

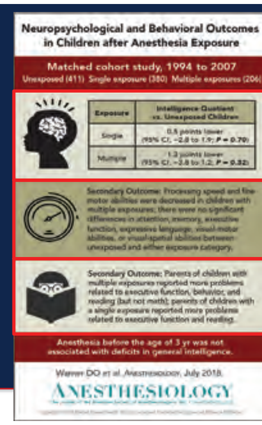
David O. Warner, M.D., Michael J. Zaccariello, Ph.D., L.P., Slavica K. Katusic, M.D., Darrell R. Schroeder, M.S., Andrew C. Hanson, B.S., Phillip J. Schulte, Ph.D., Shonie L. Buenvenida, R.N., Stephen J. Gleich, M.D., Robert T. Wilder, M.D., Juraj Sprung, M.D., Danqing Hu, M.D., Robert G. Voigt, M.D., Merle G. Paule, Ph.D., John J. Chelonis, Ph.D., Randall P. Flick, M.D., M.P.H.

- 997 children enrolled: 380 single exposure, 206 multiple exposure, 411 no exposure to GA at <3 years, 1994-2007
- Battery of neuropsychological tests at 8-12, or 15-19 years
- Full scale IQ was primary outcome

Table 6. Primary Analysis for Scores Chosen *A Priori* as of Primary Interest

Test	n	P Value*	Single Exposure, Estimate (95% CI) of Difference from Unexposed	P Value†	Multiple Exposures, Estimate (95% CI) of Difference from Unexposed	P Value†	Unexposed, Estimate of Mean (95% CI)§
Psychometrist-administered							
WASI: Full-Scale IQ Score	993	0.599	−0.46 (−2.78, 1.87)	0.701	−1.27 (−3.75, 1.21)	0.315	106.0 (104.2, 107.8)
WRAML-2: Attention/Concentration Index (StdS)	926	0.404	0.59 (−2.34, 3.53)	0.692	−1.58 (−4.57, 1.40)	0.299	104.0 (102.1, 105.8)
CPT-II: Hit Reaction Time (TS)	981	0.504	0.20 (−1.89, 2.29)	0.853	1.09 (−0.84, 3.03)	0.268	51.6 (50.2, 53.0)
WRAML-2: Verbal Memory Index (StdS)	993	0.289	1.27 (−1.08, 3.63)	0.289	−0.82 (−3.23, 1.60)	0.507	105.7 (104.1, 107.2)
WRAML-2: Delayed Verbal Recall Composite (StdS)‖	994	0.340	1.13 (−0.84, 3.11)	0.261	−0.40 (−2.40, 1.60)	0.697	104.5 (103.2, 105.8)
WRAML-2: Verbal Recognition Composite (StdS)	992	0.343	0.78 (−1.46, 3.02)	0.495	−1.02 (−3.27, 1.24)	0.378	106.5 (105.0, 107.9)
WRAML-2: Design Memory subtest (SS)‡	995	**0.037**	0.11 (−0.37, 0.60)	0.648	−0.54 (−1.03, −0.05)	0.030	8.9 (8.6, 9.2)
WRAML-2: Design Recognition subtest (SS)	995	0.828	0.17 (−0.38, 0.71)	0.550	0.12 (−0.44, 0.68)	0.678	9.9 (9.5, 10.2)
D-KEFS Trail Making Test: Condition 4 (SS)	994	0.194	0.22 (−0.37, 0.80)	0.469	−0.33 (−0.99, 0.33)	0.323	10.0 (9.5, 10.5)
D-KEFS Tower Test, Total Achievement Score (SS)	996	0.350	0.02 (−0.42, 0.46)	0.939	−0.29 (−0.76, 0.17)	0.216	10.1 (9.8, 10.4)
Wisconsin Card Sort: Perseverative Responses (TS)	958	0.104	1.46 (−0.92, 3.85)	0.229	−1.40 (−3.97, 1.17)	0.286	55.4 (53.8, 57.0)
CTOPP: Rapid Naming Composite Score (StdS)	995	**0.047**	−2.03 (−4.78, 0.72)	0.147	−3.51 (−6.32, −0.70)	**0.014**	97.8 (95.9, 99.8)
Expressive Language Composite (StdS)‖	882	0.202	1.31 (−1.21, 3.83)	0.309	−1.13 (−3.75, 1.48)	0.398	103.6 (101.9, 105.3)
Fine Motor Composite (StdS)‖	988	**< 0.001**	−1.34 (−3.91, 1.23)	0.306	−5.53 (−8.42, −2.64)	**< 0.001**	93.7 (92.0, 95.4)
Beery Visual Motor Integration (StdS)	990	0.148	−2.48 (−5.00, 0.04)	0.054	−1.40 (−3.77, 0.97)	0.246	89.4 (87.6, 91.1)
Visual–Spatial Abilities Composite (StdS)‖#	529	0.490	−1.73 (−4.61, 1.15)	0.239	−0.95 (−3.73, 1.84)	0.506	99.4 (97.5, 101.2)
Parental report							
BRIEF: Global Executive Composite (TS)	840	**< 0.001**	4.64 (2.36, 6.92)	**< 0.001**	3.23 (0.89, 5.57)	**0.007**	46.3 (44.9, 47.8)
CBCL: Internalizing Problems (TS)	829	**0.038**	1.16 (−1.25, 3.57)	0.347	2.94 (0.68, 5.20)	**0.011**	47.5 (46.0, 49.1)
CBCL: Externalizing Problems (TS)	829	**< 0.001**	2.03 (−0.24, 4.30)	0.080	3.91 (1.90, 5.92)	**< 0.001**	43.2 (41.9, 44.6)
CBCL: Total Problems (TS)	828	**0.001**	2.10 (−0.68, 4.88)	0.139	4.75 (2.23, 7.27)	**< 0.001**	43.8 (41.9, 45.6)
CBCL: ADHD Problems (TS)	828	**0.026**	1.41 (−0.05, 2.86)	0.058	1.97 (0.51, 3.44)	**0.008**	52.6 (51.5, 53.7)
CLDQ: Math Scale (ZS)	894	0.210	0.17 (−0.09, 0.43)	0.204	0.23 (−0.04, 0.50)	0.089	0.04 (−0.15, 0.23)
CLDQ: Reading Scale (ZS)	895	**< 0.001**	0.24 (0.07, 0.42)	**0.005**	0.44 (0.24, 0.64)	**< 0.001**	−0.29 (−0.39, −0.19)

Anesthesiology 2018; 129:89-105

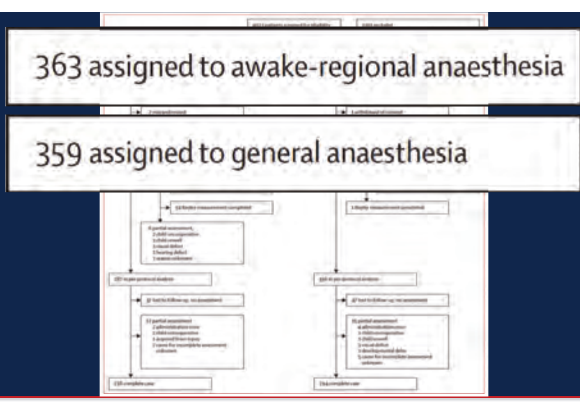


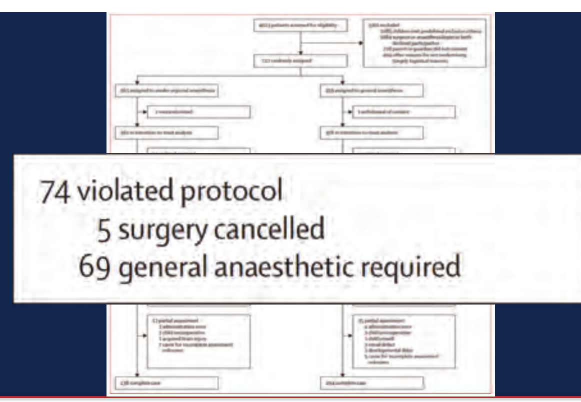
Neurodevelopmental outcome at 2 years of age after general anaesthesia and awake-regional anaesthesia in infancy (GAS): an international multicentre, randomised controlled trial

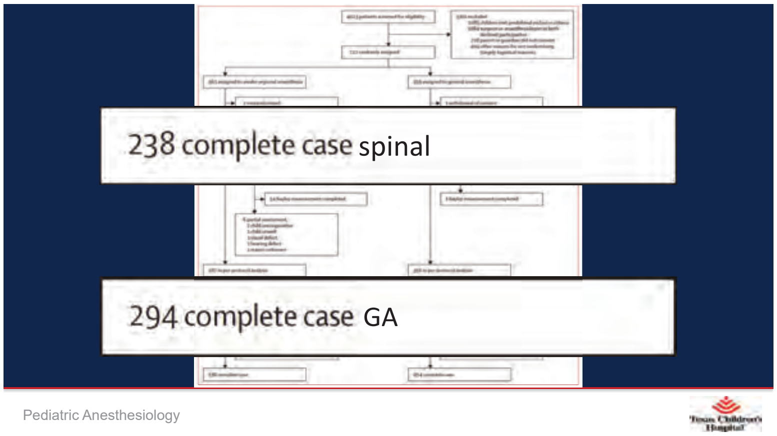
Andrew J Davidson, Nicola Disma, Jurgen C de Graaff, Davinia E Withington, Liam Dorris, Graham Bell, Robyn Stargatt, David C Bellinger, Tibor Schuster, Sarah J Arnup, Pollyanna Hardy, Rodney W Hunt, Michael J Takagi, Gaia Giribaldi, Penelope L Hartmann, Ida Salvo, Neil S Morton, Britta S von Ungern Sternberg, Bruno Guido Locatelli, Niall Wilton, Anne Lynn, Joss J Thomas, David Polaner, Oliver Bagshaw, Peter Szmuk, Anthony R Absalom, Geoff Frawley, Charles Berde, Gillian D Ormond, Jacki Marmor, Mary Ellen McCann, for the GAS consortium*

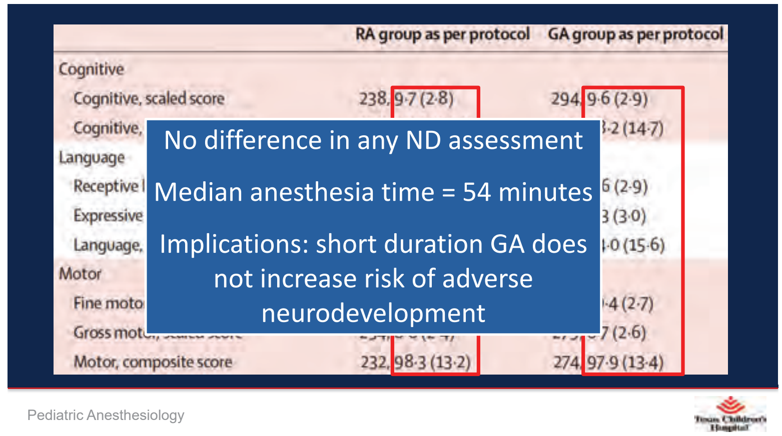
Lancet 2016; 387: 239-50

- 722 infants <60 weeks PCA randomized to GA (sevoflurane) vs. spinal (bupivacaine) for inguinal herniorrhaphy
- Bayley Scales of Infant and Toddler Development III assessed at 2 years (secondary outcome)
- Clinical equivalence margin defined as difference in means of ± 5 points

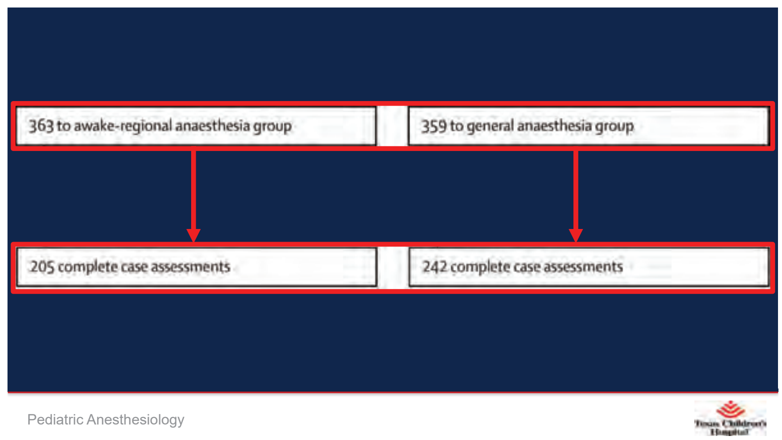


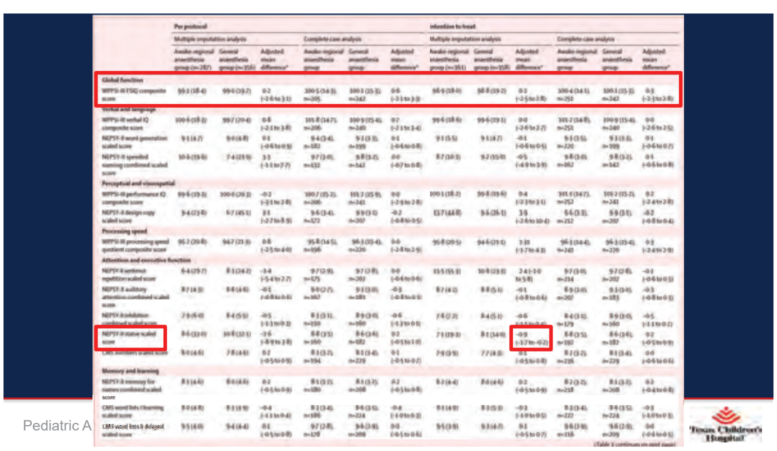


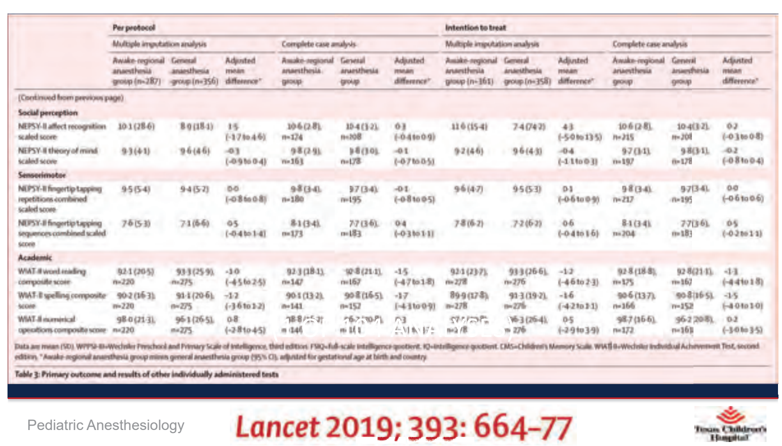

238 complete case spinal
294 complete case GA
Pediatric Anesthesiology


RA group as per protocol
GA group as per protocol
Cognitive
Cognitive, scaled score
238, 9·7 (2·8)
294, 9·6 (2·9)
Language
Motor
Motor, composite score
232, 98·3 (13·2)
274, 97·9 (13·4)
No difference in any ND assessment
Median anesthesia time = 54 minutes
Implications: short duration GA does not increase risk of adverse neurodevelopment
Pediatric Anesthesiology


GAS Study 5-Year Outcomes
Neurodevelopmental outcome at 5 years of age after general anaesthesia or awake-regional anaesthesia in infancy (GAS): an international, multicentre, randomised, controlled equivalence trial
Mary Ellen McCann, Jurgen C de Graaff, Liam Dorris, Nicola Disma, Davinia Withington, Graham Bell, Anneke Grobler, Robyn Stargatt, Rodney W Hunt, Suzette J Sheppard, Jacki Marmor, Gaia Giribaldi, David C Bellinger, Penelope L Hartmann, Pollyanna Hardy, Geoff Frawley, Francesca Izzo, Britta S von Ungern Sternberg, Anne Lynn, Niall Wilton, Martin Mueller, David M Polaner, Anthony R Absalom, Peter Szmuk, Neil Morton, Charles Berde, Sulpicio Soriano, Andrew J Davidson, for the GAS Consortium*
Lancet 2019; 393: 664–77
Pediatric Anesthesiology


363 to awake-regional anaesthesia group
359 to general anaesthesia group
205 complete case assessments
242 complete case assessments
Pediatric Anesthesiology


Per protocol
Intention to treat
Pediatric A


Per protocol
Intention to treat
Multiple imputation analysis
Complete case analysis
Table 3: Primary outcome and results of other individually administered tests
Pediatric Anesthesiology
Lancet 2019; 393: 664–77

PRIMARY OUTCOME: WESCHLER PRESCHOOL AND PRIMARY SCALE OF INTELLIGENCE FULL SCALE IQ AT 5 YEARS: NO DIFFERENCE

OTHER DOMAINS: 3 OF 124 ANALYSES WORSE WITH GA—PARENT RATED EXECUTIVE FUNCTION, MEASURED EXECUTIVE FUNCTION

Are We Out of the Woods With a Single Brief Exposure Yet?

- The GAS, PANDA, and MASK studies are very reassuring for cognitive and other directly measured outcomes of neurodevelopmental abilities that ***a single brief exposure is not a widespread problem***
  - ***We are not creating a population of children with profound neurodevelopmental handicaps***
- However, ***there is a signal that behavioral diagnoses may be affected***
  - Additional analyses/studies needed
- Studies to date are in "normal" children without pre-existing developmental delay risk factors, genetic syndromes, previous brain injury, etc.
  - These vulnerable populations deserve our attention and efforts

British Journal of Anaesthesia, 122 (6): 716–719 (2019)
doi: 10.1016/j.bja.2019.03.011
Advance Access Publication Date: 11 April 2019

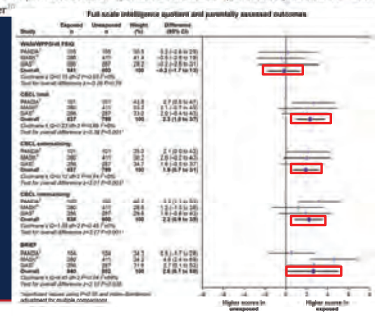
Mayo Anesthesia Safety in Kids continued: two new studies and a potential redirection of the field

Caleb Ing[1,2,*] and Ansgar M. Brambrink[1]

Interestingly, all three of these studies (MASK, PANDA, and GAS) also asked parents to rate their child for things, such as executive function and behaviour, and all three reported worse scores in some of these parent-reported outcomes, even after a single exposure.

Prospectively assessed neurodevelopmental outcomes in studies of anaesthetic neurotoxicity in children: a systematic review and meta-analysis

Caleb Ing[1,2,*], William M. Jackson[1], Michael J. Zaccariello[3], Terry E. Goldberg[4], Mary-Ellen McCann[5], Anneke Grobler[6,7], Andrew Davidson[7,8], Lena Sun[9], Guohua Li[1,10] and David O. Warner[11]

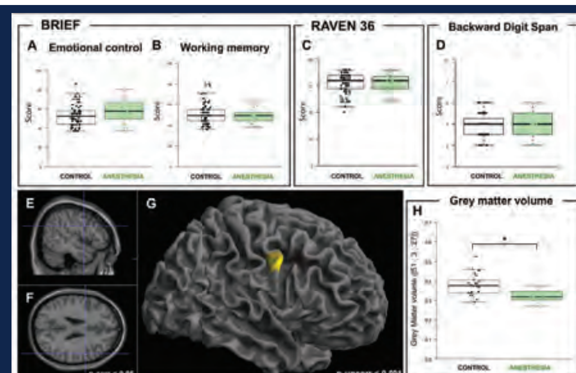


British Journal of Anaesthesia, 126 (2): 433–444 (2021)

Consequences of General Anesthesia in Infancy on Behavior and Brain Structure

Jean-Philippe Salaün, MD, PhD,*† Audrey Chagnot, PhD,* Arnaud Cachia, PhD,‡§ Nicolas Poirel, PhD,‡§‖ Valérie Datin-Dorrière, MD, PhD,‡‖¶ Cléo Dujarner, MSc,* Eloïse Lemarchand, PhD,* Marine Rolland, MD,*† Lisa Delalande, PhD,‡ Pierre Gressens, MD, PhD,# Bernard Guillois, MD,§ Olivier Houdé, PhD,‡§‖ Damien Levard, MSc,* Clément Gakuba, MD, PhD,*† Marine Moyon, PhD,‡ Mikael Naveau, PhD,** François Orliac, MD, PhD,‡‖ Gilles Orliaguet, MD, PhD,†† Jean-Luc Hanouz, MD, PhD,†‡‡ Véronique Agin, PhD,* Grégoire Borst, PhD,‡§ and Denis Vivien, PhD*§§

Anesth Analg 2023;136:240–50



Anesth Analg 2023;136:240–50

Physiologic Derangement as a Cause of Anesthetic Neurotoxicity

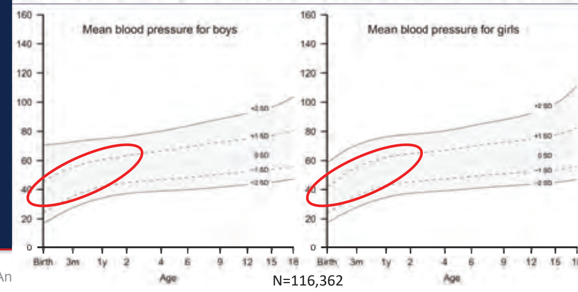
- European view is that this is more likely than neurotoxicity from the drugs
- Hypotension: Multicenter EMR study
- Critical events: APRICOT Study
- NIRS: Low cerebral oxygen saturation multicenter observational study
- EEG changes: seizures and silence

Reference Values for Noninvasive Blood Pressure in Children during Anesthesia

ANESTHESIOLOGY 2016; 125:904-13

A Multicentered Retrospective Observational Cohort Study

Jurgen C. de Graaff, M.D., Ph.D., Wietze Pasma, D.V.M., Stef van Buuren, Ph.D., Jesse J. Duijghuisen, M.D., Olubukola O. Nafiu, M.D., Sachin Kheterpal, M.D., Wilton A. van Klei, M.D., Ph.D.



N=116,362

Incidence of severe critical events in paediatric anaesthesia (APRICOT): a prospective multicentre observational study in 261 hospitals in Europe

Lancet Respir Med 2017; 5: 412-25

Walid Habre, Nicola Disma, Katalin Virag, Karin Becke, Tom G Hansen, Martin Jöhr, Brigitte Leva, Neil S Morton, Petronella M Vermeulen, Marzena Zielinska, Krisztina Boda, Francis Veyckemans, for the APRICOT Group of the European Society of Anaesthesiology Clinical Trial Network*

- 32,127 anesthetics in 30,874 infants and children
  - 33 countries
- Incidence of severe critical events: respiratory, neuro, cardiac, allergic requiring immediate intervention to prevent disability or death
- Incidence 5.2%
  - Respiratory 3.1%
  - Cardiac 1.9% (immediate poor outcome in 5.4%)
- All cause 30-day in hospital mortality 10 in 10,000

Incidence of Critical Events By Age

Most significant risk factors for cardiac events: cardiac surgery, ASA III-V

Protective factors: years of experience of anesthesiologist (1%/year)

As much as 20-30 –fold difference in incidence of severe critical events by country

5: 412-25

Anaesthesia 2019, 74, 300-311 doi:10.1111/anae.14520

ORIGINAL ARTICLE

Anaesth Crit Care Pain Med xxx (2018) xxx-xxx

SFAR
Société Française d'Anesthésie et de Réanimation

ELSEVIER

Original article

Description of practices and complications in the French centres that participated to APRICOT: A secondary analysis

Souhayl Dahmani[a,b,c,*], Anne Laffargue[d], Christophe Dadure[e,f], Francis Veyckemans[d], the French APRICOT trial group[f]

An International, Multicenter, Observational Study of Cerebral Oxygenation during Infant and Neonatal Anesthesia

ANESTHESIOLOGY 2018; 128:85-96

Vanessa A. Olbrecht, M.D., M.B.A., Justin Skowno, F.C.A., F.A.N.Z.C.A., Vanessa Marchesini, M.D., Lili Ding, Ph.D., Yifei Jiang, M.D., Ph.D., Christopher G. Ward, M.D., Gaofeng Yu, M.D., Huacheng Liu, M.D., Ph.D., Bernadette Schurink, M.D., Laszlo Vutskits, M.D., Ph.D.,

Although severe cerebral deoxygenation does occur during infant anesthesia, it is both rare and brief, and thus is unlikely to explain the reported learning and behavioral abnormalities associated with general anesthesia and surgery. (0.1% of anesthetic time during severe episodes)

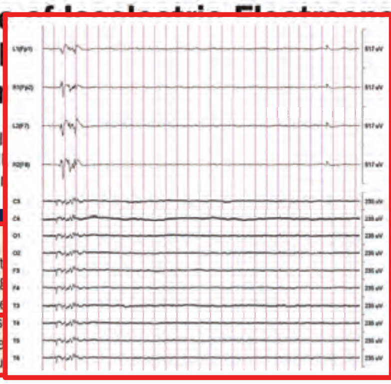
21–30% Relative decline of rSco₂ from baseline	30	8 (5–10)	0 (0–53)
>30% relative decline of rSco₂ from baseline	7	2 (0–3)	0 (0–32)
Absolute rSco₂ 60–69%	238	53 (48–57)	2 (0–85)
Absolute rSco₂ 50–59%	60	13 (10–16)	0 (0–50)
Absolute rSco₂ <50%	11	2 (1–4)	0 (0–24)

N=453

Prevalence ... ephalography Events in ... n Undergoing General A...

Ian Yuan, MD,* Will... as S. Abend, MD,†
Shih-Shan Lang, M... D, PhD,*†
Janell L. Mensinge... urth, MD*

...ub ahead of print



KEY POINTS
- **Question:** What ... y (EEG) events in infants and young ... ane or propofol infusion?
- **Findings:** Isoel... going anesthesia for surgery using s...
- **Meaning:** Curre... ently result in isoelectric EEG and su...

Incidence of epilept... g induction of anaesthesia usin...

Susanne Koch[a,b,c,1,*], Leo... Mörgeli[a,b,c], Sylvia Kramer[a,b,c], Klaus Dieter Wernecke[c], ...

...physiology 129 (2018) 1642–1648

- 39 childre...
- Sevoflura...
- 46% had ... g induction
  - 67% sev...
  - 36% prop...

Clinical Evidence for Any Effect of Anesthesia on the Developing Brain

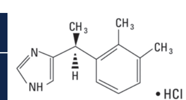
Andrew J. Davidson, M.B.B.S., M.D., F.A.N.Z.C.A., Lena S. Sun, M.D., F.A.A.P., D.A.B.A.

ABSTRACT

A recent U.S. Food and Drug Administration warning advised that prolonged or repeated exposure to general anesthetics may affect neurodevelopment in children. This warning is based on a wealth of preclinical animal studies and relatively few human studies. The human studies include a variety of different populations with several different outcome measures. Interpreting the results requires consideration of the outcome used, the power of the study, the length of exposure and the efforts to reduce the confounding effects of comorbidity and surgery. Most, but not all, of the large population-based studies find evidence for associations between surgery in early childhood and slightly worse subsequent academic achievement or increased risk for later diagnosis of a behavioral disability. In several studies, the amount of added risk is very small; however, there is some evidence for a greater association with multiple exposures. These results may be consistent with the preclinical data, but the possibility of confounding means the positive associations can only be regarded as weak evidence for causation. Finally, there is strong evidence that brief exposure is not associated with any long term risk in humans. (Anesthesiology 2018; 128:840-53)

AREAS OF RESEARCH TO ELUCIDATE THE EFFECTS OF ANESTHETICS ON THE DEVELOPING BRAINS OF HUMANS

Dexmedetomidine



- Dexmedetomidine (DEX) is a novel sedative/hypnotic/analgesic agent
  - α-2 receptors: locus ceruleus and spinal cord
  - α-2: α-1 selectivity 1600:1 (clonidine 200:1)
- Minimal respiratory depression
- Reduces post-cardiac surgical tachydysrhythmias
- Reduce doses of volatile anesthetic agents (VAA), opioids, benzodiazepines

Human Data

- No neuroapoptosis in the developing brain
- Blocks neuroapoptosis by anesthetic agents
- Neuroprotective in hypoxia-ischemia
- Neuroprotective in inflammatory states

Animal Data

Anesth Analg 2010;110:1383; Anesthesiology 2009; Ann Thorac Surg. 2011;92:964; Br J Anaesth. 2015;115:171 110:1077; Acta Anaesthesiol Scand 2010;54:710; Neurosci Lett 2006;409:128; Oxid Med Cell Longev 2015; :530371

SYSTEMATIC REVIEW

WILEY Pediatric Anesthesia

A systematic review and narrative synthesis on the histological and neurobehavioral long-term effects of dexmedetomidine

Pediatric Anesthesia. 2019;29:125–136.

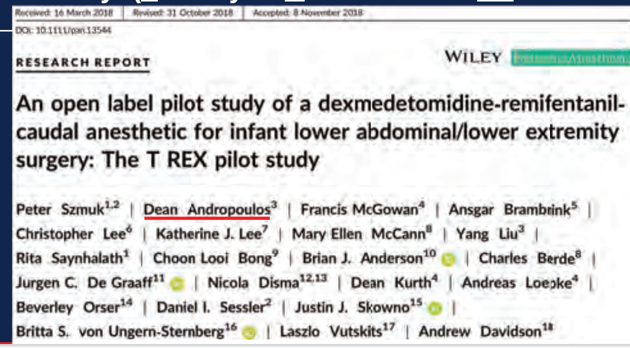
Camille E. van Hoorn[1] | Sanne E. Hoeks[1] | Heleen Essink[1] | Dick Tibboel[2] | Jurgen C. de Graaff[1]

Conclusion: In animals, dexmedetomidine was found not to induce histologic injury and to show a beneficial effect when administered with another anesthetic. No clinical results on the long-term effects in children have been identified yet.

Why Dexmedetomidine?

- Clinician's perspective:
  - Familiarity
  - Feasibility for research and adoption into clinical practice
- Widely used in pediatric anesthesia and ICU
  - Post-surgical, medical ICU, premed, opioid sparing for tonsillectomy, TIVA for spines, emergence agitation, procedural sedation
- Significant body of clinical research/clinical publications in infants/children
  - 314 in infants birth-23 months
  - 809 in children 0-18 years
- FDA labeled for adults 18+
  - ICU sedation intubated patients
  - Procedural sedation: non-intubated patients; surgical and other procedures

TREX Study: (*T*oxicity of *R*emifentanil-D*EX*medetomidine)


Received: 16 March 2018 | Revised: 31 October 2018 | Accepted: 8 November 2018
DOI: 10.1111/pan.13544

RESEARCH REPORT

WILEY

An open label pilot study of a dexmedetomidine-remifentanil-caudal anesthetic for infant lower abdominal/lower extremity surgery: The T REX pilot study

Peter Szmuk[1,2] | Dean Andropoulos[3] | Francis McGowan[4] | Ansgar Brambrink[5] | Christopher Lee[6] | Katherine J. Lee[7] | Mary Ellen McCann[8] | Yang Liu[3] | Rita Saynhalath[1] | Choon Looi Bong[9] | Brian J. Anderson[10] | Charles Berde[8] | Jurgen C. De Graaff[11] | Nicola Disma[12,13] | Dean Kurth[4] | Andreas Loepke[4] | Beverley Orser[14] | Daniel I. Sessler[2] | Justin J. Skowno[15] | Britta S. von Ungern-Sternberg[16] | Laszlo Vutskits[17] | Andrew Davidson[18]

 Pediatric Anesthesia. 2019;29:59–67.

TREX Study Objectives

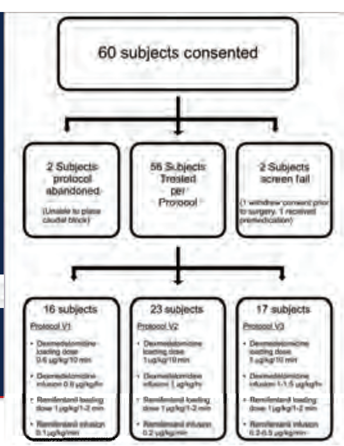
- To determine the feasibility of a Dexmedetomidine-Remifentanil-Caudal based anesthetic for lower abdominal/lower extremity surgery in infants 1-12 months of age
- ***Primary objective:***
  - The frequency of having to abandon the protocol for any reason

TREX Study (*T*oxicity of *R*emifentanil-D*EX*medetomidine)

- 60-subject pilot study; outcome: feasibility and safety
- 1-12 month old infants >120 min anesthesia time
- Surgical site covered by caudal anesthetic (hypospadias)
- Sevoflurane induction; d/c <10 minutes
- Dexmedetomidine 1 mcg/kg load; 1-1.5 mcg/kg/hr
  - Glycopyrrolate 5 mcg/kg before DEX
- Remifentanil 1 mcg/kg load; 0.2-0.5 mcg/kg/min
- Caudal catheter with ropivacaine 0.2% 1 ml/kg; top up with 0.5 ml/kg at 90-120 min

TREX Study (*T*oxicity of *R*emifentanil-D*EX*medetomidine)

Pediatric Anesthesia. 2019;29:59–67.



TREX Study (*T*oxicity of *R*emifentanil-D*EX*medetomidine)

- 8 sites enrolled subjects: (1-20)
- Eye-opening times about 7 minutes
- Most had excellent analgesia in PACU, most discharged <60 minutes
- No protocol abandonment in 56 subjects
- No serious adverse events: mild/moderate hypotension (25%) and bradycardia (16%)
- ***80% had "rescue" treatment for light anesthesia (movement/hypertension)***
- ***Protocol is feasible: 87.5% of patients with functioning caudal required no sevoflurane or propofol rescue***

Dexmedetomidine/Remifentanil/Low Dose Sevo vs. Standard

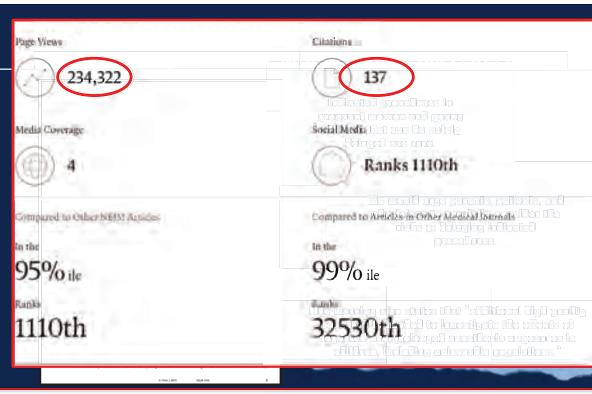
- ENROLLMENT STARTED AUGUST 2017: 411 ENROLLED AS OF 12/1/22

  TO DATE—SLOW ENROLLMENT -- CHANGE TO 2 HOURS SURGERY/2.5 HOURS ANESTHESIA TIME
- NO MAJOR ADVERSE EVENTS
- ABOUT 40% INCIDENCE OF LIGHT ANESTHESIA IN DEX/REMI GROUP VS. 2% IN SEVO GROUP
- >100 3-YEAR NEURODEVELOPMENTAL EXAMS

FDA WARNING: THE CONTROVERSY

My Perspective on the FDA Warning

- Timing was unexpected
  - ???2016 Election effect???
- Basis is primarily animal data
  - FDA CDER scientists strongly feel that non-human primate data has applicability to humans
  - >3 hours and <3 years also based on animal data
- GAS and PANDA studies of a single, brief anesthetic exposure <3 years old were **NOT** associated with later neurodevelopmental problems
- MASK Study results had been expected imminently
  - Specifically addresses multiple anesthetics



National Anesthesia Societies' Perspective

American Academy of Pediatrics
American Society of Anesthesiologists
Asian Society of Paediatric Anaesthesiologists
IARS International Anesthesia Research Society
Society for Maternal-Fetal Medicine
SOAP Society for Obstetric Anesthesia and Perinatology
Society for Pediatric Anesthesia
Congenital Cardiac Anesthesia Society
Pediatric Anesthesia Leadership Council
Society for Pediatric Pain Medicine

Warnings, uncertainty, and clinical practice

www.thelancet.com Vol 389 June 3, 2017

We suggest that when clinical data are weak, incomplete, or uncertain, especially when those data are generated from retrospective cohort analyses prone to confounding by unmeasured variables, clinicians must be familiar with the pertinent current literature and prepared to address parents' queries if they arise, but be circumspect about proactively advising about the risk of unknown or uncertain adverse outcomes.

*David M Polaner, Jeannie Zuk, Mary Ellen McCann, Andrew Davidson

EJA

Eur J Anaesthesiol 2017; **34**:327–328

EDITORIAL

Use of anaesthetics in young children

Consensus statement of the European Society of Anaesthesiology, the European Society for Paediatric Anaesthesiology, the European Association of Cardiothoracic Anaesthesiology and the European Safe Tots Anaesthesia Research Initiative

Tom G. Hansen

The evidence to support such warning is currently insufficient and incomplete. Therefore, this FDA warning is not shared by the European Societies listed below.

Furthermore, the implied 'safe' cut-off points of age 3 years or duration of procedure of 3 h quoted in the FDA warning statement are not currently supported by evidence derived from human studies.

Eur J Anaesthesiol 2017; **34**:327–328

SUPPLEMENT: SIXTH PANDA SYMPOSIUM

J Neurosurg Anesthesiol 2019;31:129–133

Anesthesia Exposure in Children: Practitioners Respond to the 2016 FDA Drug Safety Communication

Teeda Pinyavat, MD, Neeta R. Saraiya, MD,* Jerri Chen, MD, PhD,* Lynne R. Ferrari, MD,† Dena Goffman, MD,‡ Thomas A. Imahiyerobo, MD,§ William Middlesworth, MD,§ Joshua E. Hyman, MD,|| Grace Hyun, MD,¶ and Constance S. Houck, MD, MPH†*

Panelists acknowledged that the FDA had an obligation to alert the public to the possible danger of anesthetic neurotoxicity based on the multiple studies in animals. However, they were dissatisfied with the way the safety communication was developed and released, especially in its original version. The communication and the lay media's interpretation of it added to parent and provider stress, and many practitioners felt unprepared for the questions and concerns from parents that quickly arose.

All panelists agreed that emergent and semiurgent surgery should not be delayed due to the concern for neurotoxicity. The timing of elective procedures should take into account a number of factors including anesthetic risk, especially in younger patients. While there is no evidence that anesthesia and surgical practice has changed much since the FDA drug safety communication, discussions with patients and families surrounding neurotoxicity and anesthetic risk has certainly been more common. Most surgical societies do not have their own

SHOULD PARENTS BE EDUCATED ABOUT THE FDA WARNING?

RESEARCH RE

Epidemiol ... in a population

Yu Shi[1] | D ... hen J. Gleich[1] |
Andrew C. Har ... Warner[1]

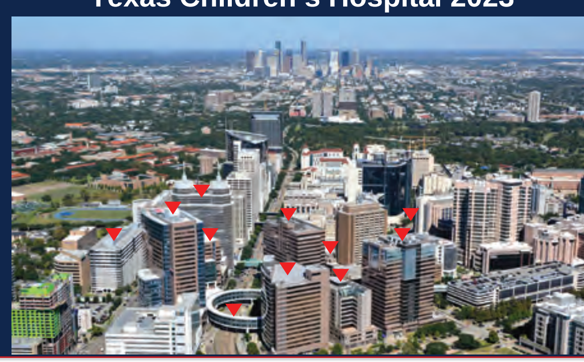
What is already known

- Utilization of general anesthesia in children has important policy, economic, and healthcare delivery implications. The US Food and Drug Administration (FDA) recently issued warning that prolonged or repeated exposure to general anesthesia before age 3 may affect brain development.

What this article adds

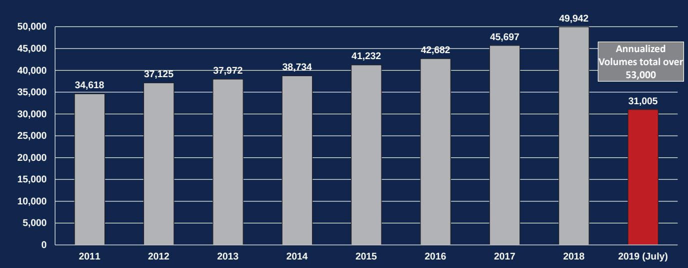
- One in 7 children were exposed to general anesthesia before age 3, and 1 in 4 children who received general anesthesia defined as high risk by the FDA warning.

Texas Children's Hospital 2023



959 Licensed Beds

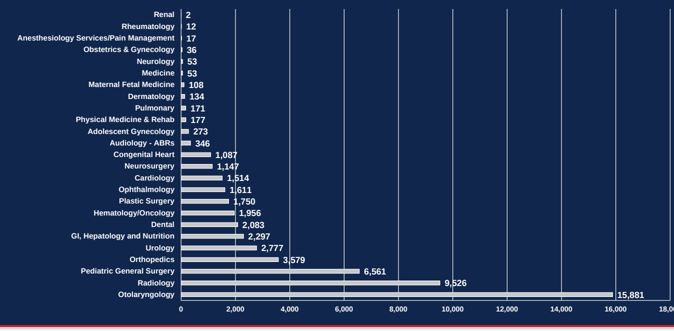
Number of Anesthetic Cases by Calendar Year: TCH Pediatric Anesthesiology



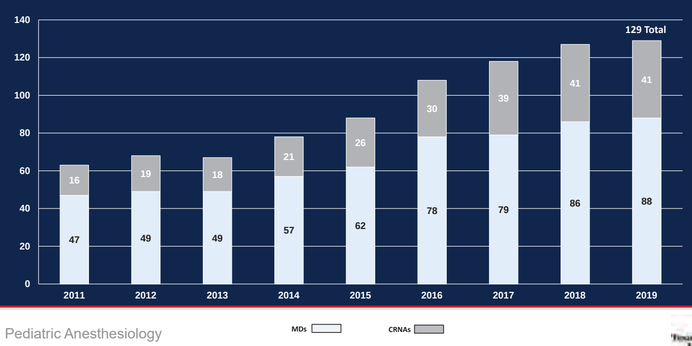
65 Anesthetic Locations

TCH Anesthetic Cases by Subspecialty

2019 Annualized Volumes



TCH Pediatric Anesthesiology Departmental Growth by Calendar Year: Providers



TCH Patients Affected by FDA Warning

TCH Department of Anesthesiology, Perioperative and Pain Medicine

>50,000 anesthetics annually

≈15,000 patients are < 3 years

≈1,500 patients < 3 years have multiple anesthetics

≈1,500 patients < 3 years have anesthetics > 3 hrs*

Maternal-fetal anesthesia: **120** procedures

**** 2/3 are CVOR or Cath Lab***

Discussion Points: Surgeons, Proceduralists, Anesthesiologists, and Referring Physicians

- Created based on Breakthrough Communications Program principles
- Focused on 3 questions:
  1. Should the procedure be done now or when the child is older?
  2. How long do we expect the procedure to take?
  3. Will repeated or additional procedures be needed?
- Distributed to all TCH Medical Staff, TCP Providers, and APP staff

www.texaschildrens.org/departments/anesthesiology/resources

Anesthesia and Your Child – Q&A

- Distribution Tool and Locations:
  - Surgery Packets
  - Radiology Registration
  - Pre-op Clinics – PASS, Heart Center
  - TCH Anesthesiology Website, Connect Site, EPIC Anesthesia Virtual
  - Community Campuses
- English and Spanish Translations
- Addresses general information about anesthesia, the associated risks, and the FDA Safety Announcement

www.texaschildrens.org/departments/anesthesiology/resources

Texas Medical Disclosure Panel New Informed Consent Language

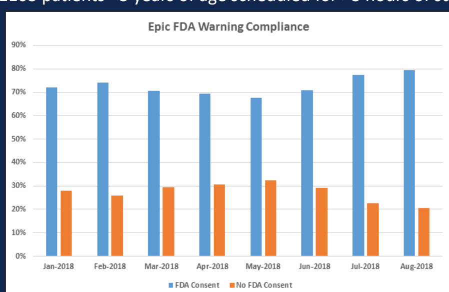
☐ ____ ESIA -
Potentia… emory,
behavio… peated
exposur… n/deep
sedation

THE "WHAT A REASONABLE PATIENT WOULD WANT TO KNOW" STANDARD FOR DISCLOSING RISKS OF A MEDICAL PROCEDURE

EPIC EMR Documentation of FDA Warning

TCH Department Practice: FDA Warning in EPIC

N= 1103 patients <3 years of age scheduled for >3 hours of surgery



Of 842 patients with 2 or more anesthetics from Jan-Aug 2018; 84% had FDA warning discussed in EPIC

FDA Warning in 2023

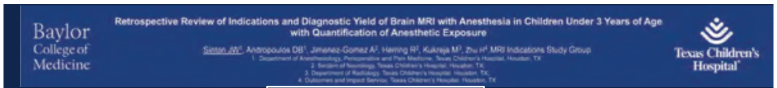
- Routinely discussed at TCH in 2023, very few questions, essentially no postponements of anesthetics
- SmartTots is drafting a letter to FDA requesting revision/updating of FDA Warning
  - Reassuring human data
  - Behavioral phenotype
  - 3-year age "cutoff", 3-hour duration
  - "Physiologic" neuroprotection
  - Will require public meetings, i.e. FDA Science Board

NEUROIMAGING:

IS IT NECESSARY IN ALL CASES?

MRI Questions

- MRIs are among the most frequently cited procedures under anesthesia that possibly could be delayed: but what is the data?
- What are the indications for brain MRI for developmental delay or new onset seizures, especially in children with no neurological or syndromic findings?
- What percentage of sedated MRIs in children <3 years are abnormal? Diagnostic? Which of these are actionable findings?



IARS and AUA Abstracts May 2018

- Analyzed 1 year of brain MRI with anesthesia/sedation <3 years, immediately before the FDA Warning
- Indications: global developmental delay, new onset seizure
- Collaborative project: Neurology, Radiology, Anesthesiology
- MRI Data
  - Abnormal Yes/No
  - ***Findings: Diagnostic findings: etiologic diagnosis***
  - ***Hypothesis: 10% yield for etiologic diagnosis***

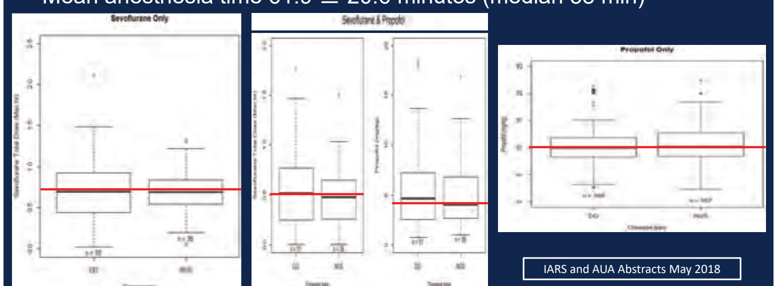
TCH MRI Indications Study Results

- Global Developmental Delay
  - Etiologic diagnosis in 63/222 (28%)
  - 19/222 changed medical management (8.6%)
- New Onset Seizure
  - Etiologic diagnosis in 53/339 (16%)
  - 29/339 changed medical management (8.5%)
- ***Overall 21% etiologic diagnosis***
  - Higher than hypothesized

IARS and AUA Abstracts May 2018

Anesthetic Exposure Data

- Mean anesthesia time 61.9 ± 20.6 minutes (median 58 min)



IARS and AUA Abstracts May 2018

Pediatric neuro MRI: tricks to minimize sedation

Pediatr Radiol Published online: 22 April 2017

Matthew J. Barkovich[1] · Duan Xu[1,2] · Rahul S. Desikan[1] · Cassandra Williams[2] · A. James Barkovich[1,2]

Fig. 1 Photo shows a neonate wrapped in vacuum bean bag with noise attenuators in place, ready for transport to scanner suite

ARE THERE DEFERRABLE ELECTIVE SURGERIES?

AAP Surgical Advisory Panel “Optimal Timing” Task Force

- Multidisciplinary task force with representation from the 10 AAP pediatric surgical specialty sections
- Consensus that many pediatric surgeries are not “deferrable” due to critical windows for neurodevelopment and function
- Initial survey of task force members has generated preliminary list of “non deferrable” surgeries based on medical literature and consensus
  - Work in progress, not finalized, discussions ongoing

Source: Constance Houck, M.D., MPH, Chair, AAP Surgical Advisory Panel

Surgeries with “Critical Window” for Repair < 3 years

- General Surgery
  - Inguinal hernia
  - Lung malformations
  - Branchial cleft, thyroglossal duct cysts
  - Lymphangioma
- Otolaryngology
  - All procedures, including PE tubes, T&A
- Neurosurgery
  - All procedures except some dermoid cysts
- Ophthalmology
  - Cataract
  - Strabismus
  - Ptosis
  - Glaucoma
  - Retina
  - Nasolacrimal duct cyst
- Orthopedics
  - Hip dislocation
  - Casting for early scoliosis
  - Club foot
- Urology
  - Undescended testicles
  - Hypospadias

Source: Constance Houck, M.D., MPH, Chair of AAP Surgical Advisory Panel

Vulnerable Populations

- Pediatric ICU Patients
  - Approximately 15/1000 population annually
  - 2/3 <4 years old
  - 20% have moderate to severe disability on discharge
  - No published data about long term sedation and neurocognitive outcomes
- Neonatal ICU Patients
  - 77.9/1000 live births (300,000 annually in U.S.)
  - No long term data about sedation and neurocognitive outcomes

JAMA Pediatr. 2015;169:855; Pediatr Crit Care Med. 2010;11:549

JAMA Oncology | Original Investigation — Published online June 20, 2019

Association Between Anesthesia Exposure and Neurocogni[...]n Long-term Survivors of [...]eukemia

Table 3. Multivariable Regression Models Predicting Global Neurocognitive Impairment[a]

CONCLUSIONS AND RELEVANCE Higher cumulative anesthesia exposure and duration may be associated with neurocognitive impairment and neuroimaging abnormalities in long-term survivors of childhood acute lymphoblastic leukemia, beyond the known outcomes associated with neurotoxic chemotherapies. Anesthesia exposures should be limited in pediatric populations with chronic health conditions who undergo multiple medical procedures.

Pentobarbital sodium, per 10 mg/kg	1.02 (0.90-1.15)	.74
Glycopyrrolate, per 1 μg/kg	1.00 (1.00-1.01)	.14
Fluranes (per exposure)[c]	1.10 (1.01-1.21)	.03
Duration (per h)	1.03 (1.00-1.06)	.04

Smarttots.org

Should the FDA Warning Affect My Practice?

- Should the drugs/doses I use change? ***NO***-wait for research results
- Delay surgery or other procedure? ***EXTREMELY RARE***
- Not perform neuroimaging? ***NO***—but more selectivity desirable, non-sedated?
- Educate parents? ***YES***
- Waste time under anesthesia? ***NO***
- Combine anesthetics? ***YES WHEN PRACTICAL BUT NO DEFINITIVE DATA***
- Practice excellent, high-quality anesthesia minimizing major cardiopulmonary perturbations? ***ALWAYS***
- Withhold appropriate anesthesia care, i.e. “too light” anesthesia to minimize drug dosages? ***NEVER***

2007 vs. 2023: What Has Changed?

- 2007: F[...]cts of a sin[...]
- 2007: C[...] defined[...]
- 2007: N[...] some p[...]
- 2023: M[...]
- 2023: N[...]
- 2023: E[...] externalizing/internalizing/executive function: small (3-5%) effect but significant

WE ARE FAR MORE REASSURED THAT EFFECTS ON NEUROCOGNITIVE OUTCOMES ARE LESS SEVERE THAN ORIGINALLY ANTICIPATED

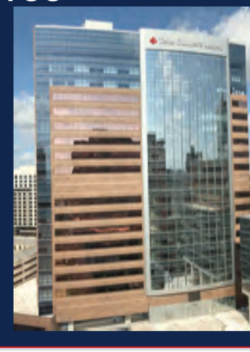
BEHAVIOR CHANGES ARE RELATIVELY SMALL BUT CONCERNING

NO REASON TO POSTPONE ALMOST ANY ELECTIVE SURGERY OR ANESTHETIC

Case Study

- 13-month-old otherwise healthy male for hypospadias repair anticipated to require 2 hours of surgery, 2.5 hours anesthesia
- No previous anesthetic history, or family history of significant problems
- Parents are very concerned about the possible anesthetic effect on the brain and ask if they should postpone surgery until after age 3 years
- They are also asking about epidural or spinal anesthesia if the surgery must be done now
- They also read about dexmedetomidine and are asking for this drug if he has to have general anesthesia

THANK YOU



dra@bcm.edu

Poll

Participate in polling in one of two ways:

VIA TEXT MESSAGE:

Text LJaneStewart to 22333 to start

Put your responses in the message at the appropriate time

VIA THE WEB:

https://pollev.com/LJaneStewart

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Scan QR Code

1

CRASH

Guiding the future of patient care

Blunt Trauma and The Use of REBOA

L. Jane Stewart MD, JD, MPH
Denver Health and Hospital Authority
University of Colorado

Anesthesiology

2

Poll

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VIA TEXT MESSAGE:

Text LJaneStewart to 22333 to start

Put your responses in the message at the appropriate time

VIA THE WEB:

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OR

Scan QR Code

3

CRASH

What is your experience with Resuscitative Endovascular Balloon Occlusion of the Aorta (REBOA)?

A: I have never heard of REBOA

B: I have heard of REBOA but never seen it used

C: I have heard of REBOA and seen it used

D: I have heard of REBOA seen it used, and had to manage a patient with a REBOA in place

E: I have had multiple experiences managing patients with a REBOA in place

F: I am a REBOA expert

4

CRASH

What is your experience with Resuscitative Endovascular Balloon Occlusion of the Aorta (REBOA)?

5

CRASH

What is your experience with Resuscitative Endovascular Balloon Occlusion of the Aorta (REBOA)?

6

Disclosures

No financial disclosures

Slide minimalist

I work at a Level I Trauma Center

7

Learning Objectives

Be able to discuss the epidemiology of blunt trauma and current treatments

Understand the use of REBOA in trauma

Understand operating room management of REBOA for anesthesiologists

Understand the potential complications of REBOA

Know applications of REBOA outside of trauma

8

Poll

Participate in polling in one of two ways:

VIA TEXT MESSAGE:

Text LJaneStewart to 22333 to start

Put your responses in the message at the appropriate time

VIA THE WEB:

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OR

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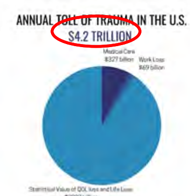
Trauma: Epidemiology

4.4 million[1]

70%

1



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10

Trauma Treatments for Non-compressible Torso Injury

Tranexamic Acid (TXA)[3,4]

Interventional Radiology[5]

Extraperitoneal Pelvic Packing (EPP)[6,7]

Resuscitative Thoracotomy (RT) + Aortic Clamping.[5,6,8,9]

11

REBOA: Overview

History and Purpose

Placement

Contraindications

Removal

Evidence/Recommendations

12

REBOA: History & Purpose

13

REBOA: History

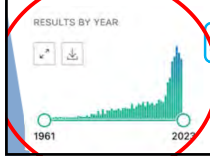
Korean War use of aortic occlusion in 2 patients by Lt. Col. Carl Hughes[10,11,12,13,14]

1954 | 1971 | 1989 | 2003 | 2013 | 2016 | 2021 | 2023

ER-REBOA™

ER-REBOA PLUS™

pREBOA-PRO™



21 patients at the Trauma Center for Brooklyn[14,15,16]

First case series with 6 civilian trauma patients published[17]

YOU ARE HERE

14

REBOA: Placement

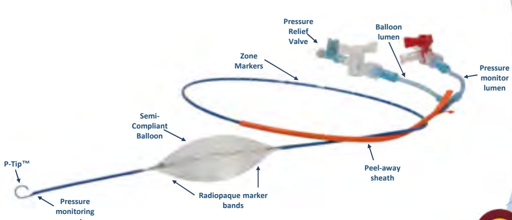
15

REBOA: Placement

(34)

16

REBOA: Placement



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REBOA: Placement

1 **Proximal pressure reading**
=above the balloon BP (reads off the REBOA catheter)

2 **Distal pressure reading**
=below the balloon BP (reads off the 7fr sheath)

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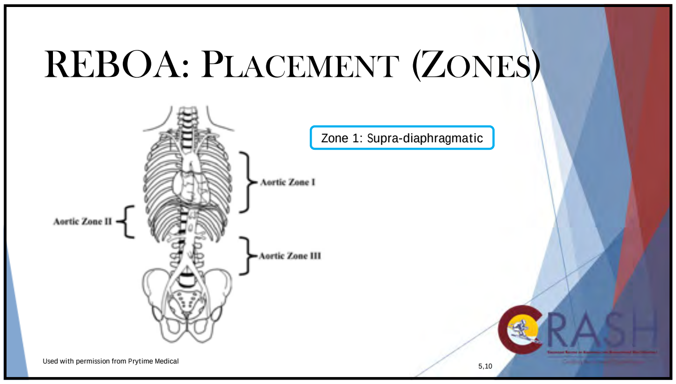

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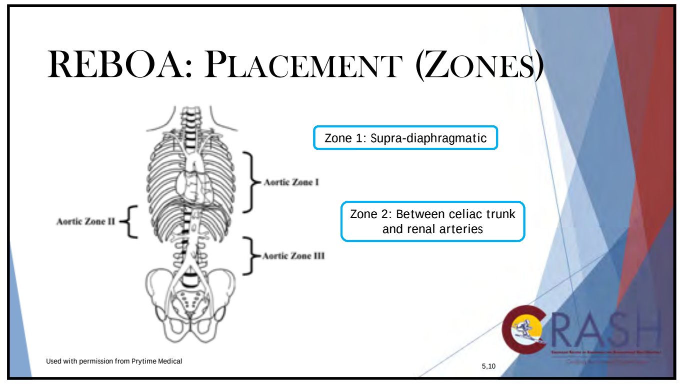

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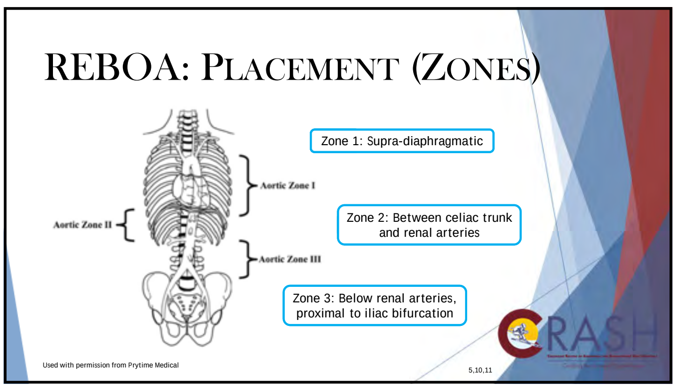

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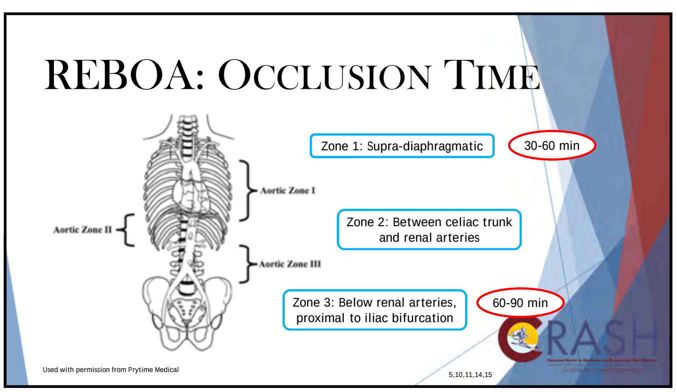

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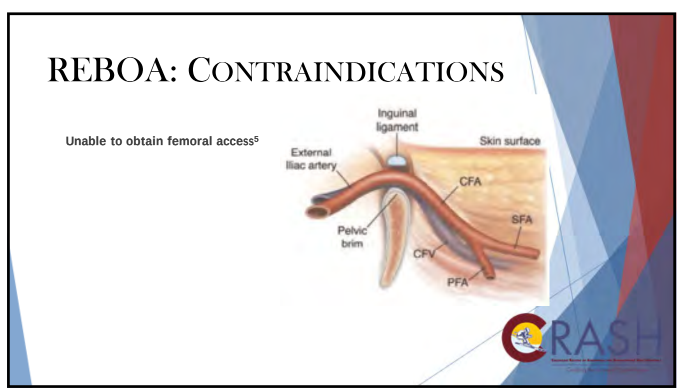


24

REBOA: Contraindications

Unable to obtain femoral access[5]

Aortic diameter greater than 3.2cm (32mm)[5,18]

Photo: https://www.vascularcures.org/abdominal-aortic-aneurysms

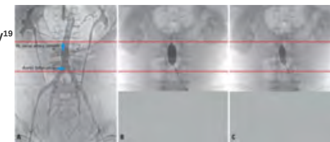
25

REBOA: Contraindications

Unable to obtain femoral access[5]

Aortic diameter greater than 3.2cm (32mm)[5,18]

Contrast media allergy[19]



19. Accessed at: https://www.jtraumainj.org/m/journal/view.php?number=1035.

26

REBOA: Contraindications

Unable to obtain femoral access[5]

Aortic diameter greater than 3.2cm (32mm)[5,18]

Contrast media allergy[19]

Pediatric Use[20]

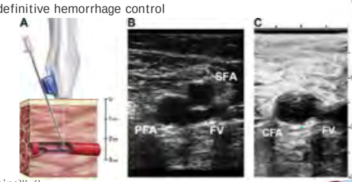
27

REBOA: Removal

REBOA removal after definitive hemorrhage control

+/- sheath removal

Hold pressure for ~5 mins[10, 21]



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(25,26,27 3,4, 34)

28

REBOA: Evidence

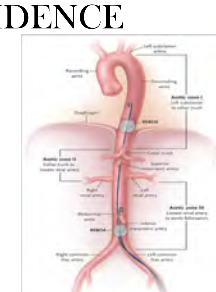
Quick arterial access is key[5,6,8,21]

Probably best placed under fluro[5]

Hardest to place in Zone III[5]

Probably a survival benefit[5,6,8,21]

There are risks[5,6,8,21]



29

REBOA: Guidelines

Open access | Systematic review

Trauma Surgery & Acute Care Open

Systematic review to evaluate algorithms for REBOA use in trauma and identify a consensus for patient selection

Amelia Walling Maiga,[1] Rishi Kundi,[2] Jonathan James Morrison,[2] Chance Spalding,[3] Juan Duchesne,[4] John Hunt,[5] Jonathan Nguyen,[6] Elizabeth Benjamin,[7] Ernest E Moore,[8] Ryan Lawless,[8] Andrew Beckett,[9] Rachel Russo,[10] Bradley M Dennis[1]

18

30

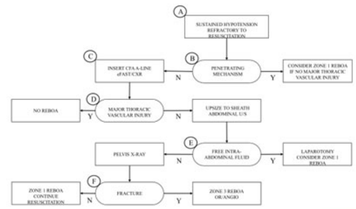
REBOA: Guidelines

A Western Trauma Association critical decisions algorithm: Resuscitative endovascular balloon occlusion of the aorta

Kenji Inaba, MD, FACS, Hasan B. Alam, MD, Karen J. Brasel, MD, MPH, Megan Brenner, MD, Carlos V.R. Brown, MD, David J. Ciesla, MD, Marc A. de Moya, MD, Joseph J. DuBose, MD, Ernest E. Moore, MD, Laura J. Moore, MD, Jack A. Sava, MD, Gary A. Vercruysse, MD, and Matthew J. Martin, MD *Los Angeles, California*

31

REBOA: Guidelines



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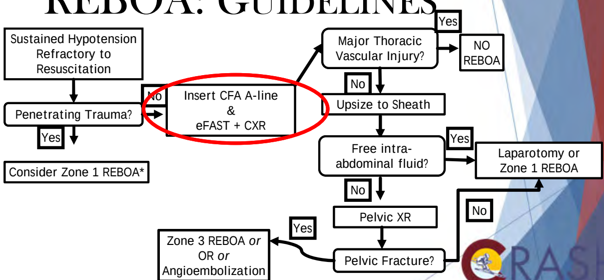
REBOA: Guidelines



*If no major thoracic vascular injury

33

REBOA: Recap

- History and Purpose
- Placement
- Contraindications
- Evidence/Guidelines

34

OR Management

- Monitors
- Hemodynamics
- Other Considerations

35

OR Management: Monitors

36

REBOA: Placement

1. **Proximal pressure reading**
=above the balloon BP (reads off the REBOA catheter)

2. **Distal pressure reading**
=below the balloon BP (reads off the 7fr sheath)

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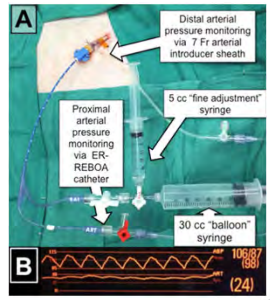
OR Management: Monitors



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OR Management: Monitors

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OR Management: Monitors

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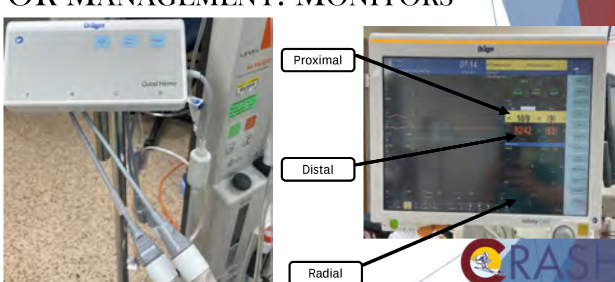
OR Management: Monitors



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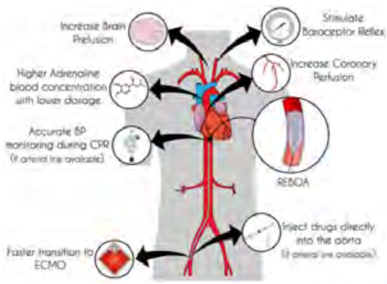
OR Management: Monitors

Radial Arterial Line

- Blood Sampling
- Removal
- Consistent Pressure Monitoring

42

OR Management: Hemodynamics



37. Accessed at: https://www.mdpi.com/2077-0383/11/3/742

43

OR Management: Other

- Surgeon Communication
- Normal arterial line management
- REBOA/Sheath flushing
- Site assessment

44

REBOA: Complications

- Thromboembolic Events[23,24,25,26,27]
- Vascular injury[27,28]
- End Organ Damage[25,26]
- Compartment Syndrome[27,28]
- Fatal Hemorrhage/Increased Intracranial Pressure[25,27,28]

45

REBOA: Non-Trauma Uses

- Placenta Accreta/Percreta[23,28,29,30]
- Non-trauma cardiac arrest[31]

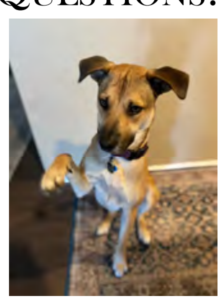
46

REBOA: The Future

- Common Femoral Access
- Pediatric Uses
- Non-Trauma Uses
- Patient Selection

47

Questions?



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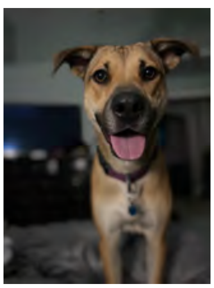
Thank You!



CRASH

51

Monday, February 27th

Update on Geriatric Anesthesia

Nathaniel J Brown, MD, PhD
Assistant Professor
CU SOM Dept of Anesthesiology
Rocky Mountain Regional VAMC
February 27 2023

1

Disclosures

No financial disclosures

2

Learning Objectives

Discuss innovations in preoperative assessment strategies for the geriatric population.

Learn about a couple of studies that can shed light on intraoperative care of the elderly.

Appreciate delirium and postoperative cognitive decline as major concerns in the postoperative care of the elderly.

3

Overview

This update is intended to discuss novel findings in areas of science that impact perioperative care.

We will divide the talk into three unequal, if predictable, sections:

preop

intraop

postop

The prevention of postoperative cognitive issues is probably the biggest issue facing anesthesia, so we will spend the most time there.

I will have the least to say about intraoperative care.

4

Preoperative Assessment

Frailty is associated with an array of poor surgical outcomes, but there is no gold standard frailty assessment tool.

A study from last October (2022) looked at 3 frailty assessments:

> Acta Anaesthesiol Scand. 2022 Oct 28. doi: 10.1111/aas.14162. Online ahead of print.

Frailty assessment tools and associated postoperative outcomes in older patients undergoing elective surgery: A prospective pilot study

Luis G Rabelo [1,2], Anna Bjornsdottir [3], Anna B Jonsdottir [4], Sveinn G Einarsson [1], Sigurbergur Karason [1], Martin I Sigurdsson [1,2]

Affiliations + expand

PMID: 36307919 DOI: 10.1111/aas.14162

5

Rabelo et al 2022

Results: Out of 99 patients, 41%, 37%, and 43% had abnormal PRISMA7, TUG, and CDT screening, respectively. Postoperative delirium was more likely to occur in patients with abnormal TUG screening (19% vs. 3%, p = .011) and CDT (17% vs. 2%, p = .019). When analyzing screening tool combinations, patients with abnormal PRISMA7 and TUG had a higher rate of non-home discharge (38% vs. 17%, p = .029); and patients with abnormal TUG and CDT had a higher rate of postoperative delirium (25% vs. 3%, p = .006) and any surgical complication (58% vs. 38%, p = .037); and patients with abnormal results from all three tools had a higher rate of postoperative delirium (21% vs. 5%, p = .045) and non-home discharge (42% vs. 18%, p = .034).

Conclusion: Approximately 40% of elderly surgical patients have abnormal PRISMA7, TUG, and CDT screening tests for frailty, and they are associated individually or in combination with increased risk of adverse postoperative outcomes. The results will aid in designing studies to further risk-stratify patients at risk of frailty and attempt to modify associated outcomes.

6

A wider look

> BMJ Open. 2022 Oct 21;12(10):e062729. doi: 10.1136/bmjopen-2022-062729.

Comprehensive geriatric assessment (CGA) in perioperative care: a systematic review of a complex intervention

Rachael Lucia Miller [1, 2], Jonathan David Barnes [3], Ronelle Mouton [4, 3], Philip Braude [5], Robert Hinchliffe [4, 2]

Affiliations + expand

PMID: 36270763 PMCID: PMC9594523 DOI: 10.1136/bmjopen-2022-062729

7

Not great news

Conclusions: CGA as an intervention is variably described and delivered in randomised controlled trials in the perioperative setting. The reporting of both the intervention and standard care is often poor with little focus on adherence. Future research should focus on clearly defining and standardising the intervention as well as measuring adherence within trials.

To date, our science hasn't yet decided how to delineate and define the problem, so we're asking a lot of different kinds of questions. While these questions are being answered, they're so different that those of us in the trenches can't draw much from them (yet!).

This will change as the field matures.

8

Multipronged approaches work better

The heterogeneity in the data that make conclusions difficult to draw about individual tests and interventions also point to complexity being met with complexity.

Let me explain.

Multidisciplinary approaches that focus on "pre-hab" to rehab (including nutrition, PT, OT, etc.) do seem to improve outcomes. (There is data forthcoming on this from the Geriatric Surgical Quality Committee at the VA, of which I am a member.)

9

A fun finding

> Digit Biomark. 2022 Jul 14;6(2):61-70. doi: 10.1159/000525344. eCollection 2022 May-Aug.

Smartphone-Based Gait Cadence to Identify Older Adults with Decreased Functional Capacity

Daniel S Rubin [1], Sylvia L Ranjeva [2], Jacek K Urbanek [3], Marta Karas [4], Maria Lucia L Madariaga [5], Megan Huisingh-Scheetz [6]

Affiliations + expand

PMID: 36156872 PMCID: PMC9386413 DOI: 10.1159/000525344

Conclusions: Our pilot study demonstrates the feasibility of using gait cadence as a measure to estimate functional capacity. Our study was limited by a smaller than expected sample size due to COVID-19, and thus, a prospective study with preoperative patients that measures outcomes is necessary to validate our findings.

10

Intraoperative Anesthesia

Question: might BIS have an evidence-based use after all?

There are some things we can do intraop that will effect postop outcomes.

11

A data-backed use for BIS

Randomized Controlled Trial > Sci Rep. 2022 Jul 26;12(1):12703. doi: 10.1038/s41598-022-16466-y.

Neuromonitoring depth of anesthesia and its association with postoperative delirium

Berta Pérez-Otal [1], Cristian Aragón-Benedí [2], Ana Pascual-Bellosta [2], Sonia Ortega-Lucea [2], Javier Martínez-Ubieto [2], J M Ramírez-Rodríguez [3]; Research Group in Anaesthesia, Resuscitation, and Perioperative Medicine of Institute for Health Research Aragón (ISS Aragón)

Collaborators, Affiliations + expand

PMID: 35882875 PMCID: PMC9325758 DOI: 10.1038/s41598-022-16466-y

12

Results

The "Hidden BIS" group spent more time with a BIS <40 compared to the "Visible BIS" group (11 min vs 26 min).

The Visible BIS group also spent about 3 fewer days inpatient.

Post-op delirium rate lower, too.

13

A meta-analysis on the same topic

Review > J Cardiothorac Vasc Anesth. 2022 Dec;36(12):4449-4459.
doi: 10.1053/j.jvca.2022.07.004. Epub 2022 Jul 8.

Bispectral Index (BIS) Monitoring and Postoperative Delirium in Elderly Patients Undergoing Surgery: A Systematic Review and Meta-Analysis With Trial Sequential Analysis

Wei Zhuen Chew [1], Wan Yi Teoh [2], Naveenaa Sivanesan [3], Pui San Loh [4], Ina Ismiarti Shariffuddin [4], Lian Kah Ti [5], Ka Ting Ng [6]

Affiliations + expand

PMID: 36038444

Conclusion: The authors' meta-analysis demonstrated that BIS-guided anesthesia was not associated with a reduced incidence of POD, but it was associated with a reduced incidence of POCD and improved recovery parameters.

14

Postoperative badness: The big players

Delirium

Post Operative Cognitive Dysfunction (POCD)

15

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)

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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.

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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.

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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.

19

Clinical Interventions in Aging — Dovepress

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.

21

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.

22

What about in people?

> Res Sq. 2023 Jan 23;rs.3.rs-2456664. doi: 10.21203/rs.3.rs-2456664/v1. Preprint

The association between gut microbiota and postoperative delirium in patients

Zhongcong Xie, Yiying Zhang, Kathryn Baldyga, Yuanlin Dong, Wenyu Song, Mirella Villanueva, Hao Deng, Ariel Mueller, Timothy Houle, Edward Marcantonio

PMID: 36747650 PMCID: PMC9900981 DOI: 10.21203/rs.3.rs-2456664/v1

their associations with postoperative delirium. Of the 86 participants [age 71.0 (69.0-76.0, 25%-75% percentile of quartile), 53% female], ten (12%) developed postoperative delirium. Postoperative gut bacteria *Parabacteroides distasonis* (Odds Ratio [OR] 2.13, 95% Confidence Interval (CI): 1.09-4.17, P = 0.026) was associated with postoperative delirium after adjusting for age and sex. The association between delirium and both *Prevotella* (OR: 0.59, 95% CI: 0.33-1.04, P = 0.067) and *Collinsella* (OR: 0.57, 95% CI: 0.27-1.24, P = 0.158) did not meet statistical significance. These findings suggest that postoperative gut microbiota (e.g., *Parabacteroides distasonis*) may serve as biomarkers in the pathogenesis of postoperative delirium, pending confirmative studies.

23

A deeper look

> PLoS One. 2023 Feb 7;18(2):e0281049. doi: 10.1371/journal.pone.0281049. eCollection 2023.

The effects of microbiome-targeted therapy on cognitive impairment and postoperative cognitive dysfunction-A systematic review

Saiko Sugita [1], Peggy Tahir [2], Sakura Kinjo [3]

Affiliations + expand

PMID: 36749772 PMCID: PMC9904456 DOI: 10.1371/journal.pone.0281049

Conclusion: In the studies we examined, most showed that MTTs decrease inflammation by down-regulating inflammatory cytokines and oxidative stress in both perioperative and non-perioperative settings. In general, MTTs also seem to have a positive effect on cognition through neural, immune, endocrine, and metabolic pathways. However, these effects have not yet resulted in a consensus regarding preventative strategies or treatments. Based on these current research results, MTTs could be a potential new preventative strategy for cognitive impairment after surgery.

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Preventing Postoperative Delirium

- Antipsychotics may help (may also hurt?).
- 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.
- Multimodal pain management, avoiding sedating medications.
- 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.

27

A more recent analysis (2022) did show a small effect favoring TIVA.

Review > Neuropsychiatr Dis Treat. 2022 Jul 15;18:1455-1467. doi: 10.2147/NDT.S374416. eCollection 2022.

Incidence of Postoperative Cognitive Dysfunction Following Inhalational vs Total Intravenous General Anesthesia: A Systematic Review and Meta-Analysis

Daniel Negrini [#] [1] [2], Andrew Wu [1], Atsushi Oba [1] [3], Ben Harnke [4], Nicholas Ciancio [1], Martin Krause [5], Claudia Clavijo [6], Mohammed Al-Musawi [7], Tatiana Linhares [1], Ana Fernandez-Bustamante [6], Sergio Schmidt [#] [8]

Affiliations + expand

PMID: 35874550 PMCID: PMC9296882 DOI: 10.2147/NDT.S374416

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Abstract

Postoperative cognitive dysfunction (POCD) has been increasingly recognized as a contributor to postoperative complications. A consensus-working group recommended that POCD should be distinguished between delayed cognitive recovery, ie, evaluations up to 30 days postoperative, anc neurocognitive disorder, ie, assessments performed between 30 days and 12 months after surgery Additionally, the choice of the anesthetic, either inhalational or total intravenous anesthesia (TIVA) and its effect on the incidence of POCD, has become a focus of research. Our primary objective was to search the literature and conduct a meta-analysis to verify whether the choice of general anesthesia may impact the incidence of POCD in the first 30 days postoperatively. As a secondary objective, a systematic review of the literature was conducted to estimate the effects of the anesthetic on POCD between 30 days and 12 months postoperative. For the primary objective, an initial review of 1913 articles yielded ten studies with a total of 3390 individuals. For the secondary objective, four studies with a total of 480 patients were selected. In the first 30 days postoperative the odds-ratio for POCD in TIVA group was 0.46 (95% CI = 0.26-0.81; p = 0.01), compared to the inhalational group. TIVA was associated with a lower incidence of POCD in the first 30 days postoperatively. Regarding the secondary objective, due to the small number of selected articles and its high heterogeneity, a metanalysis was not conducted. Given the heterogeneity of criteria fo POCD, future prospective studies with more robust designs should be performed to fully address this question.

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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-ish 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 Altıparmak, M.D.,[4] Eylem Yaşar, M.D.,[1] Mustafa Turan, M.D.,[4] 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
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[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.

32

Observational Study > BMC Anesthesiol. 2023 Jan 6;23(1):6.
doi: 10.1186/s12871-022-01960-7.

Cognitive function in older patients and their stress challenge using different anesthesia regimes: a single center observational study

Soeren Wagner[1,2], Martin Breitkopf[3], Elena Ahrens[4], Haobo Ma[4], Olivia Kuester[5], Christine Thomas[6], Christine A F von Arnim[7], Andreas Walther[3]

Affiliations + expand
PMID: 36609226 PMCID: PMC9817364 DOI: 10.1186/s12871-022-01960-7

Conclusions: We did not observe a difference in postoperative cognitive function between patients undergoing regional or general anesthesia for dermatology surgery. However, we found lower cortisol level in the RAG. Based on these findings, future studies should investigate alternatives to reduce stress in a general anesthesia setting.

33

On the more positive side:

Review > Medicine (Baltimore). 2022 Dec 30;101(52):e32597.
doi: 10.1097/MD.0000000000032597.

Impact of regional anesthesia on outcomes of geriatric patients undergoing lower extremity revascularization: A propensity score-matched cohort study

Jung A Lim[1], Yohan Seo[1], Eun-Joo Choi[1], Sang Gyu Kwak[2], Taeha Ryu[1], Jae Hoon Lee[3], Ki Hyuk Park[3], Woon Seok Roh[1]

Affiliations + expand
PMID: 36596067 PMCID: PMC9803409 DOI: 10.1097/MD.0000000000032597

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Bottom line: Regional might be better for geriatric patients in some settings

groups (GA vs RA: 6.3% vs 3.6%, $P = .083$). The 5-year survival rate and incidence of arterial and central venous catheter placement or intraoperative dopamine and epinephrine use were significantly higher in the GA group than in the RA group ($P < .05$). In addition, the frequency of immediate postoperative oxygen therapy or mechanical ventilation support was higher in the GA group ($P < .05$). However, there was no difference in the postoperative cardiopulmonary and cerebral complications between the 2 groups. These results suggest that RA can reduce intraoperative hemodynamic support and provide immediate postoperative respiratory intensive care. In addition, the use of RA may be associated with better short-term and 5-year survival rates in geriatric patients undergoing LER.

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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 data 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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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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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.

39

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."

40

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.

41

Active prevention? Maybe?

Meta-Analysis > Medicine (Baltimore). 2022 Dec 16;101(50):e32329.
doi: 10.1097/MD.0000000000032329.

Transcutaneous electrical acupoint stimulation for the prevention of perioperative neurocognitive disorders in geriatric patients: A systematic review and meta-analysis of randomized controlled trials

Shuying Li [1,2], Hailun Jiang [1,2], Wei Liu [1,2], Yu Yin [1,2], Chunsheng Yin [1,2], Hao Chen [1,2], Yuzheng Du [1,2], Qi Zhao [1,2], Yi Zhang [1,2], Chen Li [1,2]

Affiliations + expand

PMID: 36550918 PMCID: PMC9771360 DOI: 10.1097/MD.0000000000032329

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This review did show promise

Conclusion: In terms of clinical effectiveness, TEAS appeared to be beneficial for prophylaxis of PND during a relatively recent period, noting the limitations of the current evidence.

43

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.

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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.

Prevention starts with pre-op assessments. Multidisciplinary approaches have been shown to improve an array of outcomes.

PROTECT trial

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Some take-home points

It is best to prevent delirium (you knew that already)

POCD remains a thorny question from definition to prognostication to active research. There is no treatment. Some degree of active prevention may be possible, but the research isn't there yet.

How we administer anesthesia *might* matter; if so, there is a mild bias toward:

- TIVA
- Regional
- but this is FAR from established in the literature.

Frailty is a major predictor of many unfavorable postoperative outcomes (you knew that already)

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Thank You!

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Anesthesia for Non-Cardiac Surgery in Congenital Heart Disease

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CRASH 2023
Vail, Colorado
February 27, 2023

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Baylor College of Medicine

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Disclosures

- None

2

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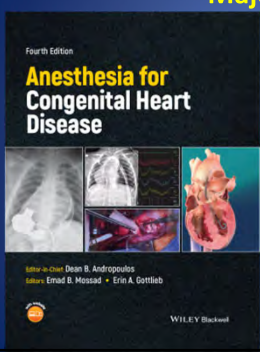

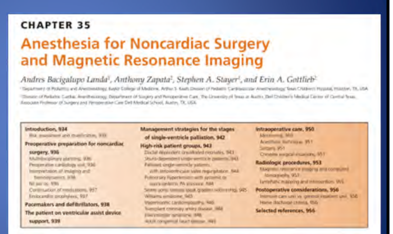

3

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Circulation: Cardiovascular Quality and Outcomes
2022;Dec 15:e000113; on line ahead of print

AHA SCIENTIFIC STATEMENT

Perioperative Considerations for Pediatric Patients With Congenital Heart Disease Presenting for Noncardiac Procedures: A Scientific Statement From the American Heart Association

Viviane G. Nasr, MD, MPH, Chair; Larry W. Markham, MD, Vice Chair; Mark Clay, MD; James A. DiNardo, MD; David Faraoni, MD, PhD, FAHA; Danielle Gottlieb-Sen, MD, MPH, MS; Wanda C. Miller-Hance, MD; Nancy A. Pike, PhD, CPNP-AC/PC, FAHA; Chloe Rotman, MLIS; on behalf of the American Heart Association Council on Lifelong Congenital Heart Disease and Heart Health in the Young and Council on Cardiovascular Radiology and Intervention

4

Learning Objectives

- Understand the basic pathophysiologic approach to congenital cardiac lesions
- Review the preoperative evaluation of CHD patients
- Discuss conduct of anesthesia for non-cardiac surgery for CHD patients
- Discuss recent changes to infective endocarditis guidelines
- Review the outcomes of anesthesia for non-cardiac procedures in patients with CHD

5

Incidence/Prevalence of Congenital Heart Disease

- 8-12 per 1000 infants in the U.S. are born with CHD
  - Most common birth defect requiring treatment
  - Similar incidence worldwide
- Survival now >95% for CHD surgery in many countries
  - ≈30,000 CHD surgeries annually in US: 25,000 <18 yrs; 5,000 >18 yrs; mortality 2.7%
  - 120 CHD surgery programs, approximately 350 surgeons
- ≈ 1.4 million adults/1 million children with CHD in U.S.—1 in 150
  - 55% simple lesions: ASD, VSD most common
  - 30% moderately complex: TOF most common
  - 15% complex lesions: TGA, single ventricle lesions

They will require anesthesia for non-cardiac surgery Circulation 2022;145:e153

6

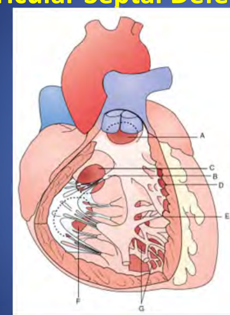
Non-Cardiac Surgery in Congenital Heart Disease

- 30% of children with CHD have extracardiac anomalies
- 41% of patients who had cardiac surgery <1 year of age also had at least 1 non-cardiac surgery by age 5 years
- NC surgery procedures in U.S. increased from 38,212 in 2015 to 45,993 in 2019 (20%)
- At Texas Children's Hospital, 20-30 patients with CHD per day have non-cardiac surgery or diagnostic procedures

Circ Cardiovasc Qual Outcomes
2022 Dec 15:e000113

7

Ventricular Septal Defect (VSD): Anatomy



A: Supracristal; subarterial

C: Perimembranous

F: Inlet; canal-type

D,E,G: Muscular

Andropoulos et al; Congenital Heart Disease,
Anesthesia and Uncommon Diseases, 6th Ed., Fleisher L., (ed.) 2012, p. 123

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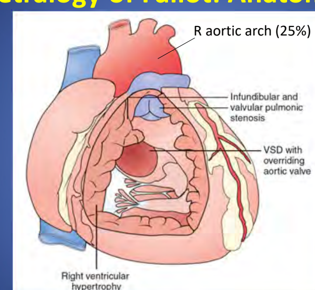
VSD Pathophysiology

- Ranges from small, asymptomatic with minimal left-to-right shunt
  - Endocarditis
  - Aortic valve insufficiency
- Larger VSD with CHF symptoms
- Unrestrictive VSD with pulmonary hypertension
  - Eisenmenger Syndrome possible

9

Tetralogy of Fallot: Anatomy



Andropoulos et al; Congenital Heart Disease,
Anesthesia and Uncommon Diseases, 6th Ed., Fleisher L., (ed.) 2012, p. 123

10

TOF Pathophysiology

- Unrepaired:
  - Acyanotic with left to right shunt
  - Cyanotic
- Repaired:
  - Pulmonary insufficiency
  - RV dilation/dysfunction
  - Arrythmias

11

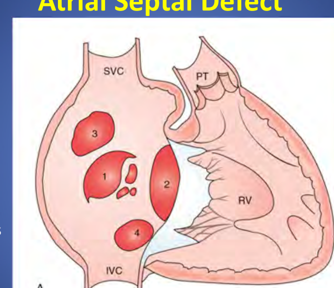
Atrial Septal Defect

1: Secundum

2: Primum

3: Superior sinus venosus

4: Inferior sinus venosus



Andropoulos et al; Congenital Heart Disease,
Anesthesia and Uncommon Diseases, 6th Ed., Fleisher L., (ed.) 2012, p. 95

12

Atrial Septal Defect Pathophysiology

- Primarily left-to-right shunt, often asymptomatic for years
- May have paradoxical embolus: TIA, stroke
- II/VI systolic murmur, fixed split second heart sound
- Acyanotic, cardiomegaly on CXR
- Diagnosis: echocardiography
- Treatment: device closure in cath lab or surgery with CPB
- Beware of partial anomalous pulmonary venous return

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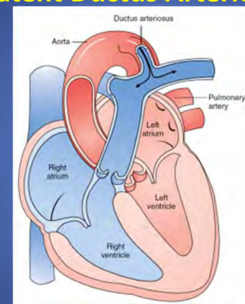
Patent Ductus Arteriosus



Andropoulos et al; Congenital Heart Disease,
Anesthesia and Uncommon Diseases, 6th Ed., Fleisher L., (ed.) 2012, p. 92

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Patent Ductus Arteriosus Pathophysiology

- Acyanotic: Left to right shunt depends on diameter, length, tortuosity, resistances in systemic/pulmonary circulations
- II-III/VI long systolic or continuous murmur
- Diagnosis: echo
- Adults: beware calcified, dilated, hypertensive PDA
- Treatment: surgery via L thoracotomy (non-bypass), device closure in cath lab
- Eisenmenger Syndrome possible

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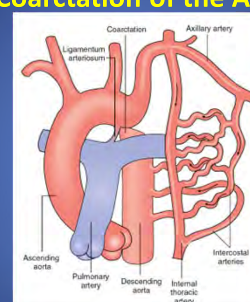
Coarctation of the Aorta



Andropoulos et al; Congenital Heart Disease,
Anesthesia and Uncommon Diseases, 6th Ed., Fleisher L., (ed.) 2012, p. 105

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Coarctation of the Aorta Pathophysiology

- Surgery:
  - Repaired via left thoracotomy; cath lab stenting
  - May have had subclavian flap: diminished BP left arm
- Diagnosis: echo/MRI
- Residual hypertension, coarctation, collateral circulation
- LV hypertrophy, early atherosclerosis

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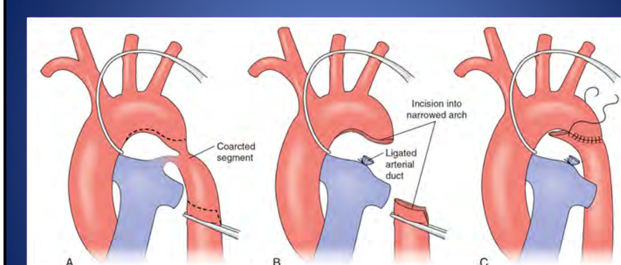
Coarctation Repair



Andropoulos et al; Congenital Heart Disease,
Anesthesia and Uncommon Diseases, 6th Ed., Fleisher L., (ed.) 2012, p. 106

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D-Transposition of the Great Arteries

- Aorta and PA reversed in utero
- Parallel circulations: depends on communication for oxygenation: ASD,VSD,PDA
- Often profound cyanosis at birth
- Diagnosis: echo, may need balloon atrial septostomy
- Surgery: arterial switch operation since mid-1980’s
- Still possible to see Mustard or Senning patients

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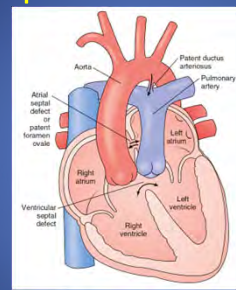
D-Transposition of the Great Arteries



Andropoulos et al; Congenital Heart Disease, Anesthesia and Uncommon Diseases, 6th Ed., Fleisher L., (ed.) 2012, p. 116

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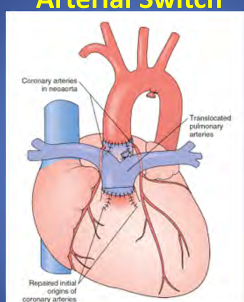
Arterial Switch



Andropoulos et al; Congenital Heart Disease, Anesthesia and Uncommon Diseases, 6th Ed., Fleisher L., (ed.) 2012, p. 116

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Atrioventricular Canal

- Most frequently associated with Trisomy 21 (Down Syndrome)
- Early pulmonary hypertension possible with delayed repair
- Residual or progressive mitral regurgitation may necessitate surgery later in life
- Adults may have Eisenmenger Syndrome

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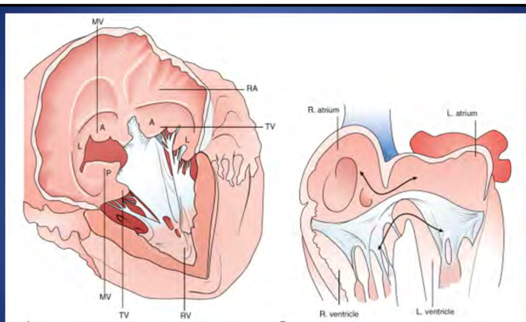

Andropoulos et al; Congenital Heart Disease, Anesthesia and Uncommon Diseases, 6th Ed., Fleisher L., (ed.) 2012, p. 98

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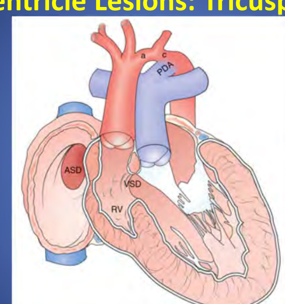
Single Ventricle Lesions: Tricuspid Atresia



Andropoulos et al; Congenital Heart Disease, Anesthesia and Uncommon Diseases, 6th Ed., Fleisher L., (ed.) 2012, p. 123

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Single Ventricle Lesions: Hypoplastic Left Heart Syndrome

- 0.7% of CHD but one of most common neonatal operations
- Severe mitral and aortic stenosis or atresia
- Very small or non-existent LV
- Treatment: Norwood operation; “hybrid” Norwood, transplant
- Formerly 100% fatal in first month; now 70-75% survive long term
- We are now seeing young adults who had Norwoods in the 1980s-1990s

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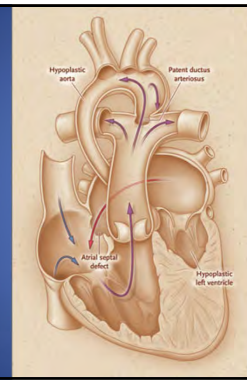

Ohye R et al. N Engl J Med 2010;362:1980-92

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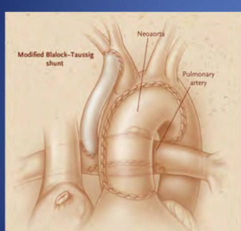
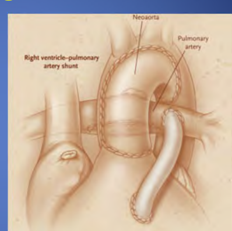
Norwood Stage I Palliation



“Classic” BT Shunt



Sano Modification

Ohye R et al. N Engl J Med 2010;362:1980-92

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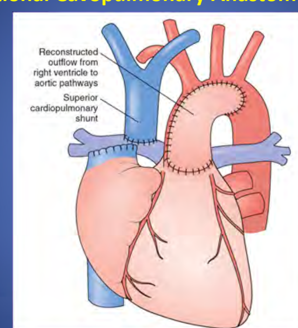
Bidirectional Cavopulmonary Anastomosis (Glenn)



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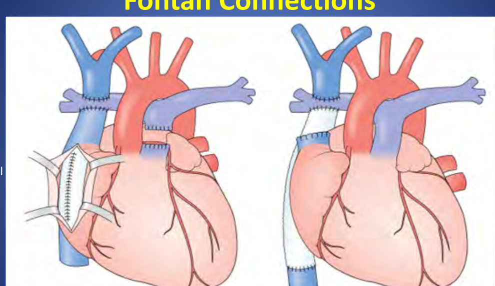
Fontan Connections

Lateral Tunnel



Extracardiac

Andropoulos et al; Congenital Heart Disease,
Anesthesia and Uncommon Diseases, 6th Ed., Fleisher L., (ed.) 2012, p. 119

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Single Ventricle Pathophysiology After Fontan

- CVP is the driving force for pulmonary blood flow
- Hypovolemia is poorly tolerated
- Positive pressure ventilation increases intrathoracic pressure, decreases pulmonary blood flow, decreasing cardiac output
- Pneumoperitoneum may be poorly tolerated
- Non-sinus rhythm is poorly tolerated
- May have fenestration: beware air in IV

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Preoperative Evaluation of Patients with Congenital Heart Disease

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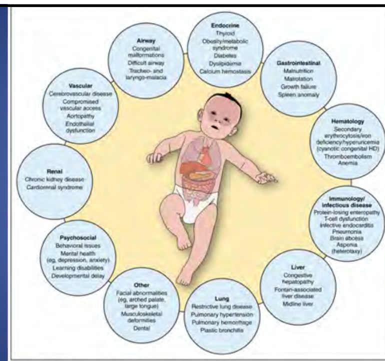

Figure 4: Noncardiac conditions in patients with congenital heart disease.
HD indicates heart disease.

Circ Cardiovasc Qual Outcomes. 2022 Dec 15:e000113

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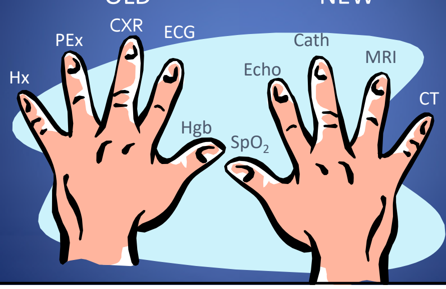
10 Fingers of CHD Diagnosis



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Preoperative Evaluation: Practical Pathophysiologic Approach to CHD

- Is the patient cyanotic or acyanotic?
  - Cyanotic: is there a single functional ventricle?
  - Acyanotic: Left-to-right shunting, or obstructive/regurgitant lesion?
- Corrective or palliative surgery?
  - Resulting anatomy and residual defects?

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Cardiology Consultation

- General recommendations:
  - Cyanotic patients:
    - Well compensated: cardiology visit/echo within 6 months
    - Less well/poorly compensated: preoperative consultation
  - Acyanotic patients:
    - Well compensated: no consultation unless otherwise indicated
    - Less well/poorly compensated: preoperative consultation

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Common Preop Planning Issues

- CHD center with expertise
  - Cardiologist, Surgeon, ICU, Anesthesiologist for complex patient or procedure
- Inpatient vs. outpatient surgery
  - Proximity to help/expertise, inpatient admission
  - ASA III can undergo outpatient procedures if well compensated/minor surgery/plan to return
- Invasive monitoring: need increases with complexity
- of lesion/patient status/invasiveness of surgery
- Availability of emergency drugs/cardioversion/ defibrillator
- Blood transfusion: goals for oxygen carrying capacity
- Need for inotropes/vasodilators
- ICU care: postoperative ventilation/observation

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Conduct of Anesthesia

- No single drug or technique is prohibited for non-cardiac surgery in CHD
- Understand the pathophysiology and desired hemodynamic and ventilatory state
- Design anesthetic techniques to achieve the desired goals

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Infective Endocarditis Prophylaxis

- Major changes to AHA recommendations in 2007—no substantive changes since
  - Wilson et al. Circulation 2007;116:1736
- More limited cardiac indications
- More limited procedural indications

38

Infective Endocarditis Prophylaxis

Table 3. Cardiac Conditions Associated With the Highest Risk of Adverse Outcome From Endocarditis for Which Prophylaxis With Dental Procedures Is Reasonable

Prosthetic cardiac valve or prosthetic material used for cardiac valve repair

Previous IE

Congenital heart disease (CHD)*

- Unrepaired cyanotic CHD, including palliative shunts and conduits
- Completely repaired congenital heart defect with prosthetic material or device, whether placed by surgery or by catheter intervention, during the first 6 months after the procedure†
- Repaired CHD with residual defects at the site or adjacent to the site of a prosthetic patch or prosthetic device (which inhibit endothelialization)

Cardiac transplantation recipients who develop cardiac valvulopathy

*Except for the conditions listed above, antibiotic prophylaxis is no longer recommended for any other form of CHD.

†Prophylaxis is reasonable because endothelialization of prosthetic material occurs within 6 months after the procedure.

Circulation 2007;116:1736

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Infective Endocarditis Prophylaxis

Antibiotic prophylaxis is no longer recommended for any other form of CHD, except for the conditions listed in Table 3.

Antibiotic prophylaxis is reasonable for all dental procedures that involve manipulation of gingival tissues or periapical region of teeth or perforation of oral mucosa only for patients with underlying cardiac conditions associated with the highest risk of adverse outcome from IE (Table 3).

Antibiotic prophylaxis is reasonable for procedures on respiratory tract or infected skin, skin structures, or musculoskeletal tissue only for patients with underlying cardiac conditions associated with the highest risk of adverse outcome from IE (Table 3).

Antibiotic prophylaxis solely to prevent IE is not recommended for GU or GI tract procedures.

Circulation 2007;116:1736

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Infective Endocarditis Prophylaxis

Table 5. Regimens for a Dental Procedure

		Regimen: Single Dose 30 to 60 min Before Procedure	
Situation	Agent	Adults	Children
Oral	Amoxicillin	2 g	50 mg/kg
Unable to take oral medication	Ampicillin	2 g IM or IV	50 mg/kg IM or IV
	OR		
	Cefazolin or ceftriaxone	1 g IM or IV	50 mg/kg IM or IV
Allergic to penicillins or ampicillin—oral	Cephalexin*†	2 g	50 mg/kg
	OR		
	Clindamycin	600 mg	20 mg/kg
	OR		
	Azithromycin or clarithromycin	500 mg	15 mg/kg
Allergic to penicillins or ampicillin and unable to take oral medication	Cefazolin or ceftriaxone†	1 g IM or IV	50 mg/kg IM or IV
	OR		
	Clindamycin	600 mg IM or IV	20 mg/kg IM or IV

Circulation 2007;116:1736

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Classification of CHD

Table 1. ACS-NSQIP Classification of Congenital HD Based on Residual Lesion Burden and Functional Status

Congenital HD classification	Definition and criteria
Minor	Cardiac condition with or without medication and maintenance (eg, atrial septal defect, small to moderate ventricular septal defect without symptoms) Repair of congenital HD with normal cardiovascular function and no medication
Major	Repair of congenital HD with residual hemodynamic abnormality with or without medications (eg, tetralogy of Fallot with free pulmonary regurgitation, hypoplastic left heart syndrome including stage 1 palliation)
Severe	Uncorrected cyanotic congenital HD Patients with documented pulmonary hypertension Patients with ventricular dysfunction requiring medication Listed for heart transplantation

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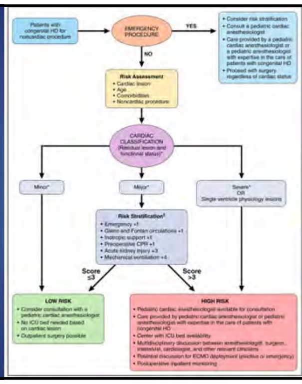

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Risk Stratification and Outcome

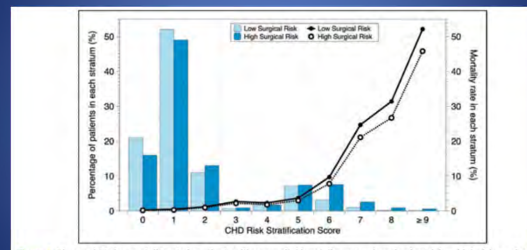

Figure 2. Observed 30-day mortality rate in patients with congenital heart disease undergoing low-risk vs high-risk surgical procedures.

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Approach to the Adult with CHD for Non-Cardiac Surgery

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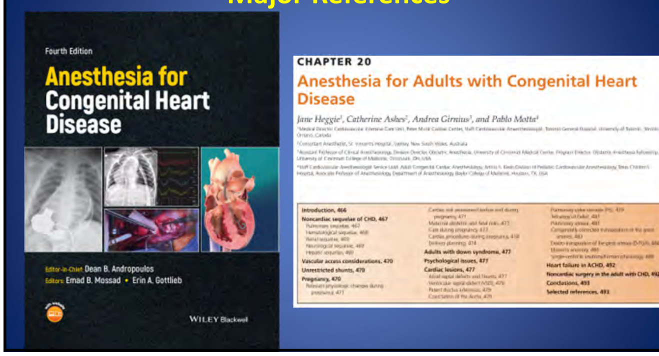
Major References



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Major References

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VOL. 73, NO. 12, 2019

CLINICAL PRACTICE GUIDELINE

2018 AHA/ACC Guideline for the Management of Adults With Congenital Heart Disease

A Report of the American College of Cardiology/American Heart Association Task Force on Clinical Practice Guidelines

Developed in Collaboration With the American Association for Thoracic Surgery, American Society of Echocardiography, Heart Rhythm Society, International Society for Adult Congenital Heart Disease, Society for Cardiovascular Angiography and Interventions, and Society of Thoracic Surgeons

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TABLE 11	ACHD Management Issues for Noncardiac Surgery
Clarify CHD diagnosis	
> Clarify prior procedures, residua, sequelae, and current status, including ACHD AP classification	
> Be aware that history obtained from only the patient and family may be faulty or incomplete	
> Obtain and review old records to ensure accurate understanding of past procedures and clinical course	
> Complete additional investigations required to define ACHD AP classification	
> Develop management strategies to minimize risk and optimize outcome	

J Am Coll Cardiol 2019;73:e81-e192

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Factors associated with increased risk of perioperative morbidity and mortality (S3.12-12):

- Cyanosis
- Congestive HF
- Poor general health
- Younger age
- Pulmonary hypertension
- Operations on the respiratory and nervous systems
- Complex CHD
- Urgent/emergency procedures

J Am Coll Cardiol 2019;73:e81-e192

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Issues to consider:

- Endocarditis prophylaxis
- Complications related to underlying hemodynamics
- Abnormal venous and/or arterial anatomy affecting venous and arterial access
- Persistent shunts
- Valvular disease
- Arrhythmias, including bradyarrhythmias
- Erythrocytosis
- Pulmonary vascular disease
- Meticulous line care (also consider air filters for intravenous lines) to reduce risk of paradoxic embolus in patients who are cyanotic because of right-to-left shunts
- Adjustment of anticoagulant volume in tubes for some blood work in cyanotic patients
- Prevention of venous thrombosis
- Monitoring of renal and liver function
- Periprocedure anticoagulation
- Possible need for nonconventional drug dosing
- Increased prevalence of hepatitis C infection because of prior procedures and remote blood transfusions
- Developmental disability

J Am Coll Cardiol 2019;73:e81-e192

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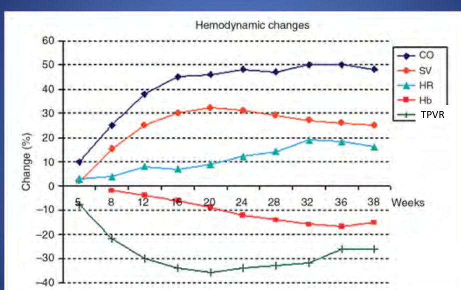
Pregnancy and CHD



ACHD4 p. 471

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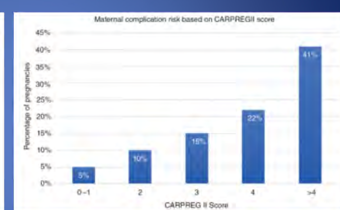
Pregnancy and CHD

Table 20.2 CARPREG II risk stratification index

PREDICTOR	SCORE
Prior cardiac events or arrhythmias	3
Baseline NYHA III-IV or cyanosis	3
Mechanical valve	3
Ventricular dysfunction	2
High-risk left-sided valve disease/left ventricular outflow tract obstruction	2
Pulmonary hypertension	2
Coronary artery disease	2
High-risk aortopathy	2
No prior cardiac intervention	1
Late pregnancy assessment	1



ACHD4 p. 472

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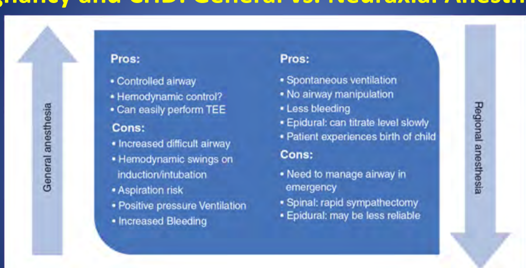
Pregnancy and CHD: General vs. Neuraxial Anesthesia



ACHD4 p. 475

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Pacemakers/Defibrillators and CHD

- Primary issue: electrocautery often interferes with/disables pacemaker sensing/pacing, or can be interpreted as arrythmia with defibrillators
- Crucial to understand underlying rhythm: is the patient pacemaker-dependent? (Life threatening bradycardia as underlying rhythm)
- Beat-to-beat BP monitoring essential: arterial line or well-functioning pulse oximeter; ECG and BP cuff alone insufficient
- Turn on pacemaker spike detection on OR ECG monitor
- Pacemaker/defibrillator pads for pacemaker dependent patients
- Consult cardiologist or industry representative whenever possible; often converting to asynchronous pacing and turning off defibrillator function is the approach

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Pacemakers/Defibrillators and CHD

Box 22.4: Perioperative management of patients with cardiac rhythm devices

Preoperative preparation
- Determination of the type of device and indication for pacing/ICD
- Assessment of underlying rhythm and pacemaker dependency
- Evaluation of device function (pacemaker check, ECG, CXR)
- Consideration of reprogramming to the asynchronous pacing mode
- Deactivation of rate-adaptive functions
- Disabling of anti-tachycardia function/defibrillation mode as appropriate

Intraoperative management
- Intraoperative monitoring (continuous ECG, monitoring of effective cardiac output; e.g., pulse oximetry, cuff blood pressure, arterial line)
- Availability of backup temporary pacing and cardioversion-defibrillation equipment
- Immediate availability of drugs (isoproterenol, emergency agents)
- Avoidance of electromagnetic interference (bipolar electrocautery preferable; place grounding pad so current passes far away from the pacemaker and leads)
- Availability of magnet (not to replace preoperative evaluation or to be used instead of reprogramming device)

Postoperative considerations
- Continuous ECG monitoring, pulse oximetry, cuff pressure, or arterial line
- Immediate availability at all times of backup pacing and cardioversion-defibrillation equipment
- Interrogation of the device, reprogramming as needed
- Reactivation of special modes (anti-tachycardia, defibrillation mode for ICDs, and others)

CXR chest radiograph, ECG electrocardiogram, ICD implantable

ACHD4 p. 554

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Case Study

- 42 y.o. female with history of tricuspid atresia
  - Atrial-pulmonary Fontan age 5 years
  - Fontan conversion to lateral tunnel (fenestrated) with Maze procedure at age 35
  - Pacemaker-defibrillator for sick sinus syndrome/atrial fibrillation
  - Medications: sotalol, amiodarone, low dose aspirin
- Presents for laparoscopic cholecystectomy
- What additional information do you need?
- General approach to anesthetic?

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Conclusions

- Prevalence of CHD, high survival, and frequent non-cardiac conditions contribute to growing numbers of CHD patients having non-cardiac surgery
- Careful preoperative evaluation and planning can help direct appropriate resources to CHD patients having non-cardiac surgery
- A relatively simple risk stratification tool can help plan for the resources needed to care for these often complicated patients

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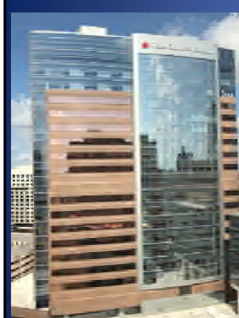
Thank You



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CRASH

Pulmonary Hypertension Case Presentations: Your Questions Answered

Monday 27th February 2023
4.00 – 6.00pm

Anesthesiology
University of Colorado Anschutz Medical Campus

Welcome!

Dean B. Andropoulos, MD, MHCM
Anesthesiologist-in-Chief,
Texas Children's Hospital
Chair, Texas Children's Department of Anesthesiology, Perioperative and Pain Medicine
Burdett S. Dunbar, M.D. Chair in Pediatric Anesthesiology
Professor, Anesthesiology and Pediatrics
Vice Chair for Clinical Affairs
Baylor College of Medicine Department of Anesthesiology

Joy Hawkins, MD
Professor of Anesthesiology
Director of Obstetric Anesthesia
University of Colorado School of Medicine

CRASH

Thin Air, Thick Vessels

Hypoxia, Pulmonary Hypertension, the Centennial State

&

A Case Report

Dr. Mark Twite, MA MB BChir FRCP
Professor for Anesthesiology
Director of Congenital Cardiac Anesthesiology
University of Colorado Anschutz Medical Campus &
Children's Hospital Colorado

Anesthesiology
University of Colorado Anschutz Medical Campus

Definition of Pulmonary Hypertension

- An elevation in mPAP, from any cause
- First classified as mPAP > 25mmHg (1st World Symposium on PH in 1973)
- New classification as mPAP > 20mmHg (6th World Symposium on PH in 2018)
  - Why the change?
    - Emerging evidence of poor survival in patients with mPAPs of 21 – 24 mmHg
    - Normal distribution of data in a healthy population

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Definition of Pulmonary Hypertension

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Hemodynamic Classification of PH

Definitions	Characteristics	Clinical groups#
Pre-capillary PH	mPAP > 20mmHg PAWP ≤ 15mmHg PVR ≥ 3 WU	1, 3, 4 and 5
Isolated post-capillary PH	mPAP > 20mmHg PAWP > 15mmHg PVR < 3WU	2 and 5
Combined pre- and post-capillary PH	mPAP > 20mmHg PAWP > 15mmHg PVR ≥ 3WU	2 and 5

Simonneau G et al. Eur Respir J. 2019;53

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Clinical Classification of PH

1. **PAH**
   - 1.1. Idiopathic PAH
   - 1.2. Heritable PAH
   - 1.3. Drug and toxin induced PAH (**table 3**)
   - 1.4. PAH associated with:
     - 1.4.1. Connective tissue disease
     - 1.4.2. HIV infection
     - 1.4.3. Portal hypertension
     - 1.4.4. Congenital heart disease
     - 1.4.5. Schistosomiasis
   - 1.5. PAH long-term responders to calcium channel blockers
   - 1.6. PAH with overt features of venous/capillaries (PVOD/PCH) involvement
   - 1.7. Persistent pulmonary hypertension of the newborn (PPHN)

Clinical Classification of PH

2. **PH due to left heart disease**
   - 2.1. PH due to heart failure with preserved LVEF
   - 2.2. PH due to heart failure with reduced LVEF
   - 2.3. Valvular heart disease
   - 2.4. Congenital/acquired cardiovascular conditions leading to post-capillary PH

3. **PH due to lung diseases and/or hypoxia**
   - 3.1. Obstructive lung disease
   - 3.2. Restrictive lung disease
   - 3.3. Other lung disease with mixed restrictive/obstructive pattern
   - 3.4. Hypoxia without lung disease
   - 3.5. Developmental lung disorders

Clinical Classification of PH

4. **PH due to pulmonary artery obstructions**
   - 4.1. Chronic thromboembolic PH
   - 4.2. Other pulmonary artery obstructions
     - 4.2.1. Sarcoma (high or intermediate grade) or angiosarcoma
     - 4.2.2. Other malignant tumors:
       - Renal carcinoma
       - Uterine carcinoma
       - Germ cell tumors of the testis
       - Other tumors
     - 4.2.3. Non-malignant tumors
       - Uterine leiomyoma
     - 4.2.4. Arteritis without connective tissue disease
     - 4.2.5. Congenital pulmonary artery stenosis
     - 4.2.6. Parasites
       - Hydatidosis

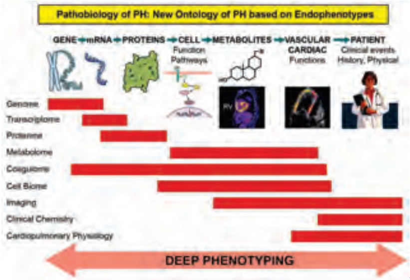
Clinical Classification of PH

5. **PH with unclear and/or multifactorial mechanisms**
   - 5.1. Hematologic disorders
     - Chronic hemolytic anemia
     - Myeloproliferative disorders
   - 5.2. Systemic disorders and metabolic disorders
     - Pulmonary Langerhans cell histiocytosis
     - Gaucher disease
     - Glycogen storage disease
     - Neurofibromatosis
     - Sarcoidosis
   - 5.3. Others
     - Chronic renal failure with or without hemodialysis
     - Fibrosing mediastinitis
   - 5.4. Complex congenital heart disease

Simonneau G et al. Eur Respir J. 2019;53

Genomic Classification of PH (PVDOMICS)

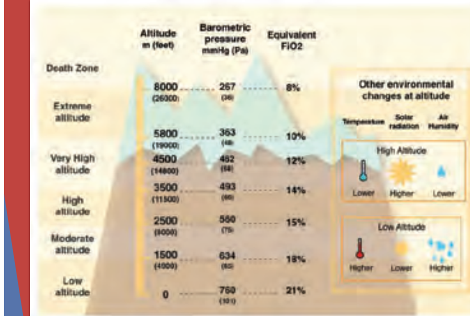
Redefining Pulmonary Hypertension through Pulmonary Vascular Disease Phenomics



Hemnes et al. PVDOMICS Study Group. Circ Res. 2017;121(10)

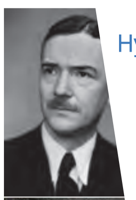
Cardiopulmonary Responses to Hypoxia

- Acute Maladaptation
  - Acute Mountain Sickness (unacclimatized person travelling above 8,000 Ft)
  - HAPE
  - HACE
- Chronic Changes
  - Hypoxia induced PH



Mt. Everest 29,000 Ft
Death zone 26,000 Ft
Mt. McKinley, AK 20,300 Ft
Mt. Elbert, CO 14,400 Ft
Leadville, CO 10,200 Ft
Vail, CO 8,000 – 11,500 Ft
Aircraft Cabin 8,000 Ft
Denver, CO 5,280 Ft
Houston, TX 50 Ft

Parati et al. Eur Heart J. 2018 May 1;39(17):1546-1554.

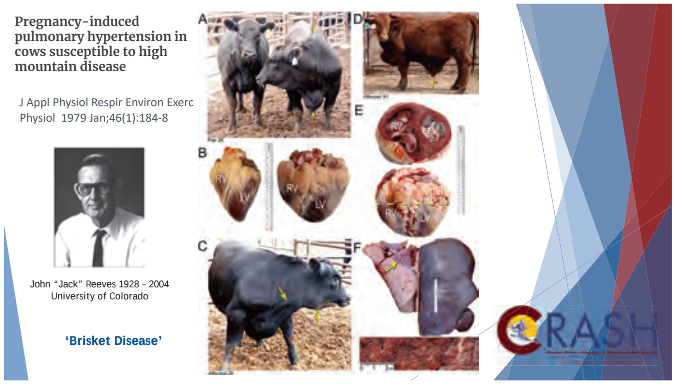



Hypoxic Pulmonary Vasoconstriction

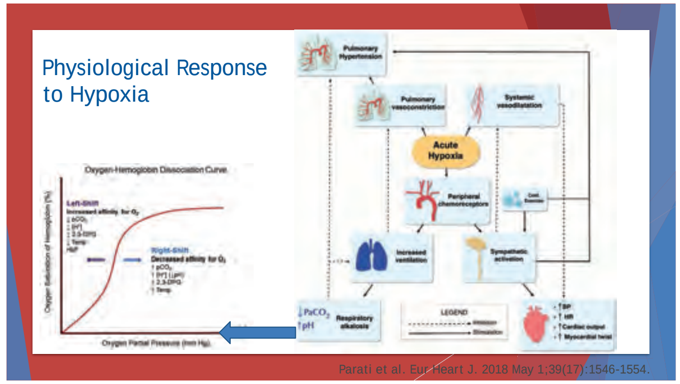
- Acute hypoxia causes pulmonary vasoconstriction
- Importance in V/Q matching
- Problematic if it occurs in the entire lung
  - HAPE (High Altitude Pulmonary Edema)

Von-Euler Liljestrand mechanism

Cattle Ranches in Colorado……..and Pulmonary Hypertension

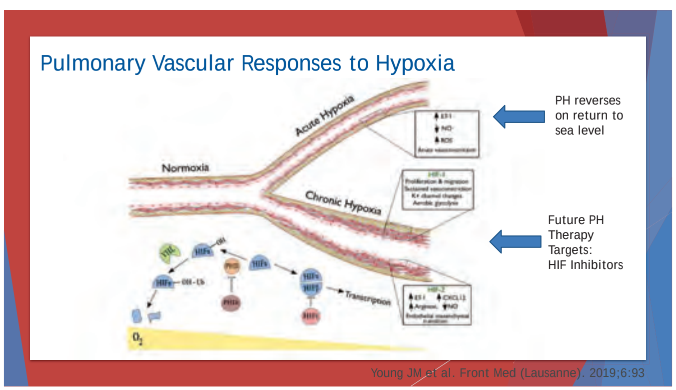


Pregnancy-induced pulmonary hypertension in cows susceptible to high mountain disease
J Appl Physiol Respir Environ Exerc Physiol 1979 Jan;46(1):184-8
John "Jack" Reeves 1928 - 2004
University of Colorado
'Brisket Disease'
A
B
C
D
E
F
RV
LV
CRASH

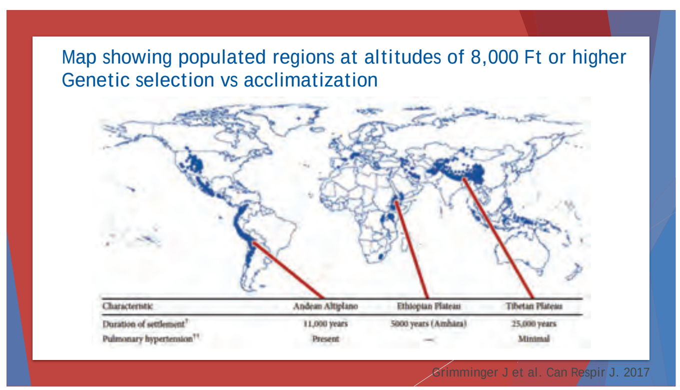


Physiological Response to Hypoxia
Oxygen-Hemoglobin Dissociation Curve
Left-Shift
Right-Shift
Oxygen Partial Pressure (mm Hg)
Pulmonary Hypertension
Pulmonary vasoconstriction
Systemic vasodilatation
Acute Hypoxia
Peripheral chemoreceptors
Increased ventilation
Sympathetic activation
Respiratory alkalosis
LEGEND
Parati et al. Eur Heart J. 2018 May 1;39(17):1546-1554.

Consequences of acute HPV
Reduced exercise capacity
Above 5,000 Ft a 10% decrease in VO_2 is observed for every additional 3,000 Ft of altitude gained
Sydykov et al. Int J Environ Res Public Health. 2021;18(4):1692.

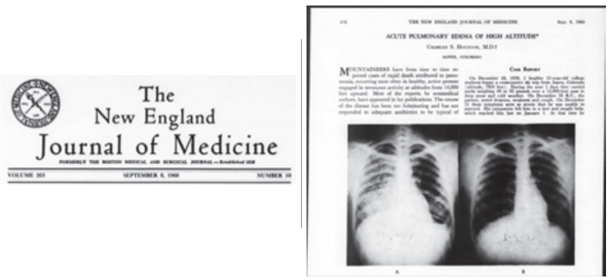


Pulmonary Vascular Responses to Hypoxia
Acute Hypoxia
Normoxia
Chronic Hypoxia
PH reverses on return to sea level
Future PH Therapy Targets:
HIF Inhibitors
Young JM et al. Front Med (Lausanne). 2019;6:93



Map showing populated regions at altitudes of 8,000 Ft or higher
Genetic selection vs acclimatization
Characteristic | Andean Altiplano | Ethiopian Plateau | Tibetan Plateau
Duration of settlement | 11,000 years | 5000 years (Amhara) | 25,000 years
Pulmonary hypertension | Present | — | Minimal
Grimminger J et al. Can Respir J. 2017

Dr. Charles Snead Houston 1913 - 2009
GOING HIGHER
Oxygen, Man, and Mountains



Case Report

- 15yr old male, 34kg, presents for surgical VSD closure Sept 2022
- Lived in the mountains of Guatemala (8,000 Ft) until 6 months ago
- Diagnosis made in Guatemala but surgery not available. Intermittent treatment with diuretics
- Relocated to Albuquerque, New Mexico (5,300 Ft)
- Initially seen by a cardiologist at an outside hospital
- Echocardiogram and cardiac catheterization performed

Echocardiogram September 2022

1. Dextrocardia, situs solitus, concordant atrioventricular connection and concordant ventriculoarterial connection.
2. Large inlet ventricular septal defect with unrestrictive (low-velocity), primarily left to right shunting. The inlet VSD measures 2.53 cm X 3.28 cm.
3. Moderately to severely dilated left atrium.
4. Moderate-to-severe mitral valve stenosis in the setting of a substantial shunt, mean gradient of 14 mmHg
5. The left ventricle is severely dilated with mildly diminished systolic function. Biplane LV EF 53.1 %.
6. Dysplastic pulmonary valve with mildly thickened leaflets and systolic doming. Mild pulmonary valve stenosis with moderate regurgitation.
7. The left pulmonary artery is normal. The right pulmonary artery is severely dilated.
8. The right ventricle is moderately dilated with normal systolic function.
9. Moderate tricuspid valve regurgitation on color flow Doppler.
10. Mild-to-moderate septal flattening in systole and diastole.

Cardiac Cath March 2022

Pressure Summary (mmHg)

Baseline

Time	Site	Sys	Dias	End	Mean	A Wave	V Wave	Max dp/dt	HR (BPM)
9:46 AM	LPCW				21	24	26		50
9:46 AM	LV	72		12				720	80
9:47 AM	AO	70	44		53				81
9:47 AM	ASAO	69	41		50				80
9:47 AM	DSAO	69	41		[illegible]				80
9:48 AM	LPA	79	24		45				70
9:48 AM	PA	73	20		44				70
9:50 AM	RV	76		11				672	80
10:06 AM	RPA	87	33		54				85

Cardiac Cath March 2022

Cardiac Output Results-M

Phase	Manual C.O. (l per min)	Manual C.I. (l per min per m²)	Qp/Qs	TDCI (l per min per m²)	Fick C.O. (l per min)	Fick C.I. (l per min per m²)	Fick HR (BPM)
Baseline			2.6/1.0		3.63	3.1	

Resistance Results (Wood Units)

Phase	PVR (WU)	SVR (WU)	PVRI (WU*m²)	SVRI (WU*m²)	TPR (WU)	TVR (WU)	TPRI (WU*m²)	TVRI (WU*m²)	PVR/SVR	TPR/TVR
Baseline	1.81		2.13		4.2	14.59	4.93	17.12		0.29

Valve Results-M

Baseline

Valve	Mean Gradient (mmHg)	Flow (ml per s)	Area (cm²)	Area Index (cm² per m²)	Sep per Dip (sec per min)	HR (BPM)
Mitral	13.49	113.67	0.82	0.7	31.37	82

What PH is this?

Increased mPAP 45 – 55 mmHg

PCWP 21 mmHg

Mean Mitral Valve Gradient 13.5 mmHg

Qp/Qs 3:1

PVRI 2 Wum^2

There are lies, damn lies and cath data…..

Adapted from Mark Twain

Guidance for assessing operability in pulmonary arterial hypertension associated with congenital heart disease

PVRI Wood units m^2	PVR Wood units	Correctability / favorable long-term outcome
< 4	< 2.3	Yes
> 8	> 4.6	No
4 - 8	2.3 – 4.6	Individual patient evaluation in tertiary center

Surgery 9/22/22

Preop diagnosis: Ventricular septal defect, pulmonary hypertension, mitral valve stenosis possible mitral valve supravalvar ring, dextrocardia situs solitus

Procedure: Mitral valve repair with resection of supra mitral valve ring, VSD repair Gore-Tex patch from right ventriculotomy

Indication: This patient is a 15-year-old male who has had a large ventricular septal defect with dextrocardia, situs solitus, bilateral SVC no bridging vein. Patient has evidence of elevated right heart pressures, but the VSD is completely unrestrictive. Pulmonary vascular resistance on a previous catheterization was calculated as normal. Patient has oxygen saturations that are 98% on room air. Patient has an echocardiogram that reveals systolic and diastolic left to right flow through the VSD. Inexplicably this patient does not have fixed pulmonary hypertension despite having a huge VSD. Patient also has evidence of mitral stenosis with a gradient of 15mmHg across the mitral valve in the face of a large left-to-right shunt. Patient likely has a supra mitral valve ring with some parachute subvalvular apparatus abnormality.

Post-op

Poor LV Function

Extubated following day

RA Clot noted

Echocardiogram 9/28/22

1. There is an organized thrombus with well defined borders that is adhered inside the right atrial appendage.

2. Mild tricuspid valve regurgitation on color flow Doppler. TR Vmax = 3.7 m/s; peak gradient = 56 mmHg.

3. S/P supravalvar mitral ring resection and mitral valve leaflet commissurotomy. Normal antegrade mitral valve flow. Mild mitral valve regurgitation.

4. The left ventricle is moderately to severely dilated with normal wall thickness and mildly to moderately diminished systolic function. Biplane LV EF = 40.1 %. Compared to the previous study on 9/26/22, the left ventricle systolic function appears much improved, was moderate-severely diminished with an EF% of 30.2%.

5. The right ventricle is mildly dilated with moderate hypertrophy and normal systolic function.

6. There is no residual ventricular level shunting from the views obtained.

Discharged 10/4/22

Apixaban

Furosemide

Spironolactone

Lisinopril

Metoprolol

Represents 1/25/23

‘He is currently critically ill with ventricular dysfunction with fluid overload in the setting of difficulties obtaining his baseline cardiac medications. Additionally, there is concern for VSD patch dehiscence which would explain his heart failure that has been exacerbated by medication non-adherence. He is currently requiring respiratory support with low-flow nasal cannula’.

Echocardiogram 1/26/23

1. Status post patch closure of inlet VSD. There is dehiscence of the basal aspect of the VSD patch with a likely small-to-moderate shunt that is predominantly left-to-right.

2. Mild to moderate tricuspid valve regurgitation on color flow Doppler. TR Vmax = 4.9 m/s; peak gradient = 95 mmHg.

3. The left ventricle is moderately to severely dilated with normal wall thickness and severely diminished systolic function. Biplane LV EF = 27.9 %.

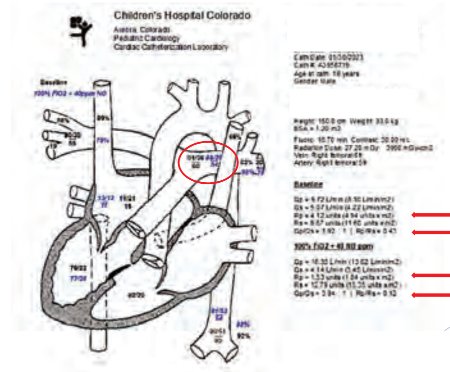
4. The previous right atrial appendage thrombus is no longer visualized.

5. Moderate mitral stenosis. Mean gradient = 8.7 mmHg at a heart rate of 110bpm.

6. Moderately to severely dilated left atrium.

7. There is echocardiographic evidence of pulmonary hypertension.

8. The right ventricle is mildly dilated with moderate hypertrophy and normal systolic function.



Surgery 2/2/23

Indication: This patient is a 16-year-old male with a history of an untreated ventricular septal defect and mitral valve stenosis with a supra mitral valve ring. Earlier this year the patient underwent repair of the ventricular septal defect and resection of the supra mitral valve ring. Patient had significant pulmonary pulmonary hypertension and decreased left ventricular function at the time of that surgery. Patient has subsequently returned with recurrent ventricular septal defect with dehiscence of the patch and mild mitral stenosis and mild insufficiency. Patient has severe left ventricular dysfunction and pulmonary hypertension. Patient presents now for repair of recurrent VSD and possible mitral valve repair. Patient is extremely high risk.

Findings: Patient was found to have significant vegetation on t he VSD patch with dehiscence in the inlet portion of the VSD. Cultures were sent of the vegetation material and the patch. There was mild mitral valve insufficiency arising from the commissure. There was severe adhesions within the mediastinum there is dextrocardia with significant severe pulmonary hypertension and decreased left ventricular function.

Echocardiogram 2/9/23

1. The left ventricle is moderately to severely dilated with normal wall thickness and severely diminished systolic function. Biplane LV EF = 27.6 %.

2. The right ventricle is mildly dilated with moderate hypertrophy and low normal systolic function.

3. Moderate tricuspid valve regurgitation on color flow Doppler. TR Vmax = 3.8 m/s; peak gradient = 56 mmHg.

4. S/P supravalvar mitral ring resection and mitral valve leaflet commissurotomy. Status post mitral valve stitch annuloplasty Mild mitral stenosis. Mean gradient = 3.9 mmHg. Moderate mitral valve regurgitation.

5. Status post revision of VSD patch. previously noted tiny residual membranous ventricular septal defect not visualized.

Post-op

Extubated following day, milrinone, low dose epinephrine

Infective endocarditis: Dehisced VSD patch coag negative staph (Staph Warneri)

Currently continues with milrinone, mexilitene (PJRT), aldactone, furosemide, magnesium and potassium supplements, cefazolin

Heart Failure Treatment: Entresto (Sacubitril/Valsartan)
Sacubitril – neprilysin inhibitor
Valsartan – angiotensin receptor blocker

Remains an inpatient on nasal canula O_2 and AVAPS at night

Pulmonary Hypertension Case Presentations: Your Questions Answered

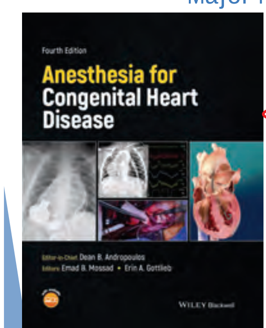
Dean B. Andropoulos, M.D., M.H.C.M.
Anesthesiologist-in-Chief and Chair, Texas Children's Hospital Department of Anesthesiology, Perioperative and Pain Medicine
Professor and Vice Chair, Baylor College of Medicine Department of Anesthesiology

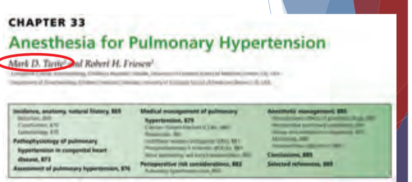
CRASH 2023
February 27, 2023

Disclosures

- None

Major Reference





CHAPTER 33
Anesthesia for Pulmonary Hypertension
Mark D. Twite and Robert H. Friesen

Case Presentation

- 9-year-old female with pulmonary hypertension (PH) due to bone morphogenetic protein receptor type 2 mutation (BMPR-2)
- Presents for emergency laparoscopic appendectomy
  - RLQ pain/tenderness, fever, nausea, positive ultrasound
- Receiving triple-drug therapy for PH: epoprostenol (Flolan) IV, bosentan, sildenafil
- Tires easily with minimal exertion
- PH Center is 500 miles away

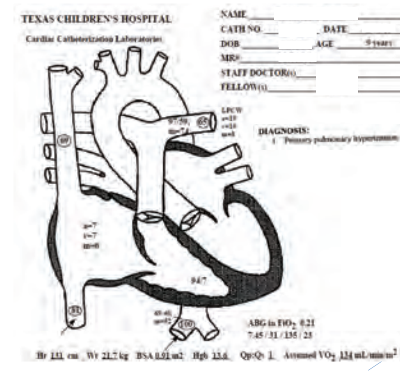
Case Presentation (cont'd)

- Surgeon says case is emergent, no time for transfer to PH center
- What are your considerations?
  - Additional preoperative testing
  - Intraoperative approach to monitoring, medications, emergency preparations, pain control
  - Postoperative admission/monitoring

Photo with parent/patient permission

Patient Data

- Echo: Mild TR 5.7-6 m/sec, mod/severe RVD/RVH, mildly depressed RV function, MPI 0.59; compressed LV with EF 63%



Catheterization Data

	FiO_2 0.21	FiO_2 0.92 + iNO 40 PPM	FiO_2 0.92 + iNO 40 PPM + iloprost
RAP mm Hg	6	9	11
PAP mm Hg	97/59 (74)	90/52 (67)	90/52 (67)
PA Sat %	65	79	78
PCWP mm Hg	8	10	10
FA pressure mm Hg	69/40 (52)	78/44 (57)	70/40 (51)
FA Sat %	100	100	100
CI L/min/m²	2.2	2.2	2.5
PVRI (WoodU/m²)	30	25.9	22.8
SVRI(WoodU/m²)	20.9	21.8	16
Rp:Rs	1.44	1.19	1.43

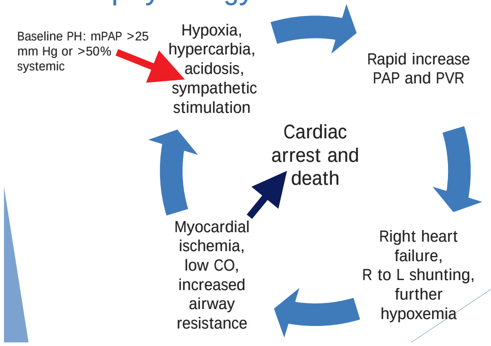
Pediatric PH and Perioperative Risk

- Children with PH have a 30-400 times greater risk of cardiac arrest under anesthesia for non-cardiac surgery and cardiac catheterization, compared to children without PH/heart disease
- Children with PH have a 20-350 times greater risk of death under anesthesia for non-cardiac surgery and cardiac catheterization, compared to children without PH/heart disease
- Risk increases with severity of PH
- Suprasystemic PH confers the greatest risk

PH Pathophysiologic Classification for the Anesthesiologist

- Degree of PH:
  - 50-75% systemic
  - 75-100% systemic
  - Suprasystemic
- Reactivity to oxygen and iNO, other pulmonary vasodilators
- Symptomatology
- Medications: prostaglandins, PDE5 inhibitors, endothelin antagonists, anticoagulation

Pathophysiology of a PH Crisis



Prevention of PH Crises During/After Anesthesia

- Choose anesthetic that does not increase PVR, or lower SVR excessively
- Exception: PV obstruction—lowering PVR may worsen
- Monitoring: invasive arterial/central venous/PAP for high risk non-cardiac cases; echo—transthoracic or TEE
- Frequent ABG
- Prophylactic iNO for high risk cases
- ICU care and medical consultation postoperatively
  - Excellent multidisciplinary communication

PH Crises During Anesthesia

- Mild
  - PAP 50-75% systemic with no hemodynamic compromise, baseline SpO_2
  - Perhaps not a "crisis"
- Moderate
  - PAP 75-100% systemic
  - Compromised RV function
  - Decreased SpO_2 <10%, and systemic BP not >20%
- Severe
  - Suprasystemic PAP
  - Significant arterial desaturation >10%
  - >20% decrease systemic BP
  - Myocardial ischemia
  - Increased airway resistance

PH Crisis Diagnosis Under Anesthesia

- Direct PAP monitoring
  - Used infrequently; can measure easily with open chest
  - Reserve for high-risk cases; not available for non-cardiac surgery
  - May use with SvO_2
- Echocardiography
  - Transesophageal, epicardial, transthoracic
- TR jet velocity consistent with RVP>50% systemic
- Flattening/paradoxical motion of interventricular septum
- Depressed RV function
  - Preserved with lesser PH crisis, or with significant inotropic support

Treatment of PH Crisis During Anesthesia

- Hyperoxygenation and hyperventilation
  - Both acutely decrease PAP/PVR
- Increase depth of anesthesia
  - Lower PVR without effecting SVR
  - Synthetic opioids, i.e. fentanyl 10-25 mcg/kg are most effective
- Increase pH with IV sodium bicarbonate
- Provide adequate RV preload

Treatment of PH Crisis During Anesthesia

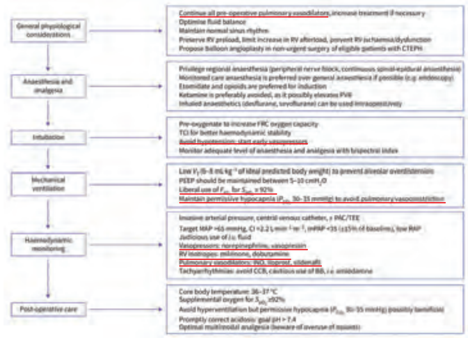
- Inotropic support:
  - Milrinone infusion with loading dose if tolerated
  - Epinephrine bolus or infusion
  - Vasopressin to maintain SVR
- iNO 20 PPM
- CPR
- ECMO
  - E-CPR: rapid institution if no response to standard CPR

Freisen et al Ped Anesth 2008;18:208
Galante Curr Opin Anesthesiol 2009;22:378
Adatia et al Cardiol Young 2009;19(E-supplement-1):23

Anesthetic Agents and PH

- No single agent is ideal
  - Combinations/balanced technique
  - Hemodynamic goals more important than individual agents
- Opioids
- Anesthetic gases
- Ketamine
- Etomidate
- Propofol
- Dexmedetomidine

Adult PH: Anesthetic Approach



Eur Respir Rev 2021;30:210166

Our Case: Anesthetic Considerations

- Short painful procedure; not cooperative
- No ASD
- Minimal reactivity to pulmonary vasodilators
- Requires immobility, maintained airway with normal/low $PaCO_2$, high SaO_2
- Avoid catecholamine surge with port placement
- Rapid awakening without respiratory depression
- Resuscitation drugs and iNO in OR
- Continue all PO PH medications; DO NOT STOP IV PH medications!

Anesthetic Course

- Preoxygenation FiO_2 1.0
- Etomidate induction 0.3 mg/kg IV
- Sevoflurane 2-3% end-tidal
- Remifentanil 0.2-0.25 mcg/kg/min
- Muscle relaxation with rocuronium
- Laryngotracheal anesthesia 30 mg lidocaine
- ET intubation
- Ropivacaine 0.2% 4 cc to sites by surgeon
- Stable throughout; trachea extubated awake
- 60 minute anesthetic

CRASH

Questions and Comments?

CRASH

THANK YOU

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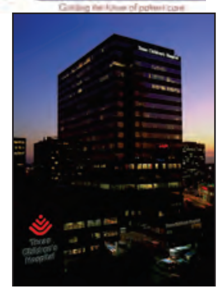


PULMONARY HYPERTENSION IN PREGNANCY: CASE PRESENTATION

Joy L. Hawkins, MD

*** I have no conflicts to disclose.***

GOALS & OBJECTIVES

1. **Discuss the diagnosis, management, and outcomes of pulmonary hypertension (PH) during pregnancy.**
2. **Review the physiologic effects of obstetric medications and techniques on PH.**
3. **Develop a safe delivery plan for vaginal or cesarean delivery.**

CASE SCENARIO

- J.C. was a 36-year old G2P1 at 25+ weeks gestation who had been followed for 3 years in our Pulmonary Hypertension clinic for severe primary pulmonary hypertension (PPH). Her pregnancy was diagnosed at ~ 20 weeks, and although unplanned was much desired. Termination was discussed but refused. The fetus was growing normally at that point.

CASE SCENARIO

- Following her initial diagnosis 3 years ago, she had been stabilized on a regimen of Coumadin, Lasix, oxygen by nasal cannula, and a continuous prostacyclin infusion via port and central line. Because she responded so well, she had been removed from the active pulmonary transplant list. When her pregnancy was diagnosed, Coumadin was changed to heparin due to teratogenic concerns.

CASE SCENARIO

- The Anesthesiology service was initially consulted when a central line infection required removal and replacement, along with vancomycin therapy. Her obstetric history was additionally complicated by:
  - Prior cesarean delivery for dystocia 14 years ago.
  - Morbid obesity with BMI 45, 260 lbs.
  - New diagnosis of fetal hypoplastic left heart.
  - Breech fetus at 25 weeks; receiving betamethasone.

CASE SCENARIO

- Issues at our multi-disciplinary care conference:
  - Thrombocytopenia of 67K platelets, presumably due to heparin (HIT), so LMWH was substituted.
  - Teratogenicity concerns: Coumadin, Bosentan
  - Tocolytic agents: because of their side effects, no attempt would be made to treat PTL if it occurred.
  - Oxytocic choices were also limited because of their physiologic side effects.

SIDE EFFECTS OF OBSTETRIC MEDICATIONS

- L&D meds that ↑ pulmonary vascular resistance:
  - Prostaglandin F-2 alpha (Hemabate)
  - Methylergonovine (Methergine)
  - Parenteral narcotics (hypoventilation and ↑ CO_2)
  - Butorphanol (Stadol)
  - Nitrous oxide for labor analgesia or GETA

SIDE EFFECTS OF OBSTETRIC MEDICATIONS

- L&D meds that ↓ systemic vascular resistance:
  - Neuraxial local anesthetics
  - Parenteral IV morphine
  - Calcium channel blocking agents
  - Beta-agonist tocolytics (e.g. terbutaline)
  - Magnesium sulfate when given as a bolus
  - Oxytocin as a bolus or in high concentrations

CASE SCENARIO

- This was our anesthesia problem list:
  - Severe pulmonary HTN with PAS 70-90 mmHg and severely dilated right ventricle
  - Anti-coagulation with LMWH after thrombocytopenia with heparin
  - Morbid obesity
  - High probability of repeat cesarean if induced
  - Fetal hypoplastic left heart syndrome

PULMONARY HTN DURING PREGNANCY

- A diagnosis of exclusion, e.g. mitral stenosis, lupus, pulmonary embolism, peripartum cardiomyopathy
- Primary PH is typically women 20-30 years old
- Estimated incidence of 1-2 per million
- Mortality 30-50% during pregnancy & postpartum; possibly improved with new therapies
- NYHA functional class III or IV has ↑ mortality
- Most deaths occur within 1 month postpartum

PULMONARY HTN DURING PREGNANCY - DIAGNOSIS

- Signs & symptoms: fatigue, dyspnea on exertion, palpitations, pre-syncope or syncope, chest pain
- These are subtle and usually missed, as they are common during pregnancy in general
- ECHO: RA and RV enlargement, ↓ RV function, paradoxical movement of the intra-ventricular septum, TR can be used to estimate PA systolic
- The diagnostic standard is a right heart cath

PULMONARY HTN DURING PREGNANCY - PHYSIOLOGY

- ↑ blood volume and cardiac output during 2^{nd} and 3^{rd} trimester may ↑ PA pressures further, increasing afterload on the RV → PH crisis; usually 20-28 weeks gestation
- Hypercoagulability during pregnancy and postpartum may ↑ the tendency for thrombus formation in the lungs, thus a need for anti-coagulation
- Pregnancy is contraindicated due to high maternal and fetal mortality. But then so is hormonal contraception – thus pregnancies occur.

CASE SCENARIO

- Our patient understood her risks but would not end the pregnancy. Her stated goal was to see her daughter's 1st birthday.
- The primary objective of her medical management was to achieve low-risk clinical status: lower PVR and improve right heart function as much as possible, optimizing RV systolic function at the least degree of TR.

PULMONARY HTN DURING PREGNANCY – MEDICAL MGT

- Continuous oxygen therapy for O_2 sat $\geq$ 95%
- Anti-coagulation with LMWH; heparin at term
- Diuretics as needed based on symptoms and CVP
- Oral vasodilators: sildenafil (Viagra, Revatio) or tadalafil (Cialis), calcium channel blockers
- Epoprostenol / Flolan by continuous infusion as a vasodilator and platelet inhibitor
- Nitric oxide for acute exacerbations intrapartum

VAGINAL VS. CESAREAN DELIVERY

Effects	Vaginal Delivery	Cesarean Delivery
Advantages	Less blood loss	Able to time the delivery and have consultants available
	Avoids surgical stress	Avoids the need for emergency cesarean – highest morbidity/mortality
	Better hemodynamic stability	
	Early ambulation	
Disadvantages	Labor can be prolonged and unpredictable	Involves a major abdominal surgery and anesthetic
		↑ risk of hemorrhage
		↑ risk of postoperative infection
		↑ postop pulmonary cx

DELIVERY PLANNING

- Thus, mode of delivery should be based on obstetric indications
- Monitors: arterial line and PA catheter placed in the cath lab under fluoro due to ↑ PAS and dilated RV *versus* avoid PA cath 2º arrhythmias, thrombus, PA rupture?? TEE is not an option in labor
- Analgesia for labor: continuous spinal opioid infusion (i.e. wet tap → 5 mcg sufentanil / hour) pending coagulation status (LMWH, platelets)
- Planned assisted vaginal delivery to avoid Valsalva

DELIVERY PLANNING

- Anesthesia for cesarean delivery: slow titration of continuous spinal or epidural using bupivacaine, *versus* GETA with a rapid sequence induction (etomidate, opioids) after aspiration prophylaxis
- Location: main OR versus L&D operating rooms using resources and personnel brought there?
- Nitric oxide would be on standby
- Recovery in the MICU with the Pulmonary Critical Care service

ODDS & ENDS FROM CASE REPORTS

- Epidural lidocaine + aerosolized prostacyclin for C/S
- Choose epidural ropivacaine for its slow onset during titration and ↓ cardiotoxicity
- Have a variety of pulmonary vasodilators for GETA
- TEE is more useful than a PA catheter during GA to diagnosis decompensation due to hypovolemia
- ECMO can be instituted prior to C/S if acute decompensation occurs, but there is a high rate of complications in pregnancy

ODDS & ENDS FROM CASE REPORTS

- Case series have shown no difference in outcomes with C/S versus vaginal delivery or neuraxial anesthesia versus general.
- NTG boluses are sometimes used for uterine relaxation during labor and delivery; patients taking sildenafil (or similar drugs) can experience profound hypotension – avoid!
- In a recent series of cardiac surgery patients, the highest risk factor for pre-incision cardiac arrest was severe pulmonary hypertension (OR 3.40).

CASE SCENARIO

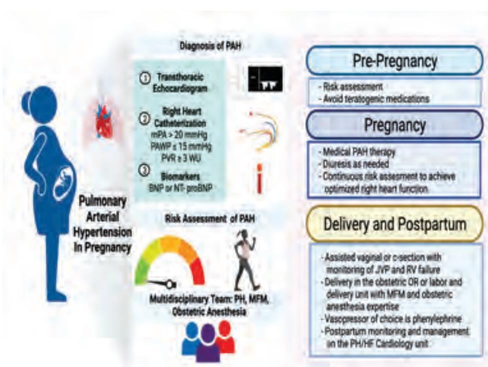
- At 36 weeks there was no interval fetal growth and the biophysical profile was only 4/10, necessitating delivery.
- Breech presentation and non-reassuring fetal monitoring required cesarean delivery.
- We chose to use the L&D OR with MICU / PH attendings present for consultation. Cardiac surgery was aware and available for possible ECMO. An OB anesthesia attending and a Cardiac attending co-managed the case.
- A PA catheter was placed in the cardiac cath lab prior to transport to the O.R. A pre-induction arterial line was inserted. General anesthesia was induced uneventfully with an easy intubation. TEE was placed and positioned.

CASE SCENARIO

- Hemodynamic goals: maintain preload & afterload but avoid volume overload, tachycardia or ↑ cardiac output that would ↑ pulmonary blood flow.
- Just after delivery her PA pressures rose to 120 mmHg and her systemic pressure fell to the 90s, but both responded to dobutamine, phenylephrine and NTG.
- Nitric oxide was available in the room with respiratory therapy present, but was not used.
- She was extubated in the OR and taken to the MICU with stable hemodynamics.

CASE SCENARIO

- At two months of age the infant received a successful heart transplant.
- Six months after delivery the patient was stable in her baseline condition.
- Shortly after her daughter's 1st birthday, her husband found her dead at home of a sudden cardiac event.



CONCLUSIONS THAT HAVEN'T CHANGED IN OVER A DECADE

"Primary pulmonary hypertension is associated with a poor survival and a poor quality of life. At present there is no cure, understanding of the disease is incomplete, and treatment options are limited…As maternal mortality is 30-50%, pregnancy is best avoided and some advocate termination…The optimum mode of delivery is unclear." *Int J Obstet Gynecol **2009**;18:156*

REFERENCES

- J Cardiovasc Dev Dis 2022; 9: 195

Management of pulmonary arterial hypertension in pregnancy: experience from a nationally accredited center

- N Engl J Med 2021; 384: 61

Breathing for two

Tuesday, February 28th

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

WHAT'S NEW IN OBSTETRIC ANESTHESIA FROM 2022?

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

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

Anesthesiology
UNIVERSITY OF COLORADO
ANSCHUTZ MEDICAL CAMPUS

CRASH

Colorado Review of Anesthesia for Surgicenters And Hospitals

Guiding the future of patient care

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.

Anesthesiology
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GUIDELINES, POLICIES & PROCEDURES

"It's a baby. Federal regulations prohibit our mentioning its race, age, or gender."

STATEMENT ON ORAL INTAKE IN LABOR

ASA Committee on Obstetric Anesthesia (approved 10/22) found at www.asahq.org / Guidelines

- Gastric emptying in labor is delayed as much as 90%; worse with opioids or no analgesia, improved with neuraxial.
- Lower esophageal sphincter pressure is reduced as early as 1st trimester; 50% have GERD by 3rd trimester.
- Most GETA is emergent; difficult intubation is more common in pregnancy and increases aspiration risk.

ORAL INTAKE (cont)

- No benefits have been shown to solid food intake over drinking clear liquids, although maternal satisfaction may ↓.
- Both ASA and ACOG guidelines state consumption of solid food in active labor should be avoided.
- However strict NPO policies can cause patient distress.
- Conclusions: 1) Offer clear liquids during labor 2) High risk patients or labors may require further restrictions on intake 3) No conclusions can be made on pre-labor intake, i.e. IOL 4) Do not deny neuraxial regardless of NPO status.

STATEMENT ON QUALITY METRICS

ASA Committee on Obstetric Anesthesia (approved 10/22)

The Institute of Medicine has outlined 6 domains of quality, and these were used to develop relevant and quantifiable quality metrics for obstetric anesthesia care.

1. Mode of anesthesia for CD: avoid GA when possible
2. Neuraxial-induced hypotension during CD: monitor, prevent with pressors, and treat when below baseline
3. Post-cesarean opioid use: ↓ with multi-modal therapies

QUALITY METRICS (cont)

4. Responsiveness to the request for labor analgesia: avoid delays (defined by the institution) or failure to provide.
5. Post dural puncture headache: monitor rates, response time for evaluation, and treatments.
6. Labor epidural replacements: time to adequate analgesia, regular assessments, and replacements.

www.asahq.org

STATEMENT ON ANESTHESIOLOGISTS' ROLE IN REDUCING MATERNAL M&M

- Should be an active member of each state's MMRC.
- Should be an active member of institutional-, regional-, state-level Obstetric Quality Committees and provide reviews of in-hospital cases involving acute care.
- Antenatal consultations should be sought on high-risk patients.
- Should lead in implementation of the elements in ACOG's Levels of Maternal Care related to anesthesiology practice.
- Simulations should include teaching and planning by anesthesiologists and should include all anesthesia providers.

ASAhq.org / ASA Committee on Obstetric Anesthesia

The ACOG Levels of Maternal Care: The Anesthesiologist's Role in Reducing Maternal Mortality

ASA Monitor, July 2022, pp 34-5

Levels of Maternal Care

Level 1

- Anesthesiologist, nurse anesthetist, or anesthesiologist assistant with anesthesiologist readily available at all times

Level 2

- Anesthesiologist readily available at all times

Level 3

- Board-certified or board-eligible anesthesiologist physically present at all times
- Director of obstetric anesthesia is board-certified anesthesiologist with obstetric anesthesia fellowship training or obstetric anesthesia experience

Level 4

- Board-certified anesthesiologist with obstetric anesthesia fellowship training or obstetric anesthesia experience physically present at all times
- Same criteria as Level 3 for director of obstetric anesthesia

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) and also well-controlled HTN, PEC without severe features, gestational diabetes
- ASA III: preeclampsia <u>with</u> severe features, DM requiring insulin, thrombophilia requiring anti-coagulation
- ASA IV: HELLP syndrome, cardiomyopathy with ↓ EF

Anesthesiology 2021; 135: 904-19

MATERNAL MORTALITY

New CDC data from 2017-9 in 36 states with MMRCs found:

- > 80% of maternal deaths were preventable; > 90% in American Indian and Alaska Native women.
- 25% were due to suicide or overdose, the largest cause.
- Over half occurred after 1st postpartum week when patients have been discharged and are home.
- Black women died most often of cardiac causes, white and Hispanic of mental health conditions, Asian of hemorrhage

Trost SL, CDCP and HHS, 2022

MATERNAL MORTALITY

A review of 237 maternal deaths due to suicide or drug overdose in Michigan from 2008-2018:

- 71% had a documented psychiatric illness; 48% had $\geq$ 2 dx, but only 34.5% had documentation of taking medication for their mental illness.
- Of those who died of drug overdose 71% had a known history of substance use disorder, but only 27.4% of those received medication-assisted treatment.
- Conclusions: few who died received proper treatment- why?

Am J Obstet Gynecol MFM 2023;5:100811

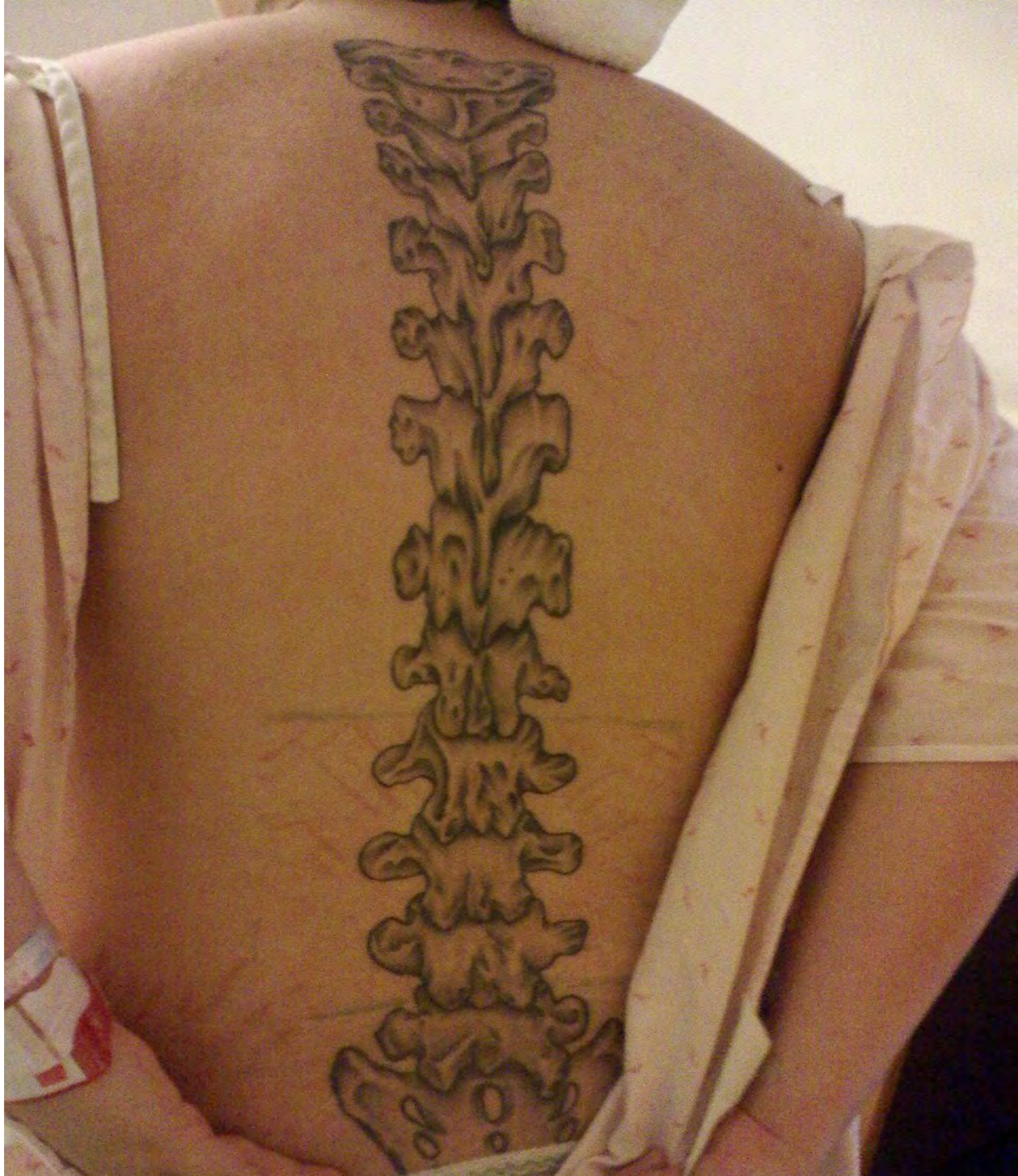
MATERNAL MORTALITY IN THE UK

Results from the UK and Ireland Confidential Enquiries into Maternal Deaths and Morbidity 2017-19 (a triennial publication):

- Cardiac disease is the largest cause of ***indirect*** maternal death; neurologic causes (epilepsy and stroke) were 2nd.
- Indirect = pre-existing but made worse by pregnancy; Direct=caused by the pregnancy itself.
- Thromboembolism is the largest ***direct*** cause up to 6 weeks postpartum; hemorrhage and sepsis the next most common.
- Suicide is the leading cause of direct deaths occurring within a year after pregnancy.

MBRRACE-UK Saving Lives, Improving Mothers' Care 2021

LABOR ANALGESIA



NOCEBO EFFECT

Nocebo = using negative words that predispose patients to expect adverse events. Consider positive alternatives.

Anaesthesia 2022;77: 1113 and 11 (suppl.)

Nocebo terms	Alternative wording
Here comes a big bee sting.	This medicine will make you numb and comfortable for the block.
This is the worst part.	Most people find this is easier than they thought.
Let me know if you feel pain or nausea.	If you need anything at all I'm right here, just let me know.

VIRTUAL REALITY

Is immersive virtual reality effective as a distractive tool on patient satisfaction and pain relief? Does it benefit patients with pre-existing anxiety and depression?

- Used an Oculus Quest All-in-one VR Gaming Headset and patient selected the environment they preferred.
- Satisfaction was high (88/100) and 95% would use again.
- VR improved pain scores in early labor.
- Anxiety and depression scores were similar to control.

BMC Pregnancy and Childbirth 2022;22:354

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.

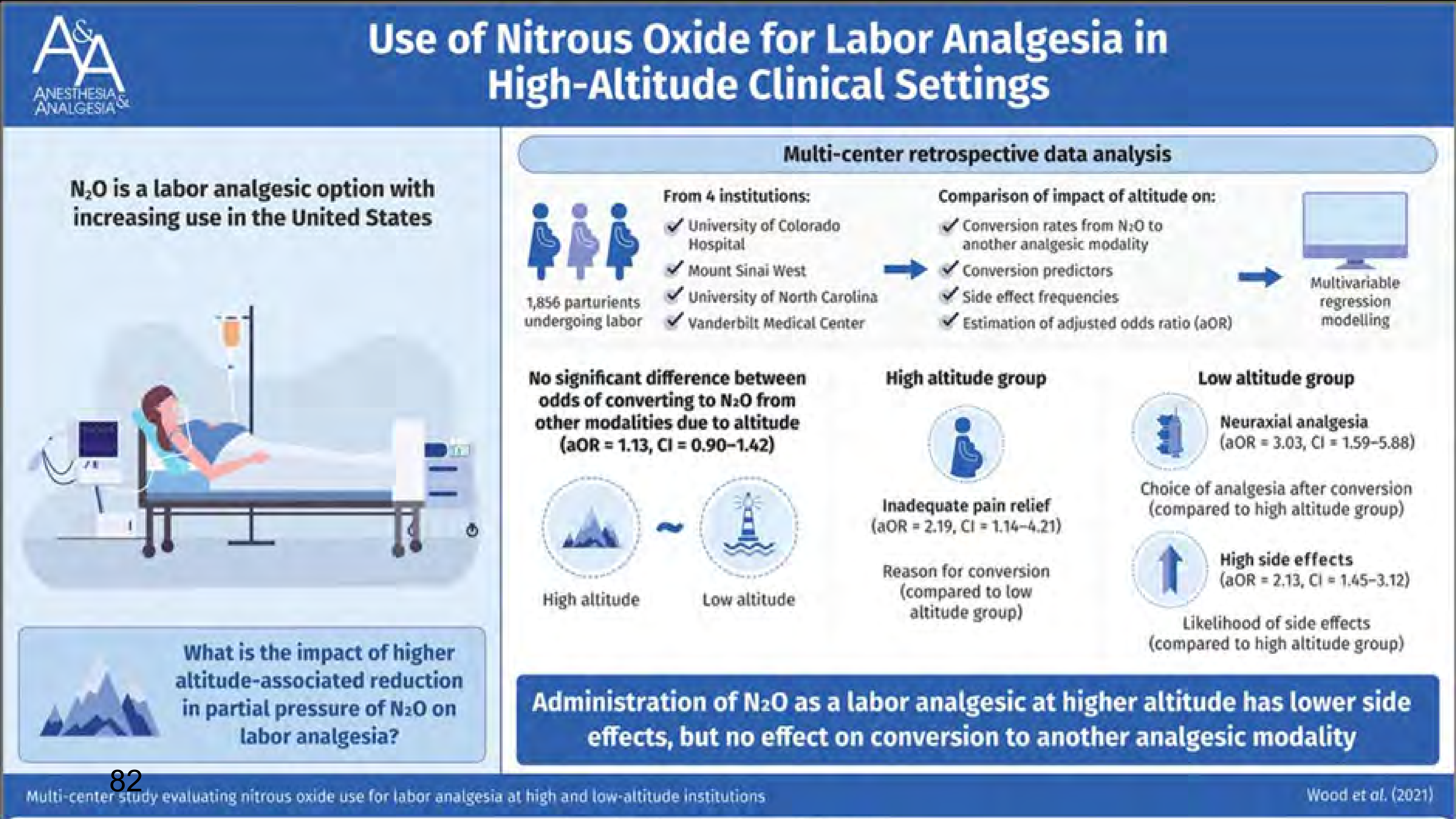
APSF newsletter, June 2020, pp 60-1

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 2022; 134: 294


Anesthesia & Analgesia
Use of Nitrous Oxide for Labor Analgesia in High-Altitude Clinical Settings
N_2O is a labor analgesic option with increasing use in the United States
What is the impact of higher altitude-associated reduction in partial pressure of N_2O on labor analgesia?
Multi-center retrospective data analysis
1,856 parturients undergoing labor
From 4 institutions:
✓ University of Colorado Hospital
✓ Mount Sinai West
✓ University of North Carolina
✓ Vanderbilt Medical Center
Comparison of impact of altitude on:
✓ Conversion rates from N_2O to another analgesic modality
✓ Conversion predictors
✓ Side effect frequencies
✓ Estimation of adjusted odds ratio (aOR)
Multivariable regression modelling
No significant difference between odds of converting to N_2O from other modalities due to altitude (aOR = 1.13, CI = 0.90–1.42)
High altitude
~
Low altitude
High altitude group
Inadequate pain relief (aOR = 2.19, CI = 1.14–4.21)
Reason for conversion (compared to low altitude group)
Low altitude group
Neuraxial analgesia (aOR = 3.03, CI = 1.59–5.88)
Choice of analgesia after conversion (compared to high altitude group)
High side effects (aOR = 2.13, CI = 1.45–3.12)
Likelihood of side effects (compared to high altitude group)
Administration of N_2O as a labor analgesic at higher altitude has lower side effects, but no effect on conversion to another analgesic modality
Multi-center study evaluating nitrous oxide use for labor analgesia at high and low-altitude institutions
Wood et al. (2021)

BENEFITS OF NEURAXIAL *ANALGESIA*

Is labor neuraxial analgesia (epidural or CSE) associated with ↓ risk of severe maternal morbidity. YES

- 575K women with vaginal delivery in NY hospitals 2010-17
- Neuraxial was associated with 14% ↓ risk of morbidity.
- ↓ risk was similar between white and minority women.
- 21% of the risk reduction was ↓ risk of hemorrhage.
- Increasing access and utilization of neuraxial may help reduce maternal morbidity and improve health outcomes.

JAMA Network Open 2022; 5: e220137

OPTIMIZING NEURAXIAL: DPE

"To puncture or not to puncture: DPE vs standard epidural"

- Benefits of DPE in the <u>general</u> pregnant population are modest and inconsistent. Need *at least* a 25g spinal.
- When used in <u>obese</u> parturients, there was no difference in quality of analgesia compared to epidural without DPE.
- Editorial: "Dural puncture seems to be a clever idea in search of an indication….individual clinician judgment will probably guide the development of a home, if any, for the dural puncture epidural technique."

Anesthesiology 2022; 136: 667, 678 + infographic

OPTIMIZING NEURAXIAL: DPE

Are labor epidural catheter replacement rates lower if DPE is used for placement?

- Retrospective trial compared DPE to standard epidural procedures for labor analgesia.
- DPE was associated with fewer catheter failures (OR 0.64).
- DPE had longer mean time to catheter replacement and required supplementation significantly later (like CSE).
- No difference in PDPH or blood patch.

Int J Obstet Anesth 2022; 52: 103590

PROGRAMMED INTERMITTENT BOLUS

What is the optimal interval between boluses using PIEB?

- 100 women in labor were randomized to varying time intervals between 10 ml boluses after DPE.
- The ED50 interval was 37 minutes and the ED90 interval was 52.5 minutes.
- The trend for PIEB maintenance is for larger boluses (8-10 ml) and longer intervals ~ 45 minutes.

Anesth Analg 2022; September PAP

GASTRIC EMPTYING IN LABOR

Is gastric emptying in labor affected by epidural analgesia?

- 4 groups: nonpregnant women, term pregnant women, laboring women without analgesia, laboring with CLE
- Gastric ultrasound was performed before and at 15, 60, 90, and 120 minutes after a light meal.
- Gastric emptying was delayed in laboring women compared to nonpregnant and term pregnant women
- Epidural analgesia facilitates gastric emptying during labor

Anesthesiology 2022; 136: 542

GASTRIC EMPTYING

	Non-pregnant	Term pregnant	Labor + epidural	Labor no analgesia
Gastric emptying at 90 min	52%	45%	31%	7%

With modern obstetric anesthesia practices, risk of aspiration is 1 per million but practice hasn't changed.

ANESTHESIA FOR CERCLAGE

We do not have an optimal spinal anesthetic for short ambulatory procedures such as cervical cerclage placement.

What is the ED90 of intrathecal chloroprocaine for cerclage?

- ED90 of 3% chloroprocaine + fentanyl was 49.5 mg.
- Median duration of surgery was 15 minutes.
- Median time to block resolution was 60 minutes for motor and 90 minutes for sensory.
- Time to PACU discharge readiness was 150 minutes.

Anesth Analg 2022; 134: 834

ANESTHESIA FOR CERCLAGE

How do spinal 3% 2-chloroprocaine and 0.75% hyperbaric bupivacaine compare for cervical cerclage?

- Randomized to 50 mg 3% CP or 9 mg bupivacaine + fentanyl
- No difference for time to motor block resolution (110 min)
- But sensory block resolution: 143 CP vs 198 min bupivacaine
- PACU discharge criteria were met 76 minutes earlier in the CP group. No TNS. Similar need for adjuncts (~ 10%).

Anesth Analg 2022; 134: 624

CESAREAN DELIVERY

SURGICAL ISSUES

Azithromycin is effective at ↓ SSI after unplanned cesarean when given within 1 hour before or even after skin incision.

Obstet Gynecol 2022; 139: 1043

A meta analysis of maternal outcomes associated with uterine exteriorization found ↑ risk of IONV but no ↓ Hgb compared to uterine repair in situ.

Can J Anesth 2022; 69: 216

A meta analysis found skin closure with absorbable sutures ↓ wound complications by 50% compared to staples.

Obstet Gynecol 2022; 140: 293

OPTIMAL PRE-OXYGENATION

Does low-flow nasal oxygen + face mask pre-oxygenation extend safe apnea time? YES

- Physiologic <u>model</u> comparing BMIs 24-50
- Low-flow nasal oxygen was started after optimal face mask pre-oxygenation; it extended time to reach 90% saturation similar to high-flow nasal oxygen.
- For low BMI extended 25 min; for BMI 50, extended 10 min
- Low flow cannula ***is*** readily available in all operating rooms.

Br J Anaesth 2022; 129: 581 and 468 (editorial)

PARTNER PRESENCE DURING GA

Scoping review of the literature on partner presence in the OR during emergency cesarean using regional or general:

- Most parents preferred to have the partner present.
- Most staff are reluctant to allow partners during GA.
- Most arguments against presence are personal opinion.
- Most arguments in favor are clinical findings.

Eur J Anaesthesiol 2022; 39: 939

LEFT 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 until 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 <u>less</u> phenylephrine and ephedrine.

Anesth Analg 2021; 133: 1235-43

Eur J Anaesthesiol 2022; 39: 236-43 (review)

LEFT UTERINE DISPLACEMENT

Review of current knowledge on supine hypotensive syndrome

- We don't tilt correctly: you need an angle of at least 30^0
- We *under*estimate the angle by visually judging
- Surgical conditions are impaired with tilt, slowing delivery
- It causes patient discomfort; feelings of sliding, postoperative sciatic neuropathy
- All women have IVC compression but very few have sx
- Fetal acid-base status is not affected <u>if</u> BP is maintained.

Eur J Anaesthesiol 2022; 39: 236

ISOBARIC vs HYPERBARIC BUPIVACAINE

Randomized comparison of isobaric vs hyperbaric 0.5% bupivacaine for lower limb surgeries (extrapolate to cesarean!):

- Found 73% efficacy of hyperbaric compared to 100% efficacy of isobaric bupivacaine when administered intrathecally in equal volumes and amounts.
- Longest postoperative analgesia with isobaric bupivacaine.
- Consider substituting when/if drug shortages occur again.

Scientific Reports 2023;13:2736

INTRAOP INTRATHECAL FENTANYL

Are low doses (< 12.5 mcg) or higher doses (> 12.5 mcg) of intrathecal fentanyl preferable during cesarean delivery?

- Meta analysis of 11 RCTs with 1350 patients
- Higher doses result in reduced need for intraoperative analgesic supplementation and prolonged time to first request for analgesia postoperatively.
- Higher doses associated with more pruritus.
- Doses > 12.5 mcg should be used for optimal benefit.

Int J Obstet Anesthesia 2022; 50: 103270

SPINAL ANESTHESIA MISC.

Need for conversion to GA is rare but more common with emergencies and when lower bupivacaine dose is used.

Acta Anaesth Scand 2023; 67: 29

Low-dose ketamine (0.5 mg/kg infused over 40 minutes after cord clamp) during cesarean did not ↓ depression scores at 2 days in women with prenatal depression. But it <u>did</u> reduce IONV and ↓ postop pain at 4 hours.

Front Surg 2022; 9: 1050232

IT morphine does not prevent chronic post-cesarean pain.

Br J Anaesth 2022; 128: 700

NOREPINEPHRINE DURING CESAREAN

A comparison of infusions of phenylephrine 100 mcg/min or norepinephrine (NE) 5 mcg/min after spinal for cesarean found no difference in fetal acidosis, but base excess was significantly ↑ in the NE group and there was less maternal bradycardia.

Eur J Anaesthesiol 2022; 39: 269

A comparison of phenylephrine or norepinephrine titrated to keep maternal BP at baseline after spinal for cesarean found equivalent prevention of hypotension but higher maternal cardiac index with NE.

Anesth Analg 2022: October PAP

OXYTOCIN

Patients receiving magnesium prior to delivery (e.g. preeclampsia) require ↑ oxytocin dose during cesarean.

Anesth Analg 2022; 134: 303

Patients with twin pregnancy require higher oxytocin dosing than those with singleton pregnancy.

Anesth Analg 2022; December PAP

NEURAXIAL MORPHINE

Neuraxial morphine is the “gold standard”. How concerned should we be about respiratory depression?

- ~5000 patients received spinal (100-450 mcg) or epidural (3-5 mg) morphine after cesarean in a single center.
- There were no RRT events for respiratory depression and no oxygen desaturation events, no initiation of oxygen therapy, and no naloxone administration.
- The risk of clinically significant respiratory depression after neuraxial morphine for cesarean (even high doses) is low.

Int J Obstet Anesthesia 2022; 52: 103592

MULTI-MODAL ANALGESIA

What is the best timing for scheduled NSAIDs and acetaminophen after cesarean delivery, simultaneously q 6 hours of alternating q 3 hours?

- Ketorolac 30 mg IV or PO NSAIDs + acetaminophen 1 gram ordered q 6 hours → alternate q 3 hrs or give both q 6 hrs?
- Combined administration resulted in significantly less opioid consumption: 26.3 MME vs 105 MME in total.
- Mothers get fewer interruptions and (hopefully more rest).

J Clin Anesth 2022;80:110847

BENEFITS OF DEXAMETHASONE

Intraoperative dexamethasone (D) is an effective anti-emetic after cesarean. Does it also provide opioid-sparing effects?

- Systematic review and meta-analysis of D's effect on early resting pain scores and time to first rescue analgesia.
- D was associated with significant reduction in resting pain scores at all times, ↑ time to first request for analgesia (mean 2.64 hrs), and a small but significant reduction in opioid consumption at 24 hrs.

Eur J Anaesthesiol 2022; 39: 498

JAMA Network Open

RCT: Efficacy of Single Wound Infiltration With Bupivacaine and Adrenaline During Cesarean Delivery for Reduction of Postoperative Pain

POPULATION

288 Women

Pregnant women undergoing planned cesarean delivery at full term

Mean age, 32.5 y

INTERVENTION

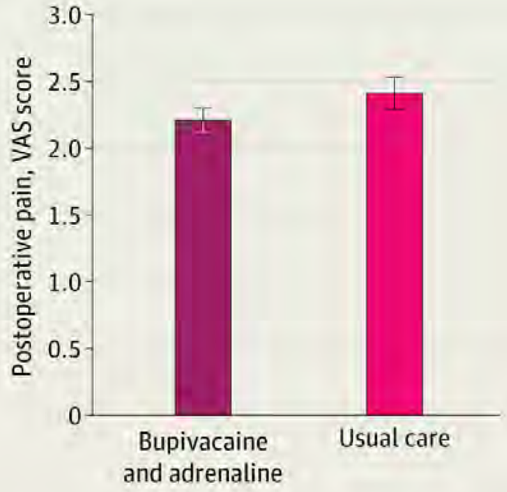
288 Participants randomized

143 Bupivacaine and adrenaline
Single intraoperative administration of subcutaneous bupivacaine and adrenaline before wound closure

145 Usual care
Usual intra- and postoperative care without intervention

FINDINGS

A single subcutaneous administration of bupivacaine and adrenaline during cesarean delivery significantly reduced postoperative pain compared with usual intra- and postoperative care



Mean between-group difference in VAS score, intervention vs control: −0.20 (95% CI, −0.35 to −0.05)

SETTINGS / LOCATIONS

1 Medical Center in Israel

PRIMARY OUTCOME

Mean pain intensity during the 24-h postoperative period after cesarean delivery as measured by a visual analog scale (VAS) score (range, 0-10, with a higher score indicating more pain)

Garmi G, Parasol M, Zafran N, Rudin M, Romano S, Salim R. Efficacy of single wound infiltration with bupivacaine and adrenaline during cesarean delivery for reduction of postoperative pain: a randomized clinical trial. *JAMA Netw Open*. 2022;5(11)e2242203. doi10.1001/jamanetworkopen.2022.42203

DELAYED CORD CLAMPING

A review of high quality evidence that supports delayed (1-3 minutes) umbilical cord clamping to promote placental transfusion for both preterm and term neonates:

- No effect on maternal blood loss during C/S
- Preterm benefits: ↓ mortality, less surfactant use, more stable hemodynamics and less need for inotropic support, ↓ PVR and PDA shunt, ↑ Hct so ↓ need for transfusion
- Huge benefits from a simple and no-cost strategy.

Obstet Gynecol 2022;139:121

ANESTHETIC MORBIDITY

ADVERSE EVENTS

Canadian hospitalization database was reviewed for serious complications related to anesthesia in obstetric patients.

- 2.6M hospitalizations & 8361 adverse events; 9% were serious
- Adverse events declined significantly over the 13 years.
- PDPH was most common → 83% of events
- Rate of difficult or failed intubations was low; 2% of events
- Events were more common in cesarean deliveries, OR 1.12
- Also more common with general than neuraxial, OR 1.71
- There was a positive association with cardiomyopathy (OR 8.34), eclampsia (OR 3.11), and OSA (OR 1.91)

Can J Anesth 2022;69:72

DIFFICULT AND FAILED INTUBATION

Review of MPOG data on almost 15,000 intubations during general anesthesia for cesarean between 2004 and 2019:

- 1:49 were difficult intubations; 88% based on the view and 16% who required $\geq$ 3 attempts.
- 1:808 were failed intubations (defined as any attempt without successful ETT placement). All 18 were rescued using a supraglottic airway. There was 1 arrest, no deaths.
- Risk factors: MP 3 or 4, BMI $\geq$ 40, and maternal age $\geq$ 35.

Anesthesiology 2022; 136: 697-708

GETA AND PREECLAMPSIA

How often to preeclamptic women receive general anesthesia just due to thrombocytopenia or unavailable platelet count?

- South African registry of obstetric airway management
- Thrombocytopenia < 75K was the reason for GA in 17%; half were confirmed counts and half had unavailable results.
- Of the unavailable group, 89% were subsequently found to have platelets > 75K, so GA was unnecessary.
- Consider the risk-benefit ratio when count unavailable.

Anesth Analg 2022; October PAP

PDPH: LONGTERM OUTCOMES

What is the risk of chronic health problems after wet tap and PDPH? Does blood patch ↓ these morbidities?

- Systematic review and meta analysis with 1M parturients and 1M controls
- Wet tap and/or PDPH were associated with ↑ risk of chronic headache, backache, neckache, and depression.
- Blood patch did not ↓ the risk.
- What should our follow-up be? Can we prevent these?

J Clin Anesth 2022;79:110787

PDPH: TREATMENT

What factors are associated with a failed epidural blood patch?

- Prospective, multi-center trial of 643 women
- EBP failed in 28%, was completely successful in 33% and partially successful in 39%
- 20% required a 2^{nd} EBP
- Factors associated with failure: interval < 48 hours since dural puncture and wet tap at a higher level (L1-3 vs 3-5)
- History of migraine also associated with needing 2^{nd} EBP

Pain 2022; 129: 758

SUBDURAL CATHETER: CASE REPORT

Healthy G3P2 with normal BMI requested epidural at 6 cm. Two attempts were unsuccessful at L2-3, then placed at L3-4. Aspiration and test dose negative. Because of unilateral sensory block on the right, the catheter was withdrawn 1 cm and re-bloused. She complained of shortness of breath and numbness of her right face and arm, followed by headache, ptosis, miosis and anhidrosis on the right side = Horner's Syndrome. Full resolution after 24 hours.

Anesthesiology News, February 2022, p. 38

SUBDURAL CATHETER: DIAGNOSIS

Major criteria:

- Negative aspiration of CSF
- Disproportionately extensive sensory block

Minor criteria:

- Delayed onset of sensory and motor block
- Variable extent of the motor block
- Disproportionate sympathetic block

TXA MEDICATION ERROR

IT administration of TXA has been reported from a wide range of hospitals worldwide. It has a 50% risk of mortality or life-changing neurologic disability. It is the most common neuraxial drug administration error in recent reports.

J Clin Anesthesia 2022;82:110889

If accidental epidural administration of TXA occurs, treat with saline lavage.

Can J Anesth 2022;69:1169


MACAINE HCl 0,5 %
4 ml

TXA DRUG-ERROR DEATHS

Recent cases of inadvertent intrathecal administration of TXA instead of local anesthetic for spinal anesthesia, with convulsions and 50% mortality. A list of recommendations for preventing intrathecal TXA administration includes:

- Store separately from anesthetic drugs in the OR.
- Never put on the cart used for opening the spinal tray.
- Check the label of spinal drugs multiple times.
- Utilize barcode scanning if possible.

Am J Obstet Gynecol 2023;228:January


CYNEX 500
CYNEX 500
Marcaine® HCl 0,5%
Spinal Injection
CYNEX 50

PAIN DURING SURGERY: GUIDELINES

"Litigation arising from pain during caesarean section under neuraxial anaesthesia has replaced accidental awareness under general anaesthesia as the most common successful medicolegal claim against obstetric anaesthetists."

- Approved by the Obstetric Anaesthetists' Association (OAA)
- 11 recommendations with emphasis on consent, adequate testing of the block, and management of intraoperative pain
- Any woman who experiences pain should receive follow-up.

Anaesthesia 2022; 77: 588

PAIN DURING SURGERY: REVIEW

What is the prevalence of inadequate neuraxial for elective cesarean and conversion to general anesthesia?

- Review of 54 RCT, 3497 patients
- 14.6% required supplemental analgesia or conversion to general anesthesia
- 0.06% were converted to GETA (is this too few?!)
- Combined spinal-epidural less likely than epidural to be inadequate: 10% vs 30% (no spinal comparison).

Anaesthesia 2022; 77: 598

PAIN DURING SURGERY: DEFINITION

Editorial: "If a mother reports being in pain, the anesthesiologist must believe her and take appropriate action. She is the only one who knows. Failure to do so compounds her distress."

- Severity of reported harm after awareness under regional is equivalent to that after awareness under general.
- Anesthetic complications such as pain during surgery were a significant predictor of postpartum PTSD - more than emergency situations or newborn complications.

Anaesthesia 2022; 77: 523

HYPOXIC ISCHEMIC ENCEPHALOPATHY (HIE)

Review of 21 years of litigation in the UK for anesthetic negligence resulting in HIE. Examples from actual cases.

- #1: Anesthetic delay due to delayed response time, availability, waiting to dose the epidural until in the OR, choosing to place a spinal rather than GETA.
- #2: Communication – not understanding the urgency of the case or continuing with task while FHT deteriorate
- #3: Hypotension after neuraxial with delayed treatment.
- #4: Documentation: explain your thoughts, accurate times

Anaesthesia 2022;77:919

EPIDURAL-RELATED FEVER

Epidural analgesia in labor is associated with ↑ rates of maternal fever. How can it be prevented?

- Systematic review of 37 studies found no cause and no effective preventive strategies.
- Interventions included: reduced epidural dose, prophylactic steroids, prophylactic paracetamol, prophylactic antibiotics. None worked.
- Why do we care? Intrapartum fever of any cause is associated with neonatal brain injury.

Br J Anaesth 2022;129:567

EPIDURAL-RELATED FEVER

Does the rate of fever differ between continuous epidural vs continuous spinal labor analgesia (CSA)?

- Retrospective study of 81 CSA and 162 matched controls who received epidural analgesia.
- No difference in the rates of fever between the modalities.
- Since epidural uses 10x the dose of LA as CSA, a dose-dependent effect of bupivacaine or fentanyl doesn't mediate fever.

Anesth Analg 2022;135:1153, 1151 (editorial)

SURGICAL OR MEDICAL MANAGEMENT?

How do the outcomes of operative and non-operative management (NOM) of appendicitis compare during pregnancy?

- Immediate surgery is associated with lower odds of amniotic infection and sepsis than NOM.
- There was no difference in preterm labor, preterm delivery or other maternal complications between surgery and NOM.
- Immediate operation had lower hospital charges.
- Failed NOM requiring surgery had the worst clinical outcomes.

JAMA Network Open 2022; 5: e227555

SURGICAL OR MEDICAL MANAGEMENT?

A review of acute cholecystitis from the surgical literature encourages early surgical intervention for acute cholecystitis.

- Compared to medical management during pregnancy, surgery patients had less preterm labor, fewer premature deliveries, and fewer days in-hospital.
- “During pregnancy, early laparoscopic cholecystectomy, compared with delayed operative management, is associated with a lower risk of maternal-fetal complications (1.6% vs 18.4%) and is recommended in all trimesters.”

JAMA 2022; 327: 96575

ANESTHETIC NEUROTOXICITY

Excellent review: *Long-term cognitive and behavioral outcomes following early exposure to general anesthetics.*

<u>Summary:</u>

…the findings of deficits in some neurodevelopmental domains (e.g., behavioral problems, ADHD) and not others (e.g., intelligence) will help guide the selection of appropriate outcomes in future studies that can further evaluate whether anesthetics have an impact on neurodevelopment in children.

Current Opinion Anaesth 2022;35:442

OBSTETRIC
&
MEDICAL COMPLICATIONS

"I'm going to give it to you straight, Mr Watson, for a 27 year old you're in pretty bad shape."

MATERNAL CARDIAC ARREST

Are survival rates different between maternal in-hospital cardiac arrest vs nonpregnant in-hospital arrest?

- Resuscitation database compared outcomes of women ages 18-50, pregnant or not
- No difference in ROSC or survival to discharge
- Pregnant women were more likely to survive with a good neurologic outcome (OR 1.57)

Am J Obstet Gynecol 2022;226:401

UTERINE ATONY

To risk-stratify patients, what are the greatest risk factors for postpartum hemorrhage due to uterine atony?

- A meta-analysis of 27 studies found 15 risk factors
- A large proportion of PPH have no risk factors!
- Prior PPH, placenta previa, abruption, uterine rupture and multiple gestation were highest risk. Also, IOL, oxytocin exposure and chorioamnionitis.
- New factors: HTN, diabetes, Hispanic and Asian race
- Obesity and magnesium were NOT associated with atony.

Obstet Gynecol 2021;137:305

PLACENTA ACCRETA SPECTRUM

- Review of the prenatal diagnosis and management:

  Obstet Gynecol Clin N Am 2022;49:423

- Two studies found the association of placenta previa *with* PAS ↑ the risk of worse maternal outcome and higher resource use including transfusion, ICU admission, hysterectomy and intraop bowel/bladder injuries.

  JAMA Network Open 2022;5:e2228002

  Obstet Gynecol 2022;140:599

PLACENTA ACCRETA SPECTRUM

What is typical RBC use during PAS surgery?

- Meta-analysis found 5 studies reporting mean transfusion data on 221 patients → 6.6 units PRBC transfused. They recommend a minimum of 6 PRBC be prepared.

  Obstet Gynecol 2022; PAP (Miller)

- How should we select patients for whom the REBOA or vascular control device will provide the greatest benefit? Intraop "staging" was better than using for everyone or deciding whether to use based on prenatal imaging.

  Am J Obstet Gynecol MFM 2022;4:100498

AMNIOTIC FLUID EMBOLISM: DIAGNOSIS

AFE is often over-diagnosed. SMFM and the AFE Foundation propose strict criteria for diagnosis of AFE. There must be:

- Sudden onset cardio-respiratory arrest or hypotension + respiratory compromise (cyanosis, oxygen sat < 90%).
- Overt DIC prior to EBL-related coagulopathy.
- Clinical onset during labor or within 30 minutes of delivering the placenta.
- No fever $\geq 38^0$ C during labor.
- **Triad: hypotension + hypoxia + coagulopathy**

APSF Newsletter 2022;37:83

AMNIOTIC FLUID EMBOLISM

- Demographics of AFE: incidence of 6 per 100K, PAS ↑ the risk 10-fold, and mortality was up to 46% if associated with cardiac arrest and coagulopathy.

  JAMA Network Open 2022;5:e2242842

- Excellent review of AFE and pulmonary embolism.

  Obstet Gynecol 2022;49:439

- Biologic plausibility of AOK therapy for AFE?

  Case Rep Obstet Gynecol 2017;8458375 / PMID 29430313

TREATMENT OF PPH: OXYTOCICS

Does prophylactic methylergonovine during intrapartum C/S vs oxytocin alone reduce the need for add'l uterotonics?

- Yes: fewer uterotonics (20% vs 55%), better tone, ↓ incidence PPH (RR 0.6), ↓ QBL, and ↓ need for transfusion.

Obstet Gynecol 2022;140:181

In Niger, maternal deaths due to hemorrhage were halved using 3 steps: 1) patients were given a dose of misoprostol during prenatal visit to take if birth occurs at home, 2) uterine tamponade balloon placed at hospital if still bleeding after 30 min, then 3) shock garment used to give time to get to surgery and transfusion.

Lancet Global Health 2023;11:e287

TREATMENT OF PPH: CALCIUM

A pilot study gave 1 gm calcium chloride or placebo to women with at last 2 risk factors for PPH.

- Administered over 10 minutes after cord clamping.
- Uterine atony occurred in 20% of calcium recipients versus 50% of placebo recipients (RR 0.38).
- Peak ionized calcium was 1.6 mmol/L and the CaCl was tolerated well by recipients.

J Clin Anesth 2022; 110796

TREATMENT OF PPH: TXA

What is appropriate TXA dosing? *At least* 1 gm IV was needed to inhibit activation fibrinolysis, but higher BMI correlated inversely with plasma TXA levels. Higher dosing?

Br J Anaesth 2022;129:937 / Am J Obstet Gynecol 2022;227:763

Prophylactic TXA did <u>not</u> reduce blood loss in women with multiple gestation (primarily twins).

Am J Obstet Gynecol 2022;227:889

TREATMENT OF PPH: TXA

Is early administration of TXA a cost-effective strategy for reducing maternal M&M due to PPH in the U.S.?

- Based on a decision-analytical mode
- Early administration (within 3 hours of diagnosis of PPH) of TXA to 100K women would prevent 16 maternal deaths, 9 laparotomies and 155 re-operations with an annual cost savings of $23.15 million.

Am J Obstet Gynecol MFM 2022;4:100588

TREATMENT OF PPH: TXA

Review article on TXA: Current known and unknowns

- Prophylactic TXA does not reduce PPH to a meaningful degree after vaginal or cesarean delivery.
- The WOMAN trial found TXA was associated with a 37% reduction in death if given within 3 hours of PPH, but it is unclear whether TXA reduces the risk of morbidity from PPH in well-resourced countries – “can be considered”.
- Catastrophic neurologic damage can occur after accidental IT administration.

Anesth Analg 2022;135:460 and 459 (infographic)

POC COAGULATION TESTING ON L&D

Clinical Expert Series: Obstetrics & Gynecology

- Laboratory assessment is essential in PPH.
- Both ROTEM and TEG provide results within 10-20 min.
- Normal ranges are now available for pregnancy.
- Correct blood products can be given early, limiting use of unnecessary transfusion of other blood products.
- Some studies have shown shorter hospital stays, lower costs and less need for re-operation.

Obstet Gynecol 2022;139:463

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: e21-e41

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

PREECLAMPSIA: PREVENTION

The incidence of HTN in pregnancy ↑ from 13-16% from 2017-9. Risk was 1 in 5 for mothers 35-44 and 1 in 3 for mothers 45-55 years old. Also higher in Black and American Indian/Alaska Native mothers and in the Midwest, South and lower income communities.

MMWR 2022;71:585

How often do at-risk women receive aspirin therapy to prevent preeclampsia? < half of women with DM, obesity, and/or chronic HTN receive the recommended prophylaxis.

JAMA 2022;327:388

CHRONIC HTN IN PREGNANCY

Should mild chronic HTN be treated during pregnancy? Does keeping < 140/90 reduce adverse pregnancy outcomes?

- 2408 women randomized when < 23 weeks gestation to receive treatment when BP >140/90 or >160/105.
- Targeting < 140/90 was associated with better pregnancy outcomes: ↓ in preeclampsia with severe features, indicated preterm birth, placental abruption, or fetal/neonatal death.
- No ↑ in risk of small for gestational age birth weight.

N Engl J Med 2022; 386: 1781-92 (CHAP Trial)

MANAGEMENT OF ECLAMPSIA

What are the expected fetal heart rate changes associated with an eclamptic seizure and what should management be?

- Decelerations occurred in 79% of cases for 2-15 minutes followed by tachycardia. 48% also had minimal variability.
- Maternal support and stabilization were prioritized.
- Other than C/S for abruption, 2/3 did not have immediate operative intervention and outcomes were good for mother and newborn. Don’t run to the OR!

Am J Obstet Gynecol 2022;227:622

PREVENTION OF ECLAMPSIA

Given that 30% of eclamptic seizures occur postpartum, what is the optimal duration of postpartum magnesium?

- Treatment for $\leq$ 12 hours vs 24 hours was not associated with increased risk of eclampsia.
- Benefits of shorter treatment: less flushing, shorter Foley catheter insertion, less time to ambulation and shorter hospital stay.

Obstet Gynecol 2022;139:521

FUTURE IMPLICATIONS

Is there an association between a history of adverse pregnancy outcomes (i.e., preeclampsia, gestational HTN or diabetes, preterm delivery, SGA baby) and coronary artery disease by CT angiography screening? Yes

- 10,528 women in Sweden with deliveries in 1973 or later had CT at age 50-65 years.
- There was a significant association between those with adverse pregnancy outcomes and image-identified CAD, including those women estimated to be at low risk.

JAMA 2023;329:393

OBSTETRIC MANAGEMENT OF PREECLAMPSIA

N Engl J Med 2022;386:1817

"The choice of neuraxial anesthesia is ultimately in the hands of anesthesiologists. However, a wide spectrum of practice exists, even within departments, particularly when platelet counts are 50-100K, so it is important that maternity care providers have confidence to advocate for women in their care….platelet counts in women with preeclampsia may decrease rapidly and unpredictably."

N Engl J Med 2022;387:287 (letter)

CARDIOMYOPATHY IN PREGNANCY

What is the risk of pregnancy in women with cardiomyopathy of any type?

- All major adverse CV complications are more likely including a 7-fold greater risk of severe CV events and a 4-fold greater risk of dying in hospital than other forms of heart disease during pregnancy.
- A multi-disciplinary team should manage their care.
- No data was found to assist with detailed risk stratification.

Am J Obstet Gynecol 2022;227:582

ECMO IN PREGNANCY

What is ECMO utilization during pregnancy and outcomes?

- Data from the Nationwide Inpatient Sample, 1999 – 2014
- ECMO utilization increased significantly from 1 to 11 per million obstetric discharges
- In-hospital mortality decreased significantly from 74 to 32 per 100 women who received ECMO
- ECMO during pregnancy had ↑ risk of venous thromboembolism (OR 1.83) and non-traumatic hemoperitoneum (OR 4.32)

Anesth Analg 2022;135:268

ECMO IN PREGNANCY

What are the indications for using ECMO during pregnancy?

- Review of the Nationwide Inpatient Sample 2010-16
- Respiratory failure (80%), cardiogenic shock (64%), and circulatory arrest (25%) were the most common but most had more than one indication (58%).
- Mortality was 30.5% overall, but 30% with respiratory failure, 40% with cardiogenic shock, 47% with cardiac arrest, and 42% for combined diagnoses.
- Cardiogenic shock had the highest mortality rate (OR 5).

Anesth Analg 2022;135:1172

ECMO IN PREGNANCY

Review Article: ECMO is an effective peripartum rescue therapy. Pregnant physiology including uteroplacental perfusion and thrombophilia must be considered.

Anesth Analg 2022;135:277

Editorial: There were widespread reports of ECMO for obstetric patients during COVID. ECMO has the potential to reduce maternal mortality for a variety of catastrophic indications, including future pandemics.

Anesth Analg 2022;135:264

CANCER DURING PREGNANCY

When cancer is diagnosed in pregnancy, what are the effects on the child, with or without chemotherapy?

- Danish database of liveborn children over a 40 year span
- Fetuses exposed to cancer in utero had no higher mortality, no increased risk of malformations, no ↑ risk of somatic or psychiatric disease.
- Of those exposed to chemotherapy, there were no health consequences; no ↑ risk of malformations or disease.

J Clin Oncology 2022; 40:3975

HIV IN PREGNANCY

Women who conceived on antiretroviral therapy (ART) and had a suppressed viral load at time of delivery, had **<u>no</u>** perinatal HIV transmissions.

Clin Infect Dis 2022 (Sibiude et al)

What is the best ART to use pre-conception and during pregnancy for women with HIV infection?

- Highest viral suppression was with dolutegravir (96.7%).
- There was no differences in adverse birth outcomes between regimens.

N Engl J Med 2022;387:799

OBESITY IN PREGNANCY

Excellent review: *N Engl J Med 2022;387:248*

What is the risk-benefit of bariatric surgery in women for their obstetric, neonatal and child outcomes?

- Less gestational HTN, gestational diabetes, birth injuries, and large-for-gestation neonates.
- More small-for-gestation neonates
- Surgery is highly favorable for pregnancies & newborns but requires collaboration with OB, dietician, surgeon and PCP.

JAMA Surgery 2022 (Rives-Lange et al)

JAMA 2023; PAP 2/10 (Fisher et al)

OSA IN PREGNANCY

- Snoring is common, increasing as pregnancy progresses.
- ↑ upper airway edema and nasal congestion and ↓ FRC are predisposing factors.
- OSA found in 10% 1st trimester and 26% in 3rd trimester.
- Risk factors: self-reported snoring, ↑ BMI, older age, and presence of chronic HTN.
- OSA is associated with HTN, DM, PEC, preterm birth, cardiomyopathy, CHF, and 5x ↑ risk of dying before D/C.

Obstet Gynecol 2022;140:321

SUBSTANCE USE DISORDER

Clinical Expert Series: an excellent review of maternal, fetal and child effects of tobacco, alcohol, cannabis, opioids, stimulants and benzodiazepines and their respective treatments.

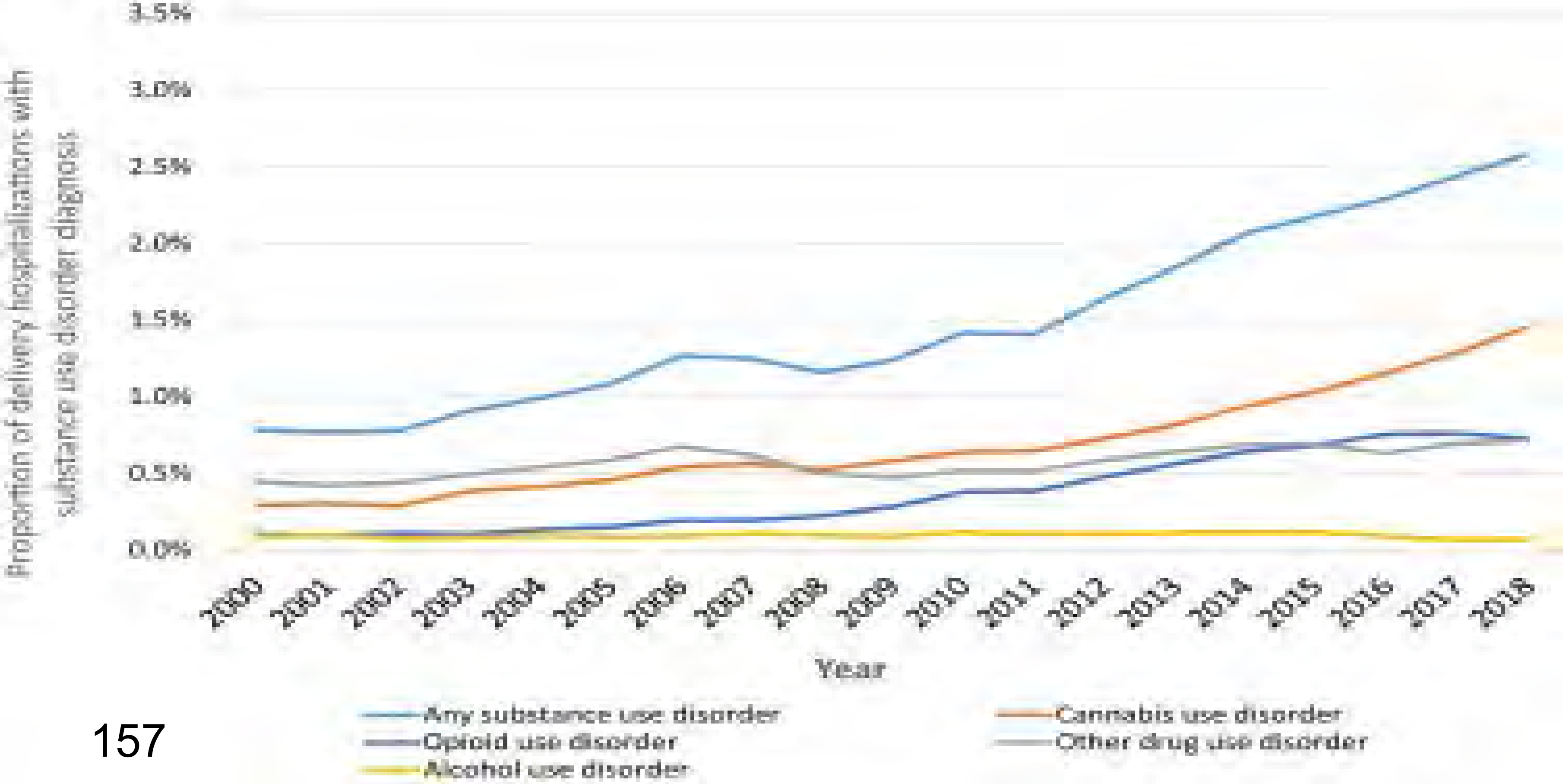
Obstet Gynecol 2022;139:317

SUD in pregnancy (cannabis, alcohol, opioid, other) has ↑ dramatically and is associated with adverse outcomes such as HTN, preterm delivery, abruption and antepartum hemorrhage.

Am J Obstet Gynecol 2022;July:100

SUBSTANCE USE IN PREGNANCY

Substance use disorder diagnoses during pregnancy have ↑ substantially from 2000-18 in the Nationwide Inpatient Sample.



Am J Obstet Gynecol 2022;227:100

PERINATAL SUBSTANCE USE DISORDER

What Obstetrician-Gynecologists Should Know About Substance Use Disorders in the Perinatal Period (Review)

Obstet Gynecol 2022;139:317

- MAT should be continued at the same dose throughout the birthing hospitalization, and pain management should be multimodal, using nonopioid medications, regional anesthesia, and opioid agonists if needed.
- Undertreated pain is a greater risk for SUD recurrence than use of an opioid agonist for postoperative pain.

OPIOID USE DISORDER IN PREGNANCY

What is the best MAT for opioid use disorder in pregnancy – buprenorphine or methadone?

- Cohort study of 10.7K buprenorphine and 4.3K methadone
- Buprenorphine had lower risk of adverse neonatal outcomes: abstinence syndrome (RR 0.73), preterm birth, SGA, and low birth weight.
- No difference maternal outcomes: delivery by cesarean or severe maternal complications.

N Engl J Med 2022;387:2033 & editorial

OPIOID USE IN PREGNANCY

What are the characteristics are associated with opioid use during pregnancy?

- Opioid use was present in 2.8% of pregnancies.
- Majority of users were: non-Hispanic white (67%), had some college education (69%), of higher parity, and had high rates of alcohol use (32%) and smoking (39%) during the pregnancy. Maternal depression → OR 2.42.
- 86% of the opioid use came from a prescription

J Women's Health 2022;PAP (Nguyen)

CANNABIS USE IN PREGNANCY: MATERNAL

Cannabis use in pregnancy has ↑ substantially and potency has tripled. Use is associated with maternal nausea, depression and anxiety. Prenatal exposure is associated with ↑ autism, SGA, preterm birth, NICU admit.

Am J Obstet Gynecol 2022;227:571 / JAMA Network Open 2022

In a large multicenter cohort, cannabis use was associated with a <u>*higher*</u> likelihood of moderate-to-severe nausea and vomiting in early pregnancy.

Obstet Gynecol 2022;140:266

CANNABIS IN PREGNANCY

Kaiser Permanente Northern California held focus groups with women who self-reported daily or weekly cannabis use.

- White and non-Hispanic black women had highest use.
- They perceived legalization was done to allow better access and exposure to cannabis. It gave them greater willingness to discuss use during pregnancy with their OB provider.
- They believed that cannabis retail staff are knowledgeable and view them as experts on the benefits of use in pregnancy.

JAMA Network Open 2022;

SEPSIS AFTER VAGINAL DELIVERY

Can a single dose of azithromycin reduce maternal infection after vaginal delivery as it does after cesarean? Yes

- 29,278 women randomized in labor to AZ or placebo.
- Maternal death or sepsis was less after AZ: RR 0.67
- Incidence of sepsis was 1.5% after AZ vs 2.4% after placebo
- No difference in neonatal sepsis, death or stillbirth did not differ between groups.

N Engl J Med 2023: PAP 2/9 (Tita et al)

COVID: MATERNAL OUTCOMES

Data from the CDC & others has shown that pregnant women have ↑ risks of ICU admission, intubation, need for ECMO, and death from COVID infection.

- COVID also ↑ risk for maternal death and morbidity due to OB causes: HTN, hemorrhage, other infections: 13% vs. 9%.
- Preterm delivery and NICU admission were more common.
- Risks were ↑ in women with moderate or severe COVID; asymptomatic cases had similar outcomes to non-infected.

JAMA 2022; 327: 748-59 and 790 (patient info)

COVID: PERINATAL OUTCOMES

Results of an individual participant data meta-analysis of 13,136 pregnant women to evaluate risks of COVID infection:

- ↑ risk of maternal mortality; RR 7.68
- ↑ risk of ICU admission or any critical care; RR 3.81 / 5.48
- ↑ risk of mechanical ventilation; RR 15.23
- ↑ risk of neonatal admission to ICU; RR 1.86
- ↑ risk of preterm birth; RR 1.71
- No increased risk of stillbirth.

BMJ Global Health 2023; 8: e009495

PRO: MATERNAL COVID VACCINATION

- 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 which should protect the infant.

  JAMA Network Open 2021; 4: e2120575 & JAMA online 4/12/21

- Population-based studies in Sweden, Norway and Canada found that vaccination in pregnancy was <u>not</u> associated with an increased risk of adverse peripartum outcomes.

  JAMA 2022; 327: 1451 (editorial), 1469, 1478

THE FETUS AND NEONATE

MATERNAL SUBSTANCE USE & MEDS

Benzodiazepine exposure during pregnancy was not associated with ↑ risks of neurodevelopmental disorders.

JAMA Network Open 2022;5:e2243282

Maternal marijuana exposure was associated with ↑ preterm delivery, NICU admission, low birth weight, low 1-minute Apgar score and head circumference.

JAMA Network Open 2022;5:e2145653

Maternal anti-psychotic prescription was not associated with ↓ standardized test scores or ↑ malformations / teratogenicity.

JAMA Intern Med 2022 / JAMA Psychiatry 2023;80:156

CANNABIS USE IN PREGNANCY: NEWBORN

Are adverse neonatal outcomes associated with marijuana-exposed pregnancies?

- Meta-analysis of 16 studies and 59K patients showed significant ↑ in 7 adverse neonatal outcomes.
- Birth weight < 2500 gm (RR 2.06), SGA, preterm delivery (RR 1.28), NICU admission (RR 1.38), ↓ mean birth weight, Apgar score at 1 minute, and infant head circumference.

JAMA Network Open 2022;5:e2145653 & editorial

HOME BIRTH RATES

- During the pandemic, planned home birth rates rose from 23% (from 1.03% in 2019 to 1.41% in 2021) and birth center deliveries rose 13%.
- The largest increases were in Black and Hispanic women.
- 1 in 50 U.S. births occurred in one of these settings.
- Fear of being infected with COVID or fear of receiving poor care in overwhelmed hospitals may have made women reluctant to delivery in a hospital.

JAMA 2022;328:2389

BIRTH OUTCOMES & SITE OF DELIVERY

What are neonatal outcomes if delivered outside hospitals?

- 9.8 million births were studied; 88% in hospitals with physician coverage, 11.4% in hospitals with midwives, 0.75% in freestanding birth centers
- BC deliveries had 4-fold ↑ in neonatal deaths; 7-fold if G1, 2-fold ↑ neonatal seizures, 7-fold ↑ 5-min Apgar score < 4
- Compared with hospital midwife deliveries, physician deliveries had significantly ↑ adverse neonatal outcomes.

Am J Obstet Gynecol 2022;226:116

AAP GUIDELINES ON BIRTHING PRACTICES

In 2022, AAP advised against the following birthing practices which may be associated with ↑ rates of neonatal morbidity/mortality, and have no clear benefits:

- Water birth -Vaginal seeding -Placentophagy
- Umbilical cord nonseverance
- Non-medical deferral of Hep B vax and ocular prophylaxis
- Delayed bathing of newborns exposed to active genital HSV or maternal history of HIV, hepatitis B or C

Pediatrics 2022;e2021055554

KANGAROO CARE

15M preterm babies yearly; leading cause of death < 5 years.

- New WHO guidelines for preterm babies advise immediate "kangaroo care" i.e., skin-to-skin contact with a caregiver, starting immediately after birth, no initial time in incubator.
- Combined with exclusive breast feeding, it saves lives, ↓ infections, prevents hypothermia and improves feeding.
- The guidelines are especially relevant in low resource countries where preterm mortality can be 90%.
- Consider during C/S if your Neonatologists approve.

ASAmonitor.pub/30VbPpf

PERIVIABLE RESUSCITATION

Has active treatment of live-born neonates 22-25 weeks changes over time (2014-2020)?

- Yes – frequency of active resuscitation significantly ↑ but rates of active treatment varied by race and ethnicity.

JAMA 2022;328:652, 624 (editorial)

- NEJM Clinical Decision article: a pro/con to recommend resuscitation for ALL neonates born at 22 weeks vs selective resuscitation; anesthesiologists <u>will</u> be involved with these cases for analgesia or cesarean delivery.

N Engl J Med 2022;386:391


AND WE'LL SEE WHAT'S
NEW IN 2023!
THE END

CRASH

COLORADO REVIEW OF ANESTHESIA FOR SURGICENTERS AND HOSPITALS

Guiding the future of patient care

Ambulatory Surgery

what could go wrong?

Alison Brainard MD

Associate Professor

Director Cherry Creek North Ambulatory Surgery Center

Anesthesiology
UNIVERSITY OF COLORADO
ANSCHUTZ MEDICAL CAMPUS

Conflicts of Interest

- None

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

Learning Objectives

At the conclusion of this talk, attendees will be able to:

1. Analyze best practices on patient selection for free standing ambulatory surgery centers (ASCs)
2. Discuss keeping the ORs full – what are the national trends for block release, block utilization, and case cancellations
3. Describe best practices around risk management, safety huddles and peer reviews
4. Create a recipe for creating a culture of psychological safety
   a. Dealing with the difficult surgeon
   b. Dealing with the difficult patient

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

Ambulatory Surgery

- Definition: From ASAHQ: "Outpatient surgery, also called same-day, ambulatory, or office-based surgery, provides patients with the convenience and comfort of recovering at home, and can cost less. It might also help lower your risk of infection."
- Types of Centers: Free-standing ASC, In-Office or Hospital based
- Facts:
  - According to the CDC, two-thirds of cases are ambulatory
  - Benefits: reductions in waiting times, decreases hospital costs, and the risk of nosocomial infection
  - Large retrospective database studies of ambulatory surgeries have estimated serious complication rates of less than 1% [3,4] and mortality rates of 1 in 50 000 to 1 in 100 000 [5,6].

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Guiding the future of patient care

Ambulatory surgery centers (ASC)

- Must be licensed by CMS if they are taking care of Medicaid or Medicare patients
- Patients must be expected to stay 23 hours or less. Unanticipated longer admission MUST be rare*
- American Recovery and Reinvestment Act (Recovery Act) appropriated $50 million to the Department of Health and Human Services (HHS) with $10 million devoted to the state level to increase state-level regulation

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Stand up if…

- You've ever worked done anesthesia for outpatient surgery
- You've ever worked at an ASC
- You currently work at an ASC
- You have a leadership role for an ASC

Predicting an Unanticipated Admission

Identifying Those at High Risk for Major Complications

- **Hypothesis:** Specific patient history and surgical characteristics place patients scheduled for common day case-eligible surgeries at a greater risk of major morbidity and mortality within 72h after such procedures.
- **Method:** Data mining using the American College of Surgeons' National Surgical Quality Improvement Program (ACS-NSQIP) from 2005 to 2010.
- **Results:** 241,600 outpatient cases; 232 cases experiencing an event; **21 mortalities** and **234 perioperative morbidities** (multiple morbidities in some cases) within 72h postoperatively
  - Incidence of 0.095%, or approximately **1 in 1,053 cases**
  - Of the 232 cases experiencing an event, 195 (84%) were discharged within 23h of surgery.
  - No intraoperative deaths; 9 deaths on the day of surgery, 7 on POD #1, and 5 on POD #2.

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

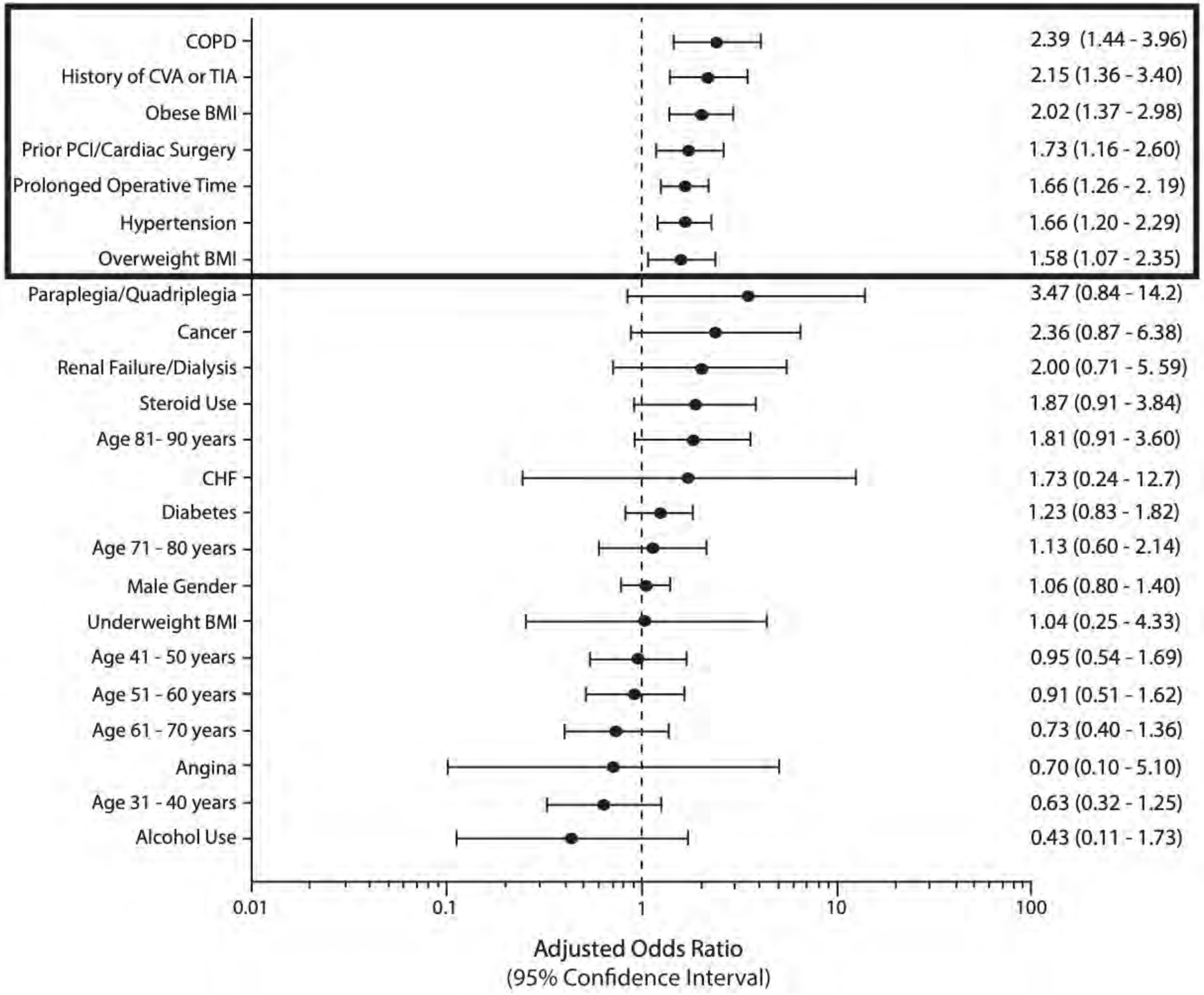
Michael R. Mathis, Norah N. Naughton, Amy M. Shanks, Robert E. Freundlich, Christopher J. Pannucci, YiJia Chu, Jason Haus, Michelle Morris, Sachin Kheterpal; Patient Selection for Day Case-eligible Surgery: **Identifying Those at High Risk for Major Complications.** *Anesthesiology* 2013; 119:1310–1321

Secondary Outcomes Analysis Showed

- 2,797 patients (1.1%) required an unplanned admission.
- The most common events included:
  - Pneumonia (46)
  - Unplanned postoperative intubation (37)
  - Wound disruption (25)
  - Postoperative bleeding (21)
  - Sepsis (19).

Patient Selection for Day Case-eligible Surgery: Identifying Those at High Risk for Major Complications

- Authors used the American College of Surgeons' National Surgical Quality Improvement Program Database to analyze common day case surgeries from 2005-2010
- Primary outcome morbidity or mortality within 72 hours



Michael R. Mathis, Norah N. Naughton, Amy M. Shanks, Robert E. Freundlich, Christopher J. Pannucci, YiJia Chu, Jason Haus, Michelle Morris, Sachin Kheterpal, Patient Selection for Day Case-eligible Surgery: **Identifying Those at High Risk for Major Complications**. *Anesthesiology* 2013; 119:1310–1321

Reasons for admission

Surgical 40%

Anesthetic 20%

Medical 19%

Monitored anesthesia care when compared with general anesthesia (OR 0.17; 95% CI 0.04 to 0.68)

BMI 30-35 (OR 2.81; 95% CI 1.31 to 6.04).

Advanced age (> 80 yr) (OR 5.41; 95% CI 1.54 to 19.01);

ASA III (OR 4.60; 95% CI 1.81 to 11.68); ASA class IV (OR 6.51; 95% CI 1.66 to 25.59);

Length of surgery of one to three hours (odds ratio [OR] 16.70; 95% confidence interval [CI] 4.10 to 67.99) and length of surgery more than three hours (OR 4.26; 95% CI 2.40 to 7.55);

Whippey, A., Kostandoff, G., Paul, J. *et al.* Predictors of unanticipated admission following ambulatory surgery: a retrospective case-control study. *Can J Anesth/J Can Anesth* **60**, 675–683 (2013).

Patient Selection…

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Outpatient Surgery Admission Index from Independent a Predictors of Immediate Hospital Admission

1 point	• 65 years or older • OR time longer than 120 min
1 point	• Cardiac Diagnoses • Peripheral Vascular Disease • Regional Anesthesia
1 point	• Cerebrovascular Disease • Malignancy • HIV
2 points	• General Anesthesia

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Never have I ever…

- 54 yo patient with a BMI of 54 coming in for a lap chole. PMHx significant for Type 2 DM (Hgb A1C 7.5), GERD and well controlled HTN
  - Hospital with planned admission
  - Hospital with planned discharge to home
  - Free-standing ASC

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Obesity - A GROWING PROBLEM

- Systematic review of published studies also showed that BMI alone did not increase perioperative complications or unplanned admissions after ambulatory surgery
- National Survey of Ambulatory Surgery) found that morbidly obese patients had a similar incidence of adverse postoperative outcomes, delayed discharge, and unplanned hospital admission, when compared with nonobese patients
- In Lopez and Byers study looking at patients presenting for weight loss surgery, looking to see the prevalence of OSA in obese patients
  - Severely obese group (BMI 35-39.9 kg/m2) had a prevalence of 70%
  - Morbidly obese group (BMI 40-40.9 kg/m2), the prevalence was 74%
  - Superobese group (BMI 50-59.9 kg/m2) 77 per cent.
  - BMI 60 kg/m2 or greater, the prevalence of OSA rose to 95 per cent.
- Probably needs individualized decision based on type of surgery, anesthesia and comorbid conditions

Never have I ever

- 45 yo Male presenting for distal radius fracture ORIF. PMHx significant for obesity (BMI 39), HTN (well controlled on Lisinopril and Metoprolol). On his preop call, it is reported that his STOP-BANG questions put him at high risk of Obstructive Sleep Apnea.
  - Proceed with the case as planned with GA and a supraclavicular PNB
  - Proceed with case under PNB and very little sedation
  - Move case to hospital based OR

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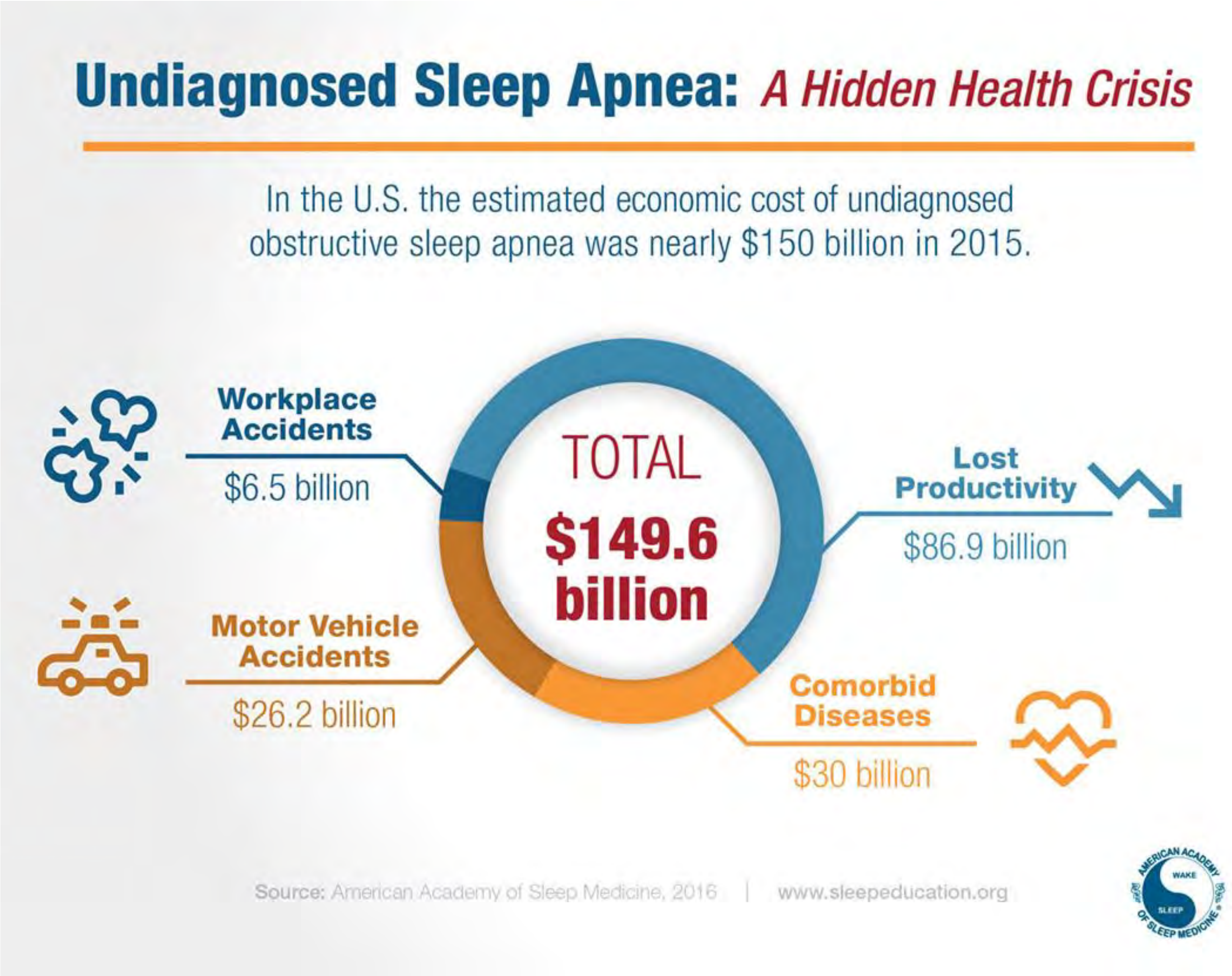

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ANESTHESIA & ANALGESIA

Patient Selection for Adult Ambulatory Surgery: A Narrative Review

Rajan, Niraja MD*; Rosero, Eric B. MD, MSc†; Joshi, Girish P. MBBS, MD, FFARCSI†

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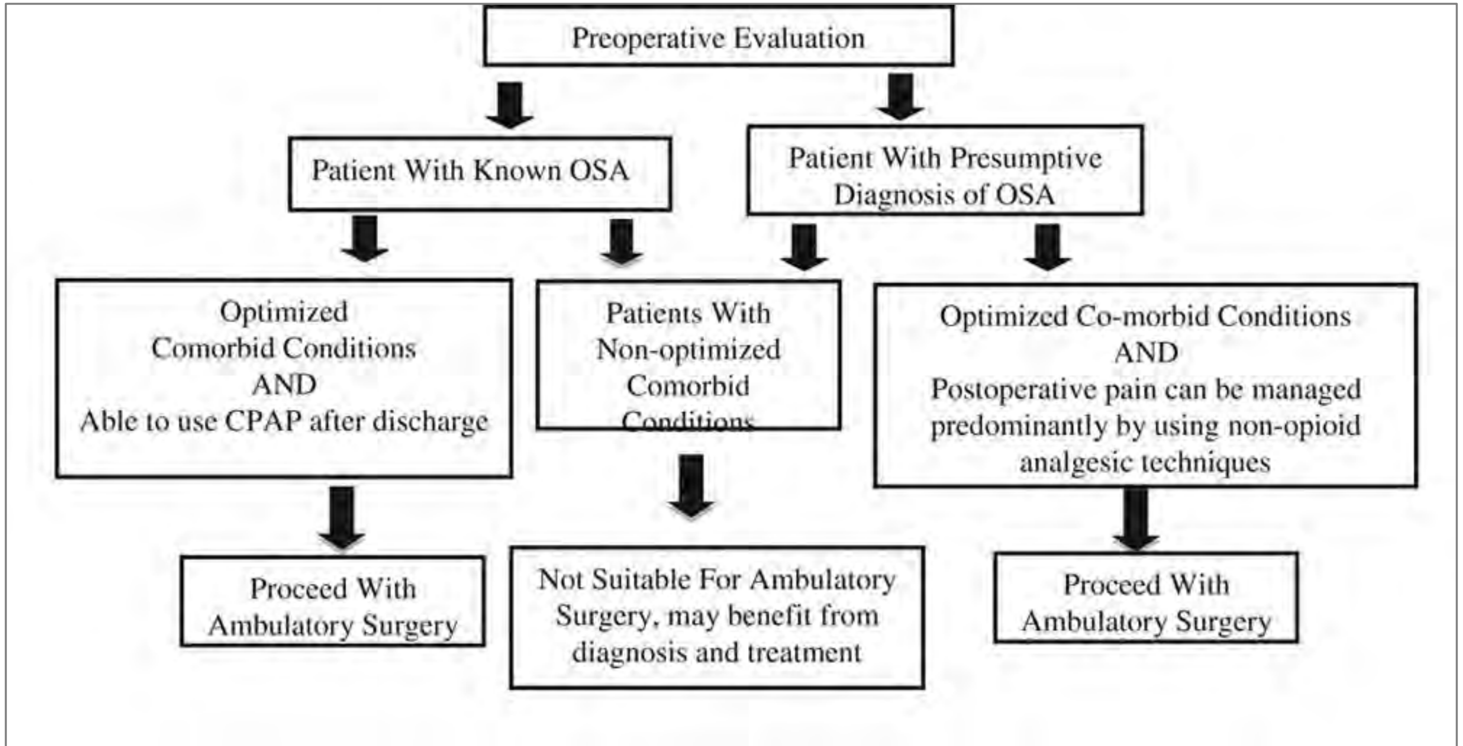
SAMBA CONSENSUS STATEMENT - Decision making in preoperative selection of a patient with OSA



Preoperative Considerations:

- Comorbid conditions include hypertension, arrhythmias, heart failure, cerebrovascular disease, and metabolic syndrome.
- If OSA is suspected during the preoperative evaluation, one could proceed with a presumptive diagnosis of OSA albeit with caution.
- Educate surgeon, patient and family (see the text for details)

Intraoperative Considerations:

- Non-opioid analgesic techniques, when possible.

Postoperative Considerations:

- Exercise caution in OSA patients who develop prolonged and frequent severe respiratory events (e.g., sedation analgesic mismatch, desaturation, and apneic episodes) in the postoperative period.

Joshi, Girish P.; Ankichetty, Saravanan P.; Gan, Tong J.; Chung, Frances

Anesthesia & Analgesia115(5):1060-1068, November 2012.

STOP-BANG

Ask the patient the following:

Do you snore loudly? Louder than talking or loud enough to be heard through closed doors	No 0	Yes +1
Do you often feel tired, fatigued, or sleepy during the daytime?	No 0	Yes +1
Has anyone observed you stop breathing during sleep?	No 0	Yes +1
Do you have (or are you being treated for) high blood pressure?	No 0	Yes +1

Objective measures:

BMI	≤35 kg/m²	0
	>35 kg/m²	+1
Age	≤50 years	0
	>50 years	+1

6 points

STOP-BANG

High risk of OSA

Copy Results

Next Steps »»

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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,

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Never have I ever

- 82 yo F presenting for cysto and bladder sling procedure. PMHx significant for 50 pack year smoking history, COPD (on 2 inhalers), HTN (well controlled). Wears 2 LPM O2 at night. RA saturation in PreOp 91%
  - Proceed with case at ASC
  - Postpone until able to reschedule at hospital in case admission is necessary postop
  - Postpone until she agrees to quit smoking

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Risk of Post-op Pulmonary Complications

ARISCAT

Variable		Points
Age, years	≤50	0
	51-80	3
	>80	16
Preoperative SpO_2	≥96%	0
	91-95%	8
	≤90%	24
Respiratory infection in the last month*	No	0
	Yes	17
Preoperative anemia (Hgb ≤10 g/dL)	No	0
	Yes	11
Surgical incision	Peripheral	0
	Upper abdominal	15
	Intrathoracic	24
Duration of surgery	<2 hrs	0
	2-3 hrs	16
	>3 hrs	23
Emergency procedure	No	0
	Yes	8

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ARISCAT Score	Risk group	Risk of in-hospital postoperative pulmonary complications*
<26	Low	1.6%
26-44	Intermediate	13.3%
≥45	High	42.1%

*Complications were defined as a composite including respiratory failure, respiratory infection, pleural effusion, atelectasis on chest x-ray, pneumothorax, bronchospasm treated with bronchodilators, and aspiration pneumonitis.

How does our patient score?

- IF surgery is less than 2 hours…
  - 24 points = LOW RISK 1.6% risk of in-hospital post-op pulmonary complications (composite including respiratory failure, respiratory infection, pleural effusion, atelectasis, pneumothorax, bronchospasm, aspiration pneumonitis)
- IF Surgery is 3 hours….
  - 40 points = INTERMEDIATE RISK 13.3% risk of in-hospital post-op pulmonary complications
- IF Surgery is 4 hours ….
  - 47 points = HIGH RISK 42.1% risk of in-hospital post-op pulmonary complications

Never have I ever

- 45 yo M presenting for an inguinal hernia repair. PMHx of HTN (poorly controlled with home BPs of 150's/90's), obesity (BMI 31), daily marijuana use, NIDDM (HgbA1C 6.2% last month). Reports able to mow yard weekly and vacuum house
  - Proceed with GA and ETT
  - Insist on a stress test prior to surgery at an ASC
  - Needs to go to a hospital

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Ways to Assess Cardiac Risk

- GUPTA - Assesses Cardiac risk looking at :

  Cardiac risk % = $e^x / (1 + e^x)$

Where x = −5.25 + sum of the values of the selected variables

  - Age
  - ASA Status
  - Creatinine (< 1.5 or > 1.5)
  - Type of Procedure
- Revised Cardiac Risk Index - Series of yes/no questions looking at:
  - If surgery is considered "elevated risk"
  - Patient has a h/o ischemic heart disease
  - Patient has a h/o CHF
  - Patient has a h/o TIA/Stroke
  - Pre-op treatment w insulin
  - Pre-op Creatinine > 2 mg/dL

How does our patient score?

- Does he need a pre-op stress test?
  - Yes
  - No
- Is it this case safe to do at an ASC?
  - Yes
  - No

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Never have I ever

- 62 yo F presenting for ORIF distal tibia. She got tangled in her puppy's leash and fell to the ground. The puppy had been purchased to celebrate her survival of her heart attack 5 weeks ago for which 2 DES were placed. Echo at her 4 week cards appointment the shows EF 45% with no regional wall motion abnormalities, normal valve function. Letter from cardiology says "cleared for surgery"
  - Proceed under regional anesthesia with little to no sedation at ASC
  - Postpone until it can be done at a hospital setting
  - Postpone until a cardiac anesthesiologist is available

- The current US and European guidelines recommend DAPT for at least 12 months in acute coronary syndrome and for at least 6 months in stable coronary artery disease without high bleeding risk
- In a meta-analyses of randomized trials comparing short (≤6 months) vs prolonged (≥12 months) DAPT duration, short DAPT was associated with lower bleeding risk without a significant increase in ischemic risk.
- Delay surgery after PCI during the re-endothelialization period, which would be 14 days after ballooning, 30 days after bare metal stent placement, and at least 3 months (preferentially 6 months) after DES placement

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For our patient…

Emergent or urgent surgery during the re-endothelialization period

Consider continuation of dual antiplatelet therapy

In surgeries with serious bleeding risk, consider continuation of aspirin (or 3-4 days of cessation, if necessary) and discontinuation of oral $P2Y_{12}$ inhibitors with bridge therapy using cangrelor, tirofiban, or eptifibatide

In cases of non-surgical bleeding, platelet function test may be performed to guide platelet transfusion

Restart dual antiplatelet therapy as soon as possible following surgery for the intended duration after percutaneous coronary intervention

Song JW, Soh S, Shim JK. Dual antiplatelet therapy and non-cardiac surgery: evolving issues and anesthetic implications. Korean J Anesthesiol. 2017 Feb;70(1):13-21.

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Never have I ever

- 28 yo F presenting for a full body lift. She had a gastric bypass 3 years ago and has lost 250 lbs. Current BMI is 27 and patient has excess skin that is causing pain and interferes with ADLs. Surgeon estimates it will take 6-7 hours to complete the procedure, but promises "these patients always go home. I have a great pain regiment for them. My old institution always let me do these at the ASC. She's totally healthy now."
  - Proceed with case at ASC, but insist on a first case start
  - Insist the case must be done in segments, with no segment lasting more than 4 hours
  - Move to hospital setting so patient can be admitted

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Length of Case

- Cosmetic procedure complication rates range from 0.33% to 1.9% at ASCs
- State dependent limits:
  - Pennsylvania limits surgery length to 4 hours
  - Connecticut limits surgery length to 1.5 hours with a 4-hour recovery time.
- 2009 – Evidence-based safety advisory on safety selection for ASCs
  - American Society of Plastic Surgery recommended a 6-hour maximum surgery length at ASCs.
- Meta-analysis looking at facial plastic surgery
  - No increased morbidity or mortality based on case length

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Discuss keeping the ORs full – what are the national trends for block release, block utilization, and case cancellations

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Block time

- "Each 1% of room utilization equates to $100,000 of net revenue," says Steve Hess, chief information officer for UCHealth in Colorado, which recently implemented an app to facilitate block scheduling. "We were able to increase overall block utilization by 4%." That increase resulted in an additional $15 million in revenue annually. UCHealth has 10 hospitals and more than 80 ORs.
- Review utilization of assigned block time quarterly
- Make changes accordingly

Tiered block utilization

Henderson Hospital in Henderson, Nevada, uses a tiered system for block utilization. Block time utilization percentage has to be maintained for 3 months to qualify for a tier change.

Tier	Block time utilization	When block needs to be released before scheduled start
I	80%	24 hours
II	70%-79%	72 hours
III	Below 70%	7 days

- Blocks must be released 30 days before planned vacations.
- Creativity = increased volume. Utilization increased by 28% in 1 year

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CMS Requirements:

- The ASC must comply with State licensure requirements
- The ASC must have a governing body that assumes full legal responsibility for determining, implementing, and monitoring policies governing the ASC's total operation. The governing body has oversight and accountability for the quality assessment and performance improvement program, ensures that facility policies and programs are administered so as to provide quality health care in a safe environment, and develops and maintains a disaster preparedness plan.
- Surgical procedures must be performed in a safe manner by qualified physicians who have been granted clinical privileges by the governing body of the ASC
- The ASC must develop, implement, and maintain an ongoing, data-driven quality assessment and performance improvement (QAPI) program.
- The ASC must have a safe and sanitary environment, properly constructed, equipped, and maintained to protect the health and safety of patients.
- The medical staff of the ASC must be accountable to the governing body
- The nursing services of the ASC must be directed and staffed to assure that the nursing needs of all patients are met.
- The ASC must maintain complete, comprehensive, and accurate medical records to ensure adequate patient care.
- The ASC must provide drugs and biologicals in a safe and effective manner, in accordance with accepted professional practice, and under the direction of an individual designated responsible for pharmaceutical services.
- must inform the patient or the patient's representative or surrogate of the patient's rights and must protect and promote the exercise of these rights, as set forth in this section.
- The ASC must maintain an infection control program that seeks to minimize infections and communicable diseases.
- The ASC must ensure each patient has the appropriate pre-surgical and post-surgical assessments completed and that all elements of the discharge requirements are complete.
- The ASC must comply with all applicable Federal, State, and local emergency preparedness requirements. The ASC must establish and maintain an emergency preparedness program that meets the requirements of this section.

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Measures for the CY 2021 Reporting Period/CY 2023 Payment Determination

- ASC-9 Endoscopy/Polyp Surveillance: Appropriate Follow-Up Interval for Normal Colonoscopy in Average Risk Patients
- ASC-11 Cataracts: Improvement in Patient's Visual Function within 90 Days Following Cataract Surgery*
- ASC-12 Facility 7-Day Risk-Standardized Hospital Visit Rate after Outpatient Colonoscopy**
- **ASC-13 Normothermia**
- ASC-14 Unplanned Anterior Vitrectomy
- ASC-17 Hospital Visits After Orthopedic Ambulatory Surgical Center Procedures**
- ASC-18 Hospital Visits After Urology Ambulatory Surgical Center Procedures**

- * ASCs may voluntarily submit data for CY 2021 but will not be subject to a payment reduction with respect to this measure during the voluntary reporting period.

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The Ambulatory Surgical Center Quality Reporting (ASCQR) Program

- Goal of program is to promote "higher quality, more efficient health care in the ASC setting for Medicare beneficiaries through quality of care measurement, quality improvement, and information transparency through public reporting."
- Mandatory reporting of Measures ASC-9, -13, and -14- (endoscopy/polyp surveillance, normothermia and unplanned anterior vitrectomy) with data submitted annually via the Hospital Quality Reporting (HQR) system; and
- Measure ASC-20 Coverage for Healthcare Personnel (HCP) with data submitted quarterly via the Centers for Disease Control and Prevention (CDC)
- ASCs that do not meet reporting requirements, including allowing the data to be publicly available, may incur a 2.0 percentage point reduction to any payment update provided under the revised ASC payment system for that year

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Describe best practices around risk management, safety huddles and peer reviews

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Psychological Safety -

An individual's "sense of being able to show and employ oneself without fear of negative consequences to self-image, status or career"

- Originally defined in 1990
- 2015 report on malpractice claims in the US [2] implicated communication failure in 30% of all malpractice claims and 37% of high severity injury cases).
- improves the health of the workforce by promoting job satisfaction & well-being

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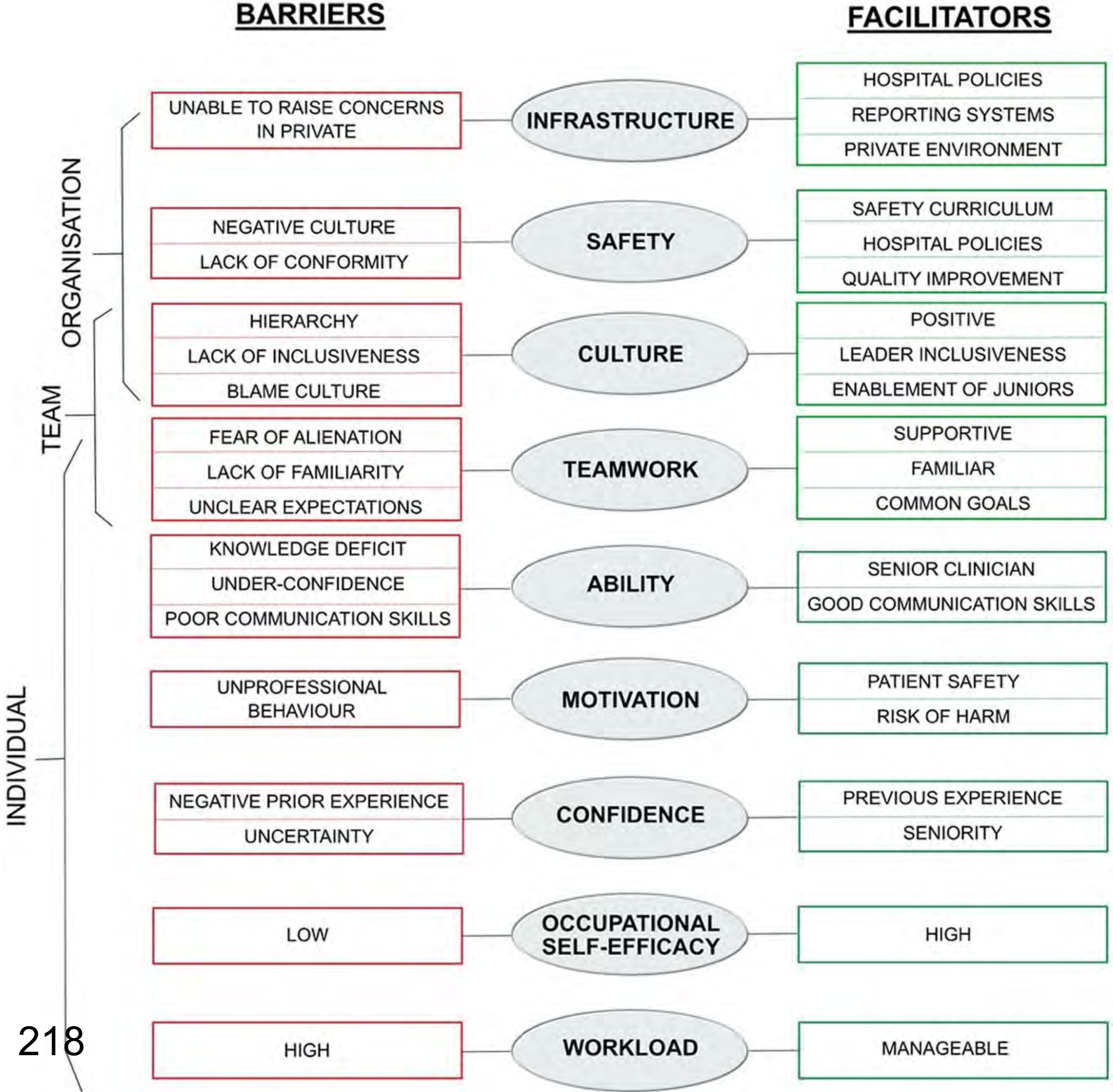

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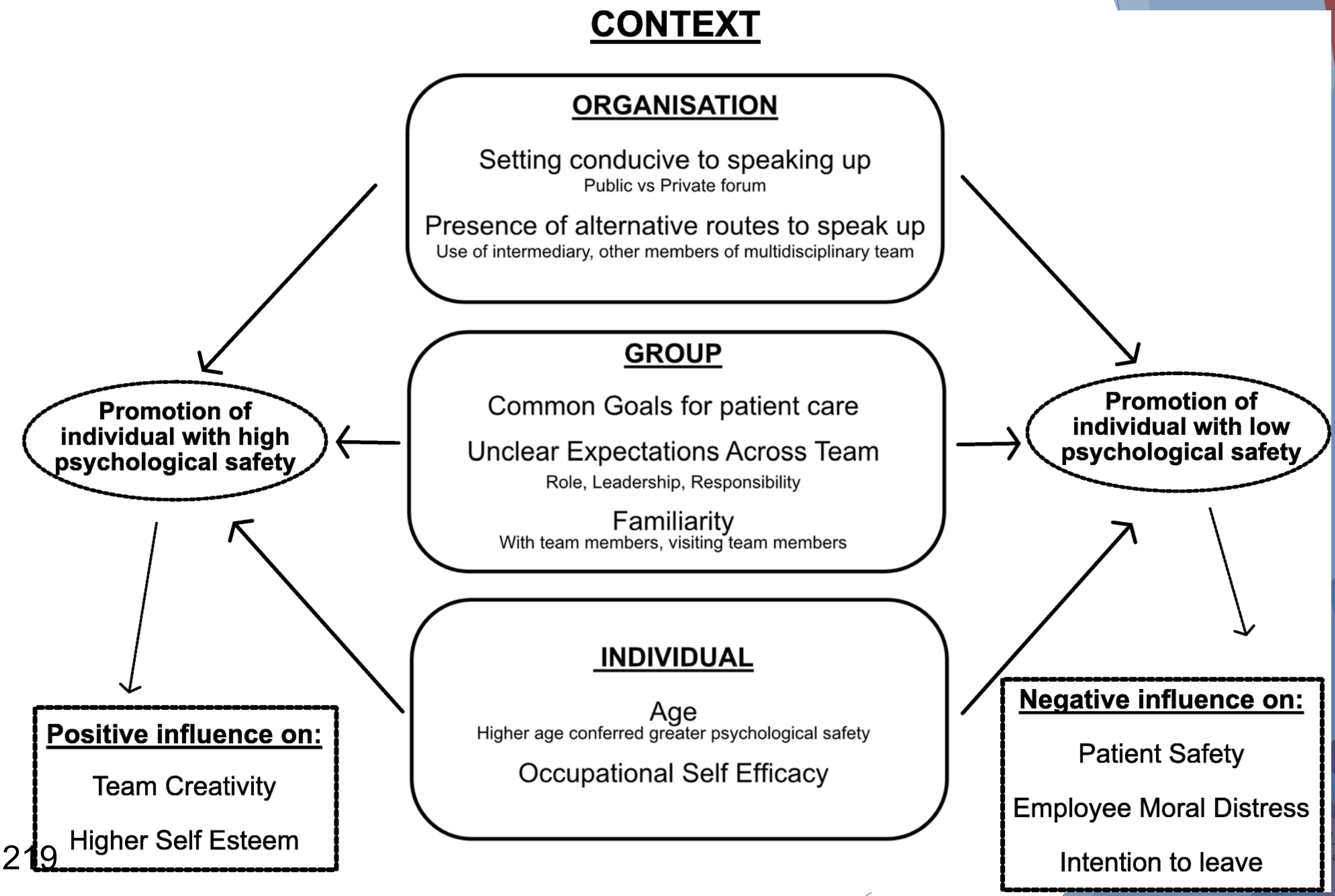
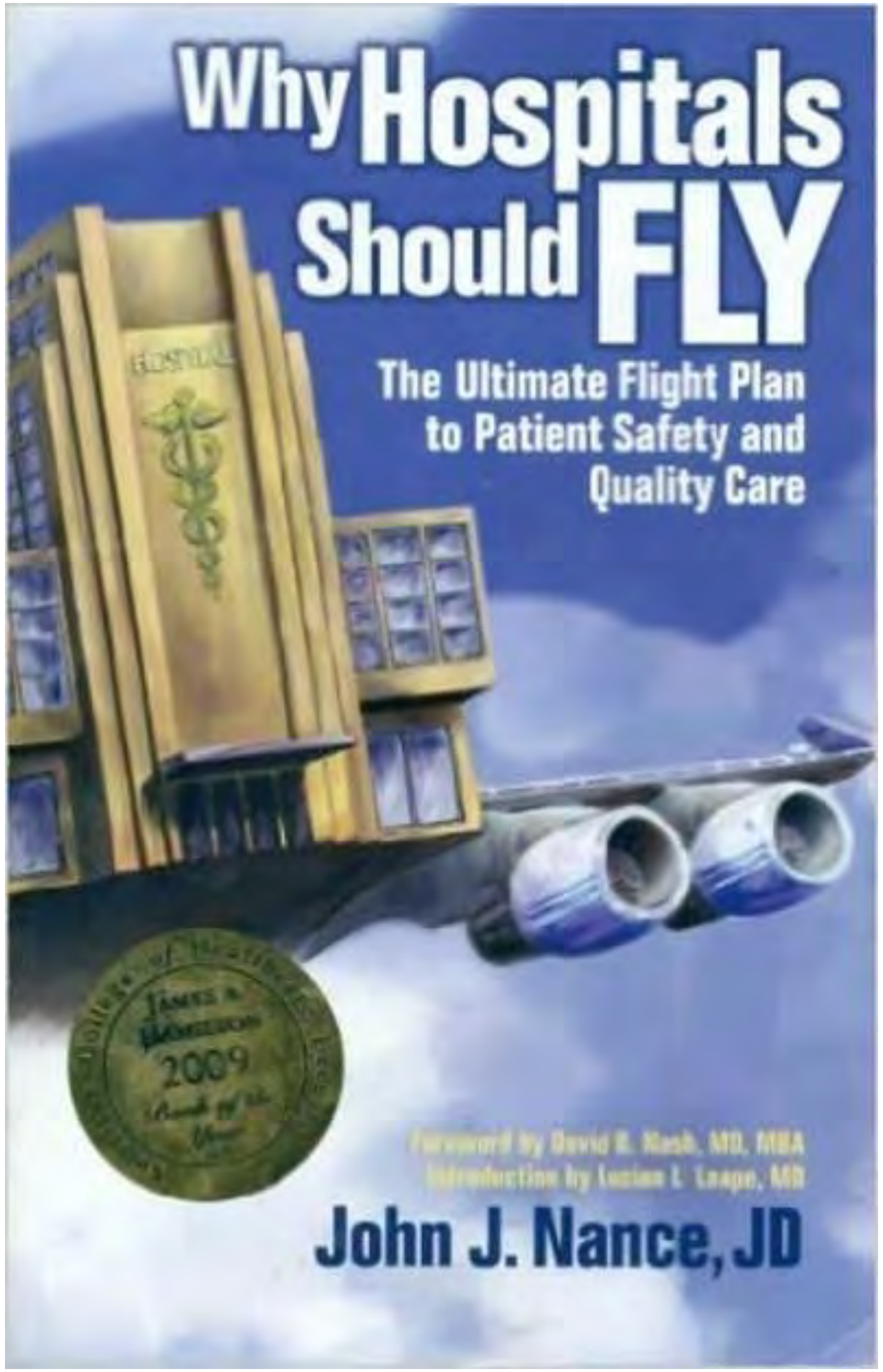

CONTEXT
ORGANISATION
Setting conducive to speaking up
Public vs Private forum
Presence of alternative routes to speak up
Use of intermediary, other members of multidisciplinary team
GROUP
Common Goals for patient care
Unclear Expectations Across Team
Role, Leadership, Responsibility
Familiarity
With team members, visiting team members
INDIVIDUAL
Age
Higher age conferred greater psychological safety
Occupational Self Efficacy
Promotion of individual with high psychological safety
Promotion of individual with low psychological safety
Positive influence on:
Team Creativity
Higher Self Esteem
Negative influence on:
Patient Safety
Employee Moral Distress
Intention to leave



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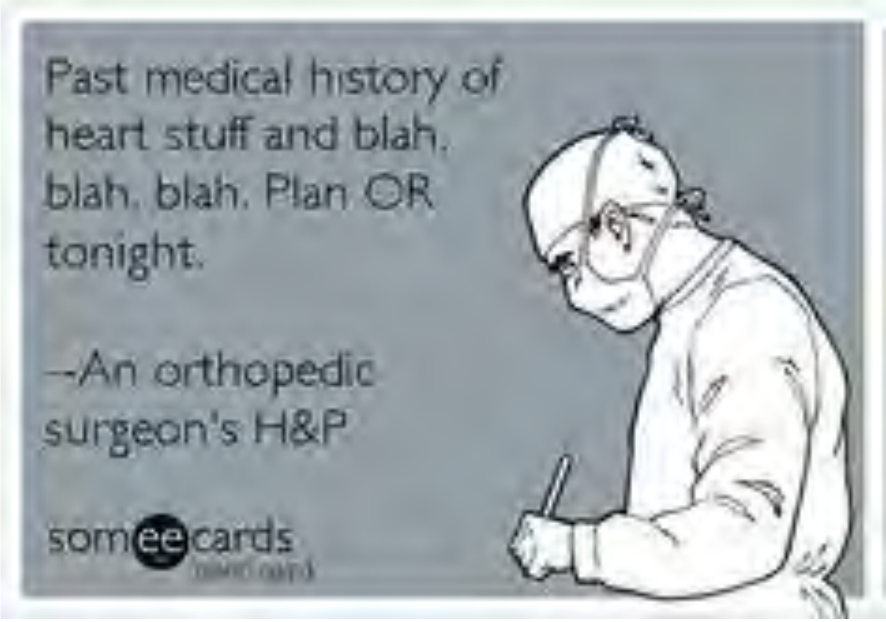
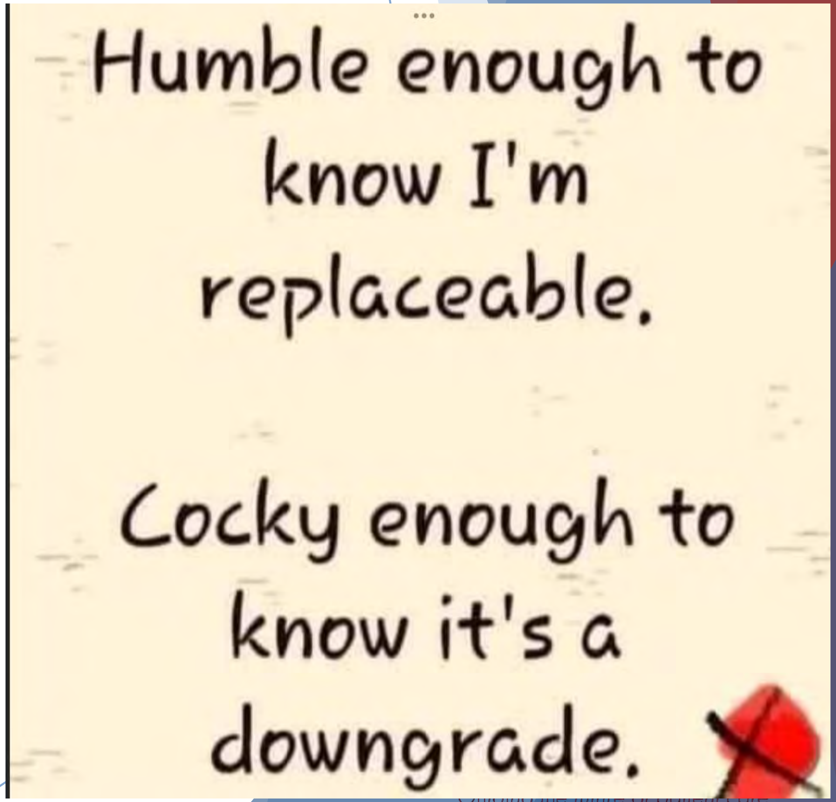
I DON'T ALWAYS BLAME ANESTHESIA
WHO AM I KIDDING, YES I DO


Past medical history of heart stuff and blah, blah, blah. Plan OR tonight.
--An orthopedic surgeon's H&P
someecards


Humble enough to know I'm replaceable.
Cocky enough to know it's a downgrade.

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Anesthesia for patients with ischemic heart disease for non-cardiac surgery

Breandan L. Sullivan MD

Associate Professor, University of Colorado School of Medicine

Co-Medical Director Cardiothoracic Intensive Care Unit

Anesthesiology

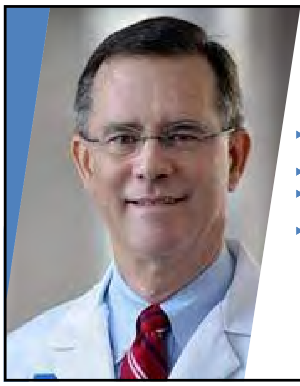
1

Panelists

Dr. Andropoulos, MD, MHCM

Dr. Brown, MD, PhD

2



Dean Andropoulos MD, MHCM

- Burdett S. Dunbar Chair in Pediatric Anesthesiology
- Texas Children's Hospital Houston
- Professor of Anesthesiology and Pediatrics
- Medical Officer SmartTots
  - Public-private partnership of the US Food and Drug administration and IARS

3

Nathaniel Brown MD PhD

- Assistant Professor Anesthesiology University of Colorado
- Cardiac Anesthesiologist Rocky Mountain Regional VA Hospital
- MD/PhD St. Louis University
- PhD Health Care Ethics

4

No Disclosures

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Outline

- Introduction
- Case 1
- Intermission
- Case 2
- Case 3
- Wrap-up Questions

6

SCOPE OF THE ISSUE

Anesthesiology Jan 2023, Vol. 138 7-9

- Every year 100 million adults inpatient, noncardiac surgery globally
- 2% develop major cardiac complications
- 13% develop prognostically important myocardial injury,
- Both negatively impact patients' short- and long-term outcomes

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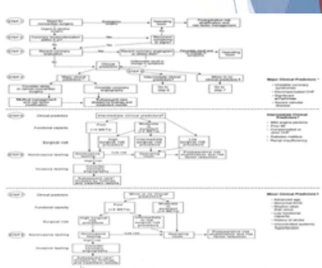
Ischemic Heart Disease and Perioperative outcomes

- Controversies
  - Beta blockers?
    - Timing/Dose
    - CVA vs MACE
  - Antiplatelet Therapy
  - Pre-operative testing
    - Test everyone/
      - Medical management vs attempted Revascularization prior to surgery
    - Delay surgery?
      - Cancer vs Quality of life
        - SPINE SURGERY vs Lung cancer resection

8

In the old days…

- Easy peasey lemon squeezey!



9

10

Fancy Algorithms

- Didn't pan out
- Traded in decisions from "must do" to "consider if justified"
- Individualized Medicine…
- Modern Problems…

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One part of the story

SAGA OF BETA BLOCKERS

12

New Data/Old Data/Same Data…

- Perioperative Beta Blockers
  - Don't cause increased risk of stroke…
    - Massive retrospective paper
- Long Convoluted history
- Slightly difficult to interpret
  - Polderman/Mangano
  - DECREASE IV
  - POISE trials
    - 1,2,3

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NEJM 1999	Polderman et al	5 mg Bisoprolol	1 week before Vascular Surgery	Prevented MI's and cardiac death 3.4% vs 34%
NEJM 2005	Lindenauer et al	B-blockers	2 days before major noncardiac surgery	782,969 pts Decreased death in high risk patients, not low risk
J Am College Caridology 2007	Fleisher et al	B-blocker	Consensus Rec's perioperative B-blocker	Don't stop beta blockers! High Risk patients should be on them!
Lancet 2008 POISE	Devereaux et at	B-blocker	100mg Metop 2-4 hours before surgery	Decreased MACE, increased CVA and death
Circulation 2014	Fleisher et al	Periop recs	Consider in high risk	Consider, maybe, possibly, not so sure…
Euro Hear Jour 2022	Halvorsen et Al	B-blocker	Consider in high risk	Consider in high risk, don't stop

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CASE Number 1

"I would rather die then go on with the pain…"

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15

CASE #1

- 37 y/o female
  - Referred for lumbar fusion surgery
  - Heart Transplant evaluation on hold secondary to functional status
    - Limited by pain with ambulation
    - Pain has been refractory to medications/injections/physical therapy
  - Multidisciplinary spine team recommending surgical intervention
  - 4 level fusion with hardware
    - Potential EBL 3

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Past Medical History/Cardiac Work-up

- Chronic debilitating back pain
- Cardiomyopathy diagnosed 12/20
  - Suspicion post viral myocarditis
  - PET scan w/u negative for myocarditis
  - Chest CT scan notable for diffuse calcium in LAD, RCA distribution
  - EF has improved with GDT
    - 15% (12/20)-31% (12/22)
    - Global biventricular dysfunction
    - No regional wall motion abnormalities

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Physical exam

- Vital signs
  - HR 45 sinus
  - BP 100/55
  - Airway Exam unremarkable
    - Mallampati 1, good neck extention
  - BMI 35
  - Pulmonary/Cardiac Exam unremarkable
    - No edema, murmurs

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Dr. Andropoulos

- Does this patient need additional work-up?
  - Medication titration (beta blockers, statin)
  - Optimization (laboratory assessment)
- How do you risk assess this patient?
  - "what are my anesthetic risks?"
- What invasive monitors do you use for this patient if any?

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Preoperative Workup and Other Considerations

- Ensure that this patient must have this extensive high-risk procedure now
  - Neurologic function compromise?
  - Pain?
- Is a more limited procedure possible?
- Assuming the answer is that the procedure should proceed as planned, in order to make this patient a cardiac transplant candidate
- Major risk factors:
  - Cardiac function
  - High BMI (equivalent of 5' 6", 217 lbs)

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Dr. Andropoulos

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Additional Preoperative Workup/Optimization

- Cardiac catheterization
  - Document the true extent of CAD, intervene when indicated; i.e. stents
  - Pulmonary hypertension with heart failure
- Exercise testing
- Biomarkers: NT-pro-BNP
- Weight loss/diet optimization
  - Greatly reduce cardiac risk
  - Insufficient time and functional status
- Assuming surgery will proceed
- Operative setting:
  - Cardiac center with full expertise available
  - TEE, Impella® or balloon pump, VAD, full cardiac ICU capability
  - Extensive multidisciplinary cardiac planning for monitoring, low CO events, postoperative care
- Patient and family discussion:
  - Extremely high-risk procedure
  - Significant risk of death, stroke, end-organ damage: cardiac, renal

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Assessment of functional capacity before major non-cardiac surgery: an international, prospective cohort study

Duminda N Wijeysundera, Rupert M Pearse, Mark A Shulman, Tom E F Abbott, Elizabeth Torres, Althea Ambosta, Bernard L Croal, John T Granton, Kevin E Thorpe, Michael P W Grocott, Catherine Farrington, Paul S Myles, Brian H Cuthbertson, on behalf of the METS study investigators

Lancet 2018; 391: 2631–40

Implications of all the available evidence

Subjective assessment of functional capacity should not be used for preoperative risk assessment. This commonly used practice does not accurately identify patients with poor fitness or those at increased risk for postoperative morbidity and mortality. As alternatives, clinicians could consider more objective measures, such as DASI questionnaires and NT pro-BNP testing to assess perioperative cardiac risk, and perhaps CPET to predict complications after major elective non-cardiac surgery.

DASI → Duke Activity Status Index

CPET → Exercise Testing

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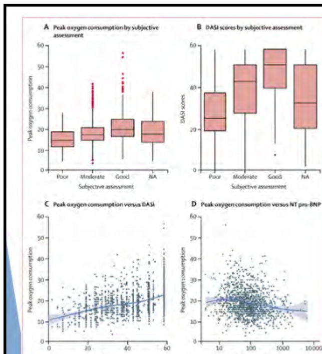

"DASI scores showed significant adjusted associations with the primary outcome of death or myocardial infarction by 30 days after surgery and with death or myocardial injury by 30 days after surgery. Additionally, DASI scores showed significant risk reclassification with death or myocardial injury by 30 days."

Lancet 2018; 391: 2631-40

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Duke Activity Status Index

Name: ____________________ Date: ____________

Can you: (please circle Yes or No)

1. Take care of yourself--that is, eat, dress, bathe, or use the toilet?	Yes	No	2.75
2. Walk indoors, such as around your house?	Yes	No	1.75
3. Walk a block or two on level ground?	Yes	No	2.75
4. Climb a flight of stairs or walk up a hill?	Yes	No	5.50
5. Run a short distance?	Yes	No	8.00
6. Do light work around the house like dusting or washing dishes?	Yes	No	2.70
7. Do moderate work around the house like vacuuming, sweeping floors, or carrying groceries?	Yes	No	3.50
8. Do heavy work around the house like scrubbing floors or lifting or moving heavy furniture?	Yes	No	8.00
9. Do yard work like raking leaves, weeding, or pushing a power mower?	Yes	No	4.50
10. Have sexual relations?	Yes	No	5.25
11. Participate in moderate recreational activities like golf, bowling, doubles tennis, or throwing a baseball or football?	Yes	No	6.00
12. Participate in strenuous sports like swimming, singles tennis, football, basketball, or skiing?	Yes	No	7.50

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Integration of the Duke Activity Status Index into preoperative risk evaluation: a multicentre prospective cohort study

British Journal of Anaesthesia, 124 (3): 261–270 (2020)

Duminda N. Wijeysundera[1,2,3,4,5,*], W. Scott Beattie[3,5], Graham S. Hillis[6,7], Tom E. F. Abbott[8,9], Mark A. Shulman[10,11], Gareth L. Ackland[8,9], C. David Mazer[1,2,3], Paul S. Myles[10,11], Rupert M. Pearse[9], Brian H. Cuthbertson[3,4,12] on behalf of the Measurement of Exercise Tolerance before Surgery Study Investigators

Editor's key points

- The Duke Activity Status Index (DASI) questionnaire is a valid measure of preoperative cardiopulmonary fitness, but it is unclear what threshold scores define an elevated perioperative risk.
- A nested cohort analysis of the Measurement of Exercise Tolerance before Surgery study sample was conducted to characterise the association of preoperative DASI scores with postoperative cardiac complications and moderate-to-severe complications.
- A DASI score of 34 was identified as a threshold for identifying patients at risk for myocardial injury, myocardial infarction, moderate-to-severe complications, and new disability in surgical patients.
- The use of the DASI should help the preoperative identification of patients at an elevated risk of postoperative morbidity.

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Intraoperative Monitoring

- Arterial line
- Central venous pressure: right internal jugular catheter
  - Oximetric catheter
  - PiCCO® system: continuous CO
- Percutaneous PA catheter
  - Cardiac output, PA wedge pressure
  - Pulmonary artery pressure
  - Mixed venous O_2 saturation
- Transesophageal echo
  - Cardiac function
  - Left ventricular volume/filling
- ALL OF THESE MODALITIES ARE COMPLICATED BY PRONE POSITIONING

CRASH

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Perioperative Cardiac Support Modalities

- Inotropic and vasodilator support: dobutamine, epinephrine, milrinone, vasopressin, bolus drugs (phenylephrine, epinephrine, calcium chloride), inhaled nitric oxide if pulmonary hypertension
- Impella®: percutaneous placement in cath lab; needs anticoagulation
  - Suitable for postoperative support
- Frequent ABGs, electrolytes
- Coagulation monitoring: ROTEM®, TEG®
- Cell saver and goal directed therapy for reinfusion; blood transfusion, platelets, coagulation factors
  - SvO_2, Hgb, platelets, prothrombin concentrate, fibrinogen, red cells, cell saver blood
- Planning for cardiac arrest
  - Cover wound, turn supine, ACLS, mechanical support

CRASH

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Postoperative Care

- Admission to CICU ventilated; extubate only when certain that cardiac function is adequate
- Continue the intraoperative monitoring
- Consider Impella® for LCOS

CRASH

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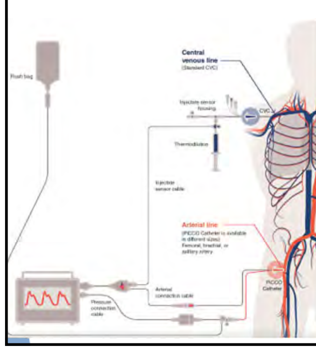
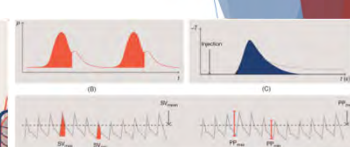
PiCCO® System





Anesthesia for Congenital Heart Disease, 4th Edition, p. 298; Gettinge AB

30

PiCCO® System Display

- Advantages (no disclosures)
  - Standard arterial line/CVP catheter placement
  - Good accuracy
  - No PA catheter or anticoagulation
  - Displays CO and other parameters continuously
- Disadvantages
  - Training required
  - Careful calibration

https://clinicalview.gehealthcare.com

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Impella® System

Abiomed: https://www.heartrecovery.com/

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Impella® Advantages/Disadvantages

- Advantages (no disclosures):
  - Can be placed in cath lab
  - Mostly percutaneous insertion, especially for temporary support
  - Relatively easily removed
- Disadvantages:
  - Anticoagulation required
  - May require axillary artery cutdown

CRASH

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CRASH
Guiding the future of patient care

Case #2

"But doc, its not my heart I worried about, it's the cancer!"

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Case #2

- 65 y/o male prostate cancer
- Robotic prostatectomy possible open PMH
  - CAD: STEMI 1 year ago
    - sudden cardiac death, 3 DES to the LAD, IABP
    - Recent EF 35% akinetic septum
    - Automatic internal defibrillator
    - ASA, Clopidogrel for his stents
- PVD
  - Femoral artery stent, complication of IABP
- Diabetes on insulin
  - HBA1c 7
- CVA
  - Weakness in left arm and slight speech deficit
  - Clopidogrel

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Dr. Brown

- How do you risk assess this patient?
- What do you recommend for this patient's anticoagulation?
- Do you recommend any changes to their defibrillator/biventricular pacing prior to the surgery?

CRASH

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Dr. Brown

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The good news: other than that, he's healthy!

- The major assessment is, on the one hand, quite easy to make:
  - He has a sick heart
  - He has other markers of poor health
  - But, the question is perhaps not "is his risk is high?" but rather "how high is his risk?"

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RCRI

- Several tools can guide risk assessment.
- NISQUIP / VASQUIP are very granular and require a lot of data.
- The most blunt, but perhaps the most ubiquitous: RCRI
  - RCRI consists of 6 binary variables:
    - elevated risk surgery
    - h/o ischemic heart disease
    - h/o CHF
    - h/o cerebrovascular disease (including TIA)
    - pre-op insulin therapy
    - preop creatinine >2 (mg/dL)

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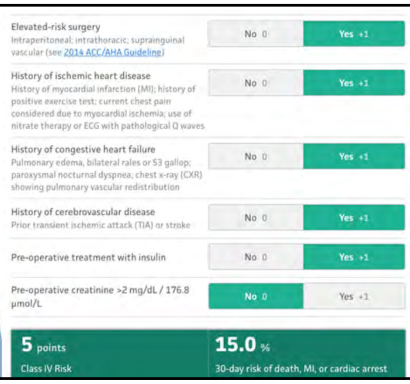
RCRI, cont

- RCRI yields a risk from 3.9% to 15% based on "yes" answers.
- Answering yes to 3 questions gets you to 15%.

- Our patient scores well, or poorly, depending on your outlook with 5/6 and that's assuming no CKD.

  - Here's a shot of the calculator:

40



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Anticoagulation

- Drug eluting stents (DES) require dual anti-platelet therapy (DAPT).

- ACC/AHA give a Class 1 recommendation of 6-12 months of DAPT after modern DES deployment.

  - Clopidogrel can probably stop.
  - ASA can stay.

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AICD management

- The patient has an Bi-V AICD.
- Even modern AICDs often need to be made "dumber" for surgery. Why?
  - Electrocautery can confuse them.
  - Magnet and an AICD?
    - usually turns off all anti-tachycardia therapies and
    - puts pacing in an asynchronous mode (DOO or VOO)
      - (guide in references)

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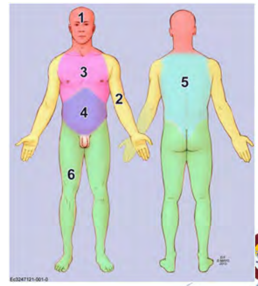
AICD and EM interference risk

- The farther away the electrocautery circuit, the better.
- This surgery is infra-umbilical.
- The electrocautery return pad should be on a lower extremity, and certainly not on the left shoulder or over the precordium!



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AICD Management, cont.

- Is pt paced? If so, how much?
  - The pacemaker keeps track of this and
  - Use of anti-tachycardia therapies.
  - The patient will generally be able to tell you if a shock was delivered…

45

It hurts!

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What if something goes wrong?

- Place external defibrillator pads on patient prior to going to surgery.
- Have magnet available.
  - If magnet placed, and pt needs defib, remove it, or use external pads.
- Communicate this to surgery, unless you don't especially like them, in which case ensure that they're standing in a puddle of saline.

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CRASH

Guiding the future of patient care

Case #3

"my heart is fine, I had the CABG, now I need the aorta fixed!"

Anesthesiology

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Case #3

- 78 y/o with abdominal aortic aneurysm
  - infra-renal endovascular repair
- PMH: CAD s/p CABG 4 years ago, COPD 4L NC, CKD creatinine 3, obstructive sleep apnea
- PSH: CABG complicated by cardiogenic shock (Perioperative ECMO), tracheostomy, temporary dialysis, prolonged rehab

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Dr. Andropoulos

- How important is this patient's functional status in deciding his preoperative work-up?
- The cardiologist says the patient is "cleared" if the anesthesia is done under regional or with sedation?

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Dr. Andropoulos

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Perioperative and long-term outcomes after open conversion of endovascular aneurysm repair versus primary open aortic repair

Nadin Elsayed, MD,[a] Rami Alhakim, MD,[a] Omar Al Nouri, DO,[a] Donald Baril, MD,[b] Fred Weaver, MD,[c] and Mahmoud B. Malas, MD, MHS,[a] *La Jolla and Los Angeles, CA*

J Vasc Surg 2023;77:89-96

Characteristic	P-OAR (n = 4353; 91.4%)	C-OAR (n = 410; 8.6%)	P value
Age, years	72 (68-77)	75 (71-80)	<.001
Female sex	1318 (30.3)	85 (20.7)	<.001
Race			.171
White	4073 (93.6)	376 (91.7)	
Black	154 (3.5)	22 (5.4)	
Other	124 (2.8)	12 (2.9)	
Hispanic or Latino	85 (2)	8 (2)	.993
BMI, kg/m²	26.4 (23.4-30)	27.1 (24.2-30.5)	.077
Symptomatic presentation	546 (12.6)	80 (19.5)	<.001
Hypertension	3685 (84.7)	371 (90.5)	<.001
CAD	1346 (30.9)	145 (35.4)	.068
CHF	364 (8.4)	57 (13.9)	<.001
COPD	1569 (36.1)	135 (32.9)	.203
CKD	1595 (36.6)	184 (44.9)	.001
Dialysis	27 (0.6)	1 (0.2)	.340
Diabetes	740 (17)	86 (21)	.043
Maximum aortic diameter, mm	58 (53-66)	70 (60-83)	<.001
Prior CEA/CAS	191 (6.1)	22 (6)	.924
Prior CABG/PCI	1339 (30.8)	173 (42.2)	<.001
Prior lower extremity revascularization (bypass/PVI)	328 (7.5)	65 (15.8)	<.001
Preoperative smoking			<.001
Never	377 (8.7)	54 (13.2)	
Prior	2204 (50.7)	278 (67.8)	
Active	1770 (40.7)	78 (19)	
Preoperative medication			
Aspirin	2915 (67)	266 (64.9)	.377
P2Y12 antagonist	368 (8.4)	42 (10.2)	.207
Statin	3044 (70)	298 (72.7)	.252
Beta-blocker	2809 (64.6)	276 (67.3)	.269
ACE inhibitor/ARB	1929 (44.4)	162 (43.9)	.844
Anticoagulant	265 (5.4)	75 (20.3)	<.001

8.6% overall conversion rate to open

However, our patient has advanced age, CHF, chronic kidney disease, prior CABG; all of which increase risk of conversion to open surgery.

If his conversion rate risk is actually much higher, i.e. 20-30%, what would you tell the Cardiologist and Patient about anesthetic and surgical risk?
How would this effect your

52

Dr. Brown

- The surgeons are unable to complete the procedure endovascularly
- Upon opening there are inferior ST depressions on the patients 5 lead EKG
  - How do you proceed?
  - Transfusion goals/Hemodynamic goals/Discussion with care team

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Dr. Brown

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Case #3

- If converting to open, anesthetic and surgical risk both increase with conversion to GA.
- I would favor tracheal intubation (over LMA, e.g.) to preserve the ability to use TEE should complications arise in this critically sick person.

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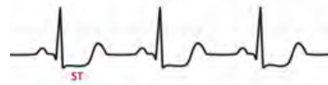
Bad News



- There is active ischemia.
- Management goals are directed toward cardiac perfusion
- Are there guidelines? Yes, but they vary quite a bit.

> Ann Surg. 2021 Jul 1;274(1):86-96. doi: 10.1097/SLA.0000000000004710.

Intraoperative Red Blood Cell Transfusion Decision-making: A Systematic Review of Guidelines

Laura Baker [1, 2], Lily Park [1], Richard Gilbert [1], Hilalion Ahn [1], Andre Martel [1], Tori Lenet [1, 2], Alexandra Davis [3], Daniel I McIsaac [2, 4], Alan Tinmouth [2, 5, 6], Dean A Fergusson [1, 2, 5, 6], Guillaume Martel [1, 2]

Affiliations + expand

PMID: 33630462 DOI: 10.1097/SLA.0000000000004710

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Case #3 management, cont.

- If available, place TEE for intraop monitoring.
- Discuss urgency with surgery.
- If evolution to ST elevations, plaque rupture may have occurred, and patient may need trip to cath lab for revascularization.
  - Alert cardiology, discuss with them. Again, discuss with surgery.

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Summary

- MACE is a common problem
- Risks should be guided by the surgery, patient risk factors, timing
- Case 1
  - Functional status important
  - BNP, Duke Activity score can act as surrogates
  - Advanced monitoring may help
  - Cardiac Support devices/Post operative expert care
- Case 3

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Summary

- Case 2
- NISQUIP / VASQUIP data bases give strong evidence based outcomes data
- Helpful for discussion when alternative treatments are available
  - Chemo/Radiation

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Summary

- Case 3

60

References

- RCRI tool (at MDCalc): https://www.mdcalc.com/calc/1739/revised-cardiac-risk-index-pre-operative-risk
- Fleisher LA, et al. "2014 ACC/AHA guideline on perioperative cardiovascular evaluation and management of patients undergoing noncardiac surgery: executive summary: a report of the American College of Cardiology/American Heart Association Task Force on Practice Guidelines." *Circulation*. 2014 Dec 9;130(24):2215-45. PMID: 25085962.
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- Friedman H, et al. Predictors of intraoperative electrosurgery-induced implantable cardioverter defibrillator (ICD) detection. J Interv Card Electrophysiol. 2017 Jan;48(1):21-26. PMID: 27665098.
- Guide to AICDs/PPMs here.
- Thomas H, et al. "Guidelines for the peri-operative management of people with cardiac implantable electronic devices: Guidelines from the British Heart Rhythm Society." *Anaesthesia*. 2022 Jul;77(7):808-817. PMID: 35429334.
- Baker L, et al. "Intraoperative Red Blood Cell Transfusion Decision-making: A Systematic Review of Guidelines." *Ann Surg*. 2021 Jul 1;274(1):86-96. PMID: 33630462.

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Questions for our Panelists

- Special thanks:
- Dr. Brown
- Dr. Andropoulos
- Dr. Ing
- Chrissie Butz

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Point of Care Ultrasound

Marianne Wallis M.D.
University of Colorado Hospital
Department of Emergency Medicine
Department of Anesthesiology, Critical Care Section

1

Disclosures

- None

2

Faculty

- Marianne Wallis, MD
- Jason Brainard, MD
- Kenji Tenabe, MD
- Hans Tregear, MD
- Nicholas Houska, MD
- Samuel Gilliland, MD

3

Objectives

- Obtain the following cardiac views: parasternal long axis, parasternal short axis, apical four chamber and subxiphoid.
- Identify basic cardiac structures in these four views
- Understand basic lung ultrasound and identify lung sliding and pleural effusions

4

Overall Flow

- 6 Rotations: ~ 18 minutes at each station
  - Parasternal long and short axis (Dr. Wallis)
  - Subxypohid view (Dr. Gilliland)
  - Apical view (Dr. Houska)
  - Cardiac function (Dr. Tenabe)
  - Lung Ultrasound (Dr. Brainard)
  - Volume responsiveness/Pathology (Dr. Tregear)
- Hands-on time for each learner to obtain the view

5

Where to go from here?

- American Society of Anesthesiologists now has a certification process
- POCUS ACGME requirements now in place
- PRACTICE PRACTICE PRACTICE!
- DON'T MAKE SIGNIFICANT CLINICAL DECISIONS YET!

6

Question and Answer Session

- Please see me or any of my colleagues after the session for further questions
- Feel free to contact me if you think of additional questions
  - Marianne.wallis@cuanschutz.edu

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Wednesday, March 1st

Perioperative Implications of Cannabis Use

Rachael Rzasa Lynn, MD
Associate Professor, Department of Anesthesiology
University of Colorado Anschu

Objectives

- Understand the cardiovascular effects of cannabis administration
- Discuss pulmonary effects of cannabis use
- List common drug interactions with cannabis
- Describe the effects of cannabis on post-operative pain

Disclosures

- Grant/research support from the Colorado Department of Public Health & Environment, National Institutes of Health and US Department of Defense

What is cannabis?

- **Marijuana =** *Cannabis sativa* **(also** *indica, ruderalis, afghanica***)**
  - **Cultivation can be traced back to 10,000 BC**
    - **First evidence of medicinal use (analgesic) in 4,000 BC**
  - **High degree of inbreeding or hybridization → CANNOT predict the biochemical content based upon strain name or physical appearance**
    - **"Chemovar"**

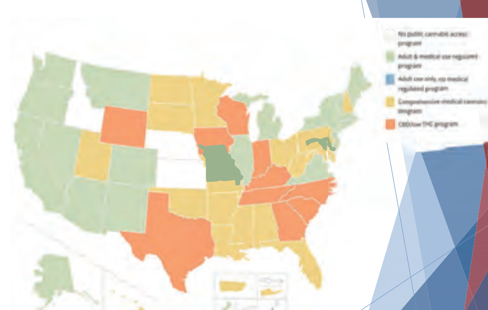
What is cannabis? Numerous active components

- Psychoactive:
  - **Δ^9-tetrahydrocannabinol (THC)**
  - **Cannabidiol (CBD)**
    - Non-intoxicating BUT may be anxiolytic, anti-psychotic, anti-depressant
  - Δ^8-tetrahydrocannabinol
    - (less psychoactive, found in trace amounts if at all)
  - Cannabinol
    - Nonenzymatic oxidative breakdown product of THC found in old Cannabis
  - Tetrahydrocannabivarin (THCV)
    - Neutral antagonist of CB_1 at low doses but agonist at high doses
    - Not found in high levels in most Cannabis strains
  - Terpenoids (eg myrcene, limonene)
- Anti-inflammatory and other:
  - CBD
  - Numerous other minor cannabinoids
    - Cannabichromene, cannabigerol, cannabidivarin
  - Flavonoids
    - Apigenin, quercetin
  - Numerous terpenoids
    - anti-inflammatory & modulate THC effects

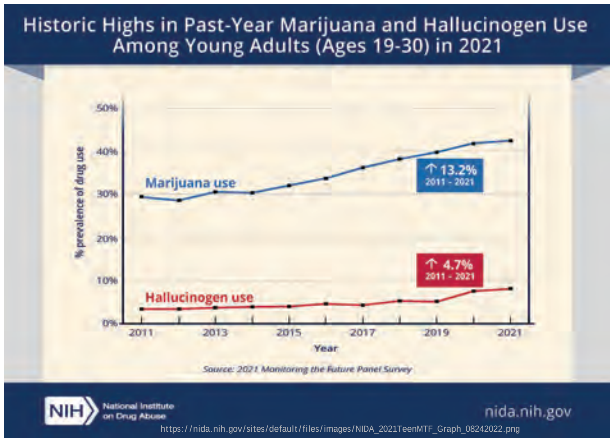
Piomelli D and Russo EB (2016) Cannabis Cannabinoid Res **1**(1): 44-46.
Katz-Talmor D (2018) Nat Rev Rheumatol 14(8): 488-498.

State policies and demographics

- Cannabis is the most commonly used federally illegal drug in the US
  - Nearly a fifth of people aged 12 or older reported use in 2021



As of May 2022
https://www.ncsl.org/health/state-medical-cannabis-laws
https://www.samhsa.gov/data/sites/default/files/2022-12/2021NSDUHFFRHighlights092722.pdf

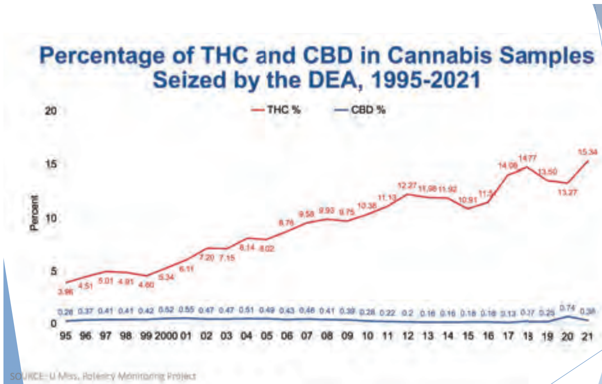


https://nida.nih.gov/sites/default/files/images/NIDA_2021TeenMTF_Graph_08242022.png

Cannabis Risks

- About 30% of people who use cannabis have cannabis use disorder.
  - Risk increased for people who begin using marijuana before age 18
- Long-term or frequent cannabis use linked to increased risk of psychosis
- Cannabis use increases the risk of suicidal ideation and attempts in adults and adolescents
- Increased risk of pregnancy complications: decreased birth weight, preterm delivery
  - May affect fetal brain development leading to attentional deficits, behavioral problems, psychopathology and lowered cognition
- Pulmonary effects
- Cardiovascular effects

https://www.cdc.gov/marijuana/data-statistics.htm
JAMA Netw Open. 2021;4(6):e2113025. *JAMA Netw Open.* 2022;5(1):e2145653
Current Opinion in Anaesthesiology 2020. 33(3):p 318-326



https://nida.nih.gov/sites/default/files/images/cannabispotency-2022.png

Not your parents' grass: THC Content

- NIDA Cannabis "High THC" concentration is 5-10%
- **Average** retail flower in Colorado is over 19%
- Concentrates (inhaled, edible, etc.) allow for even higher THC consumption
  - Average concentrate products sold by the gram were 68% THC in 2020
    - Vaporizer cartridge potency increased from 69% THC in 2019 to 80% in 2020
    - MMJ Edible average THC content increased from 540 to 737 milligrams from 2019 to 2020
- Package labeling may be wildly inaccurate

https://drive.google.com/drive/u/0/folders/1iD4pFQd3iBz_ZNtyjau-6iz5OaL7N23i
https://sbg.colorado.gov/sites/sbg/files/2020-Regulated-Marijuana-Market-Update-Final.pdf

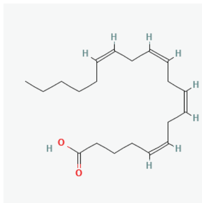
Marketed cannabinoids

Drug Name	Cannabinoid	FDA indication	Dosing
dronabinol	synthetic THC	n/v 2/2 chemotherapy; also anorexia in HIV/AIDS	start 2.5mg PO BID, max dose 10mg PO BID
nabilone	synthetic THC analog	n/v 2/2 chemotherapy	1-2mg PO BID
Epidiolex (cannabidiol)	CBD extract	seizures in Lennox-Gastaut or Dravet syndrome	start 2.5mg/kg BID up to 10mg/kg BID
nabiximols	THC and CBD extract 2.7mg THC: 2.5mg CBD/spray	none: not approved in US. Use in Canada, Europe for MS spasticity	oromucosal spray: titration from 1/day up to 12/day divided BID

Cannabis Pharmacology

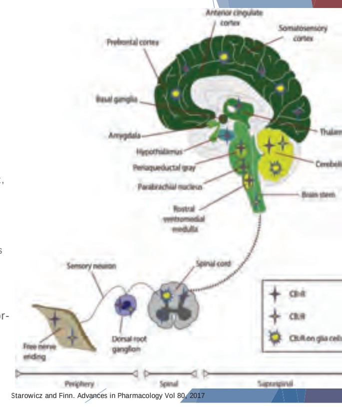
Cannabis pharmacology
Endocannabinoid System

- Endogenous cannabinoids
  - Chemically similar to arachidonic acid
    - Arachidonoylethanolamide (AEA) aka anandamide
    - 2-arachidonoylglycerol (2-AG)
- Enzymes and proteins for EC synthesis, degradation and re-uptake
  - Different enzymes for AEA and -AG synthesis
  - Degradation: oxygenation or hydrolysis
    - AEA: Fatty-acid amide hydrolase (FAAH)
    - 2-AG: Monoacylglycerol lipase
    - Both: oxygenation by COX-2, lipoxygenases or CYP450 enzymes
- G-protein-coupled receptors



Cannabis pharmacology
Endocannabinoid System

- G-protein-coupled receptors
  - CB1: Expressed in CNS (and PNS)
    - Nerve axons and presynaptic terminals
      - Also in thyroid, adrenals, liver, adipose tissue, GI tract, reproductive organs and immune cells
  - CB2: "Peripheral" cannabinoid receptor
    - Expressed on immune cells
      - Also chondrocytes, osteocytes, fibroblasts, and DRG as well as microglia
- Non-cannabinoid receptors:
    - TrpV1 (ligand-gated cation channel), "CB3" aka G protein-coupled receptor 55, Peroxisome proliferator-activated receptor-α, etc.

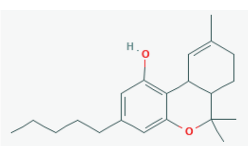


Starowicz and Finn. Advances in Pharmacology Vol 80, 2017

THC vs CBD

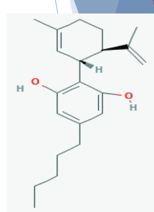
THC

- "Psychoactive" = psychotomimetic
- Agonist at CB_1 and CB_2 receptors



CBD

- Anti-inflammatory analgesic
- Relatively low affinity for CBR
  - Partial agonist at CB1
  - Weak inverse agonist at CB2
    - May activate both indirectly by increasing AEA and 2-AG
- Modulates and activates glycine receptors (so do THC and AEA)



Hemp products (by definition <0.3% THC) widely available, NOT regulated → unreliable THC component: may contain 12x legal limit

Katz-Talmor D (2018) Nat Rev Rheumatol 14(8): 488-498.
JAMA 2017 318(17):1708-1709 Cannabis Cannabinoid Res 2:274-81

Cannabis pharmacology

- Inhaled exposure → peak 15-30 minutes, effects can last > 8 hrs
- Oral exposure → onset 30 minutes to 3 hrs, lasts up to 12 hrs
  - Extensive first-pass metabolism, oral bioavailability is 10-20%
- Frequent dosing leads to accumulation (long terminal half life)
- ASRA guidelines (2022) recommend screening for cannabis use, inquiring further about dose & frequency, route of administration, and time of last use

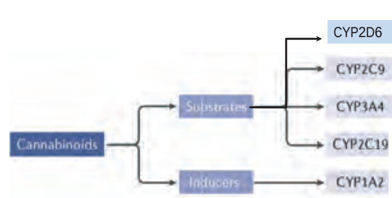
Cannabis pharmacology
Drug-drug interactions

Postulated drug interactions

Drug	Postulated result of interaction with cannabinoids
Opioids	↑Pain reduction M-opioid receptor can form a heterodimer with CB1
Cocaine	Might cause tachycardia and euphoria
Disulfiram	Hypomania
Ethanol	↑THC in serum
Warfarin	↑INR (case report)
Sildenafil	Myocardial infarction (case report)
Tricyclics	Transient cognitive changes, delirium and tachycardia (case series)
SSRIs	Mania (case report)
Lithium	↑Lithium
Barbiturates	CNS depression
Anti-cholinergic agents	Sedation
Olanzapine	Delirium

Katz-Talmor D (2018) Nat Rev Rheumatol 14(8): 488-498.

Cannabis pharmacology
Drug-drug interactions



Drug levels possibly increased by THC/CBD:

MSO4, tramadol (2D6)
Metoprolol, amiodarone (2D6)
Haloperidol (2D6)

Warfarin (2C9)
Buprenorphine (2C9)
NSAIDs (2C9)
Anticonvulsants (2C9)

Clopidogrel (2C19)

Katz-Talmor D (2018) Nat Rev Rheumatol 14(8): 488-498.
Shah S (2023) Reg Anesth Pain Med 2023;0:1-21

Cannabis and anesthetics

- Propofol affects endocannabinoid system in mouse models
  - Propofol activates CB_1 indirectly via increase in brain AEA (also inhibits FAAH)
    - Propofol effect **requires CB_1 activation**
- Patients using cannabis require more propofol for induction and LMA insertion
  - Significantly more additional Propofol required for LMA insertion for cannabis users (314±109.3mg) than non-users (263.2±69.5mg)
  - BIS <60 achieved in 57% of cannabis users, 73% of non-users (p=0.18) with fixed mg/kg propofol doses

Patel S (2003) British Journal of Pharmacology (2003) 139, 1005-1013
Flisberg, P. (2009). Eur J Anaesthesiol 26(3): 192-195.

Cannabis and anesthetics

- Patients using cannabis may require greater doses for procedural sedation

Amount of Required Sedation in Regular Cannabis Users Compared With Nonusers

	Amount of Sedation Required			P Value	
Sedative	Cannabis Nonusers (n=225)	Cannabis Users (n=25)	Greater Requirement, %	t Test	Mann-Whitney U Test
Fentanyl, µg	109.91	125.93	14	.029	.002
Midazolam, mg	7.81	9.15	19.6	<.001	<.001
Propofol, mg	13.83	44.81	220.5	.026	.001

- In a retrospective analysis of 118 patients undergoing tibial fracture repair, cannabis use was associated with greater ml administration of sevoflurane
  - No difference in desflurane, no difference in propofol, no controlling for FGF, etc.

Twardowski M (2019) J Am Osteopath Assoc.
J Clin Anesth. 2020 Dec;67:109980.

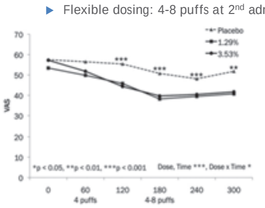
Cannabis and Pain

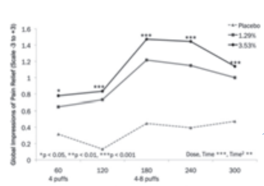
Cannabis for chronic non-cancer pain

- **Pain** is the number one indication for medical cannabis use **#1**
- Majority of studies evaluated neuropathic pain and MS-related spasticity
- Commonly used nabiximols (THC-CBD oromucosal spray, not approved in US)
  - Also cannabis flower, dronabinol (synthetic THC), nabilone (synthetic THC analog), very few CBD

Cannabis and Neuropathic Pain: Acute Effects – Wilsey et al (2013)

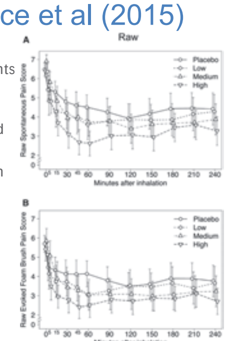
- 39 patients with heterogenous neuropathic pain disorders
- Randomized, double-blind, placebo-controlled crossover design
- Compared vaporized medium (3.53%) vs low- (1.29%) THC vs placebo cannabis
  - Flexible dosing: 4-8 puffs at 2nd admin





Cannabis and Neuropathic Pain: Acute Effects – Wallace et al (2015)

- Crossover RCT in 16 patients with painful diabetic neuropathy
- Single exposure, vaporized
- Placebo vs low (1% THC), medium (4% THC) and high (7% THC) doses
- Spontaneous pain and Evoked pain



- No significant result for proportion of participants who experienced 30% reduction in spontaneous pain

Dose	Avg Pain Intensity Score Difference from Placebo	
Low	-0.44	(p<0.05)
Med	-0.42	(p<0.05)
High	-1.2	(p<0.001)

Wallace (2015). The Journal of Pain 16, 616-627

Cannabis for chronic non-cancer pain

- Decreasing effect size with increasing study duration: greatest effect seen with intervention <4 weeks
  - Single administration provides significant relief of chronic *neuropathic* pain
  - Smaller and more inconsistent outcomes with ongoing cannabis use
- Observational studies report significant effects, while RCTs find very small effect sizes (<5mm on 100mm VAS vs placebo)

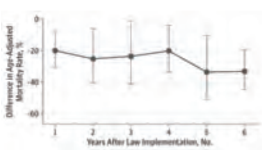
Cannabinoid Analgesic Effects: Opioid Sparing in Pre-Clinical Models

- Numerous studies show opioid sparing effects when cannabinoids are co-administered with opioids in animal models of acute and chronic pain.
  - Meta-analysis of pre-clinical animal models:
    - Median effective dose (ED50) of morphine is **3.6 times lower** when administered in combination with THC than alone.
    - The ED50 for codeine administered with THC is **9.5 times lower** than the ED50 for codeine alone.

Nielsen et al. Neuropsychopharmacology 2017 Vol 42

Cannabis and Opioids – Population Data

- Opioid analgesic overdose death rates from 1999-2010 were lower in states with medical cannabis (MC) laws
- Reduction increased over time following MC legislation



- States with MC laws saw decrease in opioid prescriptions filled in Medicare database from 2010-2015
  - Most significant for hydrocodone and morphine (17.4% and 20.7% reductions)
- MC laws were associated with a 5.88% lower rate of opioid prescribing in Medicaid database
- In a sample of patients with commercial insurance (n=4,840,562) 2006-2014, MC legalization was associated with lower odds of:
  - Any opioid use (OR 0.95; 0.94-0.96)
  - Chronic opioid use (OR 0.93; 0.91-0.95)
  - High risk opioid use (OR 0.96; 0.94-0.98)

Bradford,et al. 2018 JAMA Intern Med 178, 667-672. Wen et al 2018. JAMA Intern Med 178.
Shah 2019. J Gen Intern Med 34, 1419-1426

Cannabis and Opioids: Clinical Data


BMJ Open Opioid-sparing effects of medical cannabis or cannabinoids for chronic pain: a systematic review and meta-analysis of randomised and observational studies

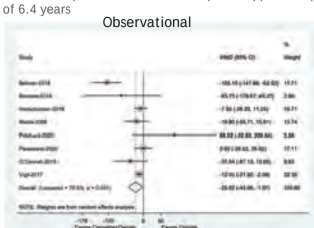
Atefeh Noori, Anna Miroshnychenko, Yaadwinder Shergill, Vahid Ashoorion, Yasir Rehman, Rachel J Couban, D Norman Buckley, Lehana Thabane, Mohit Bhandari, Gordon H Guyatt, Thomas Agoritsas, Jason W Busse

- 2021 meta-analysis found only 18 publications (RCTs or observational studies) reporting the impact of medical cannabis initiation on opioid use for chronic pain
- 5 RCTs, 13 observational
  - All 5 RCTs and 3 observational enrolled only **cancer pain**
  - All RCTs administered isolated or synthetic cannabinoids
  - All RCTs instructed patients to maintain prescribed pain med doses

Cannabis and Opioid Use for Pain (Noori): Opioid Use

- Minimal change in opioid use in RCTs (WMD -3.4MME, 95% CI -12.7 – 5.9)
- Data from 8 observational studies suggests adding cannabis may reduce opioid use in CNCP (WMD -22.5 MME, 95% CI -43.06 – -1.97)
  - 1 study found >1/2 of patients with low back pain stopped all opioid use at median follow-up of 6.4 years

Observational



Cannabis opioid-sparing effects: chronic opioid use

- Cannabis use results in self-reported reductions in opioid use for pain in observational studies
- Low quality evidence of reduced opioid requirement after initiation of short-term smoked/vaporized cannabis
- Higher quality studies have not found an opioid sparing effect

THC and opioids: safety concerns

- Few studies report on vital signs when opioids and cannabinoids combined
  - No evidence of respiratory depression or CV complications when CBD given prior to IV fentanyl bolus (0.5 or 1mcg/kg)
  - Dronabinol 20mg + morphine 30mg PO resulted in statistically significant change in SBP and DBP, as well as SpO2 (magnitude not reported)
    - Dronabinol alone increased HR
  - IV THC after oxymorphone:
    - increased sedation
    - Further decreased ventilation
    - At highest THC dose (134mcg/kg), HR and Cardiac Index increased while TPR decreased

Cannabis for post-op pain

- Adding dronabinol reduces opioid use and improves pain control in retrospective analysis (regardless of pre-admission cannabis use history)
- Clinical trials have investigated the post-operative analgesic (or antiemetic) effect of several cannabinoids
  - Dronabinol
  - Nabilone
  - levonantradol
  - Other novel cannabinoid agonists
  - CBD (buccal)
- 2020 meta-analysis of 6 trials found a significant reduction in pain vs placebo only for IM cannabinoids (1 trial), not for oral administration

Table 4. Pain Scores

Route	No. of Studies	No. of Patients	Mean difference [95% CI]
All	6	678	−0.90 [−1.69, −0.10]
Oral	5	622	−0.21 [−0.64, 0.22]
Intramuscular	1	56	−2.98 [−4.09, −1.87]

Cannabis Cannabinoid Res 2020;5:290-7.

Post-op pain in patients who use cannabis

- Mixed findings regarding differences in post-op or opioid use between cannabis users and non-users
  - Many studies under-powered
  - Cannabis use by diagnosis code (database analyses) vs patient history
  - Poor quantitation of post-op opioid use following discharge
  - Confounder of co-morbid pre-operative opioid use
    - Several studies have found that patients using cannabis preoperatively were significantly more likely to also use opioids and BZDs preoperatively

Salottolo (2018) Patient Safety in Surgery 12:16

Post-op pain and opioid use in patients who use cannabis

- McAfee 2021 – cannabis users reported more pain day of surgery, greater functional impairment, more symptoms of anxiety and depression versus non-users
  - 6% patients reported cannabis use (state where only medical cannabis was legal), over half for medical use only
  - No difference in surgical site pain at 3 or 6 months post-op
    - Users more likely to continue opioid use at 3 and 6 months but no significant difference in OME at either time

Post-op pain and opioid use in patients who use cannabis

- Retrospective multi-institutional pilot study from 3 trauma centers in CO and 1 in TX
  - 21% (54/261) of patients reported marijuana use and 30% of those reported chronic use (daily or almost daily use or >1oz over past month)
    - **Opioid use was greater** in marijuana users, both chronic and episodic, vs non-users (7.1 and 7.8, respectively vs 5.7, $p<0.05$)
      - association was not true for marijuana users who also used other dugs
    - **Pain scores were significantly greater** throughout the duration of hospitalization for marijuana users
      - Higher for episodic users than chronic users or non-users
- Retrospective review of gynelcologic oncology patients
  - those who used cannabis (almost 10%) had **significantly higher pain and opioid use** at both 12 and 36 hours post-op (did not control for intra-op medications like ketamine)

Salottolo (2018) Patient Safety in Surgery 12:16

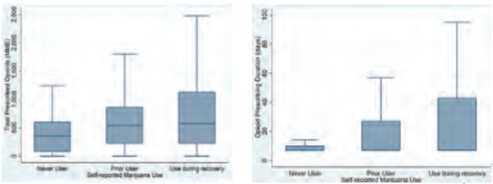
Post-op pain and opioid use in patients who use cannabis: orthopedic surgery

- Liu (2018): Internal database retrospective matched cohort analysis of major orthopedic surgery patients: cannabis users experienced **significantly more pain** at rest (5.0 vs 3.0), with movement (8.0 vs 7.0) and more sleep interruption due to pain (72% vs 58%)
- Ong (2022): single institution matched cohort of patients undergoing THA, **no difference in inpatient opioid use, opioid refills** between cannabis users and non-users
- Bowers 2022 surveyed all patients undergoing elective hand or UE surgery regarding cannabis use. **No difference in post-op opioid** use after surgery between users and non-users of cannabis, but those who reported cannabis use had **lower scores on quality of life** instrument and this was associated with increased opioid use after surgery
- Moon 2022 retrospective review all patients undergoing 1 or 2 level posterior spinal fusion at a single institution, separately analyzed only those not taking opioids pre-op. Cannabis use associated with **greater incidence of depression, increased post-op opioid use throughout hospitalization (no control for LOS) and MME prescribed after discharge**
- Wood 2022 retrospective claims analysis of patients who underwent hip arthroscopy with dx cannabis use, dependence or abuse w/in 5 years prior – matched cohort**, no difference in prescription opioid use within 60 days after surgery**
  - Queried 50,458 patients, found 360 with cannabis history (0.71%)

Liu (2018) Anesth Analg.

Marijuana use and Post-operative Pain

- Retrospective survey of 500 patients with musculoskeletal injury
  - Never user, prior user (but not during recovery) and user during recovery
    - Latter group: more total opioids and longer duration of use (but not persistent use)
      - 89% reported that marijuana helped their pain, and 81.1% said they used less opioids
        - BUT still significantly greater total MME rx and duration
      - Less effective coping strategies (more catastrophizing, greater anxiety at baseline)



Bhashyam, A. R., et al (2018). *J Bone Joint Surg Am* **100**, 2095-2102.

Cannabis-opioid interactions: cardiovascular and pulmonary effects

- THC administration alone does not affect ventilation or O2 saturation, however co-administration with opioids may further decrease ventilation and CO2 response
  - does not change respiratory rate
- No evidence that CBD + opioid affects respiratory or cardiovascular parameters

Pulmonary effects of cannabis use

Cannabis smoking and lung disease

- Effects of cannabis use on lung function difficult to discern
  - Cannabis smoke contains similar chemicals and particulates found in tobacco smoke, some in even greater quantities
  - Co-morbid tobacco use
    - Use of cannabis + tobacco worse than tobacco or cannabis alone
  - Results in obstructive pulmonary disease
    - Increased sputum, cough, wheezing among young cannabis users
    - Cannabis smoking reduces FEV_1/FVC ratio*

      *Lung volumes may be altered by breathing practices associated with cannabis smoking
      - Increased total lung capacity
      - Increased FVC

Pulmonary effects of acute cannabis use

- THC induces **bronchodilation** (oral or inhaled)
  - But inhalation of combustion products may irritate airways and cause bronchoconstriction in patients with RAD
- Case reports
  - Several reports of hemoptysis shortly after cannabis use
  - Case report of alveolar hemorrhage after GA
- EVALI
  - Dyspnea, fatigue, hypoxemia
  - acute eosinophilic pneumonia, diffuse alveolar hemorrhage, lipoid pneumonia, and respiratory-bronchiolitis interstitial lung disease

Cardiovascular implications of cannabis use

Acute cardiovascular effects of cannabis use

- Tachycardia
  - Peaks 10-30 minutes after inhalation of cannabis smoke
  - Bradycardia possible with repeated use
- Hypertension vs Hypotension – dose and chronicity
  - THC: tachycardia + hypertension from beta-adrenergic activation and parasympathetic inhibition in naïve users
  - With high doses or chronic usage → hypotension (diastolic)
  - Reduced cardiac output following THC administration in animals (reduced venous return)
- Possibly dysrhythmias

Acute cardiovascular effects of cannabis use

- Cannabis smoke increases carboxyhemoglobin, thus decreasing O_2 carrying capacity
- Unclear effects on coagulability
  - In a very small study of trauma patients, +THC associated with hypercoagulability on TEG
  - Most studies find platelet function impaired with chronic THC administration
    - One in vitro study found enhanced irreversible platelet aggregation with high but not low THC

Acute cannabis use and Myocardial Infarction

- Nearly 5-fold increased risk of MI in the first hour after smoking cannabis
  - MI onset within 5 hours of use in the majority of cases
- Frequency of cannabis use associated with risk of mortality after MI
  - 2.5-fold if use <1x weekly
  - 4-fold risk if more frequent use
- Adjusted odds of postoperative myocardial infarction after major elective surgery was 1.88 times higher for patients with vs without active cannabis use disorder in a large retrospective analysis
- CUD also associated with greater risk of post-operative cerebrovascular event

Recommendations

- Screen for cannabis use, includingdose & frequency, route of administration, and time of last use
- Counsel patients on the risks of cannabis use
- Delay elective surgery at least 2 hours after cannabis use
- If possible, consider avoidance of cannabis use for 72 hours before surgery
  - Cannabis withdrawal: measure on cannabis withdrawal scale
    - Consider use of nabilone or dronabinol, also data for gabapentin
- Be aware of possible obstructive lung disease pathology and manage ventilation accordingly
- Adjust anesthetic and analgesic doses as clinically indicated

Shared Decision Making in the Perioperative Setting:

A complex multifaceted construct

Hilary P. Grocott, MD, FRCPC
Professor, Department of Anesthesiology, Pharmacology & Therapeutics
University of British Columbia

1

Outline: shared decision making

- Definition
- Historical perspectives
- Why we should do it
- How to do it
- Challenges to SDM

2

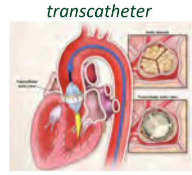
Case Study

- 56 year old female with severe aortic stenosis
- NYHA II-III symptoms
- AVA = 0.8 cm^2
- normal LVEF
- “otherwise healthy”
- referred to cardiac surgeon for AVR

3

AVR: which option?

transcatheter



TAVR

surgical

SAVR

4

The Evidence

European Journal of Cardio-Thoracic Surgery 52 (2017) 616–664
doi:10.1093/ejcts/ezx324 Advance Access publication 26 August 2017

2017 ESC/EACTS Guidelines for the management of valvular heart disease

The Task Force for the Management of Valvular Heart Disease of the European Society of Cardiology (ESC) and the European Association for Cardio-Thoracic Surgery (EACTS)

Eur J Cardio-Thorac Surg 2017;52:616-664

5

The Evidence

CLINICAL PRACTICE GUIDELINE: FOCUSED UPDATE

2017 AHA/ACC Focused Update of the 2014 AHA/ACC Guideline for the Management of Patients With Valvular Heart Disease

A Report of the American College of Cardiology/American Heart Association Task Force on Clinical Practice Guidelines

Developed in Collaboration With the American Association for Thoracic Surgery, American Society of Echocardiography, Society for Cardiovascular Angiography and Interventions, Society of Cardiovascular Anesthesiologists, and Society of Thoracic Surgeons

Nishimura et al. JACC 2017;70:252-89

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Benefit

Risk

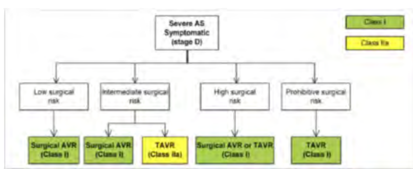
7

High Quality Evidence

Low Quality Evidence

8

What do the guidelines say?



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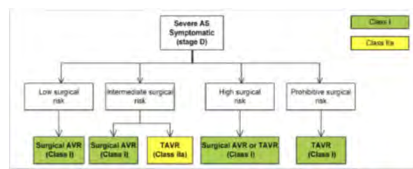
What do the guidelines say?



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Circulation

ACC/AHA CLINICAL PRACTICE GUIDELINE

2020 ACC/AHA Guideline for the Management of Patients With Valvular Heart Disease

A Report of the American College of Cardiology/American Heart Association Joint Committee on Clinical Practice Guidelines

Otto CM et al. Circulation 2021;143:e72-e227

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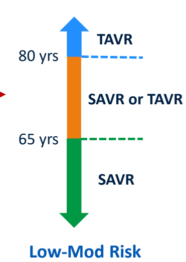
SAVR vs TAVR?



Otto CM et al. Circulation 2021;143:e72-e227

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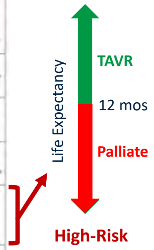
SAVR vs TAVR?



Otto CM et al. Circulation 2021;143:e72-e227

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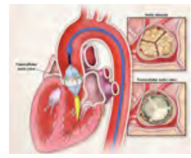
Which valve strategy should she pursue?



A) TAVR

B) SAVR

14

If SAVR, which valve option do you recommend?

A) Mechanical

B) Bioprosthetic

Nishimura et al. JACC 2017;70:252-89

15

The Evidence

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Nishimura et al. JACC 2017;70:252-89

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What do the guidelines say?

IIa	B-NR	An aortic or mitral mechanical prosthesis is reasonable for patients less than 50 years of age who do not have a contraindication to anticoagulation (141,149,151,155-157).
See Online Data Supplement 20 (Updated From 2014 VHD Guideline)		

IIa	B	A bioprosthesis is reasonable for patients more than 70 years of age (163-166).

Nishimura et al. JACC 2017;70:252-89

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Circulation

ACC/AHA CLINICAL PRACTICE GUIDELINE

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A Report of the American College of Cardiology/American Heart Association Joint Committee on Clinical Practice Guidelines

Otto CM et al. Circulation 2021;143:e72-e227

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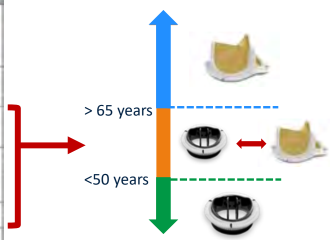
Mechanical vs Bioprosthetic AVR?



Otto CM et al. Circulation 2021;143:e72-e227

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Risks: *Bioprosthetic vs Mechanical?*

1) *Thromboembolism*
2) *Major Bleeding*
3) *Reoperation*
4) *Survival*

20

Risks: *Bioprosthetic vs Mechanical?*

REVIEWS

Mechanical Versus Bioprosthetic Aortic Valve Replacement in Middle-Aged Adults: A Systematic Review and Meta-Analysis

Dong Fang Zhao, BA, Michael Seco, BMedSc, MBBS, James J. Wu, BMusStudies, James B. Edelman, MBBS(Hons), PhD, Michael K. Wilson, MBBS, Michael P. Vallely, MBBS, PhD, Michael J. Byrom, MBChB, PhD, and Paul G. Bannon, MBBS, PhD

Sydney Medical School, University of Sydney, Sydney; Baird Institute of Applied Heart and Lung Surgical Research, Sydney; Cardiothoracic Surgery Unit and Institute of Academic Surgery, Royal Prince Alfred Hospital, Sydney; and Australian School of Advanced Medicine, Macquarie University, Sydney, Australia

Studies = 12; n = 8,661

Zhao DF et al. Ann Thorac Surg 2016; 102:315-27

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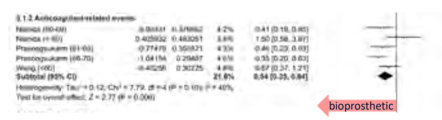
Bioprosthetic *vs* Mechanical: embolism



Thromboembolism

Hazard Ratio (95% CI) = 0.54 (0.35 to 0.84)

Zhao DF et al. Ann Thorac Surg 2016; 102:315-27

22

Bioprosthetic *vs* Mechanical: bleeding

Major Bleeding

Hazard Ratio (95% CI) = 0.48 (0.39 to 0.59)

Zhao DF et al. Ann Thorac Surg 2016; 102:315-27

23

Reoperation for Valve Deterioration

Long-Term Safety and Effectiveness of Mechanical Versus Biologic Aortic Valve Prostheses in Older Patients

Results From the Society of Thoracic Surgeons Adult Cardiac Surgery National Database

J. Matthew Brennan, MD, MPH; Fred H. Edwards, MD; Yue Zhao, PhD; Sean O'Brien, PhD; Michael E. Booth, MBA; Rachel S. Dokholyan, MPH; Pamela S. Douglas, MD; Eric D. Peterson, MD, MPH; on behalf of the DEcIDE AVR (Developing Evidence to Inform Decisions about Effectiveness–Aortic Valve Replacement) Research Team

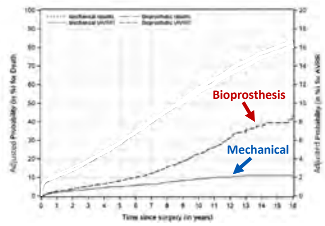
N = 24,410 bioprosthesis

N = 14,789 mechanical

Brennan JM et al. Circulation 2013;127:1647-1655

24

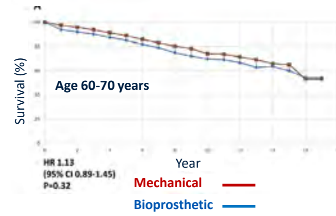
Reoperation for Valve Deterioration



Brennan JM et al. Circulation 2013;127:1647-1655

25

Bioprosthetic *vs* Mechanical: survival



Zhao DF et al. Ann Thorac Surg 2016; 102:315-27

26

Re-do AVR: valve-in-valve TAVR?

Jayendrakumar JS et al. Cather Cardiovasc Interv 2017;00:1-5

27

Re-do AVR: expanding options for TAVR?

Inspirus Resilia® valve

28

Which valve do you recommend?

A) Mechanical

B) Bioprosthetic

29

Do we have enough information to make a recommendation?

What does she want?

What are her concerns?

What are her values?

30

Shared Decision Making (SDM)

https://canadiem.org/shared-decision-making/

31

Shared Decision Making: definition

The process of using the best available evidence to support patients in making healthcare decisions ***based on the patient's own values, preferences, and beliefs.***

32

Historical Considerations

33

Paternalistic Model

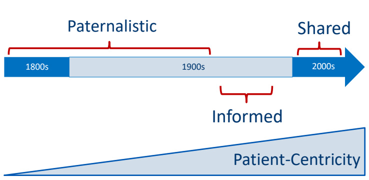
"the obedience of a patient to the prescriptions of his physician should be prompt and implicit. The patient should never permit his own crude opinions as to their fitness to influence his attention to them"

1847 *Code of Medical Ethics (American Medical Association)*

https://collections.nlm.nih.gov/catalog/nlm:nlmuid-63310420R-bk

34

Decision Making Types



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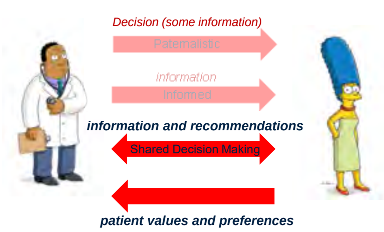
Decision Making Types



36

SHAREd Decision Making: Steps

1. Seek patient participation
2. Help explore treatment options
3. Assess patient values and preferences
4. Reach a decision with your patient together
5. Evaluate your patient's decision

37

Why SDM?

38

SDM as Ethical Imperative

"The imperative for SDM must rest on the principles of good clinical practice, respecting patients' right to know: that their informed preferences should be the basis for professional actions"

Elwyn et al. Eur J Pers Centered Health 2013;1:129

39

Perioperative Risk

"Healthcare is an intrinsically hazardous business"

Irwin MJ. Anesthesia 2014;69:1299

40

Anesthesia-related Mortality

Perioperative and anaesthetic-related mortality in developed and developing countries: a systematic review and meta-analysis

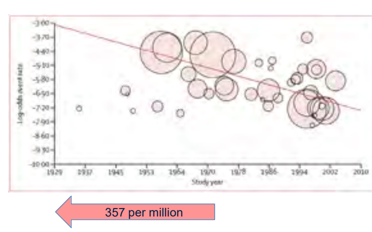
87 studies

21.4 million anesthetics

Bainbridge D et al. Lancet; 2012;380:1075-81

41

Anesthesia-related Mortality



Bainbridge D et al. Lancet; 2012;380:1075-81

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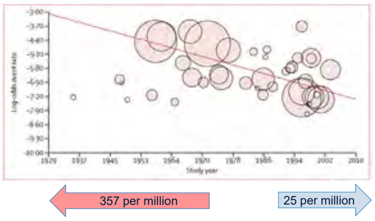
Anesthesia-related Mortality



Bainbridge D et al. Lancet; 2012;380:1075-81

43

What Risks to Consider

1) Anesthetic risk (deaths within 24 hours)
2) Surgical complications
3) Procedural (perioperative) risk
4) Loss of independence

44

Risk: problems/challenges

- No reciprocal consideration of the facts (surgeon or anesthesiologist)
- No one clinician has access to all the data
- Uncertainty:
  - Risk
  - Understanding
  - Communication

45

SDM and Communication

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SDM: importance of communication

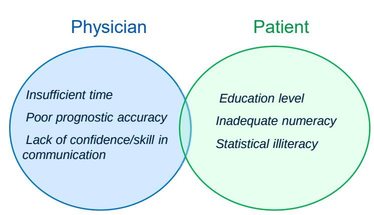
the single biggest problem with communication is the illusion that it has taken place

*- George Bernard Shaw**

*misattributed

47

Roadblocks to Communication



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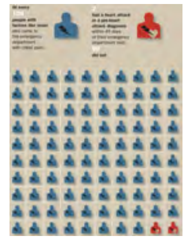
Inadequate Numeracy

"inability to understand the meaning of numbers"

2% vs. 5%

which is higher risk?

49



"You now have a 2% risk of having a heart attack."

Hess EP et al. Circ Cardiovasc Qual Outcomes 2012;5:251-259

50

Communicating Risk of Low Probability Events

Doctor: *I've done this operation 100 times and have never seen a problem*

Patient: *Great, I've got nothing to worry about then*

"Is the risk really 0%?"

51

If Nothing Goes Wrong, Is Everything All Right?

Interpreting Zero Numerators

If you haven't seen a complication in your prior X patients, does that mean the risk is "0"?

Hanley JA, Lippman-Hand A. JAMA 1983;249:1743-1745

52

How large does a study need to be to understand risk?

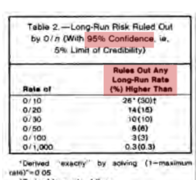


Table 2.—Long-Run Risk Ruled Out by 0/*n* (With 95% Confidence, ie, 5% Limit of Credibility)

Rate of	Rules Out Any Long-Run Rate (%) Higher Than
0/10	26* (30)†
0/20	14 (15)
0/30	10 (10)
0/50	6 (6)
0/100	3 (3)
0/1,000	0.3 (0.3)

*Derived "exactly" by solving (1−maximum rate)^n=0.05

†Derived from rule of three

the rule of "three"

3/n

Hanley JA, Lippman-Hand A. JAMA 1983;249:1743-1745

53

How large does a study need to be to understand risk?

I've done this type of case on 100 patients and have never seen a stroke

True risk = 3/n = 3/100 = up to 3%

Hanley JA, Lippman-Hand A. JAMA 1983;249:1743-1745

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Statistical Illiteracy

Mann-Whitney U test vs. Wilcoxon rank-sum test

55

Statistical Illiteracy

"Inability to understand and reason with statistics and data"

- *probability*
- *Risk (absolute and relative)*

56

Solutions to Improve Statistical Understanding

Absolute Risk rather than ***Relative Risk***

*"risk of DVT is reduced from **10% to 8%**"*

vs.

*"risk of DVT is **20% less**"*

57

Solutions to Improve Statistical Understanding

"Risk of death is 100% greater with drug X compared to drug Y"

1:8000 vs. 2:8000

(Double the risk, but minimal change in the probability)

58

Solutions to Improve Statistical Understanding

Breast cancer screening (mammography) reduces the risk of breast cancer mortality by 20%

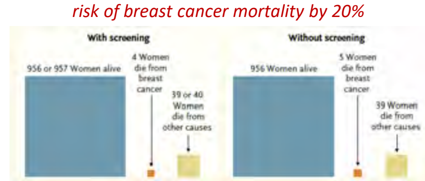
"Doctor, 20% is a very large reduction, I think I should proceed"

Biller-Andorno et al. N Eng J Med 2014;370;1965-67

59

Communicating Risk: pictograph

Breast cancer screening (mammography) reduces the risk of breast cancer mortality by 20%



Biller-Andorno et al. N Eng J Med 2014;370;1965-67

60

Threats to SDM implementation

"we don't have the right tools"

Joseph-Williams N et al. BMJ 2017;357:j1744

61

Common Events and Risks in Anesthesia

bit.ly/RCoA-Risk

62

Do Decisional Aids Work?

PERIOPERATIVE MEDICINE

Decision Aid for Cigarette Smokers Scheduled for Elective Surgery

David O. Warner, M.D., Annie LeBlanc, Ph.D., Sandeep Kadimpati, B.D.S., Kristin S. Vickers, Ph.D., Yu Shi, M.D., Victor M. Montori, M.D.

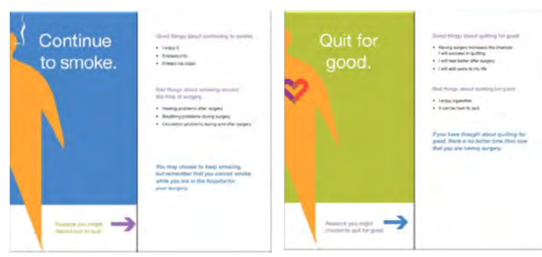
Use of decisional aids (cards)

Examined decisional quality scales

Warner DO et al. Anesthesiology 2015;123:18-28

63

Do Decisional Aids Work?



Warner DO et al. Anesthesiology 2015;123:18-28

64

Do Decisional Aids Work?

Table 2. Measures of Decisional Quality

	Usual Care (n = 83)	Decision Aid (n = 86)	P Value
Patients			
Decisional Comfort Scale			
Informed subscale (three items)	77 ± 17	87 ± 13	0.0013
Values subscale (three items)	77 ± 17	87 ± 13	0.0009
Support subscale (three items)	78 ± 17	87 ± 13	0.0068
Uncertainty subscale (three items)	76 ± 17	86 ± 14	0.0006
Effective choice subscale (four items)	73 ± 17	83 ± 12	0.0002
Total (16 items)	76 ± 15	86 ± 11	0.0003
COMRADE (eight items)	75 ± 19	88 ± 14	0.0013
OPTION (12 behaviors)	23 ± 17	46 ± 21	<0.0001
Smoking discussion comfort scale (four items)	75 ± 17	77 ± 16	0.56
Clinicians			
Decisional comfort scale (seven items)	74 ± 16	81 ± 12	0.034

Warner DO et al. Anesthesiology 2015;123:18-28

65

Do Decisional Aids Work?

- *Improve decision quality*
- *Improves patient satisfaction*
- *Cost-effective (improves efficiency)*
- *Higher level conversation*
- *Increased confidence that patient understood*

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SDM: future directions

- *Barriers to implementing it*
- *Tools to facilitate it*
- *Promoting SDM policy and accountability*
- *Can it change use/misuse of procedures*
- *Can it reduce variability in use of resources*
- *Cost effectiveness?*
- *Optimize patient outcomes?*

67

Case Study: epilogue

- 55 year old female with severe aortic stenosis
- Active lifestyle (hiking, skiing)
- Her concerns:
  - will warfarin impact activities?
  - friend had SAH on warfarin
  - regular INR testing (lives remotely)
  - worried about repeat operation

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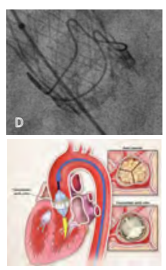
Case Study: epilogue

When/if needed



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Pediatric Anesthesia Emergencies

Debnath Chatterjee, MD, FAAP
Megan A. Brockel, MD
Richard J. Ing, MBBCh, FCA (SA)

1

Disclosures

- None

2

Learning Objectives

Upon completion of the presentation, participants will be able to:

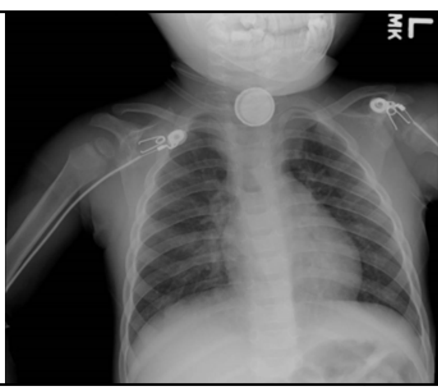
1. Explain the rationale for using honey or sucralfate following button battery ingestions in children.
2. Discuss the diagnosis and anesthetic management of a child with an airway foreign body.
3. Compare the risks and benefits of rapid sequence versus modified rapid sequence induction techniques in a pediatric patient with a full stomach presenting for emergency surgery.
4. Describe the pathophysiology and anesthetic considerations in blunt thoracic trauma in children and adolescents.

3

Scenario 2: FB 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.

4



5

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

6

Mechanism of Injury

It's not leakage!

Entrapped BB → Mucosa bridges + & - terminals → Circuit completed → Generation of hydroxide radicals → Alkaline caustic injury

7

Mechanism of Injury

Higher the voltage, faster the process

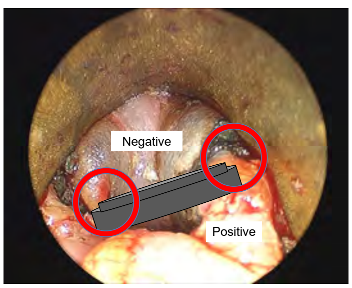
Visible injury within 15 minutes

Serious injury as soon as 2 hours

New vs. spent - 3.2 times higher risk

8

Orientation of Button Battery



Three Ns

Negative

Narrow

Necrotic

9

Extent of Damage

Size	Duration	Location
Orientation	Voltage	Esophageal pathology

10

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

11

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)

12

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)

13

Anesthetic Concerns

- Do not delay
- Rapid sequence induction
- Endotracheal intubation
- Additional IV access
- Bronchoscopy Trach perforation

Hoagland MA, et al. Anesth Analg 2020

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Pediatric Anesthesiology

NARRATIVE REVIEW ARTICLE

Anesthetic Implications of the New Guidelines for Button Battery Ingestion in Children

Monica A. Hoagland, MD,* Richard J. Ing, MBBCh, FCA(SA),* Kris R. Jatana, MD, FACS, FAAP† Ian N. Jacobs, MD,‡ and Debnath Chatterjee, MD, FAAP*

Anesthesia and Analgesia 2020

15

DOI: 10.1002/lio2.535

REVIEW

Laryngoscope Investigative Otolaryngology

Current management of button battery injuries

Rishabh Sethia MD[1] | Hannah Gibbs BS[2] | Ian N. Jacobs MD[3,4] | James S. Reilly MD[5,6,7] | Keith Rhoades BS[7] | Kris R. Jatana MD[1,2,7,8]

Laryngoscope Investigative Otolaryngology 2021

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Tweetorial

Dangers of Button Battery Ingestion in Young Children

Debnath Chatterjee, MD, FAAP
Children's Hospital Colorado

@DabeChatter

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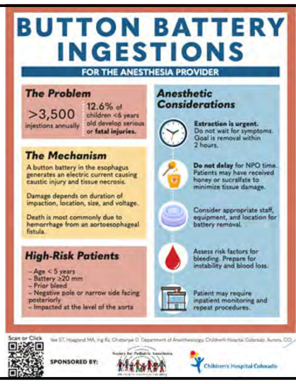
SPA Website

APSF Newsletter

18



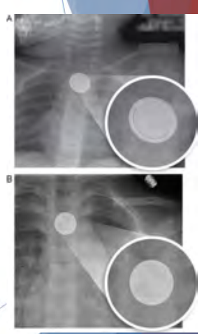
APSF Newsletter

19

20

Summary

- Halo sign on CXR
- Negative/Narrow/Necrotic
- Emergent endoscopic removal
- Active surveillance after removal
- Recognition of sentinel bleed
- Mitigation with honey/sucralfate



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Scenario 3: FB Aspiration

- A 1-year-old girl was sitting in her highchair eating chicken. As her father prepared to leave, she inspired deeply to cry and choked.

22

FB Aspiration

- A leading cause of death in children younger than 3 years old
  - Peak age is 1-2 years
  - In this age group, the most commonly retrieved AFBs are food products
- Older children are more likely to aspirate nonorganic products
- Retrieval is essential

23

Presenting Symptoms

- Vary depending on type of object, size, location, chronicity
- Coughing, wheezing, shortness of breath, fever, recurrent pneumonia
- Parents may or may not recall an event

24

FB Aspiration

Zur KB, Litman RS. Pediatric airway foreign body retrieval: surgical and anesthetic perspectives. Pediatric Anesthesia 2009;19:109-117.

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Clinical Findings

- High index of suspicion and careful history and physical exam
- Nonspecific
  - Decreased breath sounds, wheezing, dullness to percussion, crackles
  - Initially abnormal exam may become normal
  - Lung auscultation may be clear
  - 14-45% of patients with abnormal bronchoscopic exam had a normal physical exam preoperatively

CRASH

26

Types of bronchial obstruction with airway FBs

Chatterjee D. Airway Foreign Bodies in Children. Open Anesthesia.

27

Diagnostic Modalities

- Chest radiograph may help
  - May see hyperinflation or collapse or normal image
  - More definitive diagnosis when object is radiopaque
- Neck x-rays are commonly used to look for upper aerodigestive FBs
- Chest computed tomography (CT) can also be performed
- Diagnosis relies on bronchoscopy

CRASH

28

Anesthetic Considerations

- History
  - Both related and unrelated to current illness
  - Previous anesthetic history
- Physical examination
  - Upper airway exam
  - Lung auscultation, work of breathing, distress
- Vital signs and radiographic images
- Consider preoperative nebulized bronchodilator

CRASH

29

Anesthetic Considerations

- Preoperative peripheral IV access is preferred
- Consider risks and benefits of preoperative anxiolysis
- Consider atropine or glycopyrrolate
- Induction can be inhaled or intravenous
  - Total intravenous anesthesia is preferred for maintenance
- Ventilation can be spontaneous or controlled

CRASH

30

Anesthetic Considerations

Spontaneous

- Allows for continuous ventilation
- Must maintain adequate depth of anesthesia to obliterate airway reflexes yet maintain sufficient ventilatory function

Controlled

- Ability to provide optimal oxygenation and ventilation during the breathing phase
- Assurance of patient immobility
- Limited time before desaturation occurs
- Lack of assurance that positive-pressure ventilation will be successful
- Movement of the object distally

31

Brief Communication

Anesthesia for Tracheal or Bronchial Foreign Body Removal in Children: An Analysis of Ninety-Four Cases

Ronald S. Litman, DO, FAAP, Jyothsna Ponnuri, MD, and Igor Trogan, BS
Department of Anesthesiology, University of Rochester School of Medicine, Rochester, New York

No increased incidence of adverse events related to either spontaneous or controlled ventilation

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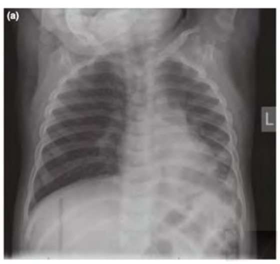

Zur KB, Litman RS. Pediatric airway foreign body retrieval: surgical and anesthetic perspectives. Pediatric Anesthesia 2009;19:109-117.

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Zur KB, Litman RS. Pediatric airway foreign body retrieval: surgical and anesthetic perspectives. Pediatric Anesthesia 2009;19:109-117.

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Zur KB, Litman RS. Pediatric airway foreign body retrieval: surgical and anesthetic perspectives. Pediatric Anesthesia 2009;19:109-117.

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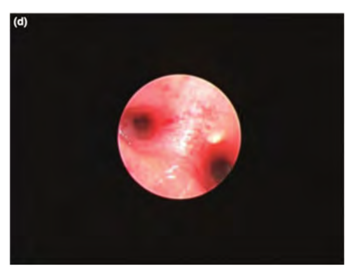

Zur KB, Litman RS. Pediatric airway foreign body retrieval: surgical and anesthetic perspectives. Pediatric Anesthesia 2009;19:109-117.

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Summary

- FB aspiration is a potentially life-threatening event in young children
- A detailed history and physical examination and a high index of clinical suspicion is critical to diagnose FB aspiration
- Both spontaneous and controlled ventilation techniques can be used during bronchoscopy for removal of airway FBs

CRASH

37

Scenario 4: Full Stomach

- A 3-year-old boy presents with testicular torsion for emergent orchiopexy. He had apple juice one hour ago and a full breakfast six hours ago.

CRASH

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PRACTICE PARAMETERS

Practice Guidelines for Preoperative Fasting and the Use of Pharmacologic Agents to Reduce the Risk of Pulmonary Aspiration: Application to Healthy Patients Undergoing Elective Procedures

*An Updated Report by the American Society of Anesthesiologists Task Force on Preoperative Fasting and the Use of Pharmacologic Agents to Reduce the Risk of Pulmonary Aspiration**

Table 1. Fasting and Pharmacologic Recommendations

*A. Fasting Recommendations**

Ingested Material	Minimum Fasting Period†
• Clear liquids‡	2h
• Breast milk	4h
• Infant formula	6h
• Nonhuman milk§	6h
• Light meal**	6h
• Fried foods, fatty foods, or meat	Additional fasting time (*e.g.,* 8 or more hours) may be needed

39

EJA | *Eur J Anaesthesiol* 2022; **39**:4–25

GUIDELINES

Pre-operative fasting in children

A guideline from the European Society of Anaesthesiology and Intensive Care

Peter Frykholm, Nicola Disma, Hanna Andersson, Christiane Beck, Lionel Bouvet, Eloise Cercueil, Elizabeth Elliott, Jan Hofmann, Rebecca Isserman, Anna Klaucane, Fabian Kuhn, Mathilde de Queiroz Siqueira, David Rosen, Diana Rudolph, Alexander R. Schmidt, Achim Schmitz, Daniel Stocki, Robert Sümpelmann, Paul A. Stricker, Mark Thomas, Francis Veyckemans and Arash Afshari

- New European guidelines favor a **6-4-3-1** regimen
  - 6 h for solids
  - 4 h for formula and nonhuman milk
  - 3 h for breast milk
  - 1 h for clear fluids

40

PRACTICE PARAMETER

2023 American Society of Anesthesiologists Practice Guidelines for Preoperative Fasting: Carbohydrate-containing Clear Liquids with or without Protein, Chewing Gum, and Pediatric Fasting Duration—A Modular Update of the 2017 American Society of Anesthesiologists Practice Guidelines for Preoperative Fasting*

Recommendations

Recommendation	Strength of Recommendation	Strength of Evidence
4. There is insufficient evidence concerning benefits and harms to recommend pediatric patients drink clear liquids until 1 h *versus* 2 h before procedures with general anesthesia, regional anesthesia, or procedural sedation (no recommendation).	Not applicable	Very low
5. To avoid prolonged fasting in children, efforts should be made to allow clear liquids in children at low risk of aspiration as close to 2 h before procedures as possible. In children with shorter clear liquid fasting duration, exercise clinical judgment.	Best practice statement	Not applicable

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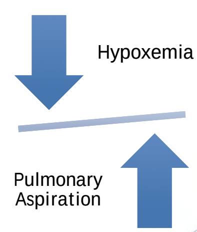
Classic RSI vs. Modified RSI

- Classic RSI
  - Positive pressure ventilation is strictly avoided
  - Concern for gastric insufflation and pulmonary aspiration
- Surveys have revealed that there are many clinical situations in which clinicians will opt for a modified RSI (mRSI) technique



Stein ML, Park RS, Kovatsis PG. Emerging trends, techniques, and equipment for airway management in pediatric patients. Pediatric Anesthesia. 2020;30:269-279.

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Modified RSI

- Low pressure, positive pressure ventilation after induction and prior to intubation
- Current (albeit limited) evidence supports the safety of mRSI to reduce hypoxemia without increasing the risk of aspiration

Stein ML, Park RS, Kovatsis PG. Emerging trends, techniques, and equipment for airway management in pediatric patients. Pediatric Anesthesia. 2020;30:269-279.

43

RSI vs. mRSI: Pyloromyotomy

- 296 neonates and infants
- 30% hypoxemia with RSI, 17% with mRSI
- AOR for hypoxemia for all patients 2.8
- In subgroup analysis of neonatal patients, AOR 6.5
- No indication that mRSI increased incidence of aspiration

Stein ML, Park RS, Kovatsis PG. Emerging trends, techniques, and equipment for airway management in pediatric patients. Pediatric Anesthesia. 2020;30:269-279.

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Cricoid Pressure

- Controversial in both adult and pediatric practice
- Reliability and feasibility of CP questioned by pediatric anesthesiologists
  - Force?
  - Potential airway obstruction
  - Associated technical problems
- Release or adjustment of the cricoid force is justified if pressure interferes with ventilation or intubation
- More than half have abandoned the maneuver

Salem MR, Khorasani A, Zeidan A. Cricoid pressure controversies: Narrative review. Anesthesiology. 2017;126:738-752.

45

Scenario 4: Full Stomach

- A 3-year-old boy presents with testicular torsion for emergent orchiopexy. He had apple juice one hour ago and a full breakfast six hours ago.

46

Summary

- Preoperative fasting should be minimized in pediatric patients
- Current evidence supports the safety of mRSI
- Use of cricoid pressure in pediatric patients is controversial

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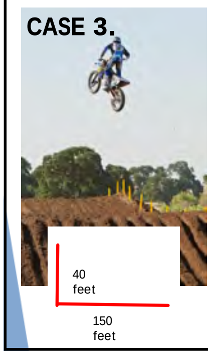
Case 3

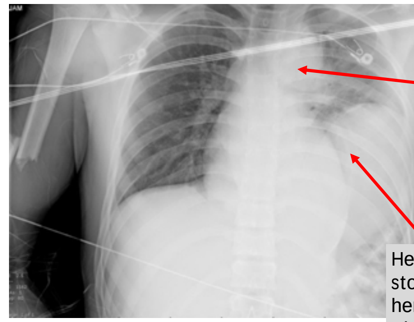
48

CASE 3.



15-year-old boy 75 kg
Motorcycle injury
Wearing a helmet and no LOC
Abrasion front lower abdomen
Fractured R humerus
Neck collar
Pale
Hb 9.8 g/dl
2 peripheral 20-gauge IVs

49



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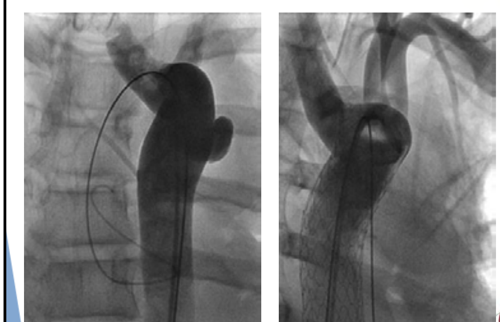
Anesthetic Approach

Prepare for a lengthy Anesthetic 3:45 am -10:45am.
Radiology Suite- cold, exposed extremities ± thoracotomy / laparotomy
Airway considerations: Neck collar
Appropriate vascular access and invasive monitoring (Art line CVP)
Serial Hb/ ABG: Associated abdominal injury ongoing bleeding
Heparinization
Urinary catheter (Contrast enhanced diuresis + length of procedure)
Blood products / Air convection warmer
Antibiotic prophylaxis and redose

51

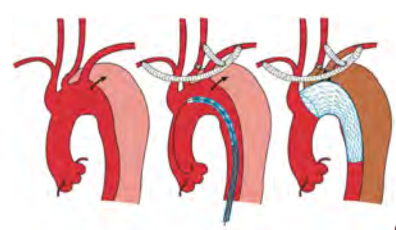


52

21mm by 10cm Gore Thoracic Aortic Graft (TAG)

53

Within a week, he underwent bilateral carotid-subclavian bypass and a second TEVAR



54

Outline for Blunt Chest Trauma

Discuss the mechanisms of injury

Understand the pathophysiology

Develop an approach to exclude cardiac injuries

Anesthetic considerations

55

Epidemiology of Blunt Chest Trauma

Blunt thoracic aortic injuries (BTAI)

USA and Canada: 7500- 8000 deaths annually

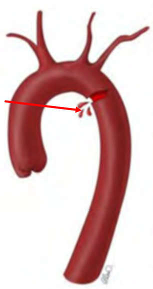
80% of patients die before hospital arrival

15-23 % of those who reach hospital :
Succumb to associated injuries within 24 hrs

Fabian TC et al. J Trauma 1997 42(3) 374-80

56

Medial Aspect Aortic Isthmus
90% reaching hospital
80% autopsy fatal cases

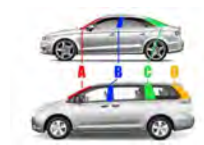


False aneurysm	58%
Dissection	25%
Intimal tear	20%

Demetriades D. Blunt thoracic aortic injuries: crossing the Rubicon.
J Am Coll Surg. 2012 Mar;214(3):247-59

57

B Pillar of Car Frames

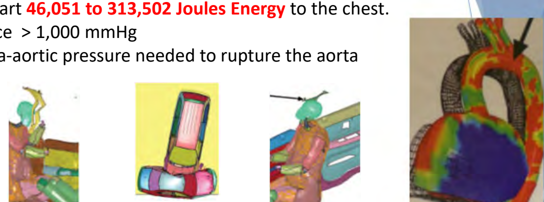


Force of the B Pillar of the car frame impact has on the human body in car accidents determines the extent of injuries

Siegel JH et al. Analysis of the mechanism of lateral impact aortic isthmus disruption in real-life motor vehicle crashes using a computer-based finite element numeric model: with simulation of prevention strategies.
J Trauma. 2010 Jun;68(6):1375-95.

58

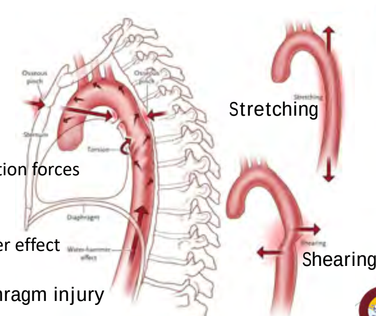
Lateral impact motor vehicle accidents
impart **46,051 to 313,502 Joules Energy** to the chest.
Force > 1,000 mmHg
Intra-aortic pressure needed to rupture the aorta



Siegel JH et al. Analysis of the mechanism of lateral impact aortic isthmus disruption in real-life motor vehicle crashes using a computer-based finite element numeric model: with simulation of prevention strategies.
J Trauma. 2010 Jun;68(6):1375-95.

59

High Speed
Sudden
Deceleration
Compression



Neschis DG NEJM 2008; 359:1708-16

60

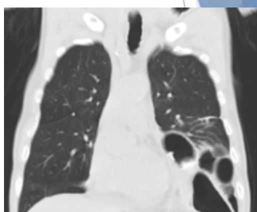
Blunt diaphragmatic and thoracic aortic rupture: An emerging injury complex

In one study of 3,886 pts

69 (1.8%) had BDR

44(1.1%) TAR

7/69 (10%): both injuries



Rizoli S. The Annals of Thoracic Surgery 1994 58 (5) 1404-1408
Mahmoud A.F. Rupture diaphragm: Early diagnosis and Mx. EJCM 2017 . 25, (2), 163-170

61

Massive Blunt Chest Compression

Vascular Injuries to ascending / descending aorta, innominate artery

Heart End-diastole **{Distended Ventricle}** most Susceptible time of high intraventricular cavity volume

Lungs Airway Contusion, hemothorax, pneumothorax, laceration

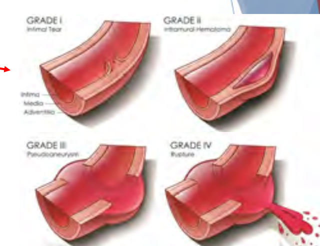
Skeletal Fractures of sternum/ thoracic vertebrae/ ribs

Sandhu H.K. J Vasc Surg. 2018 Feb;67(2):389-398

62

Classification & Risk Stratification of Traumatic Aortic Injury

Watch expectantly
Conservative therapy
depending on injury site

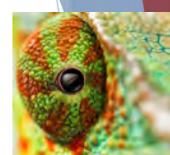


Starnes: Stratify as minimal or significant injury based on the presence of an external aortic contour abnormality

Sandhu H.K. J Vasc Surg. 2018 Feb;67(2):389-398
Starnes BW, et al. A new classification scheme for treating blunt aortic injury. J Vasc Surg. 2012 55(1):47-54.
Lee WA et al. Endovascular repair of traumatic thoracic aortic injury: J Vasc Surg. 2011 53(1):187-92

63

Diagnostics: A clinical chameleon



Prepare for Rapidly Changing Clinical Condition

Individual Signs Symptoms Prompt Investigations

No Gold-Standard Diagnostic Test (ATLS Protocol)

Complex Cardiac	Angina-like chest pain
Arrhythmia	Dyspnea
Heart Murmurs	Distended jugular veins
Hypotension	Pneumothorax
	Cardiac Tamponade

Teyssier J et al. Photonic crystals cause active colour change in chameleons. Nat Commun. 2015 Mar 10;6:6368.
Eghbalzadeh K Blunt Chest Trauma : a Chameleon. Heart. 2017 Dec 4.

64

Diagnostic Approach

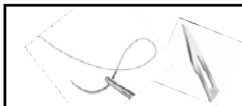
Physical examination
Chest X-Ray (14% may be normal)
Serial 12 lead ECG
Cardiac enzymes CK-MB and troponin
Cardiac echo

Chest X-Ray: rib, sternum, spine scapula, clavicle fracture
Widened mediastinum >8 cm
Tracheal deviation, NG tube R
Loss of aorto-pulmonary window

Contrast CT scan
Suspected Coronary Artery Injury: Coronary Angiogram

Eghbalzadeh K Blunt Chest Trauma : a Chameleon. Heart. 2017 Dec 4.

65



Treatment Options

1997, Kato and colleagues first reported endovascular stent grafting in 10 patients all alive at 15 months follow-up.

However not all ruptured aortas amenable to this therapy:
Ongoing bleeding, greater than 1 liter blood loss hemodynamically unstable patient: Surgery

Kato N et al. Traumatic thoracic aortic aneurysm: treatment with endovascular stent-grafts. Radiology. 1997 Dec;205(3):657-62.

Schellenberg M Inaba K. Critical Decisions in the Management of Thoracic Trauma. Emerg Med Clin N Am 2018 135-147

66

Endovascular Repair

0% used in 1997
65% used in 2007

Performed under sedation
Local anesthesia
Minimizes blood loss
Well tolerated in high-risk pts
Minimizes paraplegia
Reduces mortality

Demetriades D et al. Operative repair or endovascular stent graft in blunt traumatic thoracic aortic injuries: results of an American Association for the Surgery of Trauma Multicenter Study. J Trauma. 2008 Mar;64(3):561-70

67

Disadvantages

Endoleak 14 %
Groin access vascular damage
Stent migration
Subclavian/ carotid occlusion

We still don't know the extent of medium and long-term durability of these stents

High volume centers better outcomes

Demetriades D et al. Operative repair or endovascular stent graft in blunt traumatic thoracic aortic injuries: results of an American Association for the Surgery of Trauma Multicenter Study. J Trauma. 2008 Mar;64(3):561-70

68

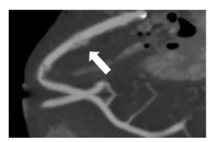
Blunt Cardiac Injuries

https://www.childrenscolorado.org/pediatric-innovation/research/surgery/screening-for-pediatric-cardiac-injuries-after-atv-accidents/
https://medictests.com/quick-dirty-guide-chest-trauma/

69

Heart Injuries

Commotio Cordis Ventricular fibrillation with no structural damage
10 to 30 ms before the peak of the T wave
Contusio Cordis Myocardium, valves, conduction system
Isolated coronary injuries / Rupture / Dissection



Inokuchi G et al. Fatal right coronary artery rupture following blunt chest trauma: detection by postmortem selective coronary angiography. Int J Legal Med. 2016 May;130(3):759-63.
Link MS et al. An experimental model of sudden death due to low-energy chest-wall impact (commotio cordis) N Engl J Med. 1998 Jun 18;338(25):1805-11.

70

Blunt Cardiac Injury : Spectrum

Minor ECG or Enzyme Abnormality
Complex Arrhythmia
Coronary Artery thrombosis
Free Wall Rupture
Septal Rupture
Cardiac Failure

Categories of Force Causing Myocardial Injury
Direct
Indirect
Compressive
Decelerate
Blast

Mattox KL et al. Blunt cardiac injury. J Trauma. 1992 Nov;33(5):649-50.

71

Physical Examination

Thoracic trauma
Hypotension
Jugular venous distention
Tachypnoea
Wheezing/rhonchi
Chest abrasion/ tenderness/ palpable crepitus/ flail chest
Fractured clavicle/ sternum/ ribs
Distant heart sounds/ tachycardia/ rub/ murmurs/ pulsus paradoxus

Elie MC. Blunt cardiac injury. Mt Sinai J Med. 2006 Mar;73(2):542-52.

72

Diagnostics: Cardiac Enzymes

CK-MB not recommended:

Skeletal muscle, Lung, Stomach, Pancreas, Liver, Small Intestine

Troponin I : Heart specific . If elevated > 2.0 ng/ml : Significant

Normal ECG and no rise in troponin at 8 hours:
No other injuries
Negative predictive value 100% : Discharge the patient

Velmahos GC et al. Normal electrocardiography and serum troponin I levels preclude the presence of clinically significant blunt cardiac injury. J Trauma. 2003 Jan;54(1):45-50

73

Diagnostics: Point of Care Echo

Up to 30% of BCI patients have abnormal cardiac echo

Pericardial effusion and tamponade are common

Focused Assessment with Sonography for Trauma (FAST)

Rapid screening 1.30 +/- 0.08 mins vs. X- Ray ; 14.18 +/- 0.91 mins, $p < 0.0001$

Indications: Heart failure, hypotension, arrhythmia

Frazee RC et al. Objective evaluation of blunt cardiac trauma. J Trauma. 1986 Jun;26(6):510-20.
Sisley AC et al. Rapid detection of traumatic effusion using surgeon-performed ultrasonography. J Trauma. 1998 Feb;44(2):291-6

74

2 Patients: June and July 2013, ATV accidents

Case 1

35 kg 11-yr-old

LOC at scene brief CPR lacerated knee: Debridement at outside hospital under GA.

Post op CT found large heart: Cardiac Echo

Troponin 38.9 (0–0.119 ng/mL)

CPB at CHCO

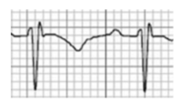
Tricuspid valve papillary muscle

Avulsion repaired.

Home POD 5

Ngo KD, Pian P, Hanfland R, Nichols CS, Merritt GR, Campbell D, Ing RJ. Pediatr Emerg Care. 2016 Jul;32(7):468-71. Cardiac Injury After All-Terrain Vehicle Accidents in 2 Children and a Review of the Literature.

75



Case 2

68 kg 13 yr old : No LOC

Troponin 9.4 ng/mL.

ECG wide complex tachycardia.

Cardiac Echo: TR, MR, VSD.

CPB repair:

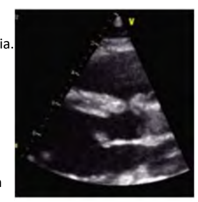
Received porcine TV, MV.

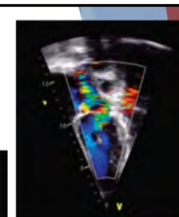
VSD Patch necrotic septum.

3rd degree Heart block :

Epicardial pacemaker

Home POD 6 warfarin aspirin





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Other Important Injuries

Tracheobronchial injuries

Usually 2 cm from carina (R)

Signs :

Dyspnea cough, stridor

Subcutaneous emphysema,

hemoptysis,

Pneumothorax.

May need rigid Bronch for ETT

Pulmonary injury

Hypoxia,

Intraparenchymal hemorrhage, Atelectasis,

Acute respiratory distress syndrome (ARDS).

Mechanical Ventilation

Vishnu Madapura MBBS, and Gabriel Pollock MD,
Cedars – Sinai Medical Center, Los Angeles, CA.
OpenAnesthesia

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Chest injuries

Hemothorax

Pneumothorax

Tension

Flail chest

- Three or more adjacent ribs are each fractured in two places, creating a floating segment and unstable chest wall.
- The flail segment moves paradoxically with respiration.

Vishnu Madapura MBBS, and Gabriel Pollock MD,
Cedars – Sinai Medical Center, Los Angeles, CA
OpenAnesthesia

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Summary

Blunt thoracic trauma in children can be very severe and the clinical picture can change rapidly.

These injuries require considerable force applied to the thorax

Additional injuries to lungs , trachea, and airways, spine and head injuries must always be considered.

Anesthetic planning requires attention to detail and potential for massive transfusion.

79

Ultrasound-Guided Regional Anesthesia Workshops

Kyle Marshall, MD

CRASH 2023

1

DISCLOSURE

- There are NO disclosures for any faculty participating.


Kyle Marshall, MD


Olivia Romano, MD


Inge Tamm-Daniels, MD


Jillian Vitter, MD


Matthew Lyman, MD


Keleigh McLaughlin, MD

2

Upper Extremity/Thoracic Workshop

- Superior Trunk/Interscalene
- Supra & Infraclavicular
- Selective Root/Forearm
  - Radial, Ulnar, Median
- Paravertebral
- PECs I&II/Serratus Anterior
- Erector Spinae

- **LESS Lecture, MORE demonstration.**
- 6 stations with models

3

Thank you to our Vendors!!

- Mindray: Rob Kimbrough
- Sonosite: Kristi Howe

- Thank you to our Models!!

4

BEER & WINE - END @ 1630!

5

Thursday, March 2nd

CRASH

Guiding the future of patient care

What's the best blood pressure under anesthesia?

The implications of perioperative hypotension

Hilary P. Grocott, MD, FRCPC
Professor, Department of Anesthesiology, Pharmacology & Therapeutics
University of British Columbia

Anesthesiology

1

Outline

- Case presentation
- Blood pressure definition
- Hypotension: Incidence and Consequences
- Where do we go from here?
- What can we do to personalize blood pressure?

2

Hypotension: how common is it?

Incidence of Intraoperative Hypotension as a Function of the Chosen Definition

Literature Definitions Applied to a Retrospective Cohort Using Automated Data Collection

Jilles B. Bijker, M.D., Wilton A. van Klei, M.D., Ph.D., Teus H. Kappen, M.D., Leo van Wolfswinkel, M.D., Ph.D., Karel G. M. Moons, Ph.D., Cor J. Kalkman, M.D., Ph.D.

1) Systematic review to define hypotension

2) N= 15,509, consecutive patients undergoing non-cardiac surgery

Bijker JB al. Anesthesiology 2007;107:213-20

3

Hypotension: how common is it?

48 definitions
in the literature

Bijker JB al. Anesthesiology 2007;107:213-20

4

Hypotension: how common is it?

<u>Incidence</u>

Systolic > 90-100 mmHg
64-82%

MAP > 90-100 mmHg
51-78%

MAP > 20-30% mmHg
80-84%

Bijker JB al. Anesthesiology 2007;107:213-20

5

Anaesthesia
Journal of the Association of Anaesthetists of Great Britain and Ireland

Anaesthesia, 2011, 66, pages 354-360

ORIGINAL ARTICLE

Defining intra-operative hypotension – a pilot comparison of blood pressure during sleep and general anaesthesia*

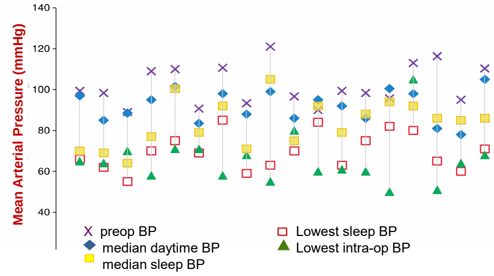
J. C. L. Soo,[1] S. Lacey,[2] R. Kluger[3] and B. S. Silbert[3]

N = 18, day surgery cases

24 hour blood pressure monitoring

Soo JCL et al. Anaesth 2011;66:354-360

6



Soo JCL et al. Anaesth 2011;66:354-360

7

	Difference in mean BP
Median daytime – median sleep; mmHg	6 (1–17 [−7 to 27])
Pre-operative BP – median daytime; mmHg	10 (5–14 [−5 to 35])
Pre-operative BP – median sleep; mmHg	21 (10–25 [−2 to 32])
Pre-operative BP – sleep nadir; mmHg	34 (26–36 [6–58])
Pre-operative BP – intra-operative nadir; mmHg	36 (25–46 [8–66])
Median sleep – intra-operative nadir; mmHg	19 (5–32 [−13 to 50])
Sleep nadir – intra-operative nadir; mmHg	3 (−4–14 [−25 to 32])

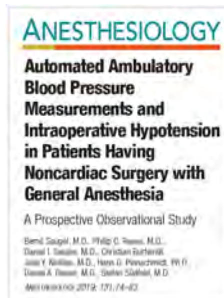
Soo JCL et al. Anaesth 2011;66:354-360

8

	Difference in mean BP
Median daytime – median sleep; mmHg	6 (1–17 [−7 to 27])
Pre-operative BP – median daytime; mmHg	10 (5–14 [−5 to 35])
Pre-operative BP – median sleep; mmHg	21 (10–25 [−2 to 32])
Pre-operative BP – sleep nadir; mmHg	34 (26–36 [6–58])
Pre-operative BP – intra-operative nadir; mmHg	36 (25–46 [8–66])
Median sleep – intra-operative nadir; mmHg	19 (5–32 [−13 to 50])
Sleep nadir – intra-operative nadir; mmHg	3 (−4–14 [−25 to 32])

Soo JCL et al. Anaesth 2011;66:354-360

9



Defining Hypotension Using Ambulatory Monitoring

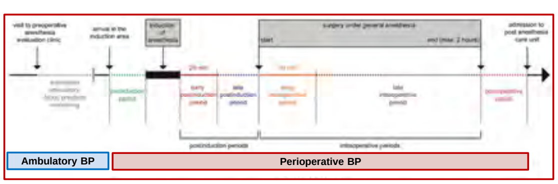
N = 370
ASA I-II, age 40-65 yrs
"healthy"

Ambulatory BP for 24 hours prior to surgery at 30 min intervals

Saugel B et al. Anesthesiology 2019;131:74-83

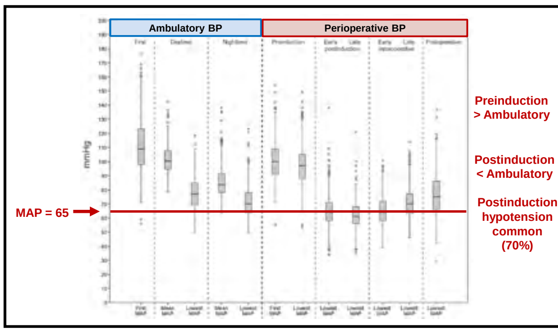
10

Defining Hypotension: methodology



Saugel B et al. Anesthesiology 2019;131:74-83

11



12

"Keep the MAP within 20-30% of baseline"

What is baseline?

- Preop holding area
- Pre-induction
- In surgeon's office/Preop clinic
- At home (awake vs. asleep)

13

Where does the "20%" come from?

ORIGINAL ARTICLES

Intraoperative Blood Pressure

What Patterns Identify Patients at Risk for Postoperative Complications?

MARY E. CHARLSON, M.D.,‡ C. RONALD MacKENZIE, M.D.,‡ JEFFREY P. GOLD, M.D.,*
KATHY L. ALES, M.D.,‡ MARJORIE TOPKINS, M.D.,† and G. TOM SHIRES, M.D.*

Charlson M et al. Ann Surg 1990;212:567-580

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ORIGINAL ARTICLES

Intraoperative Blood Pressure

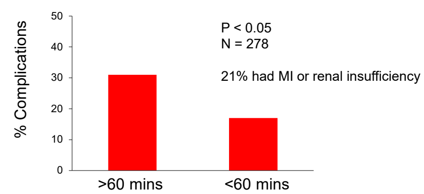
What Patterns Identify Patients at Risk for Postoperative Complications?

MARY E. CHARLSON, M.D.,‡ C. RONALD MacKENZIE, M.D.,‡ JEFFREY P. GOLD, M.D.,*
KATHY L. ALES, M.D.,‡ MARJORIE TOPKINS, M.D.,† and G. TOM SHIRES, M.D.*

Prospective observational trial
N = 278, vascular and GI surgery
"high risk" = DM, HTN

Charlson M et al. Ann Surg 1990;212:567-580

15



MAP < 20% baseline
(in-hospital pre-op BP)

Charlson M et al. Ann Surg 1990;212:567-580

16

What are the Consequences of "hypotension"?

17

Intraoperative Hypotension and Perioperative Ischemic Stroke after General Surgery

A Nested Case-control Study

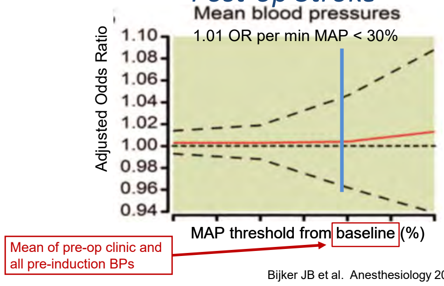
Jilles B. Bijker, M.D.,* Suzanne Persoon, M.D.,† Linda M. Peelen, Ph.D.,‡
Karel G. M. Moons, Ph.D.,§ Cor J. Kalkman, M.D., Ph.D.,|| L. Jaap Kappelle, M.D., Ph.D.,#
Wilton A. van Klei, M.D., Ph.D.*

N = 48,241
Non-cardiac, non-neurologic surgery
41 strokes = 0.09%

Bijker JB et al. Anesthesiology 2012;116:658-664

18

Post-op Stroke



Bijker JB et al. Anesthesiology 2012;116:658-664

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ANESTHESIOLOGY

Relationship between Perioperative Hypotension and Perioperative Cardiovascular Events in Patients with Coronary Artery Disease Undergoing Major Noncardiac Surgery

Pavel S. Roshanov, M.D., M.Sc., Tej Sheth, M.D., Emmanuelle Duceppe, M.D., Vikas Tandon, M.D., Amal Bessissow, M.D., M.Sc., Matthew T. V. Chan, M.B.B.S., Ph.D., Craig Butler, M.Sc., M.D., Benjamin J. W. Chow, M.D., James S. Khan, M.Sc., M.D., P. J. Devereaux, M.D., Ph.D.

ANESTHESIOLOGY 2019; 130:756-66

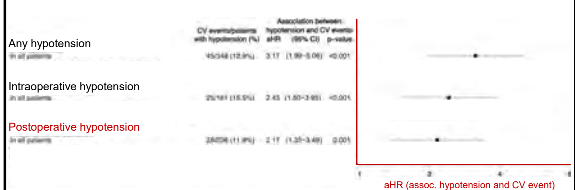
- Retrospective study
- N = 955
- > 45 years old
- Impact of hypotension/CAD on outcome

- Hypotension = SBP < 90 mmHg >10 min
- Outcome = MI or 30 day cardiovascular

Roshanov PS et al. Anesthesiology 2019;130:756

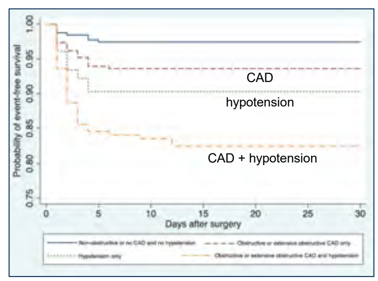
20

Hypotension and CV Outcome



Roshanov PS et al. Anesthesiology 2019;130:756

21



Roshanov PS et al. Anesthesiology 2019;130:756

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OPEN **Intraoperative Hypotension Is Associated With Adverse Clinical Outcomes After Noncardiac Surgery**

Anne Gregory, MD, MSc, FRCPC,* Wolf H. Stapelfeldt, MD,† Ashish K. Khanna, MD, FCCP, FCCM,‡§ Nathan J. Smischney, MD, MSc,‖ Isabel J. Boero, MD, MS,¶ Qinyu Chen, MS,¶ Mitali Stevens, PharmD, BCPS,# and Andrew D. Shaw, MB, FRCPC*,**

Multicenter Retrospective Study

Optum® US Electronic Health Record

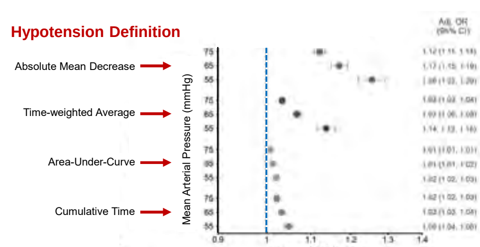
N = 368,222

Gregory A et al. Anesth Analg 2021;132:1654-65

23

Major Adverse Cardiac and Cerebrovascular Outcomes

Hypotension Definition



Gregory A et al. Anesth Analg 2021;132:1654-65

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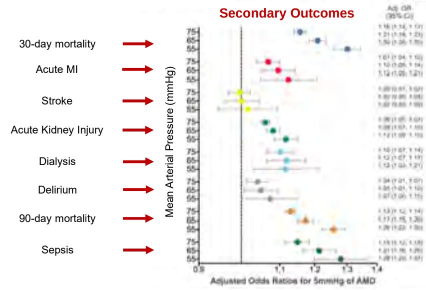

Gregory A et al. Anesth Analg 2021;132:1654-65

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CME **Association Between Intraoperative Arterial Hypotension and Postoperative Delirium After Noncardiac Surgery: A Retrospective Multicenter Cohort Study**

Luca J. Wachtendorf, cand.med.,*† Omid Azimaraghi, MD,*† Peter Santer, MD, DPhil,* Felix C. Linhardt, cand.med.,*† Michael Blank, cand.med.,*† Aiman Suleiman, MD,*‡ Curie Ahn, BS,* Ying H. Low, MD,§ Bijan Teja, MD, MBA,*‖ Samir M. Kendale, MD,* Maximilian S. Schaefer, MD,*¶ Timothy T. Houle, PhD,§ Richard J. Pollard, MD,* Balachundhar Subramaniam, MD, MPH, FASA,* Matthias Eikermann, MD, PhD,†# and Karuna Wongtangman, MD†**

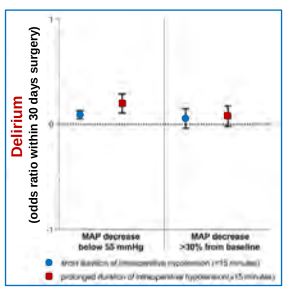
Dual-center Retrospective Study

N = 316,717 non-cardiac surgery patients

Delirium within 30 days post-op

Wachtendorf LJ et al. Anesth Analg 2022;134:822-33

26



Wachtendorf LJ et al. Anesth Analg 2022;134:822-33

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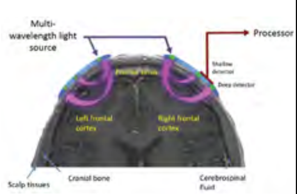
Can we individualize blood pressure/hypotension?

28

Is there a role for cerebral oximetry?



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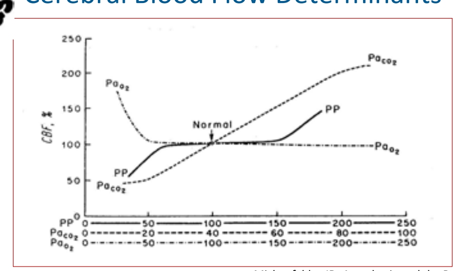
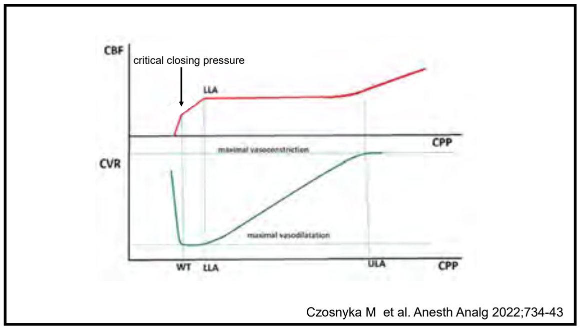
Cerebral Blood Flow Determinants



Michenfelder JD: Anesthesia and the Brain 1988

30



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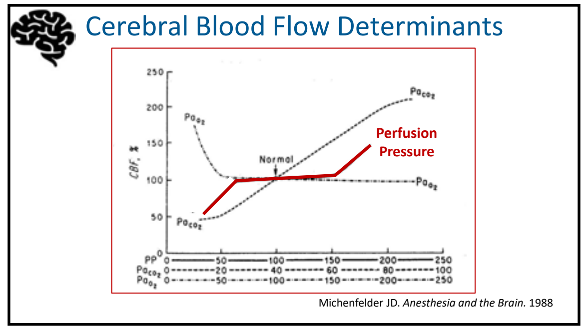

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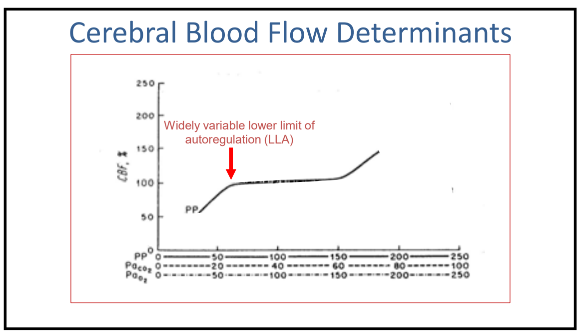

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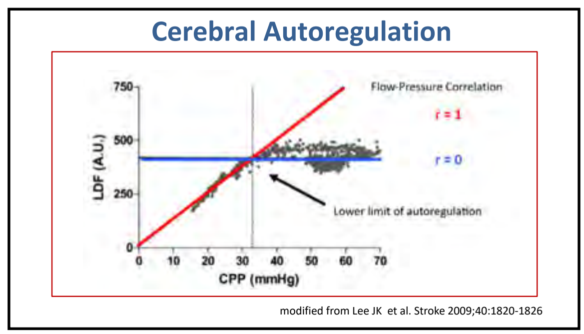

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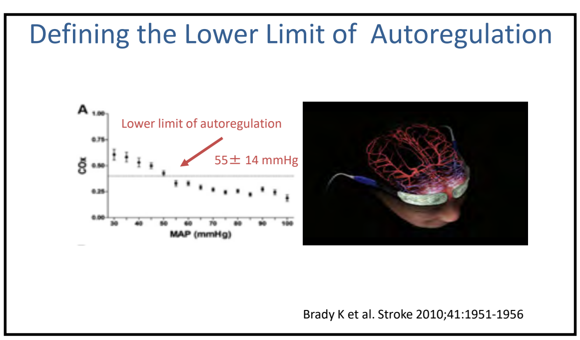

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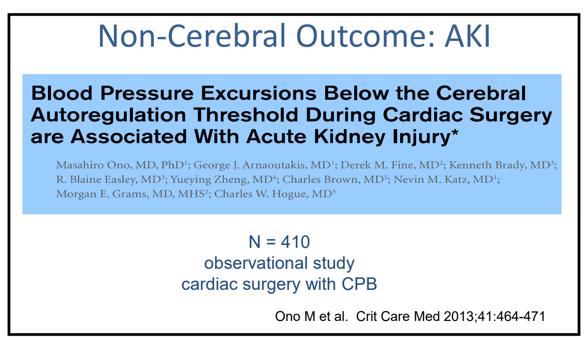

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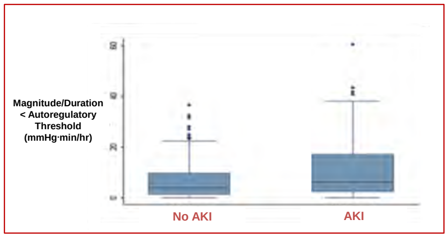
Non-Cerebral Outcome: AKI



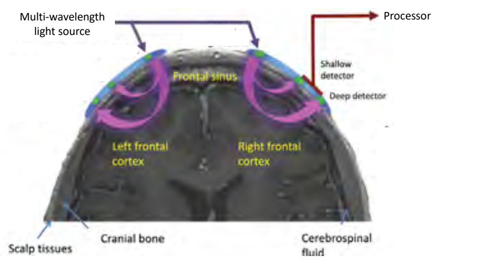
Ono M et al. Crit Care Med 2013;41:464-471

37

Cerebral Oximetry

38

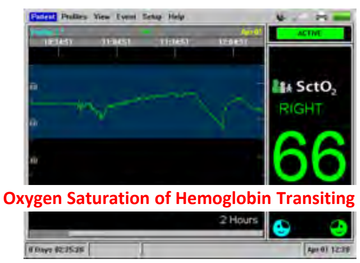
What does it measure?



Bickler P et al. Anesth Analg 2017;124:72-82

39

What does it measure?



Oxygen Saturation of Hemoglobin Transiting Brain

40

Predicting the Limits of Cerebral Autoregulation During Cardiopulmonary Bypass

Brijen Joshi, MD,* Masahiro Ono, MD,† Charles Brown, MD,* Kenneth Brady, MD,† R. Blaine Easley, MD,§ Gayane Yenokyan, PhD,‖ Rebecca F. Gottesman, MD, PhD,¶ and Charles W. Hogue, MD*

N = 410

Observational Study in Cardiac Surgery

Primary outcome: autoregulatory thresholds using cerebral oximetry

Joshi B et al. Anesth Analg 2012;114:503-510

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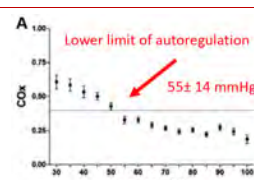
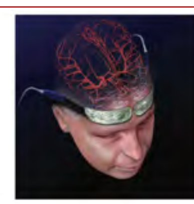
Defining the Lower Limit of Autoregulation





Brady K et al. Stroke 2010;41:1951-1956

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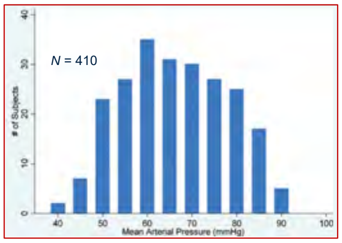
Lower Limit of Autoregulation: optimizing blood pressure



Joshi B et al. Anesth Analg 2012;114:503-510

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Circulation

American Heart Association

Autoregulation of cerebral blood flow in hypertensive patients. The modifying influence of prolonged antihypertensive treatment on the tolerance to acute, drug-induced hypotension.
S Strandgaard

n = 13 hypertensive patients vs. n = 10 controls

CBF measurements/autoregulatory curves

BP where neurologic symptoms occurred

Strandgaard S. Circulation 1976;53:720-727

44

	Bethanidine Methyldopa Hydroflumethiazide	Unilateral nephrectomy between study 1 and 2
Newly dis.	Furosemide, diazepam for 1 week Methyldopa, hydrochlorothiazide	Progressive dementia
Newly dis.	None	
	Methyldopa, hydrochlorothiazide	

Strandgaard S. Circulation 1976;53:720-727

45

	Bethanidine Methyldopa Hydroflumethiazide	~~Unilateral~~ nephrectomy between study 1 and 2
Newly dis.	Furosemide, diazepam for 1 week Methyldopa, hydrochlorothiazide	Progressive
Newly dis.	None	
	Methyldopa, hydrochlorothiazide	

Treated hypertensive patients

	LLA (mmHg)	Neuro symptoms (mmHg)
Severe HTN	113 ± 17	65 ± 10
Treated HTN	96 ± 17	53 ± 18
Normal	73 ± 9	43 ± 8

Strandgaard S. Circulation 1976;53:720-727

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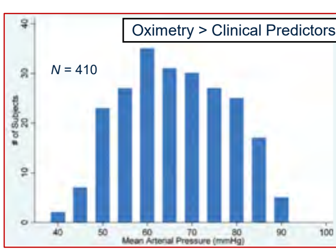
Lower Limit of Autoregulation: optimizing blood pressure

Oximetry > Clinical Predictors (HTN, age, stroke, DM)



Joshi B et al. Anesth Analg 2012;114:503-510

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The risks of too high a blood pressure: delirium

Arterial pressure above the upper cerebral autoregulation limit during cardiopulmonary bypass is associated with postoperative delirium

D. Hori[1], C. Brown[2], M. Ono[1], T. Rappold[2], F. Sieber[2], A. Gottschalk[2], K. J. Neufeld[3], R. Gottesman[4], H. Adachi[5] and C. W. Hogue[2*]

[1] Division of Cardiac Surgery, Department of Surgery, [2] Department of Anesthesiology and Critical Care Medicine, [3] Department of Psychiatry and [4] Department of Neurology, The Johns Hopkins University School of Medicine, The Johns Hopkins Hospital, 1800 Orleans Ave, Zayed 6208B, Baltimore, MD 21287, USA
[5] Department of Cardiovascular Surgery, Saitama Medical Center, Jichi Medical University, Saitama, Japan

observational study

N = 491, cardiac surgery

Hori D et al. Brit J Anaesth 2014 (Sept) doi:10.1093/bja/aeu318

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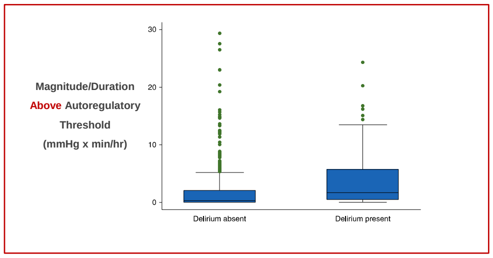
The risks of too high a blood pressure: delirium



Hori D et al. Brit J Anaesth 2014 (Sept) doi:10.1093/bja/aeu318

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Monitoring Brain Oxygen Saturation During Coronary Bypass Surgery: A Randomized, Prospective Study

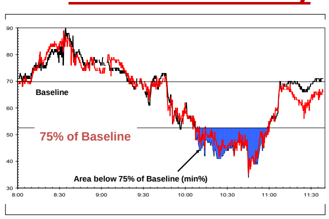
John M. Murkin, MD, FRCPC*
Sandra J. Adams, RN*
Richard J. Novick, MD, FRCSC§
Mackenzie Quantz, MD, FRCPS§
Daniel Bainbridge, MD, FRCPC*
Ivan Iglesias, MD*
Andrew Cleland, RRT‡
Betsy Schaefer, BSc*
Beverly Irwin, RN*
Stephanie Fox, RRT§

BACKGROUND: Cerebral deoxygenation is associated with various adverse systemic outcomes. We hypothesized, by using the brain as an index organ, that interventions to improve cerebral oxygenation would have systemic benefits in cardiac surgical patients.
METHODS: Two-hundred coronary artery bypass patients were randomized to either intraoperative cerebral regional oxygen saturation (rSO_2) monitoring with active display and treatment intervention protocol (intervention, $n = 100$), or underwent blinded rSO_2 monitoring (control, $n = 100$). Predefined clinical outcomes were assessed by a blinded observer.
RESULTS: Significantly more patients in the control group demonstrated prolonged cerebral desaturation ($P = 0.014$) and longer duration in the intensive care unit ($P = 0.029$) versus intervention patients. There was no difference in overall incidence of adverse complications, but significantly more control patients had major organ morbidity or mortality (death, ventilation >48 h, stroke, myocardial infarction, return for re-exploration) versus intervention group patients ($P = 0.048$). Patients experiencing major organ morbidity or mortality had lower baseline and mean rSO_2, more cerebral desaturations and longer lengths of stay in the intensive care unit and postoperative hospitalization, than patients without such complications. There was a significant ($r^2 = 0.29$) inverse correlation between intraoperative rSO_2 and duration of postoperative hospitalization in patients requiring ≥10 days postoperative length of stay.
CONCLUSION: Monitoring cerebral rSO_2 in coronary artery bypass patients avoids profound cerebral desaturation and is associated with significantly fewer incidences of major organ dysfunction.
(Anesth Analg 2007;104:51–8)

Murkin JM et al. Anesth Analg 2007;104:51-8

50

Adverse Clinical Outcomes Reduced with **Cerebral Oximetry**



Murkin JM, et al. Heart Surg Forum 2004;7(6)515.

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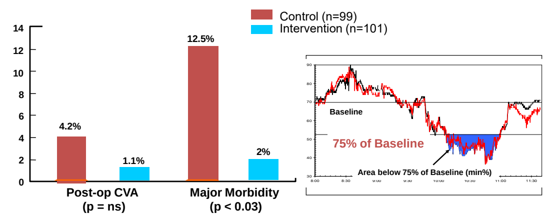
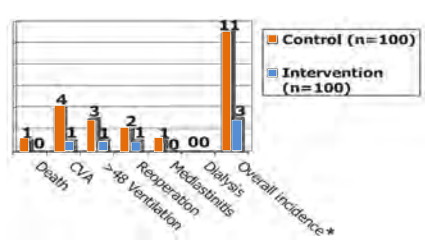
Adverse Clinical Outcomes Reduced with **Cerebral Oximetry**



Murkin JM et al. Anesth Analg 2007;104:51-8

52

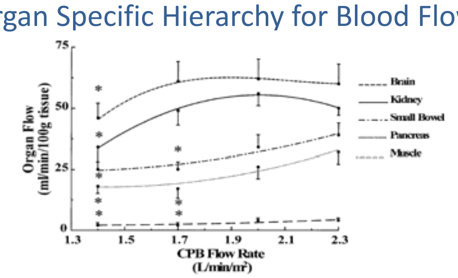
Brain as the "index organ"



Murkin JM et al. Anesth Analg 2007;104:51-8

53

Organ Specific Hierarchy for Blood Flow



Boston US et al. Ann Thorac Surg 2001;71;260-4

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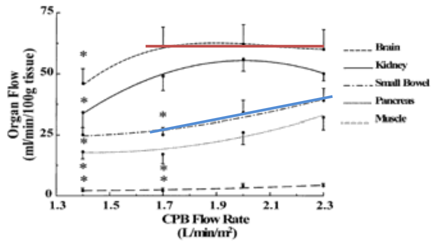
Organ Specific Hierarchy for Blood Flow



Boston US et al. Ann Thorac Surg 2001;71;260-4

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The brain as the "canary in a coal mine"?

56

What not just run everyone's blood pressure higher?

57

The risks of too high a blood pressure

Arterial pressure above the upper cerebral autoregulation limit during cardiopulmonary bypass is associated with postoperative delirium

D. Hori[1], C. Brown[2], M. Ono[1], T. Rappold[2], F. Sieber[2], A. Gottschalk[2], K. J. Neufeld[3], R. Gottesman[4], H. Adachi[5] and C. W. Hogue[2]*

[1] Division of Cardiac Surgery, Department of Surgery, [2] Department of Anesthesiology and Critical Care Medicine, [3] Department of Psychiatry and [4] Department of Neurology, The Johns Hopkins University School of Medicine, The Johns Hopkins Hospital, 1800 Orleans Ave, Zayed 6208B, Baltimore, MD 21287, USA
[5] Department of Cardiovascular Surgery, Saitama Medical Center, Jichi Medical University, Saitama, Japan

observational study
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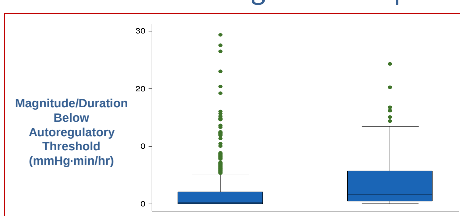
The risks of too high a blood pressure



Hori D et al. Brit J Anaesth 2014 (Sept) doi:10.1093/bja/aeu318

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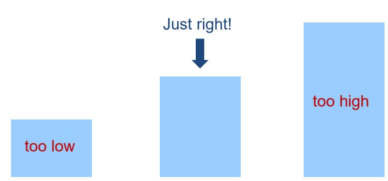
The Goldilocks Principle



MAP = 60-75 mmHg

(Oximetry-guided?)

60

Summary

- Defining baseline blood pressure
- Blood pressure and outcome relationships
- Using cerebral monitoring to guide blood pressure management
- No single unifying optimal blood pressure
- Importance of individualizing care

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Thank You

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Pushing Boundaries and Ancef: Anesthesia for Total Joints

Keleigh McLaughlin, MD
"Medicine Woman"

1

Learning Objectives

1) Identify appropriate patients for same day total joints
2) Describe the role of neuraxial vs general anesthesia for THA and TKAs
3) Recognize the benefit and limitations of peripheral nerve blocks and/or periarticular injections for analgesia in total joints

2

Disclosures

- No disclosures

3

Prevalence of Total Joints

- In the US annually
  - ~790,000 Total Knee Arthroplasties (TKA)
  - ~450,000 Total Hip Arthroplasties (THA)
  - ~130,000 Total Shoulder Arthroplasties (TSA)
- Projections for 2030:
  - ~1.28 million primary TKA
  - ~635,000 primary THA

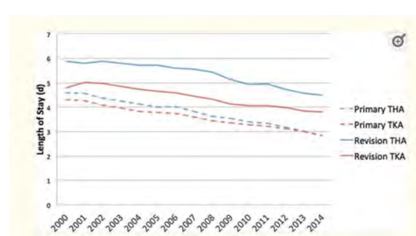
4

Same Day Discharge? That's Unpossible!

- Dr. Benchmore wants to start same-day joints at their surgery center
- Wants to know which patients qualify for same-day discharge (SDD)

5

Hx of Discharge Timing for Total Joints



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Benefits of Same Day Discharge

- Money
  - THA: ~$4000-7000/case in hospital-based setting
    - If even only 30% were eligible for SDD- that's **~$945 million per year for THA alone**!
- Similar outcomes compared to inpatient
  - 2017- NSQIP data matched cohort studies between SDD and inpatient TJA: showed no difference in overall adverse events or readmission rates

7

Complications from SDD/Readmissions

SYSTEMATIC REVIEW Open Access

Outpatient total knee arthroplasty leads to a higher number of complications: a meta-analysis

- 8 studies evaluated, 7 retrospective and 1 prospective
- 212,632 patients undergoing TKA
  - 6,607 were outpatient
  - 206,025 were inpatient
- Higher rate of complications in outpatient TKA (16.1% vs 10.5%, p=0.003)
  - Complications: ranged from cutaneous rashes to heart attacks….
- Similar readmission rates between outpatient and inpatient (4.9% vs 5.9%)

8

Barriers to Discharge

- Most common barriers:
  - Patient concerns
  - Function
  - Pain
  - Orthostatic hypotension
  - Bleeding
  - Nausea/Vomiting
  - Urinary retention

9

Barriers to Discharge

Contents lists available at ScienceDirect

The Journal of Arthroplasty

journal homepage: www.arthroplastyjournal.org

Primary Arthroplasty

Patient Perceptions of the Safety of Outpatient Total Knee Arthroplasty

Muyibat A. Adelani, MD *, Robert L. Barrack, MD

Department of Orthopaedic Surgery, Washington University School of Medicine, Saint Louis, MO

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Barriers to Discharge

- Surveyed patients who underwent primary TKA from March- September 2017
  - Prior knowledge of SDD
  - Perceived ability to undergo procedure as outpatient
  - Perceived risks and benefits to outpatient TKA
- 72.1% believed they definitely or probably could not go home the same day
  - Pain control (54.8%)
  - Bathroom (39.6%)
  - Fear of falling (39.6%)
- Perceived benefits of SDD
  - Avoidance of infection (57.3%)
  - Getting better sleep (46.9%)
  - Quieter recovery at home (42.7%)

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Patient Selection for SDD Total Joints

- Common Inclusion Criteria
  - Patient willingness
  - Social support system, home care for 24 hrs/day for several days
  - Preoperative independent ambulation
  - Primary, unilateral joint replacement

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Patient Selection for SDD Total Joints

- Common Exclusion Criteria
  - Age >70-80 yrs
  - Significant cardiopulmonary disease
  - Cirrhosis
  - Bleeding disorders
  - CKD Stage 3-5
  - Hgb <10
  - Poorly controlled DM
  - BMI >40
  - Chronic pain/preoperative opioid use

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Patient Selection for SDD Total Joints (RAPT)

- Risk Assessment and Prediction Tool (RAPT)
  - Developed in 2003
  - Attempts to predict patient's postoperative rehabilitation needs via 6 items
  - Accurately predicts discharge destination after TKA 62-89%
  - Moore et al in 2020 assessed utility of RAPT score and found that it *can* be used but may be suboptimal for SDD when compared with the institutional variables they selected, including BMI and number of allergies

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Patient Selection for SDD Total Joints (RAPT)

The Risk Assessment and Prediction Tool (RAPT)

Item	Value	Score
1. What is your age group?	50–65 years	2
	65–75 years	1
	> 75 years	0
2. Gender?	Male	2
	Female	1
3. How far, on average, can you walk? (a block is 200 m)	2 blocks or more (±rests)	2
	1–2 blocks (the shopping center)	1
	Housebound (most of the time)	0
4. Which gait aid do you use? (more often than not)	None	2
	Single point stick	1
	Crutches/frame	0
5. Do you use community supports? (home help, meals-on wheels, district nurse)	None or one per week	1
	Two or more per week	0
6. Will you live with someone who can care for you after your operation?	Yes	3
	No	0

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Patient Selection for SDD Total Joints (OARA)

- Outpatient Arthroplasty Risk Assessment (OARA)
  - Developed to predict which patients could safely undergo SDD
  - Stratifies patients by 9 separate comorbidity areas
  - Assigns scores based on presence, severity, and medical optimization
  - Score < 80 = More precisely predicted SDD than ASA score or Charlson Comorbidity Index for TKA and THA
  - Score <110= Effectively screened for SDD TSA with low rates of 90 day ED visits and readmissions

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Table 1 - OARA Score

Comorbidity Areas	Possible Points
General medical	180
Hematological	325
Cardiac	385
Endocrine	165
Gastrointestinal	185
Neurologic/psychological	185
Renal/urology	220
Pulmonary	250
Infectious disease	65

OARA, Outpatient Arthoplasty Risk Assessment

Reproduced with permission from: Table 2, Meneghini RM, Ziemba-Davis M, Ishmael MK, Kuzma AL, Caccavallo P: Safe selection of outpatient joint arthroplasty patients with medical risk stratification: the outpatient arthroplasty risk assessment score. *J Arthroplasty* 2017;32[8]:2325-2331.

*** This assessment took is provided by a third party company and requires subscription

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QUESTION

- Dr. Curls has patient who wants to undergo SDD TKA
  - 65 y/o F
  - COPD on scheduled inhalers, no O2
  - BMI 36
  - Hx of DVT not on AC
  - Lives alone, no family support
- Is this patient eligible for SDD?

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Developing Clinical Pathway for SDD

- Enhanced Recovery After Surgery (ERAS) Protocols
- Multidisciplinary Approach:
  - Patients and care givers
  - Surgeons
  - Anesthesia
  - PACU RNs
  - Physical Therapy

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Perioperative Management for SDD

- Needs to Address Barriers to Discharge:
  - Pain control
  - Bleeding
  - Function
  - PONV
  - Urinary retention

20

Preoperative Management

- Counseling, patient education and expectation setting
- Optimize comorbidities, decrease risk factors
- Multimodal analgesia
- Peripheral Nerve Blocks- more later

21

Preoperative Management

- Counseling/Pre-Surgical Education
  - Require extensive preoperative education regarding postoperative expectations
    - Pain control
    - Physical therapy
    - Home care (support 24 hrs/day for several days)
- Medical Optimization
  - Need for further workup prior to surgery
    - Clearance from PCP or Cardiologist
    - Smoking cessation
    - Controlling DM
    - Correct anemia (iron, EPO)

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Preoperative Management

- Multimodal Analgesia
  - NSAIDS
  - APAP
  - +/-Gabapentinoids
    - Anesthesiology 2020- Systematic and meta-analysis
      - No additional analgesic benefit
      - No prevention of chronic pain
      - Decreased PONV
      - Greater risk of adverse events (sedation, dizziness, visual disturbances)
  - Peripheral Nerve Blocks

23

Intraoperative Management

- Medications – antifibrinolytics
- Neuraxial vs General

24

Tranexamic Acid (TXA)

- Antifibrinolytic Agent
  - Binds to plasminogen and prevents fibrin degradation
  - Can be given PO, IV, or topically
  - Used to reduce overall blood loss
  - Typically given as a bolus prior to incision in TJA
- Complications from TXA:
  - Venous thromboembolism
  - Renal failure
  - ↑ MI, ischemic stroke, TIA
- Contraindications
  - Active PE/DVT or unstable angina
  - Vascular or coronary stent 6 mo-1yr
  - Combined hormonal contraception

25

TXA

Anesthesiology 2021: (Poeran et al)

- Retrospective cohort study of TKA and THA from 2013-2016
- Evaluated TXA administration in patients with 'high-risk' comorbidities
  - Group 1: Hx of VTE, MI, seizures, ischemic stroke/TIA
  - Group 2: Renal disease
  - Group 3: Atrial fibrillation
- TXA use was associated with decreased blood transfusion in all 3 groups with no increased risk of new onset composite complications (VTE, MI, seizures, ischemic stroke, TIA)

"If they can't receive TXA, they are probably too sick to undergo this surgery"

26

General vs Neuraxial for TKA/THA

Contents lists available at ScienceDirect

The Journal of Arthroplasty

journal homepage: www.arthroplastyjournal.org

Primary Arthroplasty

The Effect of Neuraxial Anesthesia on Postoperative Outcomes in Total Joint Arthroplasty With Rapid Recovery Protocols

Justin J. Turcotte, PhD, MBA *, Andrea H. Stone, MSN, CRNP, Ruby J. Gilmor, BS, Josephine W. Formica, Paul J. King, MD

Anne Arundel Medical Center, Annapolis, MD

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General vs Neuraxial for TKA/THA

Ambulatory Anesthesiology

ORIGINAL CLINICAL RESEARCH REPORT

Impact of Neuraxial Versus General Anesthesia on Discharge Destination in Patients Undergoing Primary Total Hip and Total Knee Replacement

Melissa Duque, MD,* Michael P. Schnetz, MD, PhD,* Adolph J. Yates Jr, MD,† Amanda Monahan, MD,* Steven Whitehurst, MD,* Aman Mahajan, MD, PhD, MBA,* and A. Murat Kaynar, MD, MPH*‡

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General vs Neuraxial for TKA/THA

Neuraxial and general anesthesia for outpatient total joint arthroplasty result in similarly low rates of major perioperative complications: a multicentered cohort study

Edward Yap [1,2] Julia Wei,[3] Christopher Webb,[1,2] Kevin Ng,[4] Matthias Behrends[2]

29

General vs Neuraxial for TKA/THA

Contents lists available at ScienceDirect

The Journal of Arthroplasty

journal homepage: www.arthroplastyjournal.org

Primary Arthroplasty

Rapid Recovery After Total Joint Arthroplasty Using General Anesthesia

Jeffrey B. Stambough, MD [a, *], G. Barnes Bloom, BSCE [b], Paul K. Edwards, MD [a], Gregory R. Mehaffey, MD [c], C. Lowry Barnes, MD [a], Simon C. Mears, MD, PhD [a]

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Neuraxial Local Anesthetic Choice

ANESTHESIOLOGY

Mepivacaine *versus* Bupivacaine Spinal Anesthesia for Early Postoperative Ambulation

A Randomized Controlled Trial

Eric S. Schwenk, M.D., Vincent P. Kasper, M.D., Jordan D. Smoker, M.D., Andrew M. Mendelson, D.O., Matthew S. Austin, M.D., Scot A. Brown, M.D., William J. Hozack, M.D., Alexa J. Cohen, B.S., Jonathan J. Li, B.S., Christopher S. Wahal, M.D., Jaime L. Baratta, M.D., Marc C. Torjman, Ph.D., Alyson C. Nemeth, M.P.T., Eric E. Czerwinski, M.S.P.T.

ANESTHESIOLOGY 2020; 133:801–11

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Neuraxial Local Anesthetic Choice

- Ambulation at 3-3.5 hrs post injection:
  - 70% of Mepi (35 of 50)
  - 37.7% of Hyper Bupi (20 of 53)
  - 17.6% of Iso Bupi (9 of 51)
- Pain and Opioid consumption higher in Mepi group but only in early postoperative period
- Same Day Discharge
  - 46% of Mepi
  - 24.5% of Hyper Bupi
  - 21.5% of Iso Bupi
- Transient Neurological Symptoms, Urinary Retention, Hypotension: no difference

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Neuraxial Local Anesthetic Choice

ELSEVIER

Contents lists available at ScienceDirect

The Journal of Arthroplasty

journal homepage: www.arthroplastyjournal.org

Systematic Review and Meta-Analysis

Mepivacaine Versus Bupivacaine Spinal Anesthesia for Primary Total Joint Arthroplasty: A Systematic Review and Meta-Analysis

Ahmed Siddiqi, DO, MBA [a, b, c, *], Yusuf Mahmoud, MD [b], Michelle Secic, MS [c], John M. Tozzi, MD [a, b, c], Ahmed Emara, MD [d], Nicolas S. Piuzzi, MD [d], Brian Culp, MD [e], Ran Schwarzkopf, MD, MSc [f], Bryan D. Springer, MD [g], Antonia F. Chen, MD, MBA [h]

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Postoperative Management

- Early Ambulation

PACU Discharge Criteria

Physical therapy criteria	Walk 80 feet on level ground Walk up and down stairs Demonstrate understanding of home exercises Perform bathroom transfers Stand from a supine position in bed Be able to dress self and perform basic activities of daily living Equipment available at home: walker, shower seat, etc.

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Postoperative Management

- Postoperative Urinary Retention (POUR)
  - Incidence ranges from 5.5– 46.3%
  - POUR increases rates of UTIs, can increase risk of PJI
- Risk factors:
  - Age, sex, certain comorbidities (ex BPH, renal disease)
  - IT morphine
  - Bupi > Mepi
  - IV fluids (>1000 mL)
  - Urinary catheter placement

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Prosthetic Joint Infection (PJI)

- Incidence:
  - ~ 0.5% within first year after THA/TKA
  - ~1.4% within first ten years after THA/TKA
- PJI most common cause of TKA failure
  - Study of 11,134 TKA, the incidence of revision at 15 years was 6.1% with 2.0% of the 6.1% done for PJI
- PJI is the third most common indication for revision THA
- Risk of PJI following TSA is less than both TKA and THA

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Infections in TJA
Risk Factors

- Patient Risk Factors:
  - Rheumatoid Arthritis
  - Immunosuppression
  - DM, CKD
  - Smoking
  - Obesity
  - Medications (MTX, Prednisone, TNF-alpha inhibitors etc)
- Surgical Risk Factors:
  - Duration of surgery
  - Location
  - Blood transfusion

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Infections in TJA
Prevention

- Antibiotic prophylaxis
  - Pre-incision Cefazolin
- Treat hyperglycemia (glucose <200)
- Decreased OR traffic
- ? Surgical hoods

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Peripheral Nerve Blocks for TJA

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Peripheral Nerve Blocks for TSA

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Interscalene Nerve Block

- Considered 'Gold Standard' for TSA

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Superior Trunk Nerve Block

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Peripheral Nerve Blocks for THA

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PENG Block

44

Erector Spinae Plane Block
(ESP)

45

Fascia Iliaca Nerve Block

46

Peripheral Nerve Blocks for TKA

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Adductor Canal vs Femoral Nerve Block
for TKA

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Infiltration between the Popliteal Artery and Capsule of the Knee (IPACK)

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IPACK Block

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Periarticular Injection

- Direct periarticular injection of the operative field
- Numerous small injections of the posterior capsule, periosteum, arthrotomy, and subcutaneous tissues for TKA, and pericapsular tissues for THA
- Often involves a 'cocktail'
  - Local Anesthetic
  - Ketorolac
  - Epinephrine
  - Clonidine
  - Opioid

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Periarticular Injection

Contents lists available at ScienceDirect
The Journal of Arthroplasty
journal homepage: www.arthroplastyjournal.org

Systematic Reviews and Meta-Analyses Associated with the Practice Guidelines of AAHKS, ASRA, AAOS, Hip Society and Knee Society

The Efficacy and Safety of Periarticular Injection in Total Joint Arthroplasty: A Direct Meta-Analysis

Charles P. Hannon, MD, MBA [a,*], Yale A. Fillingham, MD [b], Mark J. Spangehl, MD [c], Vasili Karas, MD [d], Atul F. Kamath, MD [e], Francisco D. Casambre, MPH [f], Tyler J. Verity, BA [f], Nicole Nelson, MPH [f], William G. Hamilton, MD [g,1], Craig J. Della Valle, MD [d,1]

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Periarticular Injection

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journal homepage: www.arthroplastyjournal.org

Practice Guidelines

Periarticular Injection in Total Joint Arthroplasty: The Clinical Practice Guidelines of the American Association of Hip and Knee Surgeons, American Society of Regional Anesthesia and Pain Medicine, American Academy of Orthopaedic Surgeons, Hip Society, and Knee Society

Charles P. Hannon, MD, MBA [a,b,*], Yale A. Fillingham, MD [c], Mark J. Spangehl, MD [d], Vasili Karas, MD [e], Atul F. Kamath, MD [f], William G. Hamilton, MD [g], Craig J. Della Valle, MD [c], AAHKS Anesthesia & Analgesia Clinical Practice Guideline Workgroup

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Periarticular Injection

Abstract: 3070

Scientific Abstracts > Regional Anesthesia

Does Periarticular Injection reduce pain after knee arthroplasty among patients receiving peripheral nerve blocks?

Justas Lauzadis, Douglas Padgett, Geoffrey Westrich, Ejiro Gbaje, Fred Cushner, Richard Kahn, Yi Lin, Enrique Goytizolo, David Mayman, David Kim, Kethy Jules-Elysee, Jacques YaDeau

Department of Anesthesiology Critical Care and Pain Management at Hospital for Special Surgery

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Question

- Which of the following nerve blocks can cause footdrop?
  - A) IPACK
  - B) Adductor Canal
  - C) Fascia Iliaca
  - D) Superior Trunk

55

Question

- Which of the following nerve blocks can cause footdrop?
  - A) IPACK
  - B) Adductor Canal
  - C) Fascia Iliaca
  - D) Superior Trunk

"I don't like Adductor Canal blocks because I don't want the patients to have foot drop"- someone who scored highly on Step 1

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Summary

- Identify appropriate patients for SDD
- Counsel patients thoroughly regarding postop expectations
- Multimodal analgesia
- TXA for almost everyone
- Neuraxial and general are both safe, Mepi > Bupi
- Early ambulation
- Cefazolin
- Nerve blocks and PAI are good adjuncts

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Thank You

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Cancer Outcomes and Anesthetic Management: An Introduction

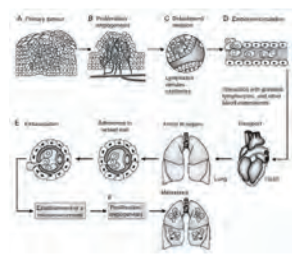
Roland Flores, MD
University of Colorado Anschutz Medical Campus
@TheRolandFlores

Objectives

- To review (very briefly!) the proposed mechanisms of cancer metastasis and recurrence and the immune system's role in limiting cancer spread
- To illustrate the effects of the perioperative period on these mechanisms and defenses
- To introduce the implications of anesthetic management choices in cancer outcomes

Anesthesiologists: The Physicians of the Perioperative Period

Metastasis, in a nutshell: The seed and soil hypothesis



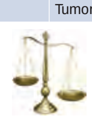
Snyder & Greenberg, British Journal of Anesthesiology 2010

Why is surgery so problematic for cancer recurrence?

- Handling and disruption of the tumor may release cells into circulation
- Removal of primary tumor may lead to decrease of circulating anti-angiogenic factors
- Increase in local and systemic release of growth factors after surgery
- And probably most importantly…perioperative immunosuppression

The immune system and cancer

Powers for good	Forces of evil
CD4 Th1 cells IL-2 IL-12 IFN-γ	CD4 Th2 cells IL-4 IL-6 IL-10
CD8+ cytotoxic lymphocytes	CD4 Th17 cells
Natural killer cells	CD4 regulatory T (T-reg) cells
	Myeloid-derived suppressor cells (MDSCs)
	Tumor-associated Macrophages



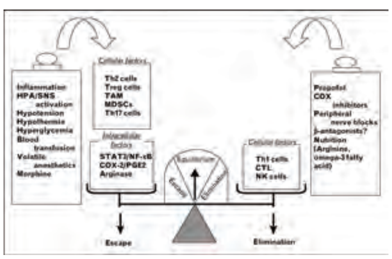
How does surgery affect this balance?

- Most significant factor: The surgical stress response
  - Sympathetic nervous system activation resulting in catecholamine release
    - Interfere with NK activity & increase IL-6 levels
    - Shift the immune response to Th2 (immunosuppression) predominance
    - Catecholamines promote angiogenesis
    - These actions are primarily via ß2 receptors.
  - Hypothalamic-pituitary-adrenal axis activation
    - Increased ACTH production leads to increased glucocorticoid release
    - Glucocorticoids kill immature T cells and shift the immune response to favor Th2

How does surgery affect this balance?

- Anesthetic consequences
  - Hypotension
  - Hypothermia
  - Transfusion
  - Medication effects
- Immunosupression response is biochemically evident within hours of surgery and lasts for several days, with a peak around the third postoperative day.

Surgery is a bad thing…



How can we ameliorate these negative influences and give our patients the best chances for survival?

- Anesthesia technique?
- Analgesic technique?
- Blood transfusion management
- Are the cardiologists right? SHOULD we avoid hypotension and hypoxemia? The answer may SHOCK you.

Inhaled Agents vs. TIVA

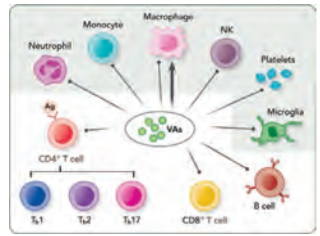
Anesthetic drugs and host defense

Drug	Adverse effect
Volatile agents	Inhibit NK cell cytotoxicity Reduce NK cell number
Propofol	Reduces NK cell number
Thiopental	Reduces NK cell number Increases number of viable tumor cells in animal models
Ketamine	Reduces NK cell number and activity Increases number of viable tumor cells in animal models
Midazolam	Reduces IL-8 levels

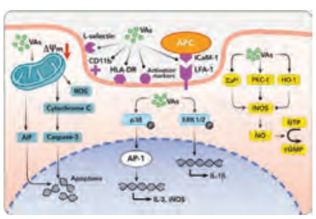
Inhaled agents

- Inhaled agents are associated with pro-cancer effects
- Mechanisms are unclear but clearly complex and multifactorial, and include immunomodulation and effect on tumor stem cells
- Halothane, isoflurane, and sevoflurane have all been long demonstrated to suppress NK cell activity and lymphocyte function, but recent research has revealed much more wide-ranging and complex effects on the immune system

Direct immunomodulating effects of volatile anesthetics



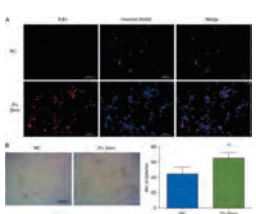
Immunomodulating pathways



In the lab: a sampling of observed effects

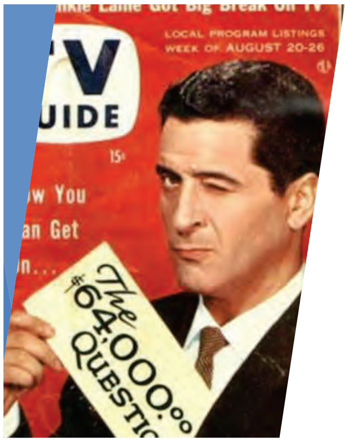
- Exposure to isoflurane has been shown to increase the resistance of colon cancer cells to the effects of anticancer drugs
- Isoflurane exposure increases melanoma metastasis in mice
- Isoflurane has been demonstrated to enhance the malignancy of head and neck squamous cell carcinoma cell lines
- Isoflurane enhances ovarian and renal cell tumor growth and malignant potential
- Nitrous oxide is associated with acceleration of lung and liver metastasis in animal models
- Sevoflurane has been demonstrated to promote the proliferation of glioma stem cells

Sevoflurane and Glioma Stem Cells



Propofol: An anesthesiologist's friend?

- Does suppress NK activity in vitro, BUT…
- Probably does not do so significantly in vivo at clinically relevant concentrations (whereas ketamine and thiopental appear to be significant)
- Mouse studies suggest that propofol increases CTL activity against tumor cells
- Increases Th1/Th2 ratio, which is good
- Has some COX-2 inhibitory activity, which is also good
- In humans, propofol-remifentanil anesthesia was associated with increased IL-10 activity in patients undergoing open cholecystectomy.
- In patients undergoing supratentorial tumor excision, patients has less immunosupression under propofol anesthesia compared to isoflurane.



Is TIVA superior to inhaled agents?

Very possibly.

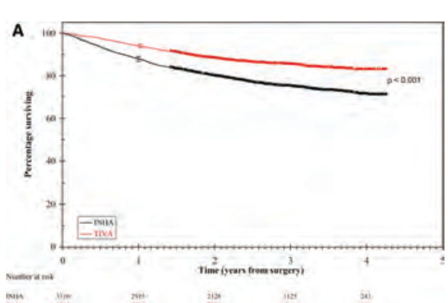
Wigmore et al.

- Retrospective cohort study of more than 7,000 patients who had general anesthesia for cancer surgery over 3 year period
- Patients who received both techniques, were under 16 yo, or who were having emergent surgery were excluded
- 3316 patients received inhalational agents; 3714 received propofol/remifentanil TIVAs
- Statistical analysis used 2607 matched pairs

Overall Group and Matched Group

Variables	Overall Patients INHA (n = 3,316)	Overall Patients TIVA (n = 3,714)	P Value	Matched Patients INHA (n = 2,607)	Matched Patients TIVA (n = 2,607)	P Value
Age (yr)						
Mean (SD)	57 (15.2)	57 (14.4)	0.256*	57 (15.1)	57 (14.9)	0.3021†
BMI	2,741	3,175	0.257*	2,140	2,257	0.192
Mean (SD)	27 (5.7)	27 (5.1)		27 (5.6)	27 (5.2)	
	n (%)	n (%)		n (%)	n (%)	
Sex						
Male	1,415 (43)	1,181 (32)	< 0.001	991 (38)	995 (38)	0.909
Female	1,901 (57)	2,533 (68)		1,616 (62)	1,612 (62)	
Blood transfusion						
No	3,058 (92)	3,586 (97)	< 0.001	2,457 (94)	2,497 (96)	0.011
Yes	258 (8)	128 (3)		150 (6)	110 (4)	
Epidural use						
No	2,922 (88)	3,392 (91)	< 0.001	2,311 (89)	2,320 (89)	0.692
Yes	394 (12)	322 (9)		296 (11)	287 (11)	
ASA						
I	427 (13)	727 (20)	< 0.001	391 (15)	382 (15)	0.876
II	2,041 (62)	2,376 (64)		1,663 (64)	1,670 (64)	
III	827 (25)	597 (16)		536 (20)	542 (21)	
IV	21 (0.6)	14 (0.4)		17 (1)	13 (1)	
Surgical severity group						
1	377 (11)	254 (7)	< 0.001	212 (8)	235 (9)	0.430
2	1,424 (43)	2,244 (60)		1,323 (51)	1,302 (50)	
3	787 (23)	722 (19)		600 (23)	626 (24)	
4	748 (23)	494 (13)		472 (18)	444 (17)	
Metastases at surgery						
No	2,474 (75)	2,998 (81)	< 0.001	1,986 (76)	2,009 (77)	0.452
Yes	842 (25)	716 (19)		621 (24)	598 (23)	
BMI	n = 2,741	n = 3,175	0.001	n = 1,858	n = 1,858	0.2411†
Underweight (< 18.5)	72 (3)	45 (1)		48 (2)	34 (1)	
Normal (18.5–24.9)	1,064 (39)	1,153 (36)		643 (35)	611 (36)	
Overweight (25.0–29.9)	962 (35)	1,209 (38)		758 (35)	668 (36)	
Obesity (≥ 30)	643 (23)	768 (24)		495 (25)	544 (24)	

* Independent t test. † paired t test.
ASA = American Society of Anesthesiologists; BMI = body mass index; INHA = volatile (inhalational); TIVA = total IV anesthesia.



Overall survival

TIVA/PVB vs Volatile & Opioids

Recurrence of breast cancer after regional or general anaesthesia: a randomised controlled trial

Daniel I Sessler, Lijian Pei, Yuguang Huang, Edith Fleischmann, Peter Marhofer, Andrea Kurz, Douglas B Mayers, Tanja A Meyer-Treschan, Martin Grady, Ein Yiu Tan, Sabry Ayad, Edward J Mascha, Donal J Buggy; on behalf of the Breast Cancer Recurrence Collaboration*

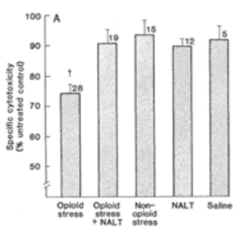
Summary

Background Three perioperative factors impair host defence against recurrence during cancer surgery: the surgical stress response, use of volatile anaesthetic, and opioids for analgesia. All factors are ameliorated by regional anaesthesia-analgesia. We tested the primary hypothesis that breast cancer recurrence after potentially curative surgery is lower with regional anaesthesia-analgesia using paravertebral blocks and the anaesthetic propofol than with general anaesthesia with the volatile anaesthetic sevoflurane and opioid analgesia. A second hypothesis was that regional anaesthesia-analgesia reduces persistent incisional pain.

TIVA vs Volatile Agents Take Home

Infographic predates the TIVA/PVB study

Role of pain in cancer recurrence

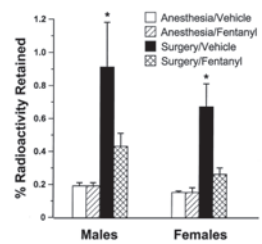


Acute pain activates the stress response via the SNS and the HPA axis – these responses can exacerbate or maintain pain

This stress response can decrease NK cells and their activity

Pain may have additional immunosuppressive effects, possibly mediated via endogenous opioids' effect on the μ3 receptor

Pain management and tumor growth



Pain management and tumor growth

- Morphine has been shown to influence immunomodulation & immune cell function
- Negative dose dependent action on NK cytotoxicity
- Inhibits IL-2 and CD4+ and CD8+ cells
- Synthetic opioids appears to have less immunomodulating effects than morphine

Opioids

- Morphine may be problematic
  - Inhibits spontaneous and cytokine-enhanced NK cell cytotoxicity; appears to be mediated by the μ3 opioid receptor
  - Animal data suggest that morphine is proangiogenic and promotes breast cancer and non-small cell lung tumor growth
  - However, a few studies have shown protective effects
- Fentanyl and possibly other synthetic opioids have similarly contradictory data
  - Doesn't bind to μ3; actually appears to increase NK activity
  - Several studies show no significant immunosuppressive effects
  - On the other hand, rat studies again show tumor-promoting effects.

Are All Opioids Bad?

- Not Necessarily …
- "Tramadol use is associated with enhanced postoperative outcomes in breast cancer patients: a retrospective clinical study with *in vitro* confirmation"
- Enhanced NK activity after uterine cancer surgery

Neuraxial or regional anesthesia

Overall and recurrence-free survival

Author	Year	Cancer type	Design type	Survival	Study quality*	GA No.	EA No.	Hazard Ratio	95% CI
Christopherson-I [6]	2008	Non-metastatic colon cancer	Prospective	Overall survival	7	92	85	0.216	0.065–0.718
Christopherson-II [6]	2008	Metastatic colon cancer	Prospective	Overall survival	7	92	85	0.699	0.395–1.236
Gupta-I [14]	2011	Colon cancer	Retrospective	Overall survival	6	95	360	0.82	0.30–2.19
Gupta-II [14]	2011	Rectal cancer	Retrospective	Overall survival	6	93	295	0.45	0.22–0.90
Lin [15]	2011	Ovarian cancer	Retrospective	Overall survival	6	37	106	0.824	0.699–0.930
Myles [16]	2011	Abdominal malignancies	Prospective	Overall survival	7	216	230	0.95	0.77–1.18
Cummings [17]	2012	Colon cancer	Retrospective	Overall survival	8	32,481	9,670	0.91	0.87–0.94
Exadaktylos [3]	2006	Breast cancer	Retrospective	Recurrence-free survival	6	79	50	0.21	0.06–0.71
Biki [2]	2008	Prostate cancer	Retrospective	Recurrence-free survival	6	123	102	0.43	0.22–0.83
Gottschalk [8]	2010	Colorectal cancer	Retrospective	Recurrence-free survival	7	253	256	0.82	0.49–1.35
Ismail [18]	2010	Cervical cancer	Retrospective	Recurrence-free survival	6	69	63	0.95	0.54–1.67
Luis [19]	2010	Colon cancer	Retrospective	Recurrence-free survival	7	951	182	1.326	0.980–1.871
Tsui [7]	2010	Prostate cancer	Prospective	Disease-free survival	6	50	49	1.33	0.64–2.77
Wuethrich [20]	2010	Prostate cancer	Retrospective	Progression-free survival	7	158	103	0.45	0.27–0.75
Myles [16]	2011	Abdominal malignancies	Prospective	Recurrence-free survival	7	216	230	0.95	0.76–1.17
Oliveira Jr [21]	2011	Ovarian Cancer	Retrospective	Recurrence-free survival	7	127	55	0.37	0.19–0.73
Lai [22]	2012	Hepatocellular carcinoma	Retrospective	Recurrence-free survival	7	117	62	3.66	2.59–5.15
Cummings [17]	2012	Colon cancer	Retrospective	Recurrence-free survival	8	31,099	9,278	1.05	0.95–1.15

Colon cancer and epidurals

- 2012 retrospective study by Cummings of over 42,000 patients from the linked Medicare-Surveillance, Epidemiology, and End Results database Patients were all over 66 years old with non-metastatic colon cancer who underwent open colectomy
- 22.9% received epidurals
- Patients who received epidurals were more likely to be younger, male, white, married, and Midwestern
- No significant difference in perioperative complications
- Found no significant difference in cancer recurrence (odds ratio 1.05, CI [0.95, 1.15], *p*=0.28)

Survival Benefit

- Five-year survival was 61% in the epidural group and 56% in the traditional pain management group
- Median survival was 7.24 years in the epidural group versus 6.09 years

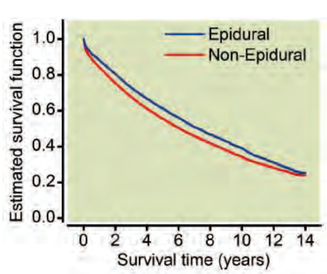


Table 2. Association between Epidural Use and All-cause Mortality

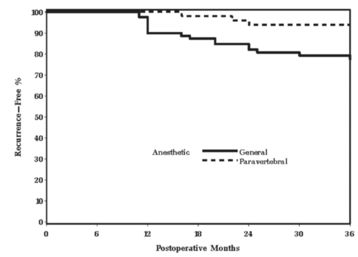
Models*	Hazard ratio	95% CI	*P* Value
Model 1A	0.86	(0.83, 0.89)	<0.001
Model 1B	0.91	(0.87, 0.94)	<0.001
Model 2A	0.92	(0.88, 0.96)	<0.001
Model 2B	0.92	(0.88, 0.96)	<0.001
Model 2C	0.92	(0.88, 0.96)	<0.001

Adjusted data

Peripheral nerve blocks

- Exadaktylos and colleagues retrospectively studied 129 consecutive patients who underwent mastectomy and axillary clearance in an Irish hospital
- 50 patient received paravertebral blocks in addition to general anesthesia, while the remaining 79 received general anesthesia and postoperative morphine analgesia.
- No significant difference between the groups in terms of patient factors, surgical details, tumor presentation, or prognostic factors.
- The median pain scores were less in the paravertebral group

Paravertebral block for breast cancer surgery

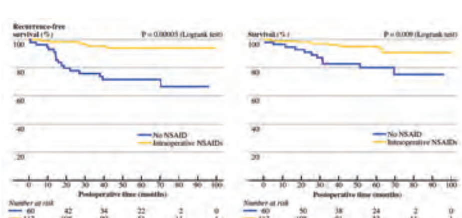


Other modalities

- Local anesthetics: Possible tumor inhibiting effect via direct effects on EGF receptors or via inhibition of the voltage-gated sodium channels on cancer cells
- COX-2 inhibitors: Promising in animal models
  - COX is over-expressed in many cancers
  - Prostaglandins inhibit NK cytotoxicity
  - Long-term use is associated with reduced incidence of cancer

How about toradol?

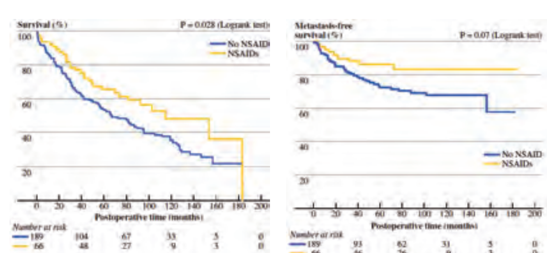
- If COX-2 blockers are promising, what about our intraoperative NSAIDs?
- Somewhat new area of interest
- Theory: May reduce tumor adhesion to endothelial cells and invasive potential. But mainly…



Forget et al. *Annals of Surgical Oncology*, 2013.

Toradol and diclofenac

Toradol and diclofenac




RESEARCH ARTICLE

Intraoperative ketorolac in high-risk breast cancer patients. A prospective, randomized, placebo-controlled clinical trial

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Does Ketorolac Increase Disease Free Survival in High Risk Breast Cancer?

Blood transfusions

- More than 200 studies have described an association between perioperative blood transfusion and increased risk of cancer recurrence
- The implications of transfusion has been investigated for many cancer types, including colorectal, bladder, breast, head and neck, endometrial, esophageal, hepatocellular, prostate, and kidney.
- Why? Same story -- immunosuppression

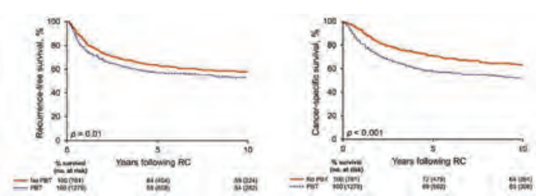
Blood transfusions and immunosuppression

- Historical fun fact: Perioperative transfusions were observed to enhance the survival of transplanted kidneys, thus tipping us off that transfusion might suppress the immune system
- Transfusion-related immunomodulation (TRIM)
- Mechanism is not totally clear
  - Leukocyte mediated? Probably not, since removal of white cells doesn't fix it
  - Seems to involve induction of Treg cells, which suppress CD4 and CD8 cells
  - May also be related to arginine depletion, which suppresses T-cell function

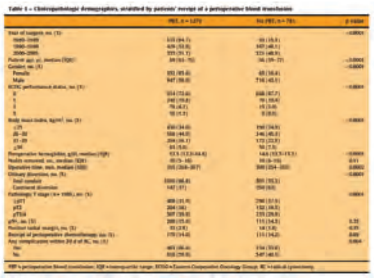
Bladder cancer

- Linder et al recently published a retrospective study of 2060 patients undergoing radical cystectomy for bladder cancer at the Mayo Clinic
- 62% (1279 patients) received transfusion with a median of 2 transfused units
- Results were complicated, but showed an increased risk of both recurrence and mortality for transfused patients.

Outcomes



Bladder cancer



Multivariate Analysis

	HR	95% CI	p value	HR	95% CI	p value	HR	95% CI	p value
Age at surgery	1.00	0.99–1.01	0.87	1.01	1.00–1.01	0.20	1.03	1.02–1.04	<0.0001
Gender (ref. female)	1.19	0.98–1.45	0.08	1.22	1.01–1.47	0.04	1.33	1.16–1.53	<0.0001
Body mass index	0.96	0.88–1.05	0.34	0.97	0.88–1.06	0.44	1.02	0.95–1.08	0.65
ECOG performance status	1.06	0.93–1.20	0.37	1.28	1.15–1.44	<0.0001	1.40	1.29–1.52	<0.0001
Preoperative hemoglobin level	0.96	0.92–1.01	0.12	0.90	0.86–0.94	<0.0001	0.89	0.87–0.93	<0.0001
Receipt of PBT	1.20	1.01–1.42	0.04	1.31	1.10–1.57	0.003	1.27	1.12–1.45	0.0002
Pathologic tumor stage (pT2–4 compared with ≤pT1)	2.16	1.84–2.54	<0.0001	3.04	2.55–3.62	<0.0001	1.83	1.64–2.05	<0.0001
pN+	1.91	1.54–2.37	<0.0001	1.78	1.45–2.18	<0.0001	1.68	1.42–1.99	<0.0001
Total no. nodes removed	0.98	0.97–0.99	0.0005	0.99	0.98–0.99	0.002	0.99	0.98–1.00	0.0008
Positive radial margin	0.97	0.86–1.08	0.53	1.00	0.98–1.02	0.65	1.00	0.98–1.02	0.80
Receipt of perioperative chemotherapy	1.03	0.82–1.29	0.82	1.31	1.06–1.62	0.01	1.07	0.90–1.27	0.46
Year of cystectomy	1.00	0.99–1.01	0.77	1.00	0.99–1.02	0.59	1.00	0.99–1.01	0.89
Early complication	1.05	0.90–1.23	0.51	1.04	0.88–1.21	0.66	1.09	0.98–1.22	0.13

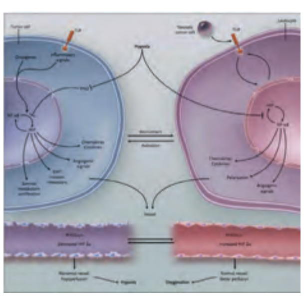
HR = hazard ratio; CI = confidence interval; ref. = reference; ECOG = Eastern Cooperative Oncology Group; PBT = perioperative blood transfusion.

Cochrane Review: Transfusions and colorectal cancer

- 2006 meta analysis of 36 studies with a total of over 12,000 patients undergoing curative resection of colorectal cancer
- Twenty-three of the studies showed a detrimental effect of perioperative transfusion on cancer recurrence
- Pooled data estimated that transfusion yielded an overall odds ratio of 1.42 (95% CI 1.2-1.67)
- Effect appeared to be dose-related; patients receiving 3 or more units had double the risk of recurrence compared to patients receiving 1 or 2 units
- Timing of the transfusion (pre-, intra-, or post-operative) did not seem to make a significant difference

Hypotension and hypoxemia: Shockingly not helpful in cancer patients

Okay, but why particularly?

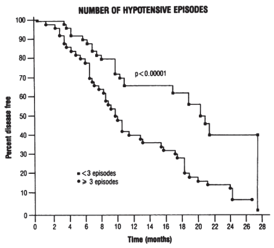


Eltzschig and Carmeliet. *New England Journal of Medicine*, 2011

Hypotension study

- 1991 retrospective study of 116 patients who had undergone complete hepatic resection for colorectal metastasis
- “Baseline” MAP was defined as the MAP at surgery start.
- Hypotension was defined as any value less than 80% of baseline MAP
- Of all the variables analyzed, the single most predictive factor for future recurrence was the number of hypotensive episodes during surgery. (p = <0.00001)

Hypotensive episodes and recurrence-free survival



Younes et al. *Annals of Surgery*, 1991.

Esophageal cancer and hypotension

- 2012 retrospective study of 53 patients who had undergone complete resection of esophageal cancer
- Defined hypotension as SBP<70 for all patients
- Found significant difference in 1-year cancer-specific survival for patients who had one or more hypotensive episodes (p=0.0002)

Beta blockers and Cancer

- 2018 Retrospective Meta-analysis of over 300K patients
- The administration of BB was not associated with increased overall survival, all cause mortality, disease free survival, progression free survival, recurrence free survival
- Associated with improved survival in patients with ovarian CA, pancreatic CA, and melanoma

Conclusions

- Cancer is complicated. Anesthesiology is complicated. The interplay between the two is significant, but in general incompletely understood. Ongoing research is critical
- The perioperative period is a critical time for cancer patients due to the attendant immunosuppression.
- Many of our anesthetic drugs, particularly volatile agents and opioids, likely significantly contribute to this immunosuppression.
- Pain is bad. Treat it aggressively, but consider avoiding opioids (particularly morphine) if possible. Consider NSAIDs and lidocaine.
- Blood transfusions should be avoided when possible.
- Hypoxia and hypotension continue to be bad ideas.
- Beta blockers MAY be helpful in certain subgroups

Anesthetic Considerations for Head & Neck Cancer

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Disclosures

- I have no financial conflict of interest in relation to this program/presentation.
- I am a member of the educational board of the Society for Head and Neck Anesthesia (SHANA).
- I am a co-author on the "Expert consensus statement on the perioperative management of adult patients undergoing head and neck surgery and free tissue reconstruction from the Society for Head and Neck Anesthesia," which was published in *Anesthesia & Analgesia.*

You may have been taught differently or seen and done things another way before.

These patients and problems often require adaptable, individualized plans, but a baseline plan for regular and/or emergency management can be established.

Acknowledgements

The further you get along, the more important it is to look back, see and thank who pushed you to get there.

Objectives

Following this lecture, a participant should be able to:

- Describe the preoperative assessment and preparation for patients undergoing head & neck surgery.
- Outline anesthetic management goals in patients undergoing head and neck flap reconstructive surgery.
- Define the steps necessary to evaluate a tracheostomy and emergently manage it.
- Outline the preparation and performance of an awake fiberoptic intubation.

Head & Neck Cancer Statistics

- In the United States, the incidence of oral and pharyngeal cancers is over 54,000 cases per year, resulting in over 11,000 yearly deaths.
- Although smoking and alcohol consumption are traditional risk factors for head and neck cancer, they are declining in many countries.
- There is a steady increase in diagnoses of human papillomavirus (HPV)-related cancers, frequently affecting the oropharynx.

Mody MD, Rocco JW, Yom SS, et al: Head and neck cancer. Lancet 398:2289-2299, 2021.

Head & Neck Cancer Survival

- The prognosis and survival of squamous cell carcinoma of the head and neck depends on, among many other variables, the stage at presentation, the site of involvement, and the human papillomavirus status.
- The 5-year overall survival in patients with stage I–II disease is typically 70–90%.
- Patients with stage III–IV disease typically have a poorer prognosis; for example, patients with locoregionally advanced laryngeal carcinoma have an approximate survival of 40% at 5 years.

Mody MD, Rocco JW, Yom SS, et al: Head and neck cancer. Lancet 398:2289-2299, 2021.

Preoperative Evaluation

- It is imperative that you discuss the specific pathology and surgical plan with the surgeon before starting these procedures.
- You will be sharing the airway at times which requires constant communication.
- Ensure CT scan and preop nasal endoscopy have been reviewed to anticipate degree and extent of tumor burden or airway involvement.

Image from *Medscape Reference*

Preoperative Endoscopic Airway Evaluation (PEAE)

- PEAE extends the airway exam beyond the naked eye and available lines of sight.
- Can change the clinical approach to airway management in high-risk patients.
- In particular, large lesions occupying the hypopharynx may herald difficult or impossible SGA placement.

Anesthesia for Otolaryngologic Surgery, ed. Basem Abdelmalak and D. John Doyle. Published by Cambridge University Press. 2013

Image from Weill-Cornell Medicine

Preoperative Airway Ultrasound

- Gaining interest in recent years.
- Useful for:
  - Airway size and prediction of endotracheal tube.
  - Prediction of difficult laryngoscopy.
  - Airway device placement and depth.
  - Prediction of post-extubation stridor.
  - Emergent surgical airway placement.
  - Evaluation of airway anatomy.

Osman, A., Sum, K.M. Role of upper airway ultrasound in airway management. j intensive care 4, 52 (2016). https://doi.org/10.1186/s40560-016-0174-z

Anesthetic Management Goals in Free Flap Surgery

Gorphe P, et al. Indications and Clinical Outcomes of Transoral Robotic Surgery and Free Flap Reconstruction. Cancers. 2021; 13(11):2831

Vasopressors

- Though opinion is often against vasopressors, there is little to no evidence that their use worsens flap outcomes and growing evidence demonstrates that they may indeed improve outcomes.
- From the SHANA expert consensus statement in 2021: **"Vasopressors can be used to optimize the hemodynamic management of this patient population after identifying and correcting other hypotension contributing factors, such as hypovolemia, deep anesthesia, anemia, and electrolyte abnormalities."**

Anesthesia for Otolaryngologic Surgery, ed. Basem Abdelmalak and D. John Doyle. Published by Cambridge University Press. 2013
Healy DW, et al. Expert Consensus Statement on the Perioperative Management of Adult Patients Undergoing Head and Neck Surgery and Free Tissue Reconstruction From the Society for Head and Neck Anesthesia. Anesth Analg. 2021 Jul 1;133(1):274-283

Fluid Management

- Judicious use of intravenous fluids (crystalloids or colloids) and avoidance of hypovolemia and hypotension are important to maintain homeostasis and to avoid flap ischemia.
- **Fluid overload may increase the risk of free flap failure in this patient population.**
- There is a paucity of data regarding whether the specific type of fluid is beneficial/harmful in free flap surgery.

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Blood Transfusion Thresholds

- Goal is to maintain adequate perfusion to end organs as well as perfusion of grafts.
- **A reasonable target is a hematocrit of 25-30** secondary to both commonly associated comorbidities and graft considerations.
- Avoidance of hyperviscosity to prevent graft thrombosis also renders transfusions for a **hematocrit >30 unnecessary.**

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Anesthetic Type

- A balanced anesthetic method is preferred, though there is little evidence regarding whether total intravenous or inhalational maintenance is superior.
- Multimodal pain management strategies may enhance pain control during the perioperative period.
- Currently little role for regional anesthetics.

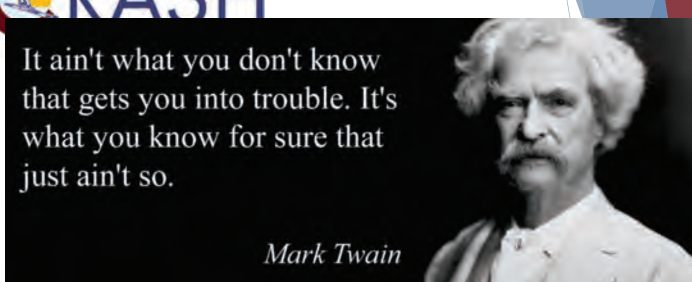
Anesthesia for Otolaryngologic Surgery, ed. Basem Abdelmalak and D. John Doyle. Published by Cambridge University Press. 2013
Healy DW, et al. Expert Consensus Statement on the Perioperative Management of Adult Patients Undergoing Head and Neck Surgery and Free Tissue Reconstruction From the Society for Head and Neck Anesthesia. Anesth Analg. 2021 Jul 1;133(1):274-283

Lines/Monitors

- Optimal monitoring of this patient population includes the use of standard ASA monitors; core temperature monitor, insertion of a Foley catheter to monitor urine output; the placement of an arterial line to monitor hemodynamic parameters, and the monitoring of fluid status metrics such as systolic pressure variation.
- Central Access is rarely necessary in the presence of multiple well functioning peripheral IVs. If one is necessary, the internal jugular should be avoided.

Anesthesia for Otolaryngologic Surgery, ed. Basem Abdelmalak and D. John Doyle. Published by Cambridge University Press. 2013
Healy DW, et al. Expert Consensus Statement on the Perioperative Management of Adult Patients Undergoing Head and Neck Surgery and Free Tissue Reconstruction From the Society for Head and Neck Anesthesia. Anesth Analg. 2021 Jul 1;133(1):274-283

Tracheostomy Management

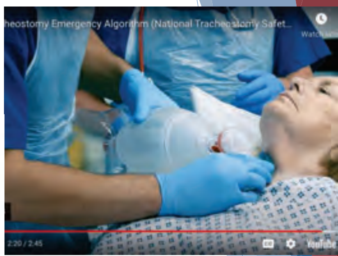


"What do I do with this thing when it fails at 3 in the morning?"

Where to go for Help

National Tracheostomy Safety Project

www.tracheostomy.org.uk



Tracheostomy

- Surgically created hole into trachea
- Temporary or permanent
- Can make airway safer during future treatment
- For medically complex patients, may be permanent

Laryngectomy

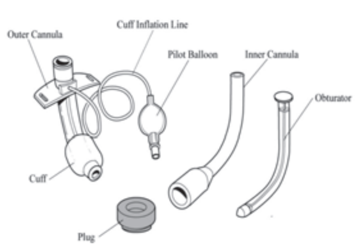
- **Laryngectomy** is the removal of the larynx and separation of the airway from the mouth, nose and esophagus.
- In a total laryngectomy, the entire larynx is removed (including the vocal folds, hyoid bone, epiglottis, thyroid and cricoid cartilage and a few tracheal cartilage rings).

Image Courtesy of Memorial Sloan Kettering Hospital

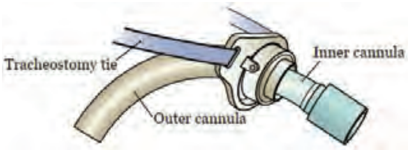
Tracheostomy Basics

- Different types of tubes available can be confusing.
- In general defined by:
  - -presence / absence of cuff
  - -presence / absence of inner cannula
  - -presence / absence of a hole (fenestration)
- Most modern tubes made from synthetic material
- **Cuffed** tubes used to seal airway to provide positive pressure ventilation or prevent aspiration.
- **Uncuffed** tubes tend to be used in chronic tracheostomy patients with effective cough reflexes.

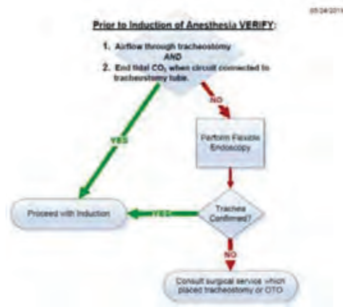
Tracheostomy Tube Components



Courtesy of "Managing the Tracheostomy Patient," Emergency Physician Monthly; http://epmonthly.com/article/managing-tracheostomy-patient/

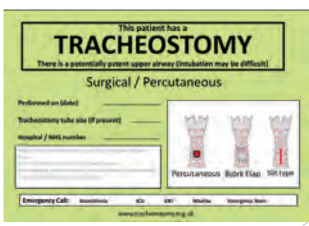


Elective Tracheostomy Management



Elective Tracheostomy Management

- **Why** was the tracheostomy placed?
- **When** was it placed?
- **What** is the trach type and size? (availability of emergency equipment)



Indications for Tracheostomy

- Acute or chronic upper airway obstruction (Ludwig's angina, obstructive sleep apnea)
- Risk of chronic aspiration (stroke patients)
- Chronic respiratory failure (ICU patients)
- Retention of bronchial secretions (weak cough, CF)
- Elective during surgical procedures of head and neck
  - **Relative Contraindications:**
    - -Uncorrected coagulopathy (plt <50,000, INR >1.5)
    - -Presence of laryngeal cancer
    - -Hemodynamic instability

Anesthesia for Otolaryngologic Surgery, ed. Basem Abdelmalak and D. John Doyle. Published by Cambridge University Press. 2013

Aren't Tracheostomies Safe?

- Klemm found 352 tracheostomy related deaths in a review of 25,056 tracheostomies performed in 21 countries, **a rate of fatal events in 1.4%**.
- Cramer et al. found 623 tracheostomy related deaths over a ten-year period in the United States.

Klemm E, Nowak AK. Tracheotomy-Related Deaths: A Systematic Review. Deutsches Ärzteblatt International. 2017 Apr;114(16):273

Aren't Tracheostomies Safe?

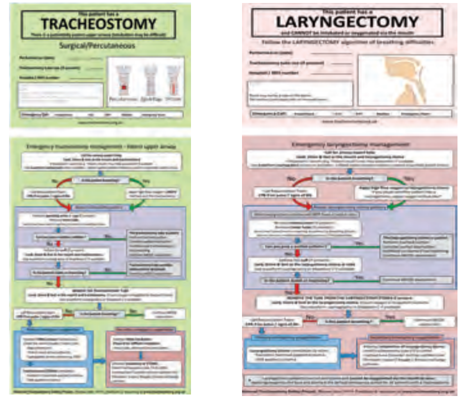
- Cramer et al. also found that these deaths were significantly more common in children (**10x more common!**) African-American children or adults, and Hispanic adults.
- Additionally, **more likely to occur on the weekend**.
- **Patient advanced education** (bachelor's, master's, etc.) found to be protective.

Klemm E, Nowak AK. Tracheotomy-Related Deaths: A Systematic Review. Deutsches Ärzteblatt International. 2017 Apr;114(16):273

High-Risk Patients

- **Children, especially newborns and infants**
- Smokers
- Alcohol abusers
- Diabetics
- Immunocompromised patients
- Persons with chronic diseases or respiratory infections
- Persons taking steroids or cortisone

Klemm E, Nowak AK. Tracheotomy-Related Deaths: A Systematic Review. Deutsches Ärzteblatt International. 2017 Apr;114(16):273



Available from the National Tracheostomy Safety Project
https://www.tracheostomy.org.uk/

Emergency Tracheostomy Management

For Podcast Listeners

Anesthesia and Critical Care Reviews and Commentary (ACCRac)

Episode 111: Tracheostomies, Cricothyrotomies and ENT surgery with Dr. Zandy Hillel

"In the event of an emergency, your closest exit may be behind you."

Laura Duggan MD, Associate Professor of Anesthesiology, the University of Ottawa

Awake Intubation

Awake Intubation

An awake intubation should be performed when there is possibility **by history or exam that the airway may be difficult to intubate and/or ventilate**.

Associated conditions include:
- Head and neck cancers
- Laryngeal and tracheal pathologies
- Head & neck radiation therapy
- Trauma
- Congenital syndromes
- Limited mouth opening.

Review of clinical nasal endoscopies, head/neck CT scans, and discussion with surgeons are invaluable.

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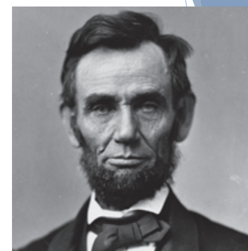
Awake Intubation

Patient Pre-Procedure Preparation

1. Decision for Awake Flexible Endoscopic Intubation
2. **IV Glycopyrrolate 0.4 to 0.6 mg early. At least 30 minutes before topicalization**
3. Prepare Intubation Cart
4. Lidocaine 4% nebulizer
5. Sedation choice upon entering room (I usually prefer small doses of Midazolam)



"Give me six hours to chop down a tree and I will spend the first four sharpening my axe."
- Abraham Lincoln

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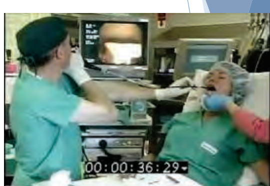
Awake Intubation

Intraoperative Procedure

1. **Remifentanil** 0.05 mcg/kg/min titrated to mild sedation
2. Madgic 4% lidocaine until no gag (atomizer)
3. Use small **Parker** (6.0-7.0) ETT
4. Advance scope via supraglottic structures
5. Pass epidural cath through cords and spray 4% lidocaine
6. With view of carina pass ETT into trachea
7. Confirm end tidal CO2
8. Induce with propofol (0.5 mg/kg)



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Difficult Airway Society Guidelines

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Great Sources of Information

DIFFICULT AIRWAY SOCIETY
DAS

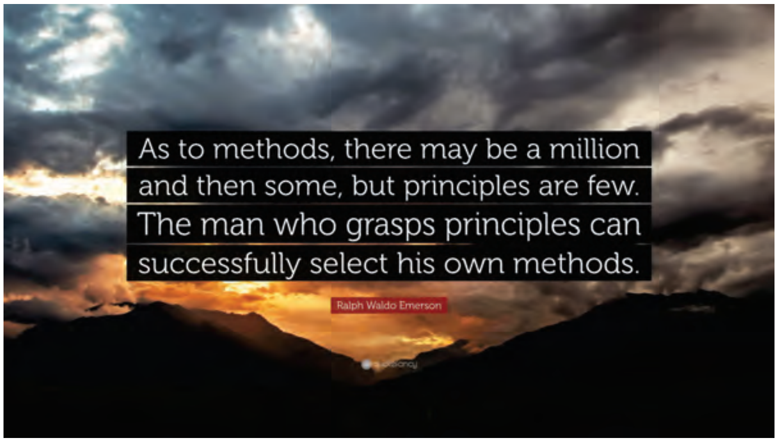
SHANA

NTSP
www.tracheostomy.org.uk
National Tracheostomy Safety Project

CRASH

Discussion/Questions?

CRASH


As to methods, there may be a million
and then some, but principles are few.
The man who grasps principles can
successfully select his own methods.
Ralph Waldo Emerson

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

Neuroanesthesia Panel: Adverse Events in Spine and Intracranial Surgery

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No conflict of Interest to Disclose

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Guiding the future of patient care

Intraoperative Emergencies: Spine Surgery

Julio Montejano, MD
Neuroanesthesiology Assistant Professor
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3

Learning Objectives

- Become familiar with common spine surgery procedures and basic terminology
- Become familiar with basic anesthetic management of spine surgery ranging from simple procedures to more complex
- Become familiar with basic preoperative assessment metrics for the spine surgical patient
- Review basic spine anatomy
- Review potential complications ranging from common to rare and catastrophic
- Discuss basic management and the evidence behind those strategies

CRASH

4

Outline

- So this is your first spine…?
- Types of Spine Surgery
- Common approaches
- Preop Risk assessment: Can your Patient Handle it?
- Anesthetic agent choice: Tips and Tricks
- Injury to Spinal Cord
- Injury to Peripheral nerves
- Vascular Injury
- Pulmonary Complications: The lungs are closer than you think
- Emboli: Clots, Fat, Cement and Air
- Post Operative Vision Loss
- Incidental Durotomy
- Recurrent Laryngeal Nerve Injury
- Summary
- Questions

CRASH

5

So this is your first Spine Surgery…?

- Become familiar with the lingo
- Can your Patient Handle it? (see Next Slides)
- What position will you be in? Will you be in multiple positions?
- How many levels?
- What are the planned corrections?
- What is the expected blood loss?
- Is this a primary spine, a redo, a redo-redo?
- Is there infected Hardware?
- Is there a tumor involved?
- Will there be neuromonitoring and what type?
- Discuss exit strategies and possibility of staging

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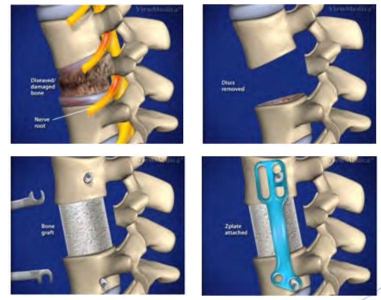
6

Types of Spine Surgery and Common Procedures

- Spinal decompression and fusion
- Microdiscectomy
- Artificial Disc Replacement
- Laminectomy
- Vertebroplasty
- Foraminotomy
- Smith-Peterson Osteotomies
- Pedicle Subtraction Osteotomies
- PLIF/ALIF/XLIF/TLIF/OLIF (Really?!)
- Corpectomy

7

Corpectomy



8

Common Approaches

- Posterior
- Anterior
  - Lumbar often requires a transabdominal approach
  - Thoracic often requires cooperation with a thoracic surgeon and intubation with a DLT for lung isolation
- Lateral
- Combination of all or any of the above
- Arms out or tucked
- Head in pins or prone view
- Wilson Frame vs Axis

9

Preoperative Risk Assessment: Can your Patient Handle it?

- 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 glucose, coagulation studies and a type and screen
  - **Screening for osteoporosis and nutritional testing**
  - Other testing as indicated per patient history
- Fitness assessment
- Expected Blood loss and volume shifts
- Positioning concerns
- Airway Management
- Vascular Access

10

Anesthetic Choices: Tips and Tricks

- Before choosing an anesthetic plan identify the types of IONM if any that will be used
  - Institutional policies and protocols if any
- Start with a propofol infusion and add agents from there:
  - Narcotics: neutral effect on signals
  - Ketamine: enhance signals
  - Lidocaine: likely detrimental effect on signals
  - Dexmedetomidine: likely detrimental effect on signals
  - Volatile Anesthetics: negative effects but MEPs>SSEPs
  - Paralytics: negative effects on MEPs and EMG

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What Could Possibly go Wrong?

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Intraoperative Spinal Cord Injury

- Most often mechanical (direct injury, stretching or crushing)
  - Can also be ischemic due to vascular injury or due to hemodynamic changes
- Utilization of IONM to monitor in real time and detect potential injury
  - Combination of SSEPs, MEPs, EMG and tEMG give highest sensitivity and specificity to identify injury during large or complex manipulations of the spinal column
  - If changes in signals are detected care must be taken to identify source
    - Isolate global vs local changes

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Intraoperative Spinal Nerve and Peripheral Nerve Injury

- Spinal roots are also at risk even during lumbar/sacral procedures
- IONM can be used to detect injury to spinal nerves and peripheral nerves due to positioning (most commonly brachial plexus)
  - SSEPs and EMG
- Patients sensitive to hemodynamic shifts can also experience ischemic injury to spinal and peripheral nerves
- Signal changes can be cortical or sub-cortical

14

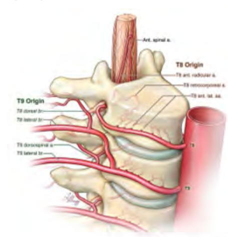
What can you do?

- Alert the surgeon immediately
  - Multidisciplinary discussion between surgeon, anesthesia and IONM teams
  - Reverse last surgical intervention if possible
- Increase blood flow
  - MAP 85-90 little evidence to push past 95
- Decrease inflammation and edema
  - High dose steroids—mixed evidence
  - Mannitol—mixed evidence
- Reposition the patient
  - Release tape
  - Reposition arms

15

Vascular Complications

- Aortic injury
- Other Major vessel injury
  - Can result in massive blood loss
- Adequate vascular access should be planned and obtained ahead of time due to limitations in positioning
- Appropriate blood products should be available
- Appropriate consult services should be available for high risk procedures



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Case

- 42yoF w/ h/o metastatic RCC with lung and spine mets p/w progressive LLE weakness in setting of known spinal canal stenosis p/f L3-S1 PSF and L3-L5 RFA w/ L4 lateral corpectomy

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Significant Events

- PSF, Corpectomy and RFA performed, patient repositioned from prone to right lateral decubitus.
  - No significant bleeding noted per surgeon report following each of the above interventions
- Acute hypotension
  - While preparing to close, venous bleeding was noted and thought to be from perforator to common iliac vein
  - Bleeding became profuse and non-compressible
  - MTP started and vascular consult called
- Vascular surgeon joined and placed aortic balloon accessed groins bilaterally and found a left common iliac artery bleed

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Outcome

- Intraaortic balloon was placed and inflated while repair to the common iliac artery was performed
- Patient became acutely hypotensive and became asystolic
- Massive PE suspected as pulmonary vasculature was not able to be imaged without any further vascular injury identified
- CPR continued while CT surgery was consulted for VA ECMO
- Ultimately efforts were deemed futile due to the extent of injury and the patient suffered intraoperative death
- EBL >8 L based on transfusion needs
  - PRBCs 23
  - FFP 36
  - PLT 7

19

Solutions to Vascular Complications

- Fix the injury!
  - High risk cases should consider vascular/cardiothoracic surgery consults preoperatively to aid in exposure or to expedite consultation should intraop injury occur
- Employ blood conservation strategies whenever possible
  - Cell saver
  - Hemodilution
- Transfusion and supportive care
- Consider high dose TXA if no contraindications exist
  - Compared to LD TXA or placebo, there is moderate evidence that HD is not associated with an increased risk of medical complications.
  - Evidence that HD TXA reduces transfusion requirements

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Pulmonary Complications: The Lungs are closer than you think

- Pneumothorax
  - Most common during anterior thoracic approaches
  - Can also happen during posterior approaches in the thoracic spine
  - Suspect tension physiology if deterioration occurs
- High peak pressure ventilation
  - Due to body habitus, positioning or pre-existing disease
- Pulmonary edema from volume overload
- Loss of airway
  - Prone FOB vs LMA placement vs repositioning and reintubation
- High risk of reintubation due to mental status and poor physiologic reserve post op

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Emboli: Pulmonary, Fat, Cement and Air

- Pulmonary Embolus
- Fat Embolus
- Cement Embolus
- Air Embolus
- Obstructive complications and delayed inflammatory reactions
- If these occur intraoperatively the patient should be monitored for subsequent complications in a critical care setting

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Post Operative Vision Loss

- Incidence of POVL after spine surgery 0.03% to 0.2%
  - Relatively rare but devastating
- Venous congestion vs arterial ischemia vs mechanical
  - Anemia, emboli, hypotension, globe compression, prone positioning, volume and/or type of fluid administered, prolonged operative times and preexisting conditions
- Modifiable Risk factors
  - Avoid hypotension
  - Avoid pressure on the eyes
  - Consider colloid volume resuscitation along with crystalloid
  - Monitor Hgb and avoid anemia
- Management
  - Ophthalmologic consultation
  - Imaging to isolate
  - Antiplatelet agents, steroids, or IOP lowering agents have not been shown to be effective

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Incidental Durotomy

- Reported incidences ranging from 1% to 17%
- Complications range from mild to severe
  - Postural headaches, vertigo, posterior neck pain, neck and/or stiffness, nausea, diplopia, photophobia, tinnitus, and blurred vision
  - Persistent leak, pseudomeningocele
- Risk factors
  - Complex spinal surgery and revision procedures
  - Old age
  - Spinal Stenosis
  - Use of high speed drills
- Management
  - Primary repair
  - Sub facial drain (controversial)
  - 24hr bedrest--little evidence but little harm

24

Recurrent Laryngeal Nerve Injury

- Preoperative risk assessment
  - Pre-existing swallowing issues, hoarse voice, previous neck surgery, previous cervical spine surgery, thyroid disease, other H&N cancer
- Incidence ranging from 0.2-16.7%
- Risk factors
  - Female gender, right sided approach, more levels=more risk (controversial)
  - Length of surgery, traumatic intubation, endotracheal cuff pressure
- Management
  - Uni vs bilateral

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Conclusion

26

Intraoperative Neurophysiologic Monitoring (IONM) Alerts and Interventions

Claudia F. Clavijo, MD
Associate Professor
Neuroanesthesiology Section Chief
Department of Anesthesiology University of Colorado

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Learning Objectives

- Review purpose and general aspects of IONM
- Learn common intraoperative neuromonitoring alerts
- Understand the importance of the anesthesia team and anesthetic choice in the preservation of responses
- Review complications related with the IONM techniques
- Discuss appropriate interventions to manage alerts

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Purpose of IONM

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

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Types of Recordings

Spontaneous

- Electroencephalography (EEG)
- Electromyography (EMG)

Evoked

- Somatosensory (SSEP)
- Motor (MEP)
- Auditory (ABR)
- EMG

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Common Surgical Applications

Spine Surgery
- Most fusions
- Spinal cord tumors

Intracranial Surgery
- Posterior fossa tumors
- Microvascular decompression
- Cerebral mass in or near eloquent cortex

Vascular Surgery
- Carotid endarterectomy
- Aortic aneurysm repair

Cardiac Surgery
- Aortic arch repair or replacement

Head and Neck Surgery
- Parotidectomy
- Thyroidectomy
- Parathyroidectomy
- Neck dissection

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Reasons For Alerts

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

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IONM Modalities

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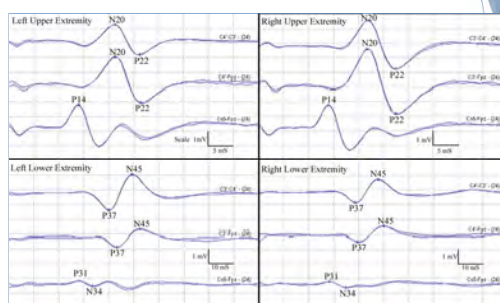
SSEPs



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SSEP Alert Criteria

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

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Examples of SSEP Alerts

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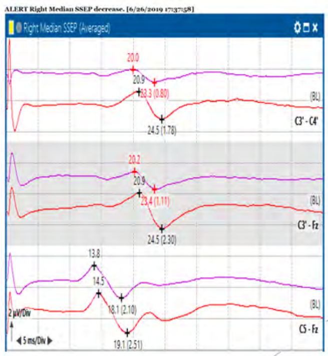

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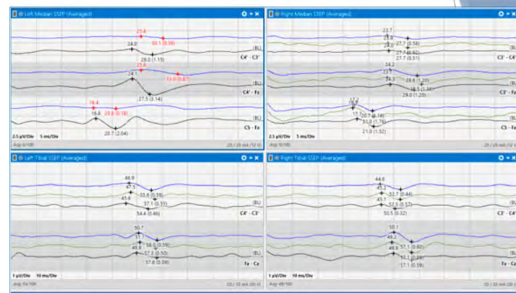

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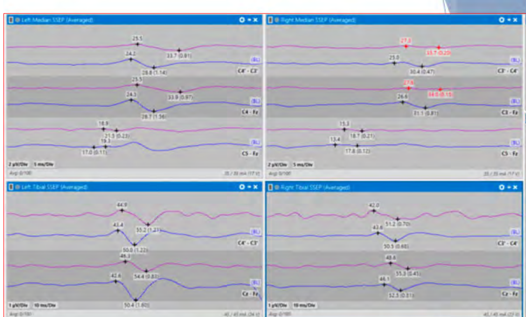

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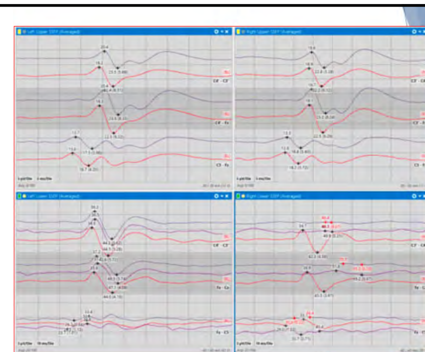

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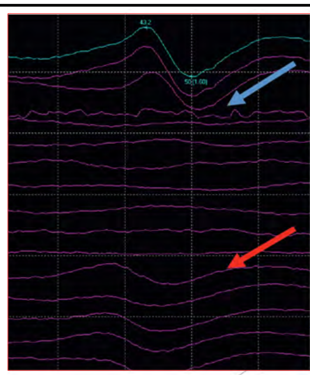

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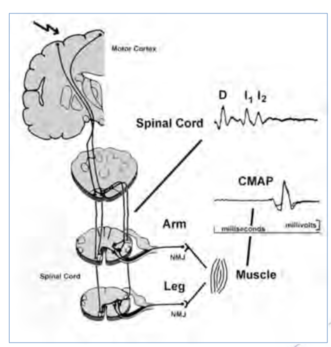
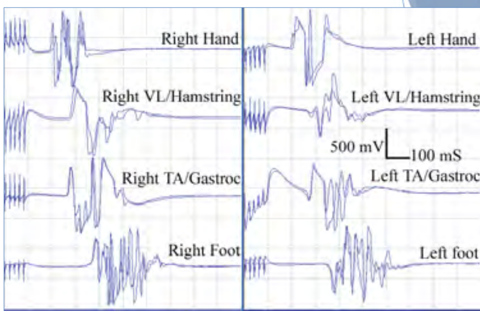
MEPs



Jameson LC, Sloan TB. Monitoring of the brain and spinal cord. Anesthesiol Clin. 2006;24(4):777-91.

42

MEPs



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MEP Alert Criteria

Controversial

- ▶All-or-nothing
- ▶Amplitude reduction (%)
- ▶Threshold increase (100 V)
- ▶Morphology change, latency

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Examples of MEP Alerts

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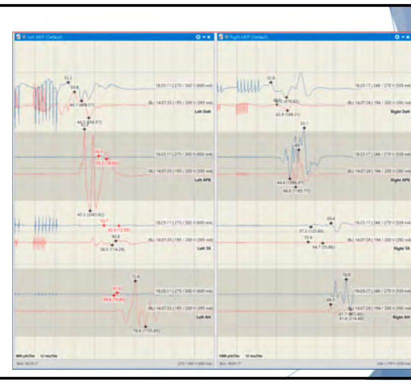

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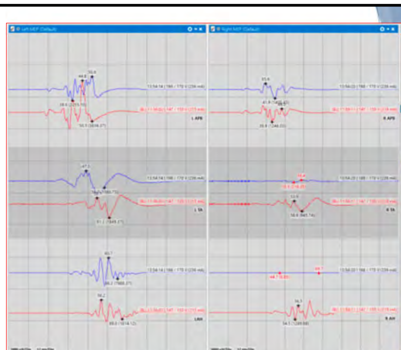

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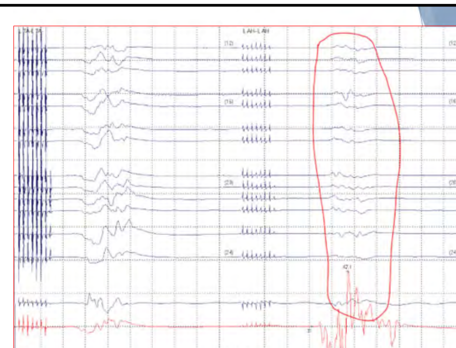

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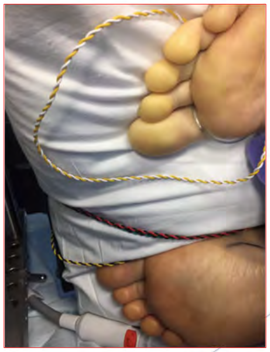

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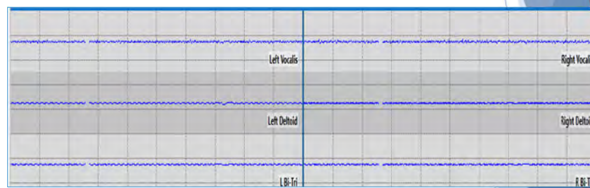
EMG



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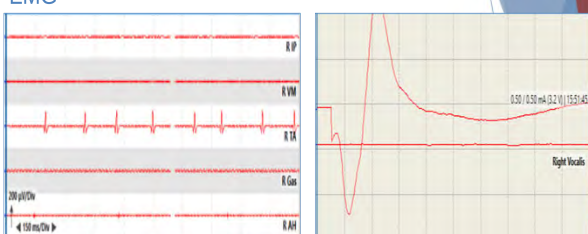
EMG



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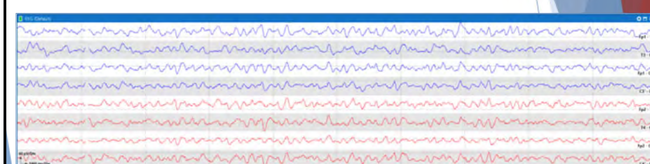
EEG



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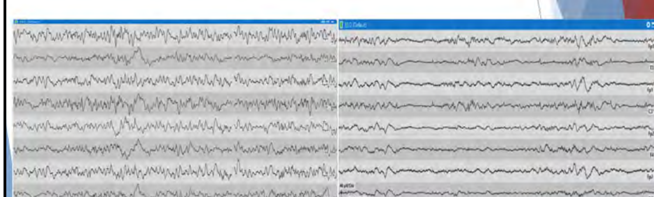
Example of EEG Alerts

53



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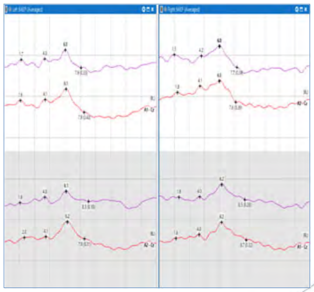
ABR



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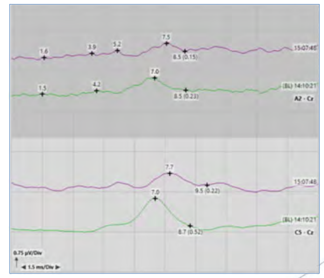
Example of ABR Alerts



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Effect of Anesthetics on IONM Responses

AGENT	EFFECT
Inhalational agent/N20	Affects SSEP, MEP
Propofol	Helps preserve responses
Sufentanil/remifentanil	No effect
Neuromuscular blockers	Affect MEP, EMG
Ketamine	Enhances responses
Dexmedetomidine	Conflicting
Lidocaine	Inconclusive

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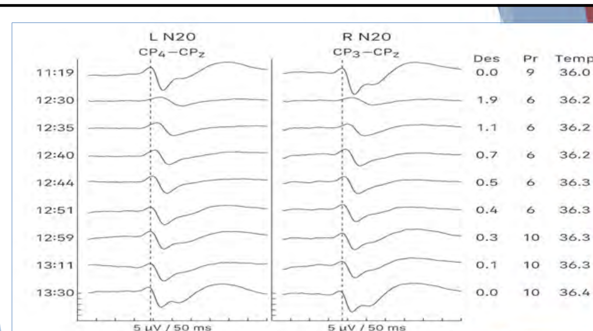
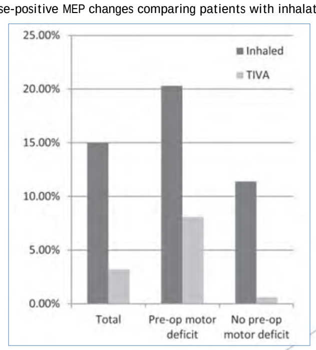


D.B. MacDonald et al. / Clinical Neurophysiology 130 (2019) 161–179

58

Rates of false-positive MEP changes comparing patients with inhalational vs TIVA

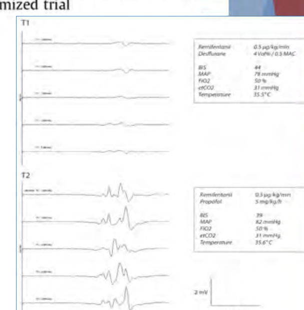


A.A. Tamkus et al. / The Spine Journal 14 (2014) 1440-1446

59

Transcranial motor evoked potentials during anesthesia with desflurane versus propofol – A prospective randomized trial

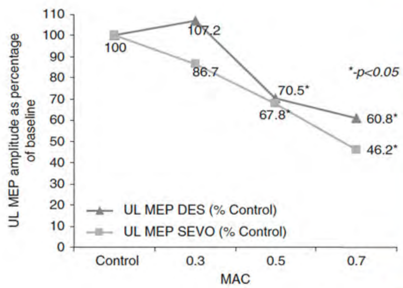
Conclusion: In patients with initially small amplitudes, desflurane may limit tcMEP recording because it produces a remarkable amplitude reduction, even in patients without PMDs.



M.J. Malcharek et al. / Clinical Neurophysiology 126 (2015) 1825-1832

60

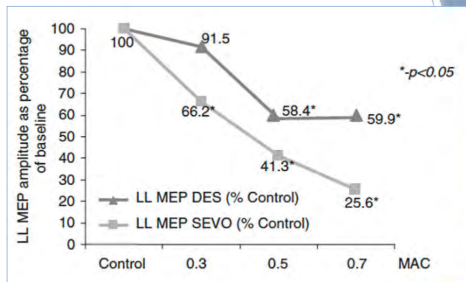
Upper Extremity Responses – No Prior Neurological Deficits



J Neurosurg Anesthesiol 2014;26:306–312)

61

Lower Extremity Responses – No Prior Neurological Deficits



J Neurosurg Anesthesiol 2014;26:306–312)

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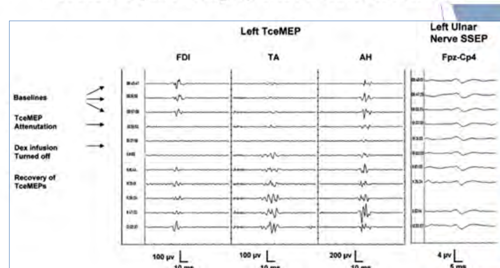
Dexmedetomidine ?

63

Loss of Transcranial Electric Motor Evoked Potentials during Pediatric Spine Surgery with Dexmedetomidine



Anesthesiology 2007; 106:393–6

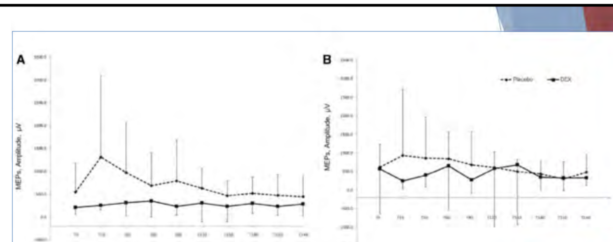
64

Susceptibility of Transcranial Electric Motor-evoked Potentials to Varying Targeted Blood Levels of Dexmedetomidine during Spine Surgery

Mohamed et al. Anesthesiology 2010; 112:1364 –73

In 40 subjects undergoing spine surgery, dexmedetomidine infusion significantly reduced the amplitude of transcranial electric motor-evoked potentials when combined with a propofol-based anesthetic

65



Dexmedetomidine does not affect evoked potentials during spine surgery

Irene Rozet et al. Anesthesia & Analgesia 2015, 121 (2), 492-501

66

Effect of Dexmedetomidine Combined Anesthesia on Motor evoked Potentials During Brain Tumor Surgery

World Neurosurg. 2019 Mar;123:e280-e287.

- Higher false-positive rate in the DEX group than in the control group
- Bilateral alterations were observed only in the DEX group
- The DEX group required significantly higher intensity and repetition rate to evoke adequate tcMEPs.
- The SSEP results were comparable between both groups.

CONCLUSIONS: This study showed that DEX had significant effects on tcMEPs during IOM in brain tumor surgery.
Because the high false-positive rate could decrease the accuracy of IOM, outcomes after using DEX should be cautiously interpreted.

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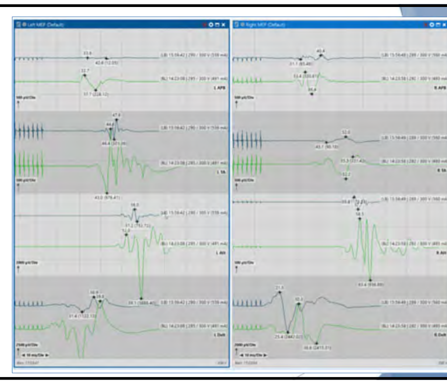
Dexmedetomidine



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Ketamine ?

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Neuroanesthesia Guidelines for Optimizing Transcranial Motor Evoked Potential Neuromonitoring During Deformity and Complex Spinal Surgery

A Delphi Consensus Study

SPINE: July 1, 2020 - Volume 45 - Issue 13 - p 911-920

STATEMENT: Ketamine can be used as an adjunctive medication with TIVA regimens to reduce the required dose of other MEP-suppressing medications and improve postoperative pain control, particularly in patients with chronic pain.

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Lidocaine ?

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Complications Related to IONM

IONM IS SAFE

- Bruising
- Myalgias
- Mouth and tongue laceration (most common)
- Mandibular fractures
- Dental luxation
- Endotracheal tube damage
- seizures (clinical and subclinical)
- Arrythmias, bradycardia, asystole

European Spine Journal (2022) 31:2723–2732

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Strategies to Manage Alerts

Communication between surgical, anesthesia, and neuromonitoring teams is crucial

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

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Intracranial Surgery Adverse Events

Tony Oliva, MD/PhD

Anesthesiology

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I care for patients undergoing intracranial surgery:

A - Yes

B - No

C - Rarely

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Learning Objectives

- Review intraoperative and postoperative adverse events relevant to intracranial surgery
- Discuss details of perioperative seizures
- Evaluate interplay of intracranial surgery and stroke
- Review the role of venous air embolism during intracranial surgery

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Intraoperative Adverse Events

- Seizures
- Stroke – occlusive and hemorrhagic
- Venous air embolism
- Hyper/hypotension
- Tachy/bradycardia
- Brain swelling

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Postoperative Adverse Events

- Seizures
- Stroke – occlusive and hemorrhagic
- PONV
- Altered mental status
- Neurologic deficit
- Pain
- Cerebral spinal fluid leak
- Venous thromboembolism
- Cerebral hyperperfusion syndrome

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Perioperative Seizures

- Associated with:
  - Increased mortality and morbidity
  - Reduced quality of life
  - Longer hospitalization
- Literature largely focuses on postoperative seizures
- With increasing frequency of awake craniotomy, intraoperative seizures happen and must be planned for

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Intraoperative Seizures

- Typically from direct cortical stimulation
  - Can be seen in awake and anesthetized patient
- Stimulation of cortex can induce seizure activity
  - Frontal, supplementary motor area, and pre-motor cortex are higher risk
  - Prophylactic anti-epileptic drugs do not impact these seizures
  - More risk with higher current and longer stimulation time

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Postoperative Seizures

- Biggest risk factor is seizure activity preoperatively
- 5-10% postoperative incidence of new seizures in the seizure-naïve brain
- Must be considered during delayed emergence

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A 51-year-old woman undergoing an awake craniotomy for resection of an intracranial mass experiences a grand mal seizure not responsive to iced saline irrigation. IV administration of which of the following medications is the BEST initial treatment?

A- Lorazepam
B - Levetiracetam
C - Remifentanil
D - Propofol

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Stroke

- Majority of perioperative stroke is hemorrhagic
- Varying definitions
  - Postoperative intracranial hemorrhage is a hematoma that requires surgical evacuation
  - Approximately 1% incidence

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Factors Associated with Stroke

- Preoperative
  - Hypertension
  - Bleeding disorder
  - Emergency case
- Intraoperative
  - ASA score IV and V
  - Hypertension
  - Type of surgery – Tumor resection is highest risk

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Hypertension and Stroke

- Abrupt intraoperative hypertension may perturb cerebral autoregulation
- If the blood-brain barrier is surgically disrupted, there is increased risk of bleeding
- Intraoperative and postoperative blood pressures matter
  - Systolic blood pressure >160 mm Hg increases risk
  - Mean arterial pressure >110 mm Hg increases risk

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Subarachnoid hemorrhage is associated with ECG changes. Which of the following new ECG findings would MOST warrant monitoring of serial cardiac enzymes?

A - QT prolongation
B - Q waves
C - ST depression
D - T wave inversion

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Venous Air Embolism

- One of the oldest known complications to surgery, documented in early 1800's
- Precordial Doppler for air-bubble detection first published in 1969
- Neurosurgery in the sitting position increasingly common into 1970's

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Venous Air Embolism

- VAE can occur in prone, supine and lateral positions
- Severity related to volume of air entrainment and rate of accumulation
- Human lethal volume estimated to be 3-5 cc/kg

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Venous Air Embolism Signs/Symptoms

- In patient under general anesthesia:
  - Most common: Decreased EtCO2 and/or SpO2, wheezing
  - More severe: Hypotension, ECG changes
- In awake patient:
  - Most common: Coughing, altered mental status
  - More severe: Acute dyspnea, chest pain, lightheadedness

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Venous Air Embolism Detection Methods

- TEE – Most sensitive
  - Detects air at 0.02 cc/kg
- Precordial Doppler Ultrasound – Most common
  - Detects air at 0.05 cc/kg
- EtCO2– Most practical
  - Change of 2 mmg Hg may indicate VAE

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Venous Air Embolism Treatment

- Request surgeon to:
  - Flood surgical field with saline
  - Pack surgical site with soaked dressings
- Reposition patient if possible
- Supportive therapy
  - 100% FiO2
  - Ionotropes PRN
  - Vasopressors PRN

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Text **ANTHONYOLIVA945** to **37607** once to join

During a craniotomy in the sitting position, which of the following is associated with an INCREASED risk of a paradoxical venous air embolism?

A - PEEP
B - Nitrous oxide administration
C - Liberal IV fluids
D - Right heart catheter placement

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Summary

- Adverse events related to intracranial surgery significantly impact morbidity and mortality
- Knowledge and recognition of adverse events improves patient care

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Questions?

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Ultrasound-Guided Regional Anesthesia Workshops

Kyle Marshall, MD

CRASH 2023

1

DISCLOSURE

- *There are NO disclosures for any faculty participating.*

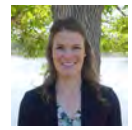
Kyle Marshall, MD

Olivia Romano, MD

Inge Tamm-Daniels, MD

Jillian Vitter, MD

Matthew Lyman, MD



Keleigh McLaughlin, MD

2

Lower Extremity/Abdominal Workshop

- Quadratus Lumborum
- TAP & Rectus Sheath
- SIFI & Fascia Iliaca
- Infragluteal Sciatic
- Popliteal Sciatic & iPACK
- Femoral: Inguinal & Adductor

- **LESS lecture, MORE demonstration**
- 6 stations with models

3

Thank you to our Vendors!!

- Mindray: Rob Kimbrough
- Sonosite: Kristi Howe

- Thank you to our Models!!

4

BEER & WINE - END @ 1630!

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