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GSA Mission Statement

It is the mission of the Georgia Society of Anesthesiologists, Inc. to associate and affiliate into one organization all physicians and others in Georgia who are engaged in the practice of, or otherwise especially interested in, anesthesiology and its subspecialties; to encourage specialization in this field; to raise the standards of the specialty; to safeguard the professional interests of its members; and in all ways to develop and further educate within the specialty of anesthesiology for the general elevation of the standards of medical practice and patient safety.

Adopted by Board of Directors, Winter Meeting, January 15, 1999

Ratified by General Membership, January 17, 1999

General Information

Welcome

The 2017 GSA Winter Forum is jointly sponsored by the American Society of Anesthesiologists and the Georgia Society of Anesthesiologists. As a convenience to GSA members and guests, this continuing education conference is structured as a two-day event. The meeting offers up to 6 *AMA PRA Category 1 Credits*™ with content derived from educational survey feedback and post-meeting evaluations over the last few years. The educational focus will inform attendees on current issues in anesthesiology and updates across multiple disciplines. The Le Meridien Perimeter Hotel, is an excellent venue for the conference. We hope that you enjoy the educational portion of the meeting and receive appropriate business and government affairs information during the GSA General Business Meeting, which will be held Saturday from 3:00 - 3:45 p.m..

Registration Fees

The GSA member rate is $350 for physicians, $75 for residents, $175 for AAs, $100 for retired physicians, and $40 for students. The non-member rate is $500 for physicians, $100 for residents, $200 for AAs, $100 for retired physicians, $40 for students, and $500 for CRNAs. Educational seminars, breakfasts and breaks are for the REGISTRANT ONLY. A $100 late fee will be applied to all registration forms received after Thursday, February 2, 2017. This late fee applies to both on-site and online registration. Guests are welcome at both Friday and Saturday evening receptions.

Accreditation

This activity has been planned and implemented in accordance with the accreditation requirements and policies of the Accreditation Council for Continuing Medical Education (ACCME through the joint providership of the American Society of Anesthesiologists and the Georgia Society of Anesthesiologists. The American Society of Anesthesiologists is accredited by the ACCME to provide continuing medical education for physicians.

Credit Designation

The American Society of Anesthesiologists designates this live activity for a maximum of 6 *AMA PRA Category 1 Credits*™ . Physicians should claim only credit commensurate with the extent of their participation in the activity.

This year's evaluation and CME certificate process is completely electronic. In order to access the course, claim your CME credits, complete the program evaluation and print your CME certificate, you must log in to the ASA Education Center at the following link: http://education.asahq.org/

Cancellation Policy

Cancellations and/or changes in registration or participation in all or any portion of the meeting must be received at GSA headquarters by February 3, 2017, to qualify for refund. Absolutely no refunds will be issued for changes received at GSA headquarters after Friday, February 3, 2017. The cancellation policy and late registration fee will be strictly enforced.

Evening Hospitality

All registrants, faculty, exhibitors and guests are invited to enjoy evening hospitality events offered Friday and Saturday. Badges are required for participation in all receptions. Please register your guests so that a badge can be produced.

Questions

Please visit the registration desk for more information or clarification on any of the meeting elements, schedule or CME verification.

Disclaimer

The information provided at this CME activity is for continuing education purposes only and is not meant to substitute for the independent medical judgment of a healthcare provider relative to diagnostic and treatment options of a specific patient's medical condition.

Educational and Learning Objectives

2017 GSA Winter Forum
Feb 3 - 5, 2017
Le Meridien Atlanta Perimeter

CME Activity Co-Directors
Stephen Anderson, MD & Allyson Speaks, MD
Northside Anesthesiology Consultants

Susan Eagle, MD
Vanderbilt University
Nashville, TN

Anesthetic Considerations for Adults with congenital heart disease presenting for non-cardiac surgery
At the conclusion of the presentation, the learner should be able to:

1. Describe the anatomy/physiology of common congenital heart lesions in adults.
2. Explain the long-term effects of repair or palliation in the adult congenital heart patient.
3. Discuss the Perioperative considerations for patients with ACHD.

Anesthetic considerations for parturient with congenital heart disease
At the conclusion of the presentation, the learner should be able to:

1. Review effects of maternal physiology on patients with congenital heart lesions.
2. Explain the risk stratification of parturient with congenital heart lesions and their offspring.
3. Discuss the peripartum management of woman with congenital heart.

Evan Cline, JD
Huff, Powell, & Bailey, LLC
Atlanta, GA

MedMal: What to expect when you're not expecting
At the conclusion of the presentation, the learner should be able to:

1. Know what to do if they've been sued.
2. Recall tips for avoiding lawsuits/minimizing liability.
3. Define the life of a lawsuit, file to trial.
4. Understand jury trials in Georgia (Lawyers, Experts, Judges, and Jurors).

Beth Duggan, MD
Emory University
Atlanta, GA

Obstructive Sleep Apnea: Using the Current Literature to Build Your Practice Algorithm.
At the conclusion of the presentation, the learner should be able to:

1. Assess physiology parameters useful in management of septic patients.
2. Define Changes in OSA pathophysiology after sedation/anesthesia.
3. Formulate a pre and postoperative algorithm to screen for treat OSA in the perioperative period.
4. Describe the role of pre/postoperative CPAP.

Management of Hyperglycemia in Non-Cardiac Surgery.
At the conclusion of the presentation, the learner should be able to:

1. Assess physiology parameters useful in management of septic patients.
2. Define Changes in OSA pathophysiology after sedation/anesthesia.
3. Formulate a pre and postoperative algorithm to screen for treat OSA in the perioperative period.
4. Describe the role of pre/postoperative CPAP.

Matt Lyon, MD
Augusta University
Augusta, GA

Bedside Cardiac Ultrasound
At the conclusion of the presentation, the learner should be able to:

1. Cite the indications of bedside Cardiac Ultrasound.
2. Assess the EF and correlate to clinical condition.
3. Assess the fluid status and correlate to clinical condition.

Workshop/Evaluation of lungs using Ultrasound
At the conclusion of the presentation, the learner should be able to:

1. Demonstrate the heart in 4 windows.
2. Demonstrate fluid volume status in a normal volunteer.
3. Interpret normal evaluation of lungs and pathologic lung conditions using ultrasound.
4. Assess for pneumothorax and RMS intubation using ultrasound.

2017 GSA Winter Forum

February 3 – 5, 2017
Le Meridien Atlanta Perimeter

Friday, February 3rd, 2017

3:00 – 6:00 p	Registration – **Hub Fireplace**
4:30 – 6:30 p	Board of Directors Meeting – **Concept Room**
5:00 – 9:00 p	Exhibitor Set Up – **Grand Salon lll**
6:30 – 7:30 p	Welcome Hospitality: Registrants, Exhibitors, and Guests – **Salon Foyer**
7:45 p	Group Dinner – Self- pay, RSVP to Brooke.Cain@politics.org

Saturday, February 4th, 2017

6:00 a	Exhibitor Set Up – **Grand Salon lll**
6:30 – 7:20 a	Registration/Breakfast with Exhibitors – **Salon Foyer/Grand Salon lll**
7:25 a	*Welcome* – **Grand Salon l&ll** **GSA President** Heather Dozier, MD *Introductions* Winter Meeting Activity Co-Directors Stephen Anderson, MD & Allyson Speaks, MD Northside Anesthesiology Consultants
7:30 – 8:30 a	Beth Duggan, MD - *Obstructive Sleep Apnea: Using the Current Literature to Build Your Practice Algorithm*
8:30 – 9:30 a	Evan Cline, JD – *MedMal: What to expect when you're not expecting*
9:30 – 10:00 a	*Break with Exhibitors* – **Grand Salon lll**
9:30 – 11:00 a	GAAA General Business Meeting – **Design + Discovery Room**
9:30 – 11:00 a	Resident Section Board Meeting – **Concept Room**
10:00 – 11:00 a	Beth Duggan, MD - Management of Hyperglycemia in Non-Cardiac Surgery
11:00 – 12:00 p	Susan Eagle, MD - *Anesthetic considerations for parturient with congenital heart disease*

12:00 – 12:30 p	*Lunch and Political Report* (Lunch will be provided in the Salon Foyer)
12:30 – 1:30 p	Susan Eagle, MD - *Anesthetic Considerations for Adults with congenital heart disease presenting for non-cardiac surgery*
1:30 – 2:00 p	*Break with Exhibitors*
2:00 – 3:00 p	Matt Lyon, MD – *Bedside Cardiac Ultrasound*
3:00 – 3:45 p	State and Federal Issues Update, General Business Meeting
3:45 – 4:45 p	Committee Meetings

Government Affairs – **Creative Room**
Practice Management – **Design + Discovery Room**
Membership – **Concept Room**
Program and Education - **Analysis Room**

4:45 – 5:00 p	General Session – Committee Reports
5:00 – 6:30 p	CWL Award Reception – **Salon Foyer**
6:30 p	Dinner on your own

Sunday, February 5th, 2017

8:30 – 10:30 a	GAAA Board of Directors Meeting - **Concept Room**

Each lecture will be followed by a 5-10 minute Q&A session.

Program and Education Committee

A special thanks to the Program and Education Committee for reviewing lecture materials to ensure lectures meet learning objectives and do not exhibit biased content. Members of the Program and Education Committee are as follows:

Brian Thompson, MD, Co-Chair
Gautam Sreeram, MD, Co-Chair
Heather Dozier, MD
Kirk Edwards, MD
Korrin Scott Ford, MD
Tanna Boyer, MD
Gina Scarboro, CAA

Disclosure and Resolution of Conflicts of Interest

The American Society of Anesthesiologists remains strongly committed to providing the best available evidence-based clinical information to participants of this educational activity and requires an open disclosure of any potential conflict of interest identified by our faculty members. It is not the intent of the American Society of Anesthesiologists to eliminate all situations of potential conflict of interest, but rather to enable those who are working with the American Society of Anesthesiologists to recognize situations that may be subject to question by others. All disclosed conflicts of interest are reviewed by the educational activity course director/chair to ensure that such situations are properly evaluated and, if necessary, resolved. The American Society of Anesthesiologists educational standards pertaining to conflict of interest are intended to maintain the professional autonomy of the clinical experts inherent in promoting a balanced presentation of science. Through our review process, all American Society of Anesthesiologists CME activities are ensured of independent, objective, scientifically balanced presentations of information. Disclosure of any or no relationships will be made available for all educational activities.

Planner, Faculty and Staff Disclosure

All Faculty, including editors, authors, reviewers, and staff for the GSA 2017 Winter Forum have reported no relevant financial relationships with commercial interest.

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Heather Dozier, MD

Matthew Klopman, MD

Jet Toney, GSA Executive Director

Brooke Cain, GSA Meeting Planner

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Evan Cline, JD

Beth Duggan, MD

Matt Lyon, MD

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(as of February 1, 2017)

Karl Stortz Endoscopy

America

Mallinckrodt Pharmaceuticals

MAG Mutual

Merck & Co., Inc

Radar Healthcare Providers

PharMEDium Services

Cumberland Pharmaceuticals

Sonosite Ultrasound

GAAA

Respiratory Motion

QGenda LLC

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The Georgia Society of Anesthesiologists is headquartered at the offices of Cornerstone Communications Group, Inc.

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For more information about the GSA, go to www.gsahq.org.
For more information about Cornerstone Communications Group, go to www.cstone1.com.

Commercial Support Acknowledgment

The Georgia Society of Anesthesiologists gratefully acknowledges the commercial support of the following companies:

MAG Mutual
Un-restricted educational grant

Northwest Anesthesia Seminars
In-Kind donation - laptop bags and pens

Sonosite
In-Kind donation - Ultrasound Equipment

Saturday, February 4

General Session

Elizabeth Watson Duggan, MD
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Updated: January 26th, 2017

EDUCATION

University of Pennsylvania Health System — Philadelphia, PA
Liver Transplant Fellow in the Department of Anesthesiology and Critical Care — 09/11-06/12
University of Pennsylvania Health System — Philadelphia, PA
Resident in the Department of Anesthesiology and Critical Care — 07/08-07/11
Duke University Medical Center — Durham, NC
Intern in the Department of Anesthesiology — 07/06-06/07
University of Virginia School of Medicine — Charlottesville, VA
Doctor of Medicine — 05/06
Amerispan Escuela de Idiomas — Costa Rica
International Language School — 03/02-05/02
Private tutorial 4-6 hours/day in Spanish Language/Grammar/Literature
University of Colorado — Boulder, CO
B.A.: Arts and Sciences — 12/00
Major: Environmental, Population and Organismic Biology
Specialty Certification: Neurosciences
GPA: 3.95, with distinction
University of Granada — Granada, Spain
Center of International Languages — 06/98-07/98
GPA: 3.90/4.00

PROFESSIONAL EXPERIENCE

Emory University Hospital — Atlanta, GA
Assistant Professor — 05/13-Present
- Division Chief, General and Transplant Anesthesiology (07/16-present)
- Medical Director of the Post Anesthesia Care Unit (PACU) (05/13-09/16)
- Director Vascular Anesthesia (05/13-07/16)
- Assistant Program Director Liver Transplant Fellowship (07/14- present)
- Member of an 8 person liver transplant anesthesia team (liver transplant volume ~150 cases/year, 5th largest liver transplant program in the United States in 2015)

Thomas Jefferson University Hospital — Philadelphia, PA
Assistant Professor — 08/12-04/13
- Member of a seven person liver transplant anesthesia team (total liver transplant volume 40-50 cases/year)
- Daily caseload includes vascular, intra-abdominal, spine and ENT surgery
- Call responsibilities include cases in the main operating rooms, trauma OR and labor and delivery suite
- Supervise residents and CRNAs
- Director of vascular education; responsible for the transplant (liver/kidney/pancreas) lecture series

University of Pennsylvania Health System — Philadelphia, PA
Instructor — 09/11-6/12
- Faculty position within the department of anesthesiology; primary clinical case load included abdominal surgery, gynecological/urological surgery and ambulatory surgery
- Supervised residents in a clinical setting
- Direct provider for 50% of operating room cases
- Appointed instructor of residency education for vascular and liver transplant anesthesia; created nine teaching modules for the resident website

University of Pennsylvania Health System — Philadelphia, PA
Liver Transplant Fellow — 09/11-6/12
- Completed 40 liver transplants (yearly case volume 130/year), including four living-related donor transplants. Advanced knowledge of veno-veno bypass acquired during fellowship.
- Completed requirements to obtain Basic TEE certification (51 TEEs performed and 100 TEEs reviewed under

the supervision of echo-certified cardiac anesthesiologists)
- Attended monthly listing meetings with transplant team; rounded with transplant team on pre and post-transplant patients
- Created an intraoperative evaluation protocol (with Penn Cardiology) for liver transplant candidates with portopulmonary hypertension
- Two department lectures given including "The use and interpretation of the pulmonary artery catheter during liver transplantation" and "Surgical techniques of liver transplantation."

University of Pennsylvania Health System Philadelphia,PA
Resident 07/08-7/11
- Completed rotations in the multiple subspecialties of anesthesia: critical care medicine, obstetrics, acute/chronic pain, cardiac anesthesia, neuroanesthesia, pediatric anesthesia and general anesthesia
- Level one trauma center including case management of penetrating injuries

Duke University Medical Center Durham, NC
Intern 07/06-06/07
- Completed clinical rotations in Pediatrics, PICU, SICU, General Internal Medicine, Cardiology, Pulmonology, Emergency Medicine, Surgery, Anesthesia, Hyperbaric Medicine

LICENSE INFORMATION

Unrestricted Georgia Medical License	Issued 3/2013, Expires 3/2018
Unrestricted Pennsylvania Medical License	Issued 5/2011, Expires 12/2014
ABA Board Certification	Issued 4/2012, Expires 12/2022
NBE Basic PTE Certification	Issued 6/2012, Expires 6/2022

HOSPITAL / MEDICAL SCHOOL COMMITTEES

Procedural Gastroenterology Executive Committee 10/16-present
- Members from the depts. of gastroenterology, Interventional Pulmonary, Surgery, and Anesthesiology as well as hospital administration formulate models of efficiency for team care, improve patient safety via data metrics, budget equipment, plan/cost/design and implement travel anesthesiology care

Emory University Hospital Operating Room and Surgical Services Committee 07/16-present
- Leadership from perioperative nursing, anesthesiology, surgery and hospital administration to analyze OR efficiency, safety modeling, QI projects and progress, group morale and OR block time use.

Perioperative IT Roadmap Committee 11/15-present
- Anesthesia representative for review of submitted perioperative IT systems applications to determine the provider needs and its applicability to practice and systems operations
- After approval, prioritize provider requests and act as a physician representative to streamline practice needs into hospital IT capability to improve patient safety and care, optimize hospital efficiency and flow

Operating Room Policies and Procedures Committee 09/15-present
- Anesthesia representative for operating room policy board; review and approve new or changed policy for operating room management, block use, patient flow and safety

Operating Room Quality Committee 09/15-present
- Team of surgeons from all specialties, one anesthesiologist, and nursing and OR representatives, engaged in overseeing, dividing resources, prioritizing projects and supporting operating room quality initiatives
- Collaborative board designed to link physician and nursing partners for QI projects, standards and goals for surgical patients

Medical Directors and Nursing Leadership Committee (committee no longer meeting) 02/15-12/15
- Medical and Nursing Directors representing all units participate in administrative and clinical decisions, guiding process of medical advancements and hospital expansion

Clinical Steering and Safety Committee- Guest Delegate, Anesthesia Department EUH 01/15-present
- Represent a voice for clinical safety improvements within the operating room environment

Stroke Leadership Committee, Emory University Hospital- Anesthesia Delegate 08/14-5/1/15
- Representative for the committee to ensure appropriate care/monitoring in PACU to meet Stroke Center of Excellence guidelines
- Assisted neurosurgical teams to re-write post-operative RASS guidelines to meet CMS requirements
- Re-designed the post-operative nausea/vomiting order set for the neurosurgical ICU patients

American Medical Women's Association Mentorship Program- Mentor, Emory School of Medicine 08/14-10/16
- Act as a mentor for women in medical school to help guide them through career choices, identify a specialty field, shadow faculty to better understand clinical obligations and support personal decisions

Airway Committee, Emory University Hospital- Chairperson 07/14-present
- Chairperson; Re-instituted a hospital wide committee to plan and design a best emergency airway response or inpatients and clinic buildings at EUH. Includes competency maintenance and credentialing procedures.

Obstructive Sleep Apnea: Using the Current Literature to Build Your Practice Algorithm

Beth Duggan, MD

Emory University School of Medicine

Department of Anesthesiology

Atlanta, GA

At the conclusion of the presentation, the learner should be able to:

1. Assess physiology parameters useful in management of septic patients.
2. Define Changes in OSA pathophysiology after sedation/anesthesia.
3. Formulate a pre and postoperative algorithm to screen for treat OSA in the perioperative period.
4. Describe the role of pre/postoperative CPAP.

OBSTRUCTIVE SLEEP APNEA

Moving Past STOP-Bang; What Do I Need to Know Now and How Should it Impact My Practice?

Elizabeth Duggan, MD
Emory University Hospital
Department of Anesthesiology
February 4th, 2017

EMORY

LECTURE OBJECTIVES

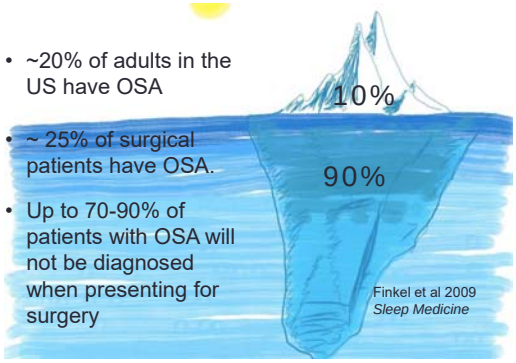
- Review ***current*** **(2011-2017)** literature to update your understanding of current evidence:
  - **Outcomes**
  - **Pre-operative screening- Moving past STOP-Bang**
  - **OSA Physiology & Mechanisms (Phenotyped and Endotypes)**
  - **The Interaction of the Disease with Anesthesia/Sedation**
  - **The role of pre and post-operative CPAP**
  - **Post-Operative Recommendations**

DISCLOSURES

- None

Of note, we will not be covering (in-depth) other sleep disordered breathing (central sleep apnea, obesity hypoventilation syndrome, e.g.) nor pediatric OSA

- ~20% of adults in the US have OSA
- ~ 25% of surgical patients have OSA.
- Up to 70-90% of patients with OSA will not be diagnosed when presenting for surgery



Finkel et al 2009
Sleep Medicine

"Preoperative screening for obstructive sleep apnoea--one death is too many. Are we Losing Sleep Over Nothing?"

"It only takes one unnecessary death or serious episode of anoxia to prompt reevaluation of clinical practice hospital to manage OSA patients undergoing surgery to avoid sentinel events."

Cheung F, Liao P. In Anaesthesia and Intensive Care. 38:5, 2010 Sept pg 949; author reply 949-50.

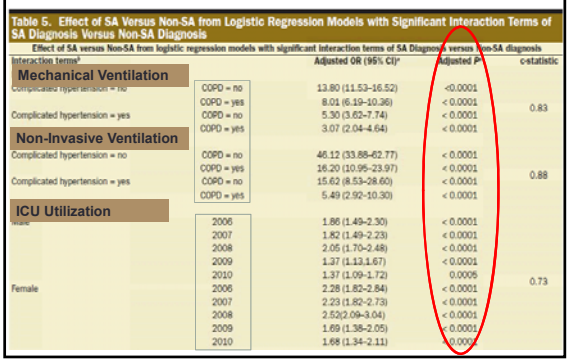
OSA Affects *Your* Outcomes [21,57,58]

- **Memtsoudis S et al. Anes Analg Feb 2014; 118(2)[21]**
  - > 500,000 patients at 400 institutions; 8.4% with diagnosed OSA
  - **OSA emerged as an independent risk factor for post-operative complications (both pulmonary/cardiac) but NOT mortality**

OUTCOME	Adjusted Odds Ratio (95% CI)
Pulmonary Complications	OR 1.86 (CI 1.65-2.09)
Cardiac Complication	OR 1.59 (CI 1.48-1.71)
Mortality	OR 1.27 (0.74-2.19)

ODDS OF EMERGENT RE-INTUBATION SLEEP APNEA COHORT 10.26 (9.01-11.69)

OSA Affects *Your* Outcomes [21,57,58]



Same story continued….

`Kaw R et al. Chest 2012`[57]

Increased overall complications OR, 6.9; p = .003

`Memtsoudis S et al. Anesth Analg 2011`[58]

Aspiration pneumonia: 1.18% vs 0.84% ortho; 2.79% vs 2.05% gen surg

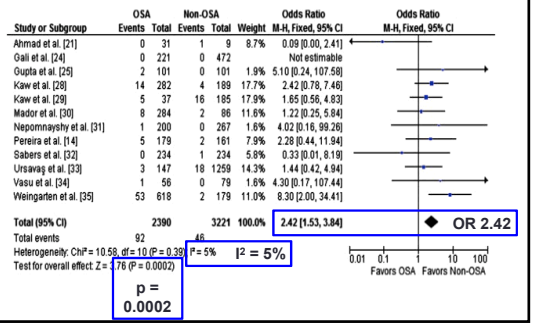
ARDS: 1.06% vs 0.45% ortho; 3.79% vs 2.44% gen surg

Intubation/mechanical ventilation: 3.99% vs 0.79% ortho; 10.8% vs 5.94% gen surg

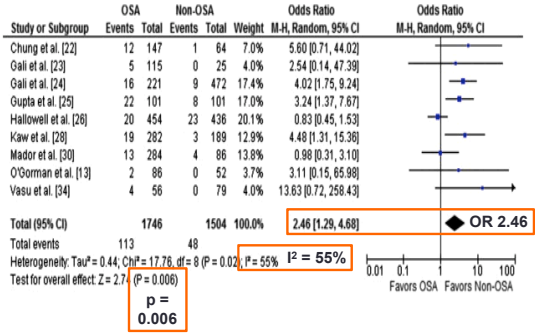
All p values <0.0001

2014 Hai et al.[91]

OSA IS a RISK for post-op respiratory failure



OSA is a RISK for ICU transfer[91]



In the ERA of ERAS…

- OSA is an independent risk factor for SSI following colectomy
  - SSI 28.6% in OSA patients vs. 10.3% in non-OSA (p =0.03)
  - Predictor of OSA, OR 8.98 (CI 1.29-12.27)
  - DM (OR 7.16)
- In the setting of SSI, LOS increased by 9d

Fortis S, Colling KP, Statz CL, Glover JJ, Radosevich DM, Beilman GJ. Obstructive sleep apnea: a risk factor for SSI following colectomy. Surg Infect. 2015 Oct; 16(5): 611-7. SOURCE 102

Most recently…
SASM Supported Meta-Analysis 2016 [104]

- Difficult Intubation – Likely
- Difficult Mask Ventilation – Inconsistent Findings
- Pulmonary Complications – Likely
- Cardiovascular Complications – +Atrial Fibrillation, Otherwise slight increase in incidence of cardiac shock/arrest (rare)
- Resource Utilization – Outpatient: No Increase
  Inpatient: +ICU (Unplanned) Admission
- Mortality - ? The event is too rare to statistically make conclusions

Practice Guidelines from…

- ASA Task Force[89]
- Society for Ambulatory Surgery (SAMBA)[103]
- Society of Anesthesia and Sleep Medicine (SASM)[18]
- The Joint Commission[105]
- Institute for Quality Improvement [20]
- American College of Physicians (ACP)[24]
- American Academy of Sleep Medicine[54]
- Patient Safety Movement Foundation
- Anesthesia Patient Safety Foundation
- The Institute of Safe Medicine Practices

OSA and Medical Malpractice

- The Preferred Physicians Medical Group released factors related to case loss in patients with OSA. Common allegations include:[55]
  - Failure to use CPAP after transfer from the PACU to the floor
  - Permitting transfer of a patient from the PACU to an unmonitored bed with known history of OSA
  - Failure to re-assess a patient immediately prior to transfer from the PACU to the floor
  - Failure to advise the patient of perioperative risk of OSA

A Review of the Legal Literature

Fouladpour N et al. Anesth Analg 2015 [102]

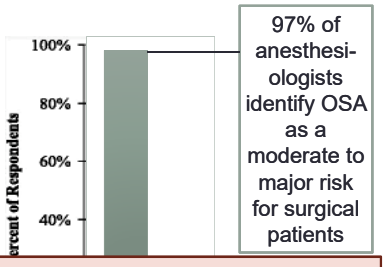
24 CASES

- 23 were DIAGNOSED OSA patients

1. 92% of the surgical procedures were elective
2. Opioids played a role in 38% of cases
3. 58% of cases related to GA
4. Verdicts favored the plaintiff in 58% of time

AVERAGE FINANCIAL AWARD

$2.3 MILLION ($650,000-$7.7 MILLION)



97% of anesthesi-ologists identify OSA as a moderate to major risk for surgical patients

53% of indicated their practice or hospital had a policy to guide with OSA management

Do Anesthesiologists Adhere to Recommendations/Guidelines?

2016 SURVEY of Canadian[106] vs. 2015 SURVEY of United States Anesthesiologists (30% Return Rate)[107]

PRE-OPERATIVE SCREENING

For a patient with DIAGNOSED but UNTREATED OSA:

50% (vs 68%) of anesthesiologists rely on suspicion alone (no formal screening mechanism/system)

18% (vs. 28%) (use a screening tool/questionnaire

2% do not screen or clinically evaluate for OSA

Do Anesthesiologists Adhere to Recommendations/Guidelines?

PRE-OPERATIVE CARE

For a patient with DIAGNOSED but UNTREATED OSA:

89% of anesthesiologists would proceed to the OR, prepare for a potentially difficult airway, minimize narcotics and avoid premedication.

6% would proceed in the same manner as a patient without OSA.

2% would defer surgery.

Do Anesthesiologists Adhere to Recommendations/Guidelines?

PRE-OPERATIVE CARE

For a patient with SUSPECTED OSA:

80% (vs. 75%) of anesthesiologists would proceed to the OR, prepare for a potentially difficult airway, minimize narcotics and avoid premedication (in the same manner as a known OSA patient)

12% (~5%) would defer surgery and refer patient to a sleep pulmonologist

5% proceed to the OR without further consideration or change in plan

Do Anesthesiologists Adhere to Recommendations/Guidelines?

Post-Operative CARE

KNOWN OSA

Non-compliant with CPAP, post-operative opioids required

- 45% of anesthesiologists send to continuous SpO_2 bed

KNOWN OSA

Compliant with CPAP, post-operative opioids required

- 69% of anesthesiologists send to continuous SpO_2 bed

WHAT CAN I DO TO KEEP MY PATIENTS SAFE?

PRE-OPERATIVE CONSIDERATIONS

ASK QUESTIONS:

Ask ALL of your patients if they carry a diagnosis of OSA

Of 111 patients who carried a diagnosis of OSA…[92]

ANESTHESIOLOGISTS acknowledged/identified disease in 85% of these patients

WE MISSED 15% of PATIENTS WITH KNOWN DISEASE

SURGEONS acknowledged/identified disease less than half of their patients (42%).

Patients Diagnosed with OSA

Severity of OSA

- Is diagnosed by polysomnography or home sleep apnea test
- Respiratory disturbance index is the average of respiratory arousals per hour related to respiratory events
- Apnea is defined as a > 90% decrease in air flow from baseline lasting 10 seconds
- Hypopnea is defined as a > 30% decrease in air flow from baseline which lasts ≥ 10 seconds and is associated with at least a 4% decrease in arterial O_2 saturation

AHI < 5 events per hour = No OSA
AHI 5-15 events per hour = MILD OSA
AHI 16-30 events per hour = MODERATE OSA
AHI > 30 events per hour = SEVERE OSA

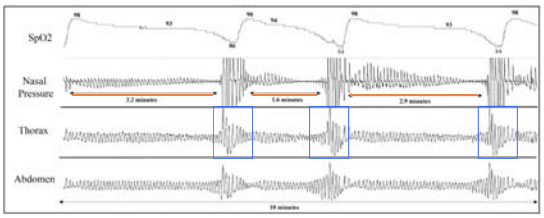
American Academy of Sleep Medicine 2007,
American Academy of Sleep Medicine Inter-Scorer Reliability Program, 2013

Preoperative AHI has been associated with Risk

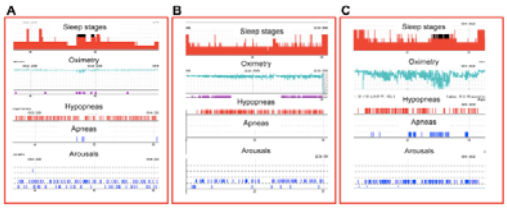
AHI = 18 events/hr (moderate sleep apnea)

Every 3 minutes this patient desaturates to 85%

Every 3 minutes this patient has a significant increase in Intrathoracic pressure



ODI = Oxygen Desaturation Index
T90 = Time spent with SpO_2 < 90%



AHI 45, 3% ODI 2, T90 0 min, Arousal index 50

AHI 45, 3% ODI 43, T90 9 min, Arousal index 36

AHI 45, 3% ODI 47, T90 77 min, Arousal index 43

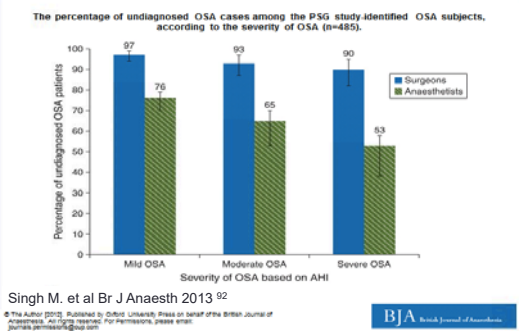
Cooksey J, Mokhlesi B. CHEST 2016.[94]

Who is at risk for OSA?

- Men(~11-24%) > Women (~7-10%)
- Post-menopausal women are equally at risk for OSA as men
- Patients who are overweight/obese, particularly those with neck circumference > 40cm (or men > 17in and women >16 in)
- Those with a family history
- Micrognathia or retroganthia (decreases the distance between cervical spine and soft tissues, limiting airway space) may increase risk 7.5x[19]
- Congenital (Down Syndrome ~ 50% incidence)[3] and acquired (Acromegaly)[7] syndromes.
- Those with tonsillar hypertrophy or craniofacial abnormalities.

Can you predict??

Make Screening Part of Your Routine



Singh M. et al Br J Anaesth 2013 [92]

BJA British Journal of Anaesthesia

Administer a screening questionnaire

STOP-Bang

- Easy to understand
- Easy to administer
- Fast
- High sensitivity and moderate specificity
- Validated for all surgical populations

Chung F, et al. Anesthesiology 2008 [9]

STOP BANG QUESTIONNAIRE

(PERIOPERATIVE COMMUNICATION TOOL)

Snoring: Do you snore loudly (louder than talking or loud enough to be heard through closed doors)?	YES	NO
Tired: Do you often feel tired, fatigued, or sleepy during daytime?	YES	NO
Observed: Has anyone observed you stop breathing during your sleep?	YES	NO
Pressure (blood): Do you have or are you being treated for high blood pressure?	YES	NO
BMI: BMI more than 35 kg/m2? (See chart)	YES	NO
Age: Age over 50 years old?	YES	NO
Neck circumference: Neck circumference greater than 40 cm?	YES	NO
Gender: Gender male? Post-Menopausal Woman?	YES	NO
⟶ TOTAL SCORE: _____ Is there a known history of OSA? Y or N	CO_2 Result if needed _____Date_____	

Created 4/7/2015 AB

STOP-BANG with a score ≥ 5 [59 - 61]

AHI	SENS	SPEC	PPV	NPV
5-14	44	73	88	23
15-29	53	70	62	51
> 30	68	68	43	86

A STOP-BANG score of 3 increases sensitivity upwards of 93-100% for moderate to severe OSA but, the specificity will decrease to 37-56% [9]

For a complete list of sensitivity/specificity analysis, see Chung et al. Chest 2016 [93]

Collop NA. Perioperative assessment and management for sleep apnea in the ambulatory surgical patient. Chest. Online First. 2015.

"The phenotype of the patient who will suffer adverse perioperative outcomes due to OSA has not yet been elucidated"

Endotypes and Phenotypes of OSA[109]

FANTASTIC review article in Jan 2017 A&A by Francis Chung and Colleagues…

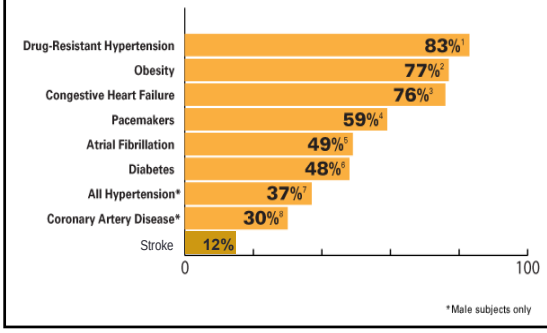
Phenotypes

1. **ANATOMY**
   - OBESITY (NECK CIRCUMFERENCE)
   - CRANIOFACIAL MORPHOLOGY
2. **AGE**
2. **GENDER (and menopause)**

Cheat Sheet…[93]

- Although ALL items on the ST-B scoring system receive a "point," not all are equally predictive of OSA.
- More predictive of the BANG components: [8]
  - **NECK CIRCUMFERENCE > 40cm**
  - **BMI > 35kg/m²**

Surgical Patients and OSA



The DES-OSA score[108]

= A screening tool based on morphologic characteristics associated with sleep apnea

- **Gender, age and MP score** were collected in patients prior to undergoing PSG by an independent and blinded provider

- In addition, measurements were made for:

1. **Height and Weight**
2. **Neck circumference (in cm)**
3. **Distance between the thyroid cartilage and chin (DTC)**
4. **Cervical mobility (Reduced < 90° between flex/extend)**

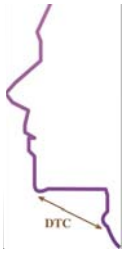
The DES-OSA score[108]

SCORE	Sens	Spec	PPV	NPV
AHI 5-15 5	83	72	91	53
AHI 16-30 6	77	73	81	68
AHI > 30 7	75	77	63	85

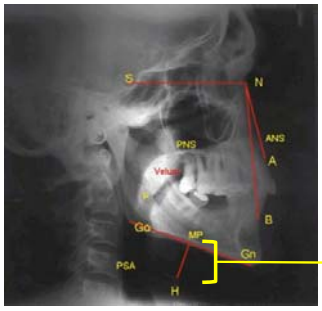
TM versus DTC Measurements

THYROMENTAL DISTANCE

DISTANCE CHIN TO THYROID



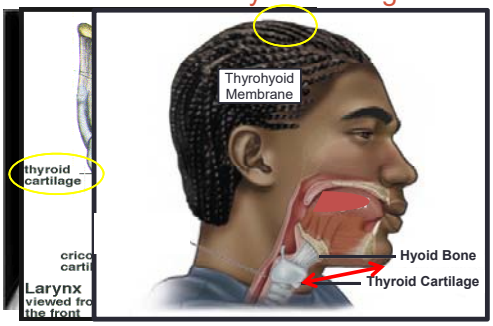
Airway Anatomy



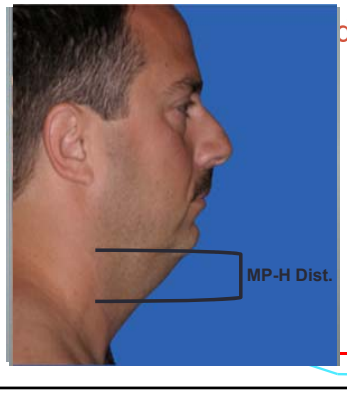
MP-H distance = Distance from the **mandibular plane** to the **hyoid bone**. Has been demonstrated that a greater distance is associated with a greater AHI on polysomnography (predictive of OSA).

MP-H Distance

Position of the hyoid DIRECTLY impacts the location of the thyroid cartilage



d Distance



REFERENCE RANGE = 11-19mm

Researchers have found a statistical relationship between AHI and MP-H distance; particularly at distances ≥ 27.4mm[87]

Endotypes and Phenotypes of OSA[109]

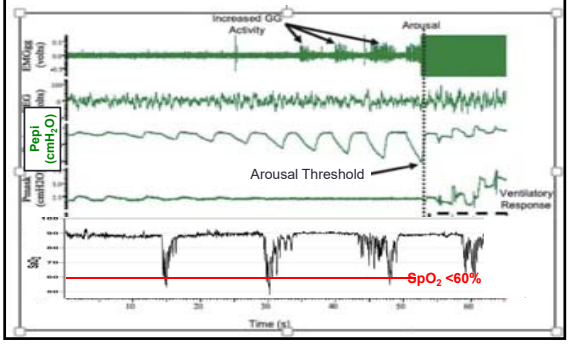
FANTASTIC review article in Jan 2017 A&A by Francis Chung and Colleagues…

Endotypes

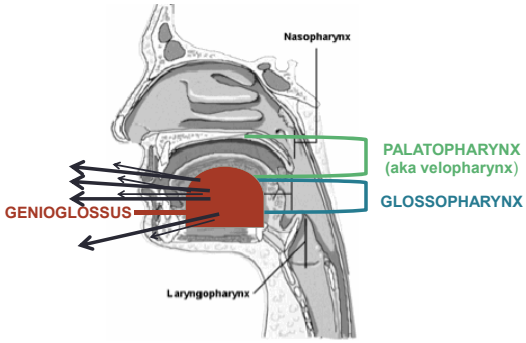
PHYSIOLOGY

- AROUSAL THRESHOLD
- UPPER AIRWAY MUSCLE FUNCTION (and REM Sleep) and AIRWAY STABILITY
- +LOOP GAIN (sensitivity to O_2 and pCO_2)
- ROSTRAL FLUID SHIFT
- POSITION

Arousal Threshold



Ineffective Upper Airway Muscle Function

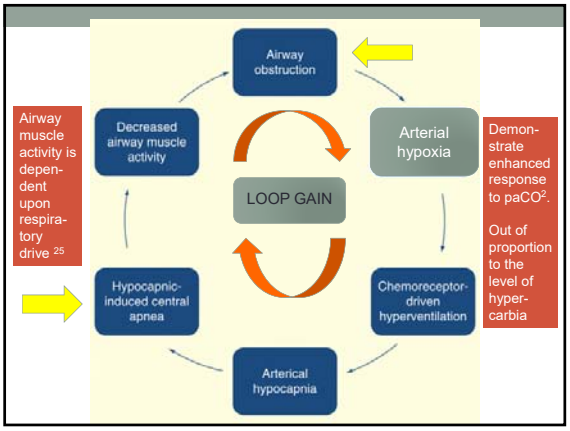


The Genioglossus

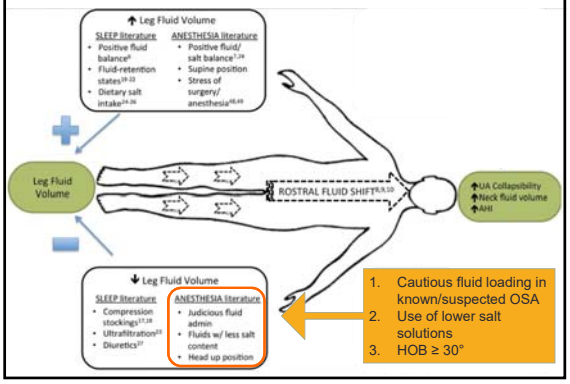
During sleep, the OSA patients with decreased neural input to their GG muscle (Ineffective Airway Dilator Endotype[109]) have a propensity for pharyngeal collapse during sleep.

AIRWAY STABILITY is further compromised by loss of pharyngeal traction due to:

1. Lower lung volumes
2. Supine positioning
3. Decreased FRC
4. Changes in REM patterns and
5. Uncoordinated pharyngeal motility



Rostral Fluid Shift[112]



1. Cautious fluid loading in known/suspected OSA
2. Use of lower salt solutions
3. HOB ≥ 30°

Positional OSA

- Position related airway obstruction is the predominant or partial component in up to 60% of patients with OSA[115]

- A predominant symptom in supine related OSA is ***DAYTIME SOMNOLENCE*** [116]
- **Young patients** (particularly men) tend to be more likely to have a positional component to their sleep apnea than elderly patients
- Head elevation to 30° significantly stabilizes the airway and in some patients, AHI < 5 with head-up ***(patients with normal BMI)*** [115]

Pre-operative CPAP

Does pre-operative CPAP improve surgical outcomes?

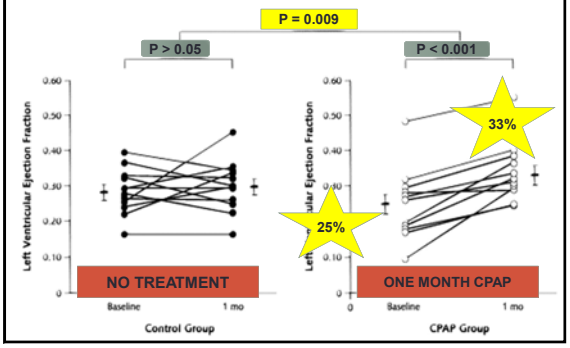
Extrapolation from **MEDICAL LITATURE**

- CPAP has unequivocally been shown to improve quality of life (daytime fatigue, concentration/memory, health care usage)

- Pre-operatively has been shown to improve cardiovascular health (BP swings, HR variability, arrhythmias, heart block)

- Improves diabetes responsiveness to insulin[95] and slows the progression of renal disease[96]

LVEF After One Month of CPAP [67]



Are outcomes influenced by pre-operative diagnosis and treatment?

Diagnosed vs. Undiagnosed Obstructive Sleep Apnea

Mutter et al., University of Manitoba and Yale University
Anesthesiology 2014; 121: 707-18.

WHO?

- Matched Cohort Analysis of 16,277 non-OSA patients vs. 1,571 patients with undiagnosed OSA (UOSA) who were subsequently diagnosed in the following five years (DOSA)

ANESTHESIOLOGY

Risk of Specific Respiratory and Cardiovascular Complications in Obstructive Sleep Apnea Patients vs. Matched Controls

Specific Complications (n)*	Odds Ratio (95% Confidence Limits)	P Value
Respiratory complications		
All OSA vs. matched controls		
Adult respiratory distress syndrome (n = 40)	3.17 (1.68–5.98)	→ <0.001
Respiratory failure (n = 27)	2.28 (1.04–4.99)	→ 0.04
Bacterial pneumonia (n = 34)	0.66 (0.26–1.67)	0.39
Aspiration pneumonia (n = 14)	1.55 (0.49–4.94)	0.46
Cardiovascular complications		
Undiagnosed OSA vs. matched controls		
Cardiac arrest and shock (n = 34)	2.40 (1.22–4.72)	→ 0.01
Acute coronary syndrome (n = 10)	0.97 (0.20–4.74)	0.97
Atrial fibrillation and flutter (n = 51)	0.97 (0.11–8.67)	0.98
Cerebral vascular accident (n = 12)	0.35 (0.05–2.70)	0.31
Diagnosed OSA vs. matched controls		
Cardiac arrest and shock (n = 40)	0.82 (0.38–1.78)	0.61
Acute coronary syndrome (n = 37)	0.60 (0.24–1.50)	0.27
Atrial fibrillation and flutter (n = 11)	0.86 (0.19–3.99)	0.85
Cerebral vascular accident (n = 19)	0.21 (0.03–1.61)	0.13

SLEEP 2015 *Abdelsattar et al.* [119]

26,842 patients general abdominal or vascular surgery patients at 52 hospitals (academic and community)

Three groups:
1. No diagnosis and low risk (STB ≤ 2)
2. Dx OSA w/o treatment or suspected OSA (STB ≥ 3)
3. Dx OSA with PAP therapy

- 30 day post-operative outcomes

SLEEP 2015 *Abdelsattar et al.* [119]

OUTCOME	NO OSA	Untreated OSA	Treated OSA	Difference (p value)
Any CP complication	4.9%	6.4%	4.2%	0.001
Post-op arrythmia	1.5%	1.6%	1.4%	0.356
Post-op cardiac arrest	0.6%	0.9%	0.4%	0.112
Post-op MI	0.6%	1.4%	0.6%	0.031
Unplanned re-intubation	1.8%	2.7%	1.4%	0.003
Post-op Pulm Embolus	1.0%	1.3%	1.4%	0.917
Post-op PNA	1.7%	1.9%	1.6%	0.522

However, THERE IS STILL MIXED DATA

2015 Meta-Analysis on the Effectiveness of CPAP on Post-Operative Events[118]

- 6 studies, 904 patients
- ALL patients had diagnosed OSA (vs. Dx by screening)
- 471 used pre-op OR post-op CPAP

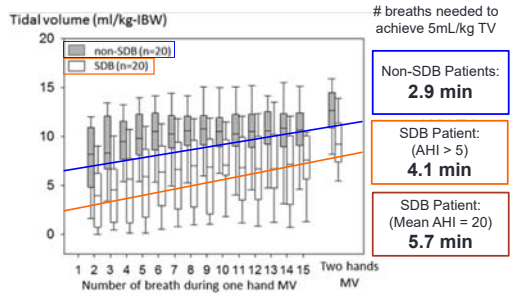
- **NO DIFFERENCE in ADVERSE EVENTS**
- Post-operative AHI was significantly improved in the CPAP group (MEAN 37 vs. MEAN 12)
- LOS showed a trend toward CPAP group (p = 0.05)

WHAT CAN I DO TO KEEP MY PATIENTS SAFE?

INTRA-OPERATIVE CONSIDERATIONS

AIRWAYS- Mask Ventilation[120]

Does OSA (= AHI > 5) reduce the ability/efficiency of MV?



Difficult Airways??

Toshwinal et al. J Clin Anes 2014[65]

127 patients; THREE GROUPS

1. Known OSA
2. STB ≥ 3
3. STB < 3

- Blinded anesthesiologists intubated the patients
- Those with known OSA or ST-B ≥ 3 were identified as being more difficult airways [MV, blade insertion, cord visualization with and without muscle relaxant ($p < 0.001$)]

Acar et al. Eur Rev Med Pharmacol Sci 2014

- 200 patients screened by STB for prospective cohort study
- 14/200 patients were labeled as a difficult intubation (CL view 4, need for an intubation aid, 3 or more attempts)
- STB ≥ 3 patient were more frequently defined as a difficult intubation (78.6% vs. 38.7%) ($p = 0.009$).

- 180 patients undergoing bariatric surgery[64]
- 68% diagnosed with OSA by polysomnography (mean AHI 31)
- 3.3% of patients required DL x 3
- Number of intubation attempts or CL view was not associated with AHI ($p = 0.09$)

Consider the patient's likely OSA endotype when planning your anesthetic…

1. Are the drugs used direct respiratory depressants?
2. Do they decrease the arousal response?
3. Do they inhibit upper airway dilator musculature?
4. Will the medications blunt CO_2 responsiveness?
5. Fluid status?

ANESTHETIC AGENT	Direct Resp. Depressant?	Decreases Arousal Response?	Decreases sensitivity to ↑ CO_2 /↓ O_2	Inhibits Upper Airway Musculature?
Opioids [19,97, 50, 52,53]	+ (rate)	+	+/+	+
Benzodiazepienes [19,49,98]	(Usually at) higher doses	+	+	++
Propofol [19, 40,50-1,95,98]	+ (tidal vol.)	+	+/+	++
Volatile Agents [19,33,49,83,95]	+/–	+	+	Yes, but overall D_{AW} minimal Δ
Ketamine [43,99,100]	Small ↓ Apnea at high doses	+	Rightward shift, same slope	–
Dexmedetomidine [83,101]	–	+	Minimal	Minimal

WHAT CAN I DO TO KEEP MY PATIENTS SAFE?

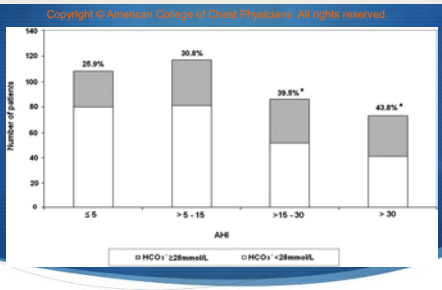
PACU CONSIDERATIONS

Screen for Respiratory Events in the PACU

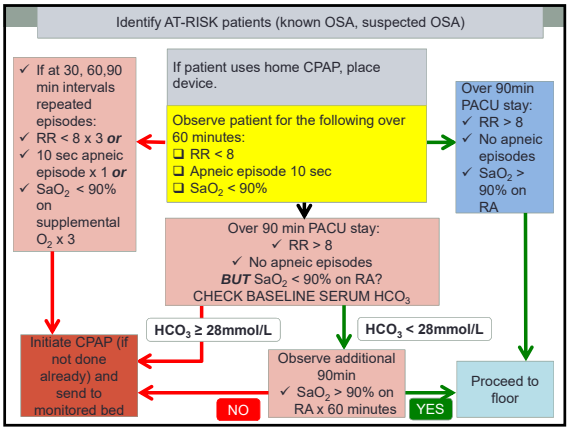
- Use a baseline screening tool to elevate suspicion in the PACU (STOP-Bang, DES-OSA)
- Know factors associated with increased risk (and why)
  - Neck Circumference, BMI
  - Types of symptoms (daytime somnolence, frequent arousals, witnessed apneas, etc).
  - Fluid overload states
  - Men = Post-menopausal women
- Evaluate craniofacial morphology (catch thin and young patients with OSA)
- LOOK AT BASELINE SERUM HCO_3

CHEST

From: Serum Bicarbonate Level Improves Specificity of STOP-Bang Screening for Obstructive Sleep Apnea



Chest. 2013;143(5):1284-1293. doi:10.1378/chest.12-1132

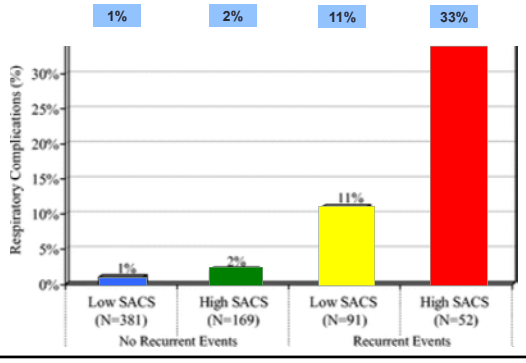


If patient uses home CPAP, place device.

Observe patient for the following over 60 minutes:
- ❑RR < 8 (x 3)
- ❑Apneic episode 10 sec (x 1)
- ❑SaO_2 < 90% on ROOM AIR

Despite home use of prescribed CPAP, studies have found that only 63% of patients will use CPAP in the post-operative period.[121]

Gali et al. Anesthesiology 2009 **(4):869-877.** [66]



The value of post-operative APAP

Liao P, et al. Anesthesiology Oct 2013 [79]

- 177 patients with AHI > 15 events/hr on PSG
- **RANDOMIZED** to APAP for 2 pre-operative and 5 post-operative nights vs. routine care
- Compliance with APAP 45% (2.5-4.6 hrs/night)

	BASELINE AHI	POST-OPERATIVE AHI on NIGHT 3	P VALUE
APAP GROUP	30.1 events/hr	3.0 events/hr	P <0.001
ROUTINE CARE	30.4 events/hr	31.9 events/hr	P = 0.302

APAP Again….

O'Gorman et al. CHEST 2013 [121]

130 Orthopedic surgery patients screened:

1. High vs. Low Risk (Flemons OSA score)– NOT PSG
2. High risk patients were randomized to APAP vs. regular care
3. Low risk patients all in regular care group

OUTCOME: NO DIFFERENCE in LOS

Study was UNDERPOWERED to detect a difference of a day)

- Interestingly, before d/c all patients underwent overnight PSG
- Subgroup analysis of patients with AHI > 15, patients had a LONGER length of stay but no increase in complications

LOS/complications without CPAP use [74]

- 693 bariatric surgery patients divided into three groups:
  1. Those with a diagnosis of OSA; used CPAP pre and post-operatively (GROUP A)
  2. Those with a ST-B score ≥ 3 (GROUP B)
  3. Those with a ST-B score < 3 (GROUP C)
- GROUP B had…

1. Higher rate of pulmonary complications (p < 0.001)
2. An increased LOS (p <0.0001)
3. 17 cases of PNA (vs 2 in group A, 4 in C, p <0.0001)
4. 7 re-intubations (vs 0 in other two groups, p = .0098)

GROUP B had two cases of sudden cardiac death

CPAP vs. O_2

- Gottlieb DJ, et al. *NEJM* June 2014 [77]
  - 318 cardiology patients screened for OSA
  - Diagnosed by PSG
  - Those with AHI 15-50 (mod to severe OSA) were randomized to sleep hygiene/education, O_2 or CPAP

1. CPAP vs O_2 – SAME reduction in nocturnal hypoxia (64% decrease in ODI)

   Oxygen masks the hypoxia that accompanies hypoventilation in OSA…
2. SBP and DBP significantly decreased in CPAP group (O2 and sleep hygiene group the same)

   A decrease by 2mmHg in SBP has been estimated to reduce mortality from CVA by 10% and from CAD by 7% [78]

Hot off the press….Oxygen!

123 patients randomized to 3d of post-op 3L O_2 NC vs. RA[122]

- NO patients with Obesity Hypoventilation Syndrome
- Limited patients with COPD
- Spine > Other orthopedic > general > urologic surgery
- Significant crossover (O_2) in the control group (20%)

❖ Decreased AHI (17.9 to 4.4, p <0.001)
❖Decreased central apnea index

O_2 decreases loop gain??

❖11.4 % of patients experienced a significant ⇧ pCO_2
❖Age, gender, BMI, NC, Type of Anesthesia and co-morbidities were not associated with increased pCO_2

Is monitoring on POD #0 sufficient?

We don't know.

- Recent studies have documented that the more serious complications occurred within the first 24 h after surgery in OSA patients.[95]
- 88% of the post-operative respiratory depression events occurred within the first 24 h after surgery.[81]
- However…

Is monitoring on POD #0 sufficient?

REM REBOUND

- REM is generally significantly decreased on POD #0
- Rebound occurs in all patients, occurring on post-operative nights #1,2 (but does not exceed pre-operative levels)
- Chung F, et al Anesthesiology 2014
  - *AHI increases to the greatest degree in all patients on POD #2 (night 3)*
  - *AHI increased by 61% on N3 with and ODI increase of 66% and a fourfold increase in time under 90% sats*
  - *However, 53% of patients were on O_2 therapy on N1 vs. only 8% on N3*

Conclusions

- SCREEN FOR OSA;
  - Be Consistent
  - Use a Validated Tool
  - Tease out possible endotypes
- ENCOURAGE KNOWN OSA PATIENTS TO USE THEIR CPAP PRE AND POST-OPERATIVELY
- PLAN AN ANESTHETIC TAILORED TO PATIENT DISEASE/RISK
- SCREEN IN THE PACU RISK STRATEFY PATIENTS
- USE CPAP POST-OPERATIVELY IF NEEDED

"It's a taser. It's for your snoring."

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Table 1: Patient factors associated with a better treatment outcome.

Patient factors associate with BETER OUTCOMES	
Demographic/Anthropometric	**Craniofacial structure**
• ↓ age • Female gender • ↓ BMI • ↓ neck circumference	• ↓ soft palate length • ↑ distance between hyoid bone and mandibular plane • ↑ mandibular plane-cranial base angle • Retrognathic mandible
Polysomnography	**Upper airway structure**
• ↓ baseline AHI • Supine-dependent OSA • Successful single night mandibular advancement titration	• ↓ nasal resistance • ↑ airway calibre with mandibular advancement

Sutherland K, Cistulli PA. Mandibular advancement splints for the treatment of sleep apnoea syndrome. Swiss Med Wkly. 2011;141:w13276

TORS- Transoral robotic surgery

Resection of the tongue base (with or without epiglottoplasty)[88]

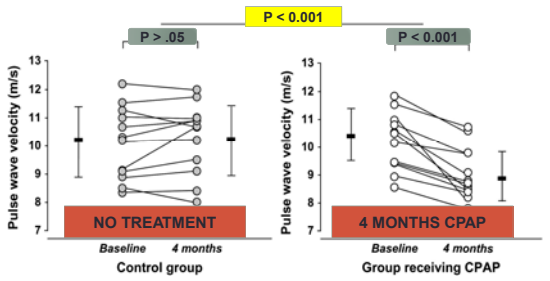
- Appears to show benefit in both reduction of AHI and hypoxias.
- When combined with UPPP (multilevel OSA surgery):
  - AHI 58 to 19 (67% reduction, p < 0.0001)
  - Sleep time < 90% was 14% to 3.6% (p , .0003)
  - ESS improved from 12.8 to 5.8 (p <0.0001)
- IS NOT EFFECTIVE for those with prior UPPP (must be combined) so, leaves questions as to longevity of this procedure

Advise the patient of their risk…

THE PATIENT (AND HIS OR HER FAMILY) SHOULD BE INFORMED OF THE POTENTIAL IMPLICATIONS OF OSA ON THE PERI-OPERATIVE COURSE.

CPAP improves pulse wave velocity [68]

(A reflection of arterial stiffness)



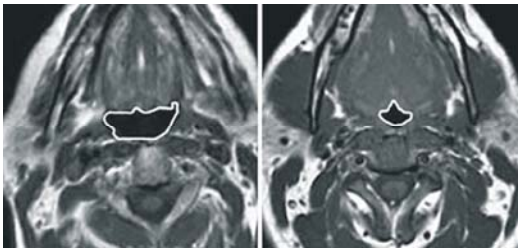
JAMA March 2015

Effect of sedative premedication on patient experience after general anesthesia: an RCT

- 1062 patients; Three groups (each 354) assigned to 2.5mg lorazepam, no premedication, placebo
- Excluded NSGY, obstetrics, cardiac, outpatient
- PATIENT SATISFACTION: NO DIFFERENCE (p=0.38)
- Time to extubation: 17min, 12min, 13min (p <0.001)
- Rate of early cognitive recovery using PQRS: 51%, 71%, 64% (p<0.001)

Airway Narrowing [4]

Same image plane in an obese, non-OSA patient (left) vs. obese individual with OSA (right). Note the reduction in air space in the patient on the right.



General Anesthesia/ Deep Sedation

Inpatient vs. Outpatient?

For those with known Diagnosis of OSA or STOP-BANG ≥ 5; Will surgery preclude the use of CPAP at home or in PACU?

YES

Patient needs to have surgery at inpatient facility; follow PACU algorithm

NO

Does patient have:
1. LVEF ≤ 40%?
2. Pulmonary HTN ?
3. Uncontrolled atrial fibrillation?
4. COPD on home O_2?
5. Neuromuscular disease?
6. Chronic pain on high doses narcotics?*

YES

NO

May proceed with ambulatory surgery; patient's post-operative pain be managed predominantly with non-opioid medication

For patients with OSA s/p UPPP; follow algorithm for suspected OSA unless a repeat PSG documents AHI < 5

General Anesthesia/ Deep Sedation

Hospital or Ambulatory Surgery Center?

BMI ≥ 50 ("Super-Obese")

YES

Procedure should be done at an inpatient facility [62, 63]

Evaluate for:
1. Presence of high-risk comorbidities?
2. Need for post-operative narcotics?

NO

Patient is eligible for same-day surgery^

NO

Known Diagnosis of OSA or STOP-BANG ≥ 5?

NO

Proceed with Ambulatory Surgery

YES

Evaluate the patient's:
1. Ability to use post-operative CPAP
2. Presence of high-risk co-morbidities

Known OSA with home CPAP **or** OSA without CPAP/STOP-BANG ≥ 5

If at 30, 60,90 min intervals repeated episodes:
- ✓ RR < 8 x 3 ***or***
- ✓ 10 sec apneic episode x 1 ***or***
- ✓ SaO_2 < 90% on supplemental oxygen

If patient uses home CPAP, place device.

Observe patient for the following over 90 minutes:
- ❑ RR < 8
- ❑ Apneic episode 10 sec
- ❑ SaO_2 < 90% on supplemental oxygen (x 2 occasions)

Over 90min PACU stay:
- ✓ RR > 8
- ✓ No apneic episodes
- ✓ SaO_2 > 90% on RA

Over 90 min PACU stay:
- ✓ RR > 8
- ✓ No apneic episodes

BUT SaO_2 < 90% on RA?
Monitor up to 90 additional minutes in PACU

Initiate CPAP (if not done already) and send to monitored bed

NO

SaO_2 > 90% on RA x 60 min

YES

May proceed home

Post-Operative Screening

- Patients who are at high risk of OSA on the screening questionnaires AND have recurrent post anesthesia care unit (PACU) respiratory events, are associated with higher postoperative respiratory complication.[14]
  - Patients with a high SACS had an INCREASED INCIDENCE OF PACU RESPIRATORY COMPLICATIONS (OR 1.5, $p < 0.001$)
  - IF RECURRENTLY HYPOXEMIC IN PACU (SaO_2 < 90 over 90 minute stay) and HIGH SACS SCORE, LIKELIHOOD OF POST-OPERATIVE REPIRATORY EVENT ROSE TO AN ODDS RATIO OF 21, $p < 0.001$).

RCTs Post-Operative CPAP Application

Gorman et al. 2013

- RCT 138 patients
- APAP to No PAP
- No difference in complications between groups ($p = 1.0$)
- No difference LOS

Liao et al. 2014

- RCT 177 patients
- APAP to No PAP
- No difference in complications between groups ($p > 0.05$)
- Trend toward shorter LOS in APAP group ($p < 0.05$)

L. Evan Cline

Evan has expertise in medical litigation, representing physicians, mid-level providers, nurses and hospitals throughout the course of her career. Evan has experience handling every stage of these complex cases, including drafting pleadings and motions; managing written discovery; taking and defending the depositions of parties, experts, and other witnesses; evaluating case strengths, weaknesses and value; preparing for trial and trying cases; and handling appellate issues. Evan particularly enjoys working with physicians and other healthcare professionals to provide information and reassurance about the medical/legal process while also helping to develop their presentation skills and fully prepare them for substantive issues that might arise in deposition or at trial.

Representative cases/experience

- Representation of physicians of various specialties in numerous cases involving allegations of professional negligence and/or gross negligence.
- Representation of numerous Georgia hospitals and medical corporations involving claims of medical malpractice and/or ordinary negligence.
- Defense verdicts in numerous cases on behalf of hospitals, medical corporations, and providers from various medical specialties, including but not limited to anesthesia, general surgery, internal medicine, orthopedic surgery, and vascular surgery.
- Thorough appellate management and successful outcomes in appellate issues arising from initial pleadings, discovery motions, and trial rulings or outcome.

Areas of Practice

- Medical Malpractice Defense
- Physician and Hospital Defense
- Premises Liability Defense
- General Civil Litigation
- Civil Appellate Practice
- Nuisance, Condemnation and Inverse Condemnation
- Georgia Composite Medical Board Representation

Education

- B.A., Journalism and Mass Communications, University of South Carolina (2005)
- J.D., Emory University School of Law (2008)

MedMal: What to expect when you're not expecting

Evan Cline, JD
Huff, Powell, & Bailey, LLC
Atlanta, GA

At the conclusion of the presentation, the learner should be able to:

1. Know what to do if they've been sued.
2. Recall tips for avoiding lawsuits/minimizing liability.
3. Define the life of a lawsuit, file to trial.
4. Understand jury trials in Georgia (Lawyers, Experts, Judges, and Jurors).

What to Expect When You're NOT Expecting.

Evan Cline
Huff Powell & Bailey, LLC
999 Peachtree Street NE
Atlanta, Georgia 30309

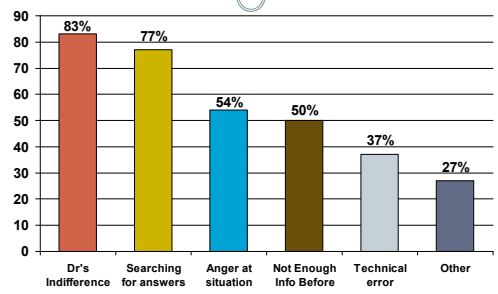
What You Can Expect Today:

- How not to get sued – *What every anesthesiologist needs to consider.*
- How to get sued! – *Interesting Examples*
- How to increase chance of getting sued! – *Examples*
- Holy cow, I may get sued!?! – *How to respond and not make it worse*
- Holy expletive, I just got sued. – *What to expect and what to do*

How Not to Get Sued

WHAT IS THE #1 REASON WHY PATIENTS FILE LAWSUITS?

How Not to Get Sued:
Why Do Patients Sue?



How Not to Get Sued:
The 3 Greatest Tools for Prevention

(1) Effective and Professional Communication

(2) Proper Management of Patient Expectation

(3) Thorough and Thoughtful Documentation

How Not to Get Sued
Step 1: Proper Communication

- Communicate clearly
- Communicate effectively
- Communicate regularly and in a timely fashion
- Communicate with courtesy and respect

How Not to Get Sued
Step 2: Manage Patient Expectations

- Help the Patient/Family Reach Realistic Expectations
  - Procedure/Diagnosis/Issue
  - Your Role vs. Other Providers
  - Patient Fears
  - Expectation for Result

How Not to Get Sued
Step 3: Thoughtful and Deliberate Documentation

- Pre-Anesthesia Evaluation
  - Patient History
  - Patient Condition at Presentation
  - ASA Rating
  - Mallampati Scoring

How Not to Get Sued
Step 3: Thoughtful and Deliberate Documentation

- Anesthesia Record
  - Chart Contemporaneously
  - Include a narrative, particularly if there is any issue in the case
- Other Documentation
  - Patient History
  - Patient Condition at Presentation
  - Plan for management, including which specialists are responsible for testing/follow up/etc.

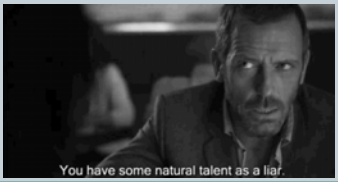
How Not to Get Sued
Step 3: Thoughtful and Deliberate Documentation

- PACU Notes
- Code Records/Notes
- Consultations (I.e. Pain)
  - Patient History
  - Patient Condition/Pertinent Test Results
  - Plan for Management (including which specialists are responsible for testing/follow up/etc.)

How To Get Sued ... In 3 Slides

How to Get Sued
Option One...

SAY SOMETHING RUDE OR NEGATIVE ABOUT YOUR PATIENT/THEIR FAMILY TO THE PATIENT OR SOMEONE ELSE.



How to Get Sued
Option Two...

WRITE AN INFLAMMATORY OR DEROGATORY REMARK ABOUT THE PATIENT OR HIS/HER FAMILY IN THE CHART.

How to Get Sued - Option Three...

SAY OR WRITE SOMETHING INFLAMMATORY ABOUT ANOTHER PROVIDER.

How To Get Increase Your Chances of Being Sued

How to Increase Chances of Being Sued.

- Time or date your records inappropriately
- Fail to document each patient encounter
- Fail to provide sufficient detail in note
- Use generic word choices in notes, leaving them open for interpretation
- Fail to address differences in information obtained from patient
- Fail to sign records in a timely fashion
- Improper reliance on templates

Computer systems/EMR
- Templates
- Times
- Audit trails

Cell phone records

Pager records

Photography

Audio and video taping

The Technology Trap

So WHY is all of this so important?

The Goal of a Plaintiff's Attorney

STRATEGY

It is not enough to find out just what was done, but more important to determine why particular decisions were made and what alternatives existed. In addition, in every case where there are multiple defendants, it is the Plaintiff's objective to drive a wedge between the Defendants in an effort to have one suggest that another may have provided substandard care.

Brophy, *Medical Malpractice Depositions*, 2004

Our Goals

BE AN ADVOCATE FOR YOUR PATIENT

BE AN ADVOCATE FOR YOURSELF

BE AN ADVOCATE FOR YOUR COLLEAGUES

Holy Cow! I May Get Sued.

HOW TO RESPOND AND NOT MAKE IT WORSE

If you think you may be sued over an issue:

- Do not talk to other providers or colleagues after the fact
- Do not make notes that are separate from the chart
- Do not pull records from the patients' chart for personal record keeping
- Do not edit the chart in any way
- If you need to add anything to the chart, do it through a proper addendum
- Alert your insurance carrier through the proper channels – they can provide privileged investigation of case including expert review

Holy Expletive! I Just Got Sued.

WHAT TO EXPECT &
WHAT YOU NEED TO DO.

If you get served with a lawsuit...

- Stay Calm.
  - You have medical malpractice insurance that covers your defense
  - Do not worry that you will have to pay money out of pocket
- Report.
  - Let your insurance carrier know about the case IMMEDIATELY
  - Same rules as last slide. Do not pull records, change records, access records, talk to providers, talk to colleagues about substance

What you can expect: Plaintiff's Burden of Proof

ELEMENTS OF MEDICAL MALPRACTICE LAWSUIT:

- Duty
- Breach
- Cause
- Harm/Damages

*** These elements must be proven through expert testimony ***

Plaintiff's Burden of Proof

BREACH

Violation or deviation from STANDARD OF CARE, which is defined as "that degree of care and skill exercised by physicians (anesthesiologists) generally under similar conditions and like surrounding circumstances.

Plaintiff must identify specific standard of care violations through the testimony of qualified experts. This can be from a physician outside the specialty of anesthesiology if they "have actual professional knowledge and experience in the area of practice or specialty in which the opinion is to be given."

Pulmonologists, CT Surgeons, ER physicians, etc.

Plaintiff's Burden of Proof:

CAUSATION

- Evidence must be from qualified experts.
- Must be offered by a "preponderance of the evidence" (more likely than not)
- So the expert must say "Dr. X's negligence in failing to recognize an esophageal intubation MORE LIKELY THAN NOT caused the hypoxic brain injury at issue in this case."

What you can expect: Pre-trial Litigation

PRE-TRIAL PHASE

- Initial Pleadings
  - Complaint/Affidavit
  - Answer
- Written Discovery
  - Exchanging Written Questions/Answers
  - Collecting Documents (Medical Records, Cell Phone Records, Employment Records, Photos)
- Depositions
  - Parties
  - Fact Witnesses
  - Experts

What you can expect: Trial

TRIAL PHASE

- Jury Selection
- Opening Statements (BOP)
- Presentation of Plaintiff's case
- Plaintiff rests and Motions are heard
- Presentation of Defense case
- Closing Arguments
- Jury Charge, Deliberation, Verdict

What you can expect: Outcomes

The GOOD news...

In Georgia, the defense wins (on average) 85-90% of medical malpractice cases.

Why?

- Patients want to trust MDs
- Patients do not want to believe that bad things can happen to them/their family
- Patients understand the challenging role of providing medical care, particularly to complex patients
- Patients know that medicine cannot fix every problem

Other Times You May Want A Lawyer:

Board Complaints

- Happen all the time.
- What to do
- Typically result in no action being taken against MD
- Why I think the process is a good one for you guys!

Treating MD Depositions

- Requesting a lawyer through your insurance company (SOL, more information)
- Really important to both your colleagues and the families of injured

HIPAA

- Under the current posture of the law in Georgia, you only are allowed to disclose protected patient information to YOUR lawyer or the lawyer representing the plaintiff's family.
- You cannot talk to defense counsel (without plaintiff's counsel present) unless you are given a copy of an authorization from the family or a court order allowing such communication.
- You are not obligated to talk to a plaintiff's attorney in private, and you should be careful when doing so.
- Depositions/Subpoenas for testimony.

Remember!! Our Goals

BE AN ADVOCATE FOR YOUR PATIENT

BE AN ADVOCATE FOR YOURSELF

BE AN ADVOCATE FOR YOUR COLLEAGUES

QUESTIONS ?

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Management of Hyperglycemia in Non-Cardiac Surgery

Beth Duggan, MD

Emory University School of Medicine

Department of Anesthesiology

Atlanta, GA

At the conclusion of the presentation, the learner should be able to:

1. Interpret current outcomes studies examining hyperglycemia in the perioperative period.
2. Define target blood glucose ranges for the preoperative period, day of surgery, and post-operative management.
3. Recommend pre-operative medication management.
4. Outline testing and treatment options for day of surgery.

Management of Hyperglycemia in Non-Cardiac Surgery Patients

Elizabeth Duggan, MD
Division Chief, Surgical Specialties Anesthesiology
Emory University Hospital
Emory University SOM
January 2017

Disclosures

- Development of a smartphone app SUGARx
  (Surgical eUGlycemia Algorithm and Rx)
- Pending approval for android and apple smart phones- will be available for free.

Objectives

- **OUTCOMES: The evidence is convincing**
- **TARGETS: Conventional vs. Intensive**
- **NOT ALL HYPERGLYCEMIA = DIABETES**
- **HOW CAN I CHANGE MY PRACTICE?**

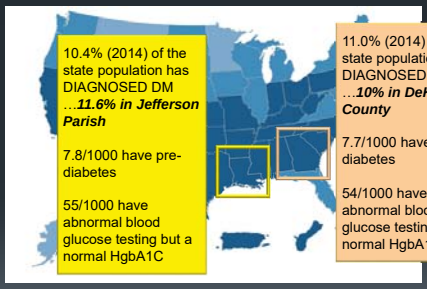
- Screening
- Pre-operative medication recommendations in diabetics
- Day of surgery testing and treatment decision-making
- Surgical Floor Treatment Options

Diabetes in the U.S.

- 9% of Americans meet criteria for the DIAGNOSIS of diabetes
- = 29 Million Americans
- 21.0 million DIAGNOSED
- 1.4 million people diagnosed annually
- 86 million Americans have prediabetes
- Diabetes: the 7th LEADING CAUSE OF DEATH in the United States

American Diabetes Association. National Diabetes Statistics. June 10, 2014.http://www.diabetes.org/diabetes-basics/statistics. Accessed Dec 31st, 2016. Centers for Disease Control and Prevention. Diabetes Statistics. https://gis.cdc.gov/grasp/diabetes/DiabetesAtlas.html. Accessed Dec 31st, 2016.

Diabetes in Louisiana…



American Diabetes Association. National Diabetes Statistics. June 10, 2014.http://www.diabetes.org/diabetes-basics/statistics. Accessed Dec 31st, 2016. Centers for Disease Control and Prevention. Diabetes Statistics. https://gis.cdc.gov/grasp/diabetes/DiabetesAtlas.html. Accessed Dec 31st, 2016.

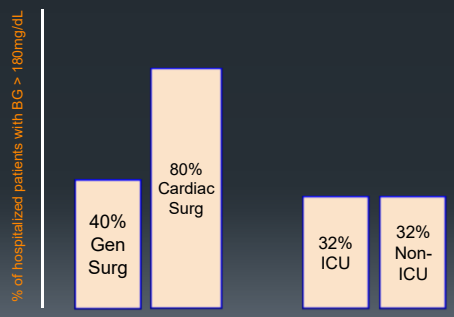
Prevalence of Hyperglycemia

- 30-60% of hospitalized patients[11]

Hyperglycemia is HARMFUL

1. Vascular surgery
2. Mastectomy
3. Neurosurgery
4. Spine surgery
5. Liver transplant surgery
6. Colorectal surgery
7. Hepatobiliary-pancreatic surgery
8. Cholecystectomy
9. Total Hip/Knee Replacement

Hyperglycemia is COMMON [12, 51]



Pre-Operative Hyperglycemia

Retrospective Analysis 61,000 non-cardiac surgery patients undergoing elective surgery.[16]

ONE YEAR MORTALITY was significantly related to first pre-operative BG.

- Crude incidence of mortality at one year

BG 60-100mg/dL	**3-5%**
BG > 216mg/dL	**12.5%**

DEATH = 2X

Abdelmalek et al. 2013

Perioperative Hyperglycemia

GENERAL and VASC SURGERY:

Risk of death due to a cardiovascular event is 4-fold higher[19]

GENERAL (non-vascular) SURGERY:

For each increase by 40 mg/dL above a BG of 140mg/dL, risk of wound infection is increased by 30%[18]

Hyperglycemia (during time POD 0-10) is associated with an increase in serum creatinine by 0.5mg/dL from baseline[12]

COLORECTAL SURGERY:

BG > 200mg/dL on POD 1 is associated with cardiac arrest. BG > 160mg/dL on POD 1 was associated with MI (DM and non-DM) [16, 60]

Hospital survival is predicted by hyperglycemia…not diabetes[66]

Population (ICU)	Mean BG (mg/dL)	P Value	Initial BG (mg/dL)	P Value	Max BG (mg/dL)	P Value
General surgical						
Survivors	134.9 (66.0-342.0)	<.001	144.7 (22-769)	.007	170.5 (68-1155)	<.001
Nonsurvivors	169.1 (85.3-404.8)		177.0 (69-421)		277.4 (93-779)	

Initial BG:

THE DIFFERENCE IN SURVIVAL IN THOSE WAS NOT PREDICTED BY DIABETIC STATUS BUT INSTEAD BY DEGREE OF HYPERGLYCEMIA

G: different

Systematic Review Of HgbA1C on Surgical Outcomes (April 2016)[59]

- Review of 20 articles (19,514 patients) published between 1980-2014 that included preoperative HbA1C levels and outcomes in all types of surgery

NO DIFFERENCE IN:

- ✓ 30 day mortality
- ✓VTE
- ✓Hospital readmission
- ✓ICU LOS
- ✓Dysrrhythmias
- ✓*Trend suggested from some articles a link between higher HgbA1C and AKI*
- ✓*Data was too variable to make conclusions on SSI and CV events*

Study by Dhartiya group et al. (Lead author of the NHS/Joint British Diabetes Society Guidelines for Perioperative Diabetes Control)

HgbA1C and Outcomes

- Primary CABG **HbA1C > 7%** is significantly associated with higher rates of **re-intubation, wound infection and bleeding**.[40]
- Preoperative **HbA1C > 6% is independently associated with higher thirty-day mortality** following elective cardiac surgery [41] and values have been **linked to reduced long-term survival** following CABG.[36]
- NSQIP data for non-cardiac surgery demonstrate **HgbA1C > 8% increased LOS (p < 0.05)** compared to age/BMI/sex matched non-diabetic cohorts.[8] HgbA1C 6.5-8 had similar LOS to the cohort (p =0.5).

Joint Surgery

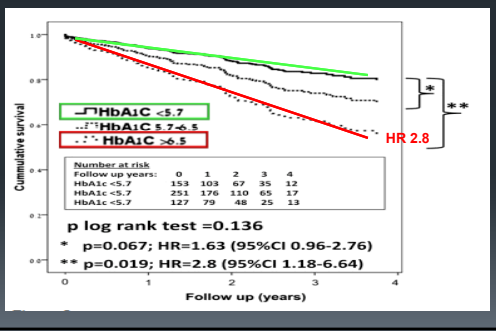
2013 **HgbA1C (> 7%)** as a marker for surgical risk in THR/TKR from the VA-SQIP[62]

- **ODDS of having one complication were 22% higher (p=0.02); odds of 90-day mortality was unchanged**

COMPLICATIONS: Return to OR, UTI, Superficial Infection, Deep Wound Infection, Sepsis, PNA, Progressive Renal Insufficiency, AKI, Re-intubation for respiratory or cardiac failure.

Most common: UTI

HgbA1c > 6.5 decreases survival



Best Abstract 2015 Academic Surgical Congress Conference[63]

Preoperative Glycosylated Hemoglobin and Postoperative Glucose Together Predict Major Complications after Abdominal Surgery

- 1017 patients (438 with pre-op HgbA1C), 21% had a major complication (Clavien-Dindo system)
  - **Of the 438 with a HgbA1C, 49% were not previously diganosed diabetics**
- HgbA1C > 6.5% was found to be the most significant risk factor for complication
- Both HgbA1C and glucose predicted outcomes when combined analysis was performed

Table 5.
Predicted Probabilities of Major Complications (n = 352)

HbA1c	Peak 24-hour postoperative glucose				
	<80 mg/dL	80 to 119 mg/dL	120 to 159 mg/dL	160 to 199 mg/dL	>200 mg/dL
<5.7%	19.59 (−15.31 to 54.50)	15.94 (5.34 to 26.53)	25.03 (12.64 to 37.42)	24.47 (11.38 to 37.57)	31.56 (14.47 to 48.66)
5.7% to 6.4%	15.50 (−14.09 to 45.11)	12.50 (4.03 to 20.97)	**20%**	**20%**	**26%**
6.5% to 7.0%	25.71 (−17.44 to 68.86)	21.21 (7.04 to 35.38)	32.16 (19.42 to 44.91)	31.51 (17.46 to 45.57)	39.57 (23.28 to 55.87)
>7.0%	24.32 (−17.77 to 66.43)	20.01 (6.45 to 33.57)	**30%**	**30%**	**37%**

Results are reported as predicted probabilities and 95% CI.

HbA1c, hemoglobin A1c.

Goodenough CJ et al. 2015[63]

Complications Avoided vs. Unnecessary Delay[62]

Threshold	No Delay/No Complications	No Delay/Complications	Complications Avoided	Successful Surgeries Delayed
5	0.70%	0.30%	7.30%	91.70%
6.5	39.85%	2.99%	4.65%	52.51%
6.6	44.37%	3.43%	4.20%	48.00%
6.7	48.90%	3.75%	3.89%	43.46%
6.8	53.18%	4.11%	3.53%	39.18%
6.9	57.01%	4.37%	3.27%	35.35%
7	60.47%	4.60%	3.04%	31.89%
7.1	63.68%	4.86%	2.78%	28.69%
7.2	66.40%	5.07%	2.56%	25.96%
7.3	69.32%	5.27%	2.36%	23.04%
7.4	71.62%	5.52%	2.12%	20.74%
7.5	73.53%	5.70%	1.94%	18.83%
9	88.00%	7.23%	0.42%	4.35%

Referral but no delay??

Underwood et al. 2015[38]

ENROLLED: 175 diabetes patients with HgbA1c ≥ 8.0%.

INTERVENTION: Endocrinology consult with medication optimization, lifestyle counseling

GOAL: Day of surgery achieve RBG < 200mg/dL

RESULT:
Prior to intervention: 33% of patients with BG > 200mg/dL
After intervention: 20% of patients arrived with BG > 200mg/dL

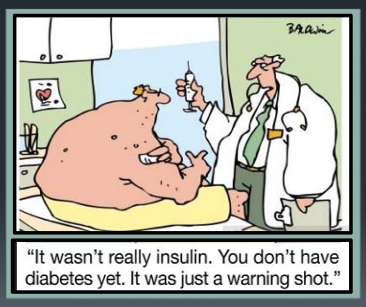
13% of patients showed improved BG on the day of surgery

Can we manage the burden of DM during the perioperative period?

HOW?

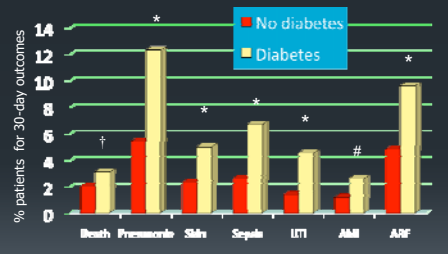
Centers for Disease Control. National Center for Health Statistics. Updated page 10/6/2016. https://www.cdc.gov/nchs/fastats/diabetes.htm. Accessed Jan 1, 2017.

Hyperglycemia in Non-Diabetics



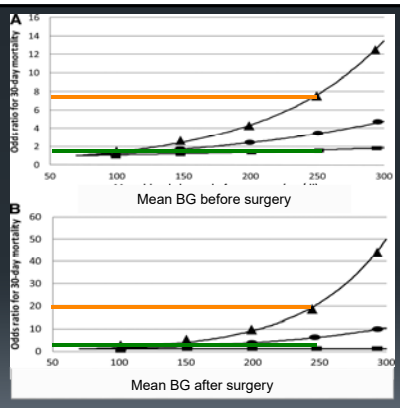
"It wasn't really insulin. You don't have diabetes yet. It was just a warning shot."

Outcomes in Diabetic vs. Non-Diabetic General Surgery (non-ICU) Patients[1,2]



†p = 0.1
* p= 0.001
#p=0.017

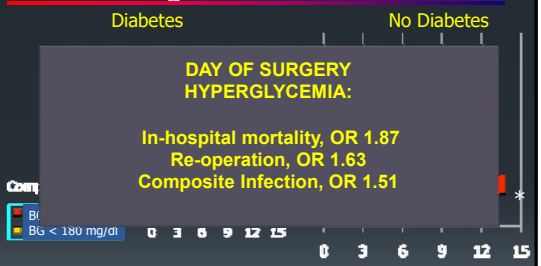
Retrospective analysis in 3184 patients admitted to Emory University Hospital in Atlanta, between 1/1/07 and 6/30/07
Frisch et al. 2010 Diabetes Care



Odds Ratio FOR 30-DAY MORTALITY
- ALL PATIENTS
- Diabetics
- Non-diabetics

A Frisch et al. Dia Care 2010;33:1783-1788 [12]

Hyperglycemia in non-diabetics is more dangerous than diabetics



* P <0.01
§ p <0.05

BG at any point on the day of surgery, post-op day 1 and 2
N= 11,633, colorectal and bariatric surgery;
29.1% with hyperglycemia

Kwon et al. Ann Surg 2013 [13]

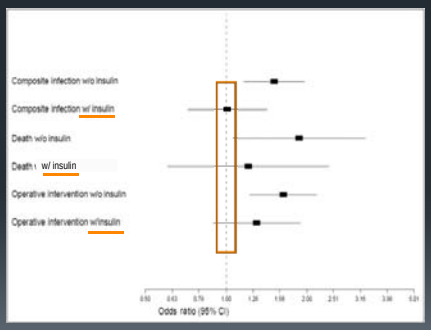
Table 5. Postoperative outcomes in diabetic and non-diabetic patients stratified by hyperglycemic events of glucose>180mg/dl

Outcome	Diabetic (N=261) Total	Glucose<180mg/dl (N=83)	Glucose>180mg/dl (N=178)	P-value[a]	Non-diabetic (N=790) Total	Glucose<180mg/dl (N=602)	Glucose>180mg/dl (N=188)	P-value[a]
30-day mortality	6	1 (1.2%)	5 (2.8%)	0.6679[a]	20	4 (0.7%)	16 (8.5%)	<0.0001[a]
Postop MI	10	0 (0.0%)	10 (5.6%)	0.0333[a]	15	9 (1.5%)	6 (3.2%)	0.2153[b]
Vent > 48 hours	8	2 (2.4%)	6 (3.4%)	0.7829[a]	37	12 (2.0%)	25 (13.3%)	<0.0001
Acute renal failure	7	1 (1.2%)	6 (3.4%)	0.4367[a]	17	5 (0.8%)	12 (6.4%)	<0.0001[a]
Prog. Renal failure	1	0 (0.0%)	1 (0.6)	0.6820[a]	17	4 (0.7%)	13 (6.9%)	<0.0001[b]
Postop stroke	6	1 (1.2%)	5 (2.8%)	0.6679	10	4 (0.7%)	6 (3.2%)	0.0149[a]
Transfusion	66	13 (15.7%)	53 (29.8%)	0.0146	225	130 (21.6%)	95 (50.5%)	<0.0001
Wound Complication[c]	12	0 (0.0%)	12 (6.7%)	0.0111[a]	47	27 (4.5%)	20 (10.6%)	0.0018
Other infection[d]	9	1 (1.2%)	8 (4.5%)	0.2796[a]	35	12 (2.0%)	23 (12.2%)	<0.0001
Graft thrombosis	1	0 (0.0%)	1 (0.6%)	0.6820[b]	1	1 (0.2%)	0 (0.0%)	0.7620[b]
Return to OR	10	0 (0.0%)	10 (5.6%)	0.0333[a]	25	12 (2.0%)	13 (6.9%)	0.0008
Readmission	35	8 (9.6%)	27 (15.2%)	0.2221	64	46 (7.6%)	18 (9.6%)	0.3964

[a] P-values generated using chi-square test of homogeneity
[b] P-values generated using Fisher's exact test
[c] Composite of wound dehiscence, hematoma, and SSI
[d] Infection other than pneumonia or wound infection

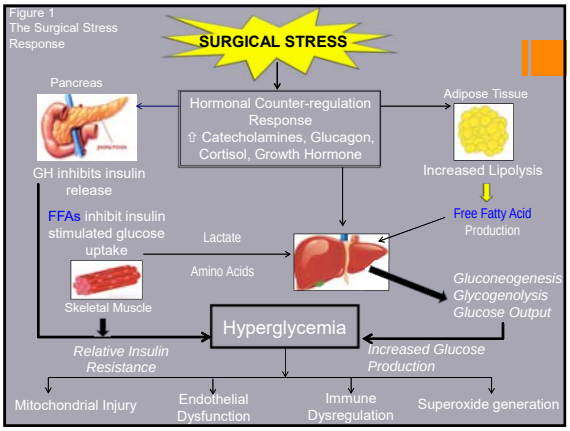
Long, Fang, Hu, Veeraswamy, Duggan, Duwayri. Abstract- Society of Vascular Surgery 2016.

Insulin's role??[13]



Not All Hyperglycemia = Diabetes

STRESS HYPERGLYCEMIA – Defines inpatient hyperglycemia that normalizes when the counterregulatory hormone surge and excessive pro-inflammatory state abate.



Paradox: NON-Diabetics are at Higher Risk from Hyperglycemia

CURRENT HYPOTHESES:

1. "Hyperglycemia is a marker" of severity of illness in non-diabetic patients
2. Under-diagnosis of disease
3. Under-treatment of non-diabetics with insulin in the peri-operative period
4. Is diabetes protective against hyperglycemia? Diabetes may be an adaptation of the body that allows tolerance of elevated blood glucose due to the chronic exposure to hyperglycemia ★

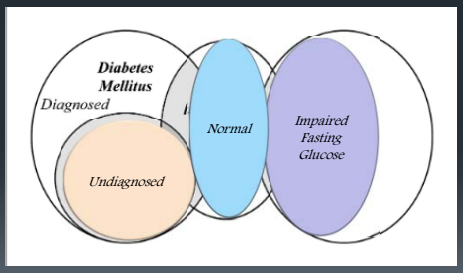
Hypothesis 1: An Increase in Inflammation and Oxidative Stress

- CABG patients placed one of four groups (with randomization for treatment target).
- OUTCOME: Difference in inflammatory markers (cortisol, CRP, IL-6, TNF-α, TBARS and DCF

DM BG 110-140	DM BG 140-180	NDM BG 110-140	NDM BG 140-180

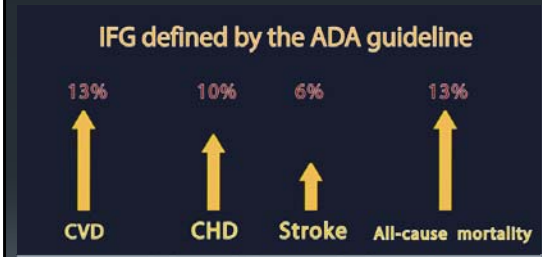
NO DIFFERENCE*

Hypothesis 2: We under diagnose diabetes *The Hyperglycemia Overlap*



Sheey et al. 2009. J Diabet Sci.[34]

Impaired Fasting Glucose Tolerance



Huang Y, Cai X, Mai W, Li M, Hu Y. *Association between prediabetes and the risk of cardiovascular disease and all cause mortality: systemic review and meta-analysis.* BMJ. 2016 (Nov): 355 :i5953.[73]

Incidence of Undiagnosed DM…

2011 Abdelmalek st al. (Cleveland Clinic)[67]
~ 35,000 records of NON-CARDIAC surgery (ASC or main OR)
~ 14% carried a diagnosis of diabetes
~ DIAGNOSIS by Fasting Blood Glucose

Factor	Glucose concentration mg·dL⁻¹ (mmoL·L⁻¹)*			*P* value[d]
	< 110 mg·dL⁻¹ (6.1 mmoL·L⁻¹)	110 – 126 mg·dL⁻¹ (6.1 – 7.0 mmoL·L⁻¹)	≥ 126 mg·dL⁻¹ (7.0 mmoL·L⁻¹)	
	n = 26,948[a]	*n* = 3,549[b]	*n* = 3,426[c]	
Age (yr)	55 ± 16	59 ± 16	61 + 15	< 0.001 [e]
BMI (kg·m⁻²)	28 ± 7	30 ± 7	30 ± 8	< 0.001 [f]
Female *n* (%)	14,857 (55)	1,623 (46)	1,526 (45)	< 0.001 [f]

Routine HgbA1C Screening?

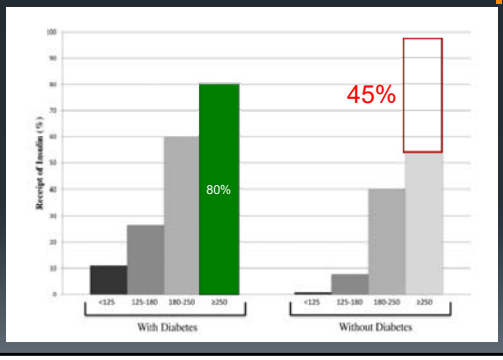
1. NN Test to diagnose DM = 9
2. Testing ALL patients (regardless of RBG) cost $250 per diagnosis of DM
3. Random BG was poorly sensitive with increasing specificity at BG > 11mmol/ L (~200mg/dL)
4. Among patients < 55yo, there was a five-fold increase in DM compared to the community population
5. Outpatient follow-up for OGTT was only 27% of patients
6. 17% of undiagnosed diabetics did not have a primary care physician

Hypothesis 3: We don't treat non-diabetics with insulin…even in the setting of hyperglycemia

- >40,000 General, Vascular, Spine, Bariatric surgery patients between 2010-2012 (published Jan 2015)[9]
- PATIENTS were excluded if they DID NOT undergo BG testing

1. FOR ALL LEVELS of BG, DM are more likely to receive insulin (p<0.001)
2. For those patients (DM and non-DM) who receive insulin, adverse events are more likely in those with persistent hyperglycemia than those whose BG is corrected

Administration of Insulin by BG level



Transition from Why to What/How?

2001

The Van Den Berghe Trial (AKA LEUVEN I)[4]

- The Leuvin Researchers postulated:
  HYPERGLYCEMIA ≠ NORMAL

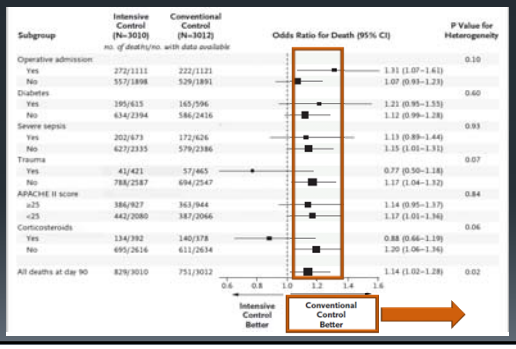
- We establish terminology for blood glucose control:
  CONVENTIONAL (BG goal 180-200mg/dL)
  STRICT/INTENSIVE (BG goal 80-110mg/dL)

GluControl (2009)[22] & VISEP (2008)[23]

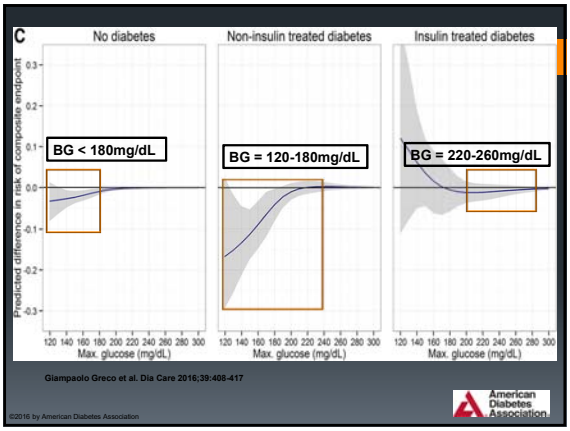
- BOTH RCTs were STOPPED PREMATURELY.
- GluControl for protocol violations.
- VISEP for safety concerns

STUDY	INCIDENCE OF BG < 40mg/dL and MORTALITY in the CONVENTIONAL GROUP	INCIDENCE OF BG < 40mg/dL and MORTALITY in the INTENSIVE THERAPY GROUP	p VALUE
GluControl	~~BG 140-180mg/dL~~	BG 80-110mg/dL	p <0.0001 p = NS
VISEP	~~BG 180-200mg/dL~~	BG 80-110mg/dL	p < 0.001 p = NS

NICE-SUGAR[24]



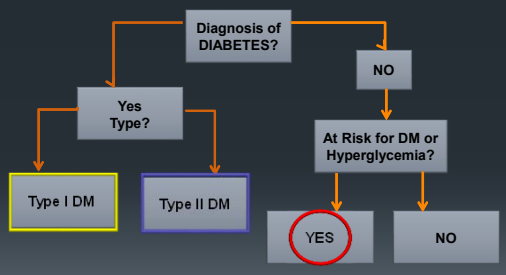
Greco[69] et al. 2016 Multicenter cohort trial of 4,316 Patients Diabetic & Non-Diabetic Prospective Cohort Study Glucose measured q6hrs x 48 hours	Cardiac surgery patients from 9 U.S. Centers (participants in the CT Surgical Trials Network) CABG Valve Combination Transplant VAD Thoracic Aorta	**DIABETICS using home insulin: BEST OUTCOMES 180-240mg/dL** **Cost reduction (-$6,225)** **Reduced LOS (-1.6 Day)** **Reduced infection (-4.1%)** DIABETICS using oral meds: No difference in outcomes **Non-diabetics:** **Best outcomes BG < 180mg/dL** **If > 180…** **Cost increase (+ $3,192)** **Increased (LOS + 0.8 days)** **Increased Infection (+1.6%)**



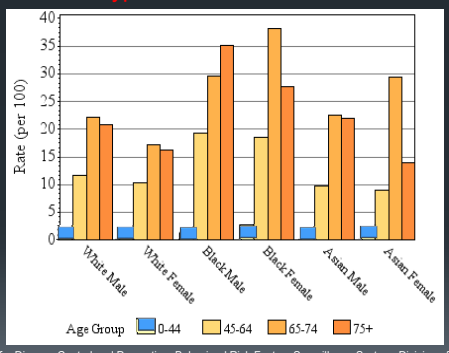
Perioperative Target Goals in 2016

Society	Critically Ill	Non-Critically Ill
AACE/ADA[30]	140-180mg/dL	< 180mg/dL
Society of CCM[26]	< 150mg/dL	
National Health Service/British Diabetes Society[27]	**SURGICAL GOAL** 108-180mg/dL	
Anaesthetist Association of Great Britain (AAGBI)[28]	**SURGICAL GOAL** 110-180mg/dL	
SAMBA[29]		**SURGICAL GOAL** 140-180mg/dL
STS[57]	**SURGICAL GOAL** BG < 180mg/dL; Insulin gtt recommended	

Pre-operative Screening

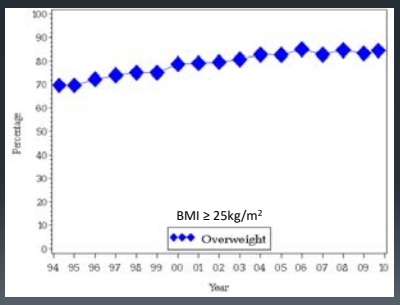


RISKS for Type II Diabetes



Center for Disease Control and Prevention. Behavioral Risk Factors Surveillance System. Division of Diabetes Translation. Updated 8/26/2014. Accessed Dec 9, 2015.

Age-Adjusted Reported Risk Factors for Diabetes



Screening for Perioperative Hyperglycemia: FIND THE AT RISK PATIENT

1. **Age ≥ 45 years old**
   and/or
   BMI ≥ 25 kg/m²

➢ HgbA1c in Pre-Operative Clinic
➢ Random BG (accucheck) preoperatively

OUR HgbA1C Data

Preoperative Medication…

ORAL MEDICATION for ELECTIVE SURGERY	Day before surgery	Day of surgery if: 1. Normal oral intake anticipated same day AND 2. Minimally invasive surgery	Day of surgery if: 1. Reduced post-operative oral intake OR 2. Extensive surgery, anticipated HD changes and/or fluid shifts
Secretagogues	Take*	Hold	Hold
SGLT-2 Inhibitors	Hold	Hold	Hold
Thiazolidinediones	Take	Take	Hold
Metformin	Take §	Take §	Hold
DPP-4 Inhibitors	Take	Take	Take*

Table 2. Oral Medication Use Day before and Day of Surgery (Duggan et al.)
* If patient undergoing bowel prep, hold secretagogue therapy
§ Hold if patient having a procedure with IV contrast dye administration, particularly in those with reduced GFR

DON'T TAKE….

Secretagogues (Sulfonylureas and Meglitidines)
- RISK FOR HYPOGLYCEMIA

SGLT-2 Inhibitors *(-gliflozins)*
- FDA package warning Dec 2015 for DKA
- AACE/ACE formal statement June 2016 recommends "stopping 24hrs prior to surgery/invasive procedure)[65]

Thiazolidinediones *(-glitazones)*
- Can increase fluid retention; caution in patients with compromised renal, liver or cardiac dysfunction.

You can consider…

Metformin
- Hold if NPO > 1-2 meals,[27,28] contrast dye procedures, renal dysfunction

DPP-4 INHIBITORS *(-gliptins)*
- Sitagliptan
  - SITA-CABG study in progress
  - SITA General Surgery – IRB approval

*** Data forthcoming for the glucagon-like peptide receptor 1 (GLP-1) agonists (-tide drugs)*

Sitagliptin vs. Insulin

Umpierrez et al. 2013 [71] & Pasqual FJ et al. 2016 [72]

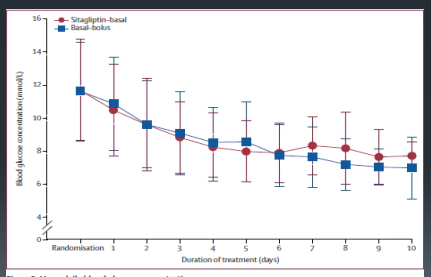


Figure 2: **Mean daily blood glucose concentrations**
Data are mean (SD). Concentrations measured in patients treated with sitagliptin-basal (red circles) or basal-bolus regimens (blue squares).

Sita-Surgery Pilot Underway…

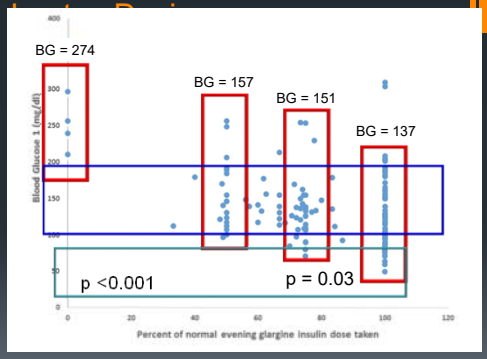
INSULIN

Insulin Regimen Changes on the Day Before Surgery[74]

DAY BEFORE SURGERY INSULIN REGIMENS	Glargine or Detemir		NPH or 70/30 insulin		Lispro, aspart, glulisine, regular		Non-Insulin Injectables	
	AM Dose	PM Dose	AM Dose	PM Dose	AM Dose	PM Dose	AM Dose	PM Dose
Normal Diet until MN (includes those permitted clear liquids until 2hrs prior to surgery)	Usual dose	80%% of usual dose	Usual dose	80% of usual dose	Usual dose	Usual dose	Usual dose	Usual dose
Bowel Prep (and/or clear liquids only 12-24hrs prior to surgery)	Usual dose	80% of usual dose	80% of usual dose if BG > 120mg/dL*	80% of usual dose if BG> 120mg/dL*	Usual dose	Usual dose	Hold at start of clear liquid diet/bowel prep	Hold at start of clear liquid diet/bowel prep

Insulin Regimen Changes on the Day of Surgery[74]

DAY OF SURGERY INSULIN REGIMENS	Glargine or Detemir	NPH or 70/30 insulin	Lispro, aspart, glulisine, regular	Non-insulin injectables
	80% of usual dose if patient uses twice daily basal therapy	50% of usual dose if BG 120mg/dL* Hold for BG < 120mg/dL	Hold	Hold



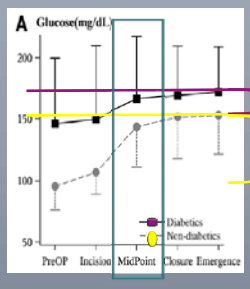
Peri-operative Monitoring and Treatment

1. Monitoring- Who and How Frequently?
2. Treatment- IV vs. SQ
   - Insulin pharmacokinetics

EMERGENCY SURGERY	ELECTIVE SURGERY
•Ascertain timing and amount of last basal/prandial dose of insulin and/or oral hypoglycemics •Check BG pre-operatively; Treat per recommendations below	•Follow preoperative oral hypoglycemia and/or insulin guidelines •Check BG pre-operatively; Treat per recommendations below
	•Critically Ill? BG poorly controlled at home •Anticipated hemodynamic changes, large volume/temperature shifts? •Duration of OR time > 4 hours?
CONTINUOUS IV INSULIN INFUSION •Check BG hourly in OR/PACU •Start variable rate insulin infusion when BG > 180mg/dL •Follow insulin infusion algorithm	YES / NO **SUBCUTANEOUS INSULIN DOSING** •Check BG in OR/PACU q2h •Treat BG > 180mg/dL q2h (up to 2 doses) •Follow SC dosing scale

•For BG < 70mg/dL, stop insulin therapy. Treat with D50 bolus (25mL) or start D10 infusion
•For BG < 50mg/dL, stop insulin therapy. Treat with D50 bolus (50mL)
•Re-check BG q15min until BG > 70mg/dL
•If BG > 180mg/dL, resume SC insulin using more sensitive scale or infusion at ½ previous rate

The Hyperglycemic Response in Non-Cardiac Surgery (RCT)

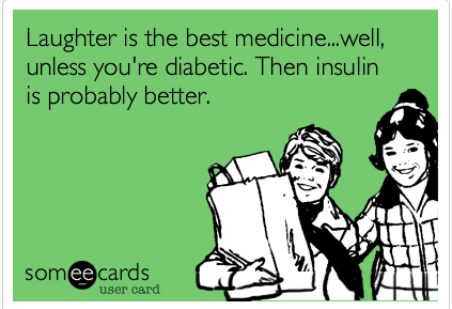


The starting point, peak

Note, the change in BG in non-diabetics is significantly greater than

At surgical midpoint, the blood glucose has increased in both populations.

Treatment = Insulin



Insulin- Which Formulation is Best?

	Intravenous Regular	Subcutaneous Rapid Acting Analogue [29, 45]
ONSET TIME	8-15 min	5-15 min
PEAK	15-30 min	60-90 min
DURATION	~60 min	3-5hrs
OR Administration	Every hour	Every 2 hours
CONCERNS?	Tubing absoprtion, hypoglycemia, conversion, ease of use	Absorption from tissues, stacking, hypoglycemia

Subcutaneous??

- Duration of action limits fine titration
  - Extremes of scale (BG < 80 or BG > 300)
- Tissue Absorption in the OR
  - Peripheral Edema/Volume Overload
  - Temperature Variation in the OR
- Expected HD/electrolyte/acid-base changes
- Access to the patient
- Do not use in critically ill patients

Evaluating Patients with **Type II Diabetes**

Insulin Sensitive	Age > 70, GFR < 45mL/min, BMI < 20kg/m^2, Newly diagnosed
Insulin Usual	
Insulin Resistant	Home TDD Insulin > 80U, BMI > 35kg/m^2, Daily steroid dose ≥ prednisone 20mg (or equivalent)

Correctional Insulin Scale for SC Administration[74]

Blood Glucose (mg/dL)	Insulin Sensitive OR Stress Hyperglycemia	Usual Insulin Needs	Insulin Resistant
	BMI < 25, Age > 70, GFR < 45mL/min		BMI > 35,High-dose steroids, Outpatient Insulin > 80 U/day
141-180	0	2	3
181-220	2	3	4
221-260	3	4	5
261-300	4	6	8
301-350	5	8	10
351-400	6	10	12
> 400	8	12	14

	Hyperglycemia		Hypoglycemia	
Outcome	OR (95% Confidence Intervals)	P-value[b]	OR (95% Confidence Intervals)	P-value[b]
30-day mortality	6.586 (2.373-18.278)	<0.01	3.294 (1.438-7.546)	<0.01
Myocardial infarction	2.663 (1.118-6.347)	0.03	1.856 (0.775-4.447)	0.17
Ventilator-dependent >48 hours	4.665 (2.301-9.457)	<0.01	2.931 (1.533-5.603)	<0.01
Acute renal failure	3.529 (1.324-9.403)	0.01	8.186 (3.301-21.809)	<0.01
Progressive renal insufficiency	7.788 (2.386-25.423)	<0.01	7.842 (2.857-23.144)	<0.01
Stroke	3.763 (1.251-11.321)	0.02	2.517 (0.891-7.109)	0.08
Transfusion	3.010 (2.146-4.223)	<0.01	2.604 (1.845-3.675)	<0.01
SSI	1.634 (0.835-3.199)	0.15	4.086 (2.090-7.990)	<0.01
Wound complications	2.337 (1.304-4.189)	<0.01	3.020 (1.726-5.285)	<0.01
Other infection[c]	5.798 (2.827-11.892)	<0.01	2.527 (1.318-4.846)	<0.01
Return to OR	3.870 (1.777-8.427)	<0.01	1.835 (0.860-3.914)	0.12
Readmission	1.160 (0.718-1.875)	0.54	2.124 (1.335-3.381)	<0.01

1,051 vascular patients from 2009-2013 at Emory University Hospital undergoing CEA, CAS, EVAR, AAA, and lower extremity re-vascularization > 18yo and with 2BG measurements.

Long CA, Fang ZB, Hu FY, Veeraswamy RV, Duggan E. Submitted to Annals of Surgery

Intraoperative Hypoglycemia

Of the 17 patients who experienced a BG ≤ 40mg/dL, 8 cases were "likely preventable."

- Inadequate communication between teams was partially responsible for 7 cases
- Failure to monitor a patient in 5 cases
- Inadequate treatment of pre-operative hypoglycemia
- Shock/Circulatory Collapse (6)

BG < 70mg/dL on day of surgery

BG ≤ 50 mg/dL → Give 1 amp D50

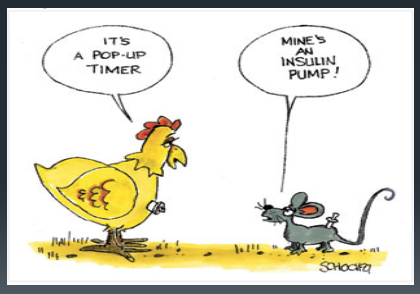
50 mg/dL < BG < 70mg/dL → Give ½ amp D50 or Start D10 infusion at 50mL/hr

1. Re-check BG q 15 min until > 70mg/dL
2. Re-check BG q 30 min until > 100mg/dL
3. After BG ≥ 100mg/dL, resume hourly check

- Stop all insulin therapy.
- For a patient with repeat BG ≤ 50mg/dL, give additional 1amp D50 and start D10 infusion at 50mL/hr
- For a patient with repeat BG = 51-70mg/dL, give additional ½ amp of D50 and start D10 infusion at 50mL/hr

- For patients who have experienced BG < 70mg/dL on insulin gtt, when BG > 180mg/dL, restart insulin gtt at ½ previous rate

Type I Diabetes



TYPE I Diabetes Perioperative Management

1. Test
2. GIVE INSULIN
3. Test
4. GIVE INSULIN
5. Test

Insulin Pumps (Elective Surgery)

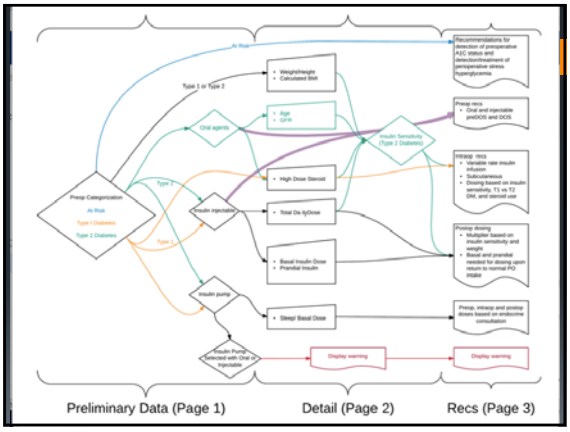
1. Evening prior to surgery: set pump at "sleep rate"
2. Check BG on arrival to hospital:
   - If BG < 80mg/dL, turn off pump and correct per hypoglycemia protocol
   - If BG between 80-180mg/dL, turn off pump and start VRII at basal rate
   - Correct for BG > 180mg/dL via IV insulin bolus and start gtt at BG/100 in U/hr
3. Check hourly BG and correct with gtt bolus/infusion rate
4. When patient alert/aware and able to manage pump AND BG < 100mg/dL, may turn off gtt and turn pump back on at sleep/basal rate

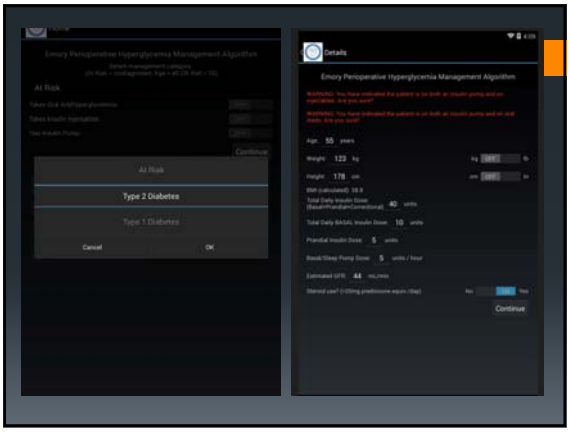
Is she crazy? This algorithm is impractical for daily use. There are far too many details to remember….

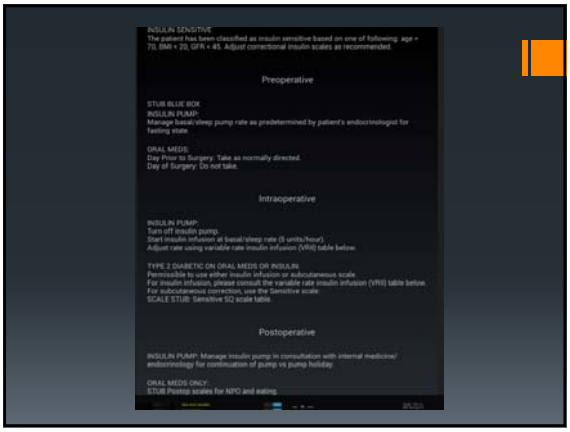
Emory Anesthesia "SUGARx" SmartPhone App

Surgical EuGlycemia Assessment and Treatment (Rx)

Dr. Vikas O'Reilly-Shah, MD PhD







CONCLUSIONS

- Perioperative hyperglycemia = RISK
  - Optimal HgbA1C?
  - Controlling BG on DOS likely decreases morbidity
- Target ranges TODAY for all diabetics and stress hyperglycemics < 180mg/dL
  - Ranges may be more personalized to patient, risk factor and surgery in the future.
- Non-diabetic patients with hyperglycemia seem to be at greater risk than diabetics with the same blood glucose levels
- Testing will prevent both hypoglycemia and improve patient care via treatment of hyperglycemia
- INSULIN- Both SC and IV gtt have roles in the perioperative environment

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Administration of Steroids

Anesthesia and Analgesia

The Effect of Intraoperative Blood Glucose Management on Postoperative Blood Glucose Levels in Noncardiac Surgery Patients[76]

- Retrospective chart review 2440 patients
- All required intraoperative glucose management
  - An increase in mean OR blood glucose of 10mg/dL was associated with an increase in postoperative blood glucose by 4.7mg/dL
- Diabetics and administration of intraoperative steroids
- Shorter surgery duration had a stronger association between intraoperative and postoperative hyperglycemia.

1970s…

- Hyperglycemia was viewed as…

1. A NORMAL, ADAPTIVE RESPONSE to stress
   - Catecholamines ➔
   - Glucagon, Cortisol ➔

Alterations in CHO Metabolism

2. The result of INSULIN RESISTANCE and IMPAIRED GLUCOSE UTILIZATION during illness.

Incidence of Diabetes = 2.29% [20]

Given its 'normalcy' as well as the relatively small number of patients with T2D, hyperglycemia was left untreated in the critically ill and post-operative patients.

1980s…

1. Researchers demonstrate that cardiac function is improved with glucose-insulin-potassium (GIK) infusions when run for 48hrs after CABG[1]
2. The therapeutic role of insulin and glucose in the post-operative period began…however, exact understanding was limited.

Glucose remained relatively untreated because hyperglycemia itself was less concerning.The role of insulin was the focus of research and clinician in improvement post-operative cardiac function began to be explored.

FACT: Incidence of diabetes in 1985 = 2.62% [20]

1990s…

1. The prevalence of diabetes in the population continues to grow (only 3.3% in 1995)
2. Adverse outcomes begin to be demonstrated in patients suffering from hyperglycemia.[2]
3. Controlling post-operative hyperglycemia (target BG < 200mg/dL) is shown to reduce infectious complications in the post-operative period.[3]
4. The "Portland" articles (Furnary et al.) begin to be released (1997)[21] demonstrating the role for continuous insulin infusions in cardiac surgery.
   - Decreased sternal wound infections
   - Decreased mortality in CABG patients with diabetes

Where have we been?

1970s:
Hyperglycemia is a NORMAL stress response
Incidence of DM in the United States = 2.29%[20]

1980s:
Glucose-Insulin-Potassium gtt (GIK) in CABG
Incidence of DM in the United States = 2.6%

1990s:
Furnary et al. (Portland Project) demonstrates that insulin in cardiac surgery decreases mortality and sternal wound infection
Incidence of DM in the United States = 3.3%

Leuven I

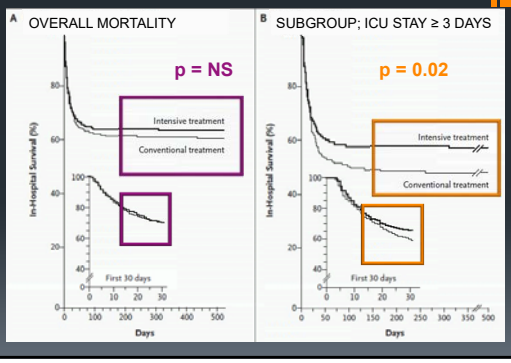
- Van Den Berghe's group reduced in-hospital mortality from 11 to 7%
- However, for those with 5+ day ICU stay mortality decreased by 9% using IIT.
- Majority of study patients were surgical
- 63% underwent a cardiac procedure
- Severe Hypoglycemia (BG < 40mg/dL) rate 5.1%

Leuven II[5] (2006)

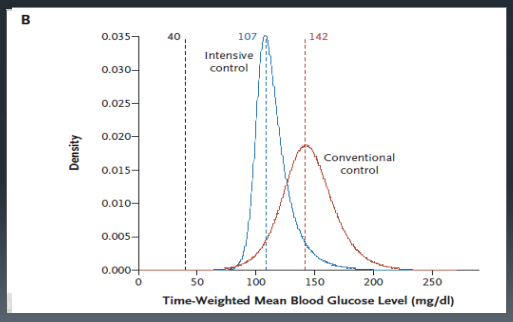
Leuvin I protocol in **1200 MICU patients**

- Overall mortality between groups was NOT different
- Overall morbidity was decreased in the IIT group
- Subgroup analysis of patients staying in ICU > 3d DID DEMONSTRATE DECREASED MORTALITY in IIT group

Leuven II[5] (2006)



NICE-SUGAR[24]



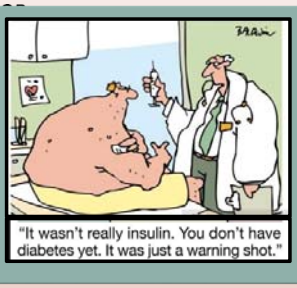
Intensive IV Insulin Protocols

Diagnosing Diabetes

American Diabetes Association.	PreDiabetes	Diabetes
HgbA1c	5.7%-6.4%	≥ 6.5%
Fasting Blood Glucose	100-125mg/dl	≥126mg/dl
Oral Glucose Tolerance Test	140-190mg/dl	≥200mg/dl
Random Blood Glucose		≥200mg/dl

High-risk for Diabetes[31]

- AGE ≥ 4
- BMI ≥ 2
- Card
- Gest
- First-
- High-
- Cond
- Hype
- Phys



HgbA1C and First-time TKR[58]

- Retrospective study of 40,491 patients undergoing TKR
- Classified as:
  - Non-Diabetic (no HgbA1C measured)
  - Controlled Diabetic (HgbA1C < 7%)
  - Non-Controlled Diabetic (HgbA1C ≥ 7%)

OUTCOMES: DVT/PE within 90 days, Infection or MI during perioperative period, and all-cause re-hospitalization within one year, need for knee revision

NO RISK of ANY of the primary outcomes in poorly controlled diabetics vs. controlled diabetics OR, patients with diabetes vs. non-diabetics

Preoperative Screening

- 2012 The Endocrine Society published clinical practice guidelines recommending pre-operative on admission for ALL patients undergoing elective surgery.[6]

All patients undergoing elective surgery

✓ BG morning of surgery

BG ≥ 140mg/dL

INPATIENT:	OUTPATIENT:
1. HgbA1c 2. 24-48hrs BG monitoring and Tx as needed	1. Refer to PCP for follow-up and evaluation

SCOAP Database II [9]

Diabetics controlled to 125-180mg/dL have a LOWER risk of adverse events (OR 0.66) than:

- Non-Diabetics with a BG < 125mg/dL
- Diabetics with a BG > 180mg/dL (OR 0.78)

MALA

- Often reported in the setting of AKI [47]
- Has been reported in CHF, sepsis, severe dehydration, shock, hypoxic states and following surgery [48]
- Extremely rare, incidence ~ 0.03 per 1000 patient years [49]

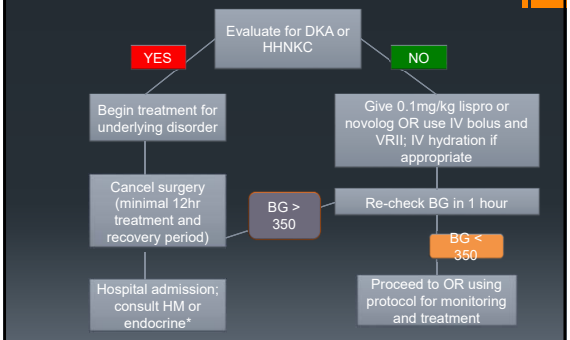
MALA

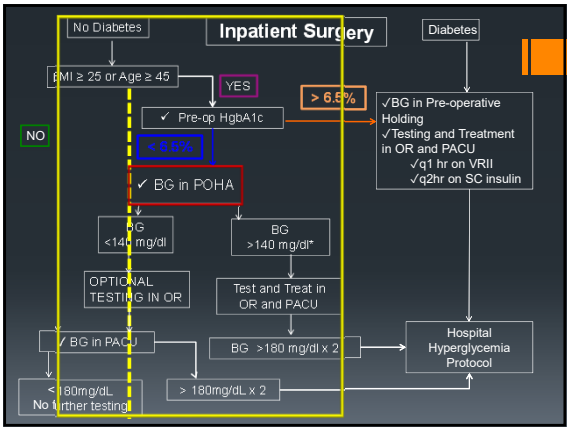
Duncan et al. Cleveland Clinic 2007 [50]

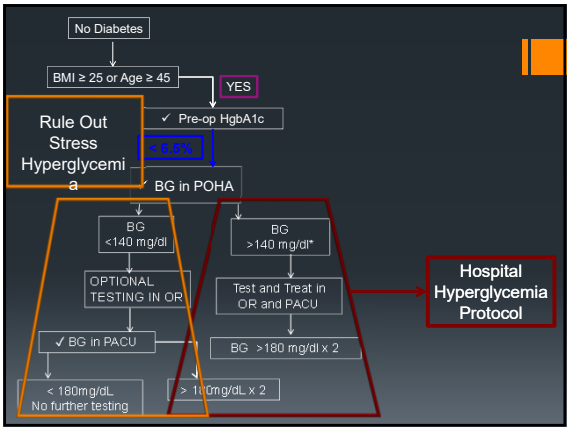
Serum Bicarbonate Levels On Admission to the ICU

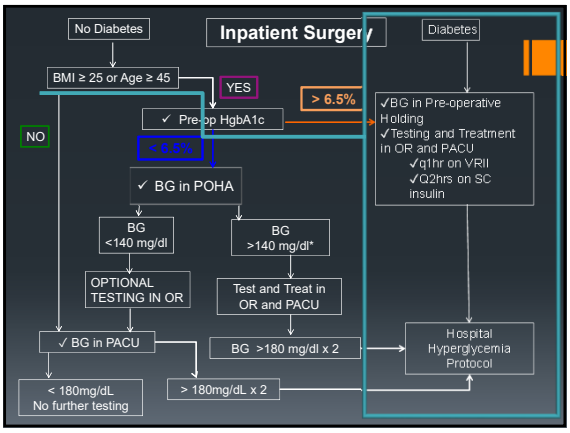
Serum HCO_3^- (mmol/L)	Metformin-treated (N = 442)	Nonmetformin-treated (N = 442)	P-value
≤16	0 (0)	0 (0)	0.06
17–21	38 (8.6)	55 (12.4)	
>21	404 (91.4)	387 (87.6)	
[a] Values in parentheses indicate percentage values.			
Base Deficit ≥ 5	**59 (15.4%)**	**40 (16.7%)**	**p = 0.65**
Base Deficit ≥ 10	**3 (0.8%)**	**6 (2.5%)**	**p = 0.09**

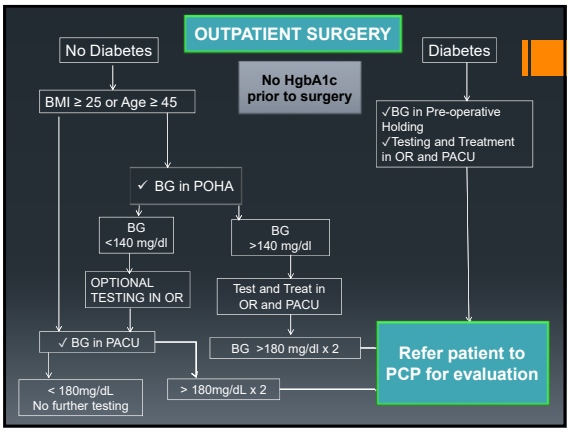
BG >350 mg/dL on the Day of Surgery

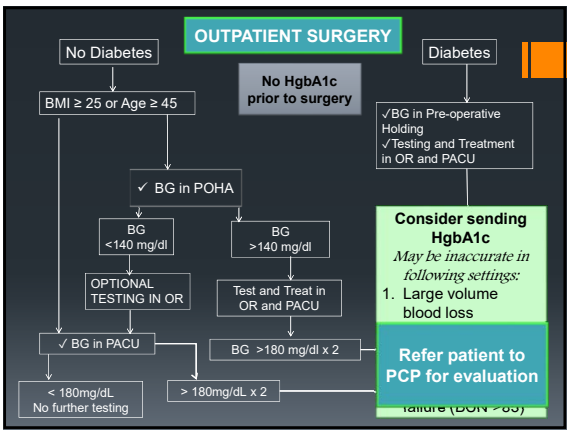


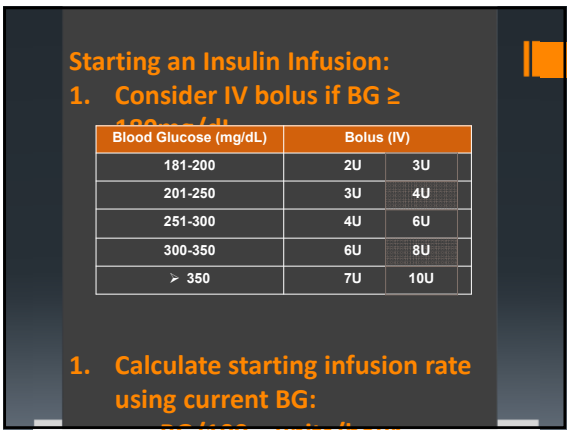


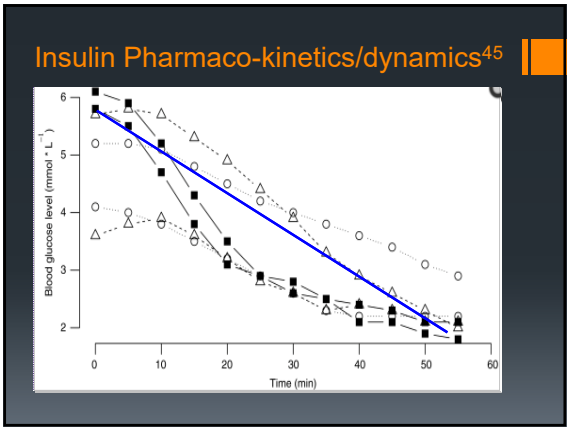


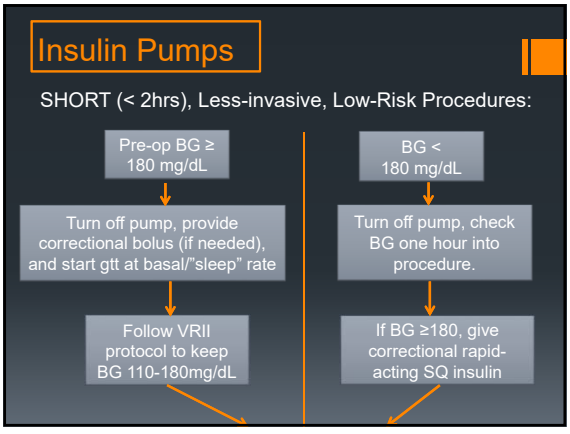

No Diabetes
Inpatient Surgery
Diabetes
BMI ≥ 25 or Age ≥ 45
YES
NO
> 6.5%
✓ Pre-op HgbA1c
< 6.5%
✓BG in Pre-operative Holding
✓Testing and Treatment in OR and PACU
✓q1hr on VRII
✓Q2hrs on SC insulin
✓ BG in POHA
BG <140 mg/dl
BG >140 mg/dl*
OPTIONAL TESTING IN OR
Test and Treat in OR and PACU
✓ BG in PACU
BG >180 mg/dl x 2
Hospital Hyperglycemia Protocol
< 180mg/dL No further testing
> 180mg/dL x 2

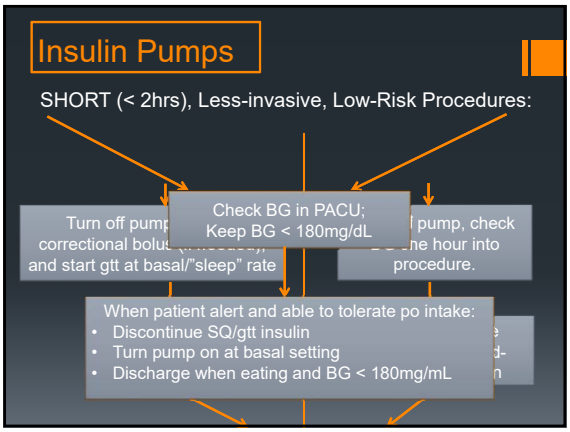

OUTPATIENT SURGERY
No Diabetes
Diabetes
BMI ≥ 25 or Age ≥ 45
No HgbA1c prior to surgery
✓BG in Pre-operative Holding
✓Testing and Treatment in OR and PACU
✓ BG in POHA
BG <140 mg/dl
BG >140 mg/dl
OPTIONAL TESTING IN OR
Test and Treat in OR and PACU
✓ BG in PACU
BG >180 mg/dl x 2
Refer patient to PCP for evaluation
< 180mg/dL No further testing
> 180mg/dL x 2


OUTPATIENT SURGERY
No Diabetes
Diabetes
BMI ≥ 25 or Age ≥ 45
No HgbA1c prior to surgery
✓BG in Pre-operative Holding
✓Testing and Treatment in OR and PACU
✓ BG in POHA
BG <140 mg/dl
BG >140 mg/dl
OPTIONAL TESTING IN OR
Test and Treat in OR and PACU
Consider sending HgbA1c
May be inaccurate in following settings:
1. Large volume blood loss
✓ BG in PACU
BG >180 mg/dl x 2
Refer patient to PCP for evaluation
< 180mg/dL No further testing
> 180mg/dL x 2


Starting an Insulin Infusion:
1. Consider IV bolus if BG ≥
Blood Glucose (mg/dL)
Bolus (IV)
181-200 2U 3U
201-250 3U 4U
251-300 4U 6U
300-350 6U 8U
➢ 350 7U 10U
1. Calculate starting infusion rate using current BG:


Insulin Pharmaco-kinetics/dynamics45
Blood glucose level (mmol * L-1)
Time (min)


Insulin Pumps
SHORT (< 2hrs), Less-invasive, Low-Risk Procedures:
Pre-op BG ≥ 180 mg/dL
Turn off pump, provide correctional bolus (if needed), and start gtt at basal/"sleep" rate
Follow VRII protocol to keep BG 110-180mg/dL
BG < 180 mg/dL
Turn off pump, check BG one hour into procedure.
If BG ≥180, give correctional rapid-acting SQ insulin


Insulin Pumps
SHORT (< 2hrs), Less-invasive, Low-Risk Procedures:
Check BG in PACU;
Keep BG < 180mg/dL
pump, check
procedure.
and start gtt at basal/"sleep" rate
When patient alert and able to tolerate po intake:
Discontinue SQ/gtt insulin
Turn pump on at basal setting
Discharge when eating and BG < 180mg/mL

Susan Eagle

CURRICULUM VITAE

Name: Susan Eagle
Office Phone: (615) 322-4056
Office Address: 1215 21st Ave South, Nashville, TN, 37232
Work Email: susan.eagle@Vanderbilt.Edu

Training

1994	B.S. in Microbiology from University of Georgia, GA United States
1999	M.D. in Medicine from Medical College of Georgia, GA United States
1999 - 2000	Internship in Internal Medicine from The Medical College of Georgia, Augusta, GA
2000 - 2003	Residency in Anesthesiology from The Medical College of Georgia, Augusta, GA
2004 - 2005	Fellowship in Cardiothoracic Anesthesiology/Pediatric Congenital Heart/Perioperative Echocardiography from Vanderbilt University School of Medicine, Nashville, TN 37232

Licensure and Certification

04/2004 - 12/2014	Boards, American Board of Anesthesiology United States (36626)
06/2005 - 06/2015	Boards, National Board of Echocardiography United States (2005-057)
07/2008 - 08/2011	DEA, Practioner of Tennessee United States (BE8180363)
06/2010 - 06/2016	Medical, Tennessee State Medical License of Tennessee United States (MD 37180)
12/2014 - Present	Anesthesiology Recertification, MOCA
10/2015 - Present	Perioperative Transesophageal Echocardiography, Recertification United States

Academic Appointments

07/2003 - 06/2010	Assistant Professor of Clinical Anesthesiology, Vanderbilt University (Nashville, Tennessee)
2006 - 2009	Director, Cardiothoracic Anesthesiology Resident Rotation, Anesthesiology, Division of

Anesthetic considerations for parturient with congenital heart disease

Susan Eagle, MD

Vanderbilt University

Nashville, TN

At the conclusion of the presentation, the learner should be able to:

1. Review effects of maternal physiology on patients with congenital heart lesions.
2. Explain the risk stratification of parturient with congenital heart lesions and their offspring.
3. Discuss the peripartum management of woman with congenital heart disease.

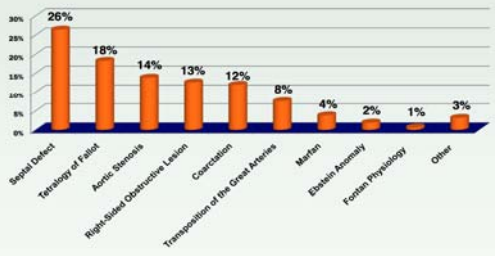
CONGENITAL HEART DISEASE IN THE PARTURIENT

Susan Eagle, MD
Associate Professor
Vanderbilt University
Department of Anesthesiology
Division of Cardiothoracic Anesthesiology

LEARNING OBJECTIVES

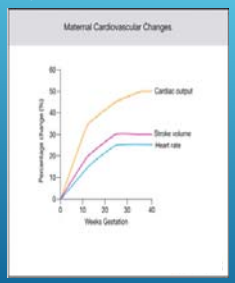
- Understand effects of maternal physiology on patients with congenital heart lesions
- Understand the risk stratification of parturients with congenital heart lesions and their offspring
- Understand the peripartum management of women with congenital heart disease

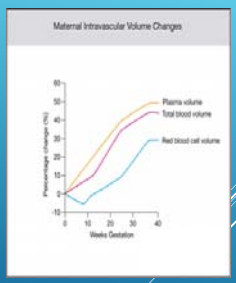
Results: Distribution of CHD in ZAHARA II



Balci A, et al. Am Heart J. 2011;**161**:269–275.

CARDIOVASCULAR CHANGES



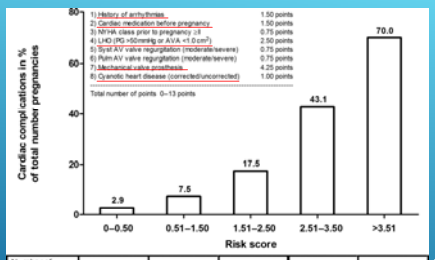


RISK STRATIFICATION: MATERNAL

- ZAHARA I (Zwangerschap bij Aangeboren HARtAfwijkingen I)
- CARPREG (CARdiac disease in PREGnancy)
- WHO (World Health Organization)
- Maternal cardiovascular events ~10%

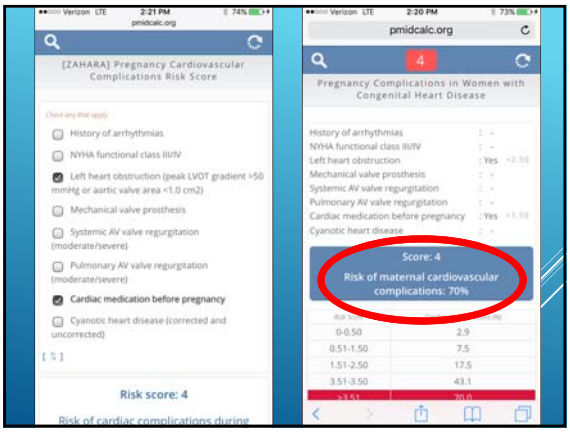
Willem Drenthen et al. Eur Heart J 2010;31:2124-2132
Balci A, et al. Heart. 2014 Sep;100(17):1373-81
Petronella G. Pieper et al. Circulation. 2013;128:2478-2487

The modified risk score for cardiac complications during completed (>20 weeks of gestation) pregnancies in women with congenital heart disease.



Number of pregnancies at risk	828	280	126	58	10
Percentage of total population	63.6	28.1	6.1	1.4	0.8

Willem Drenthen et al. Eur Heart J 2010;31:2124-2132

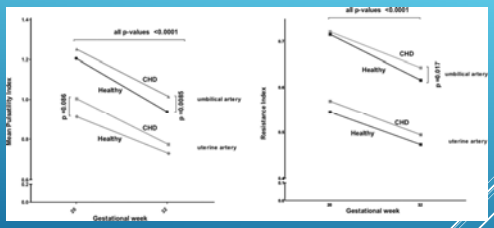


RISK STRATIFICATION: OFFSPRING

- Offspring events occurred in ~35% of deliveries
  - Small for gestational age
  - Premature birth occurred in 12.4% versus 5.7% (*P*=0.18)
  - Congenital heart disease occurred in 4.8% of offspring of CHD women versus 0% of healthy women's offspring (*P*=0.176).

Petronella G. Pieper et al. Circulation. 2013;128:2478-2487
Balci A, et al. Heart. 2014 Sep;100(17):1373-81

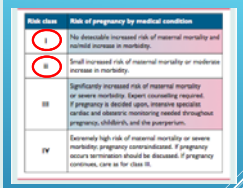
Uteroplacental Doppler flow parameters: pulsatility index and resistance index of mean of right and left uterine artery and of umbilical artery at 20 and 32 weeks of pregnancy, in women with CHD and healthy women.



Petronella G. Pieper et al. Circulation. 2013;128:2478-2487

Modified WHO classification of maternal cardiovascular risk: CLASS I-II

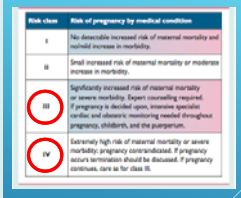
Conditions in which pregnancy risk is WHO I
• Uncomplicated, small or mild - pulmonary stenosis - patent ductus arteriosus - mitral valve prolapse
• Successfully repaired simple lesions (atrial or ventricular septal defect, patent ductus arteriosus, anomalous pulmonary venous drainage).
• Atrial or ventricular ectopic beats, isolated
Conditions in which pregnancy risk is WHO II or III
***WHO II** (if otherwise well and uncomplicated)*
• Unoperated atrial or ventricular septal defect
• Repaired tetralogy of Fallot
• Most arrhythmias
***WHO II–III** (depending on individual)*
• Mild left ventricular impairment
• Hypertrophic cardiomyopathy
• Native or tissue valvular heart disease not considered WHO I or IV
• Marfan syndrome without aortic dilatation • Aorta <45 mm in aortic disease associated with bicuspid aortic valve
• Repaired coarctation



European Heart Journal (2011) 32, 3147–3197

Modified WHO classification of maternal cardiovascular risk: CLASS III-IV

WHO III
• Mechanical valve
• Systemic right ventricle
• Fontan circulation
• Cyanotic heart disease (unrepaired)
• Other complex congenital heart disease
• Aortic dilatation 40–45 mm in Marfan syndrome • Aortic dilatation 45–50 mm in aortic disease associated with bicuspid aortic valve
Conditions in which pregnancy risk is WHO IV (pregnancy contraindicated)
• Pulmonary arterial hypertension of any cause
• Severe systemic ventricular dysfunction (LVEF <30%, NYHA III–IV)
• Previous peripartum cardiomyopathy with any residual impairment of left ventricular function
• Severe mitral stenosis, severe symptomatic aortic stenosis
• Marfan syndrome with aorta dilated >45 mm • Aortic dilatation >50 mm in aortic disease associated with bicuspid aortic valve
• Native severe coarctation



European Heart Journal (2011) 32, 3147–3197

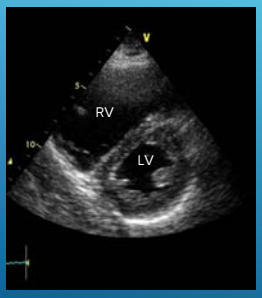
HIGH-RISK #1: PULMONARY HYPERTENSION-CHD

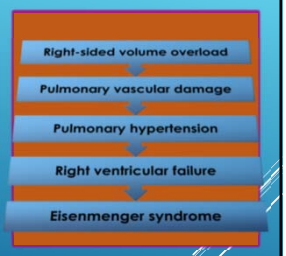
- Atrial septal defect (unrepaired)
- Ventricular septal defect (unrepaired)
- Patent ductus arteriosus
- Anomalous pulmonary veins
- Truncus arteriosus

50% maternal mortality

Hemnes A, et al. Pulm Circ. 2015 Sep; 5(3): 435–465.
Avila W, et al. Clin Cardiol. 2003;26:135–142.

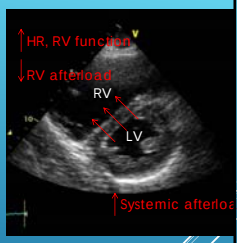
UNCORRECTED SHUNTS: PULMONARY HYPERTENSION





PULMONARY HTN-CHD

- Maintain right ventricular function
  - Maintain heart rate
  - Do not volume overload (third stage)
  - epinephrine, ephedrine if hypotensive
- Increase afterload
  - Arterial line prior to epidural
  - Slow dosing of epidural
  - phenylephrine, vasopressin if hypotensive
  - **No spinal**
- Inhaled pulmonary vasodilators
  - Nitric Oxide
  - Epoprostenol
- Prostaglandin F2 alpha (Hemabate®) should be **avoided**
- Death occurs most commonly in the third trimester or first few weeks after successful delivery, so that continued monitoring in the postpartum period is required.



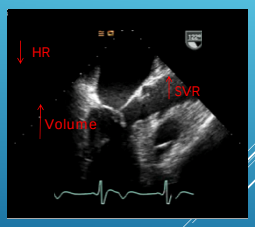
Naguib M, Dob D. Int J Obstet Anesth. 2010;19:306

HIGH-RISK #2: LEFT-SIDED OBSTRUCTIVE LESIONS

- Aortic stenosis
  - Williams Syndrome
    - (supravalvular AS)
  - Bicuspid aortic valves
- Mitral stenosis
- Hypertrophic cardiomyopathy

LEFT-SIDED OBSTRUCTIVE LESIONS: PERIPARTUM MANAGEMENT

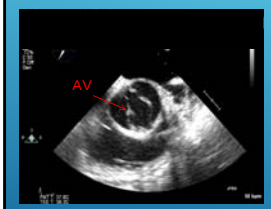
- *Maintain or increase systemic vascular resistance (SVR)
- Maintain or reduce heart rate
  - *Beta Blockade
- Maintain volume status
- Heart failure 26%; Arrhythmias 3% to 35%
- Epidural: maintain SVR
- **Avoid spinal anesthetics**

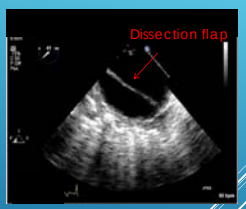


Orwat S, et al. JACC. 2016; 68 (16): 1727-1737.
Brickner E. Circulation. 2014;130:273-282.
Regitz-Zagrosek V, et al.Eur Heart J. 2011;32:3147–3197.

HIGH RISK #3: BICUSPID AV/MARFAN SYNDROME

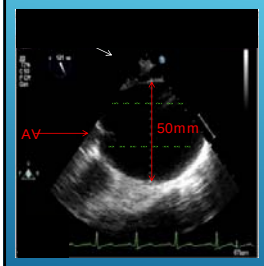
COLLAGEN VASCULAR DISORDERS: BICUSPID AV AND MARFAN SYNDROME





Subodh Verma, M.D., Ph.D., and Samuel C. Siu, M.D.
N Engl J Med 2014; 370:1920-1929

PERIPARTUM MANAGEMENT: BICUSPID AORTIC VALVE AORTOPATHY

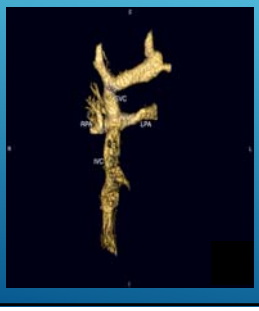


- Aortic diameter <40mm = vaginal delivery + epidural
- Aortic diameter >40mm = cesarean section + epidural
- Aortic diameter >50mm= Surgery during pregnancy

↓ SVR, HR, contractility

HIGH RISK #4: FONTAN PALLIATION

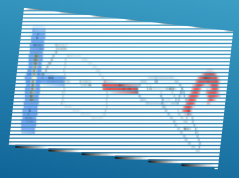
FONTAN (TOTAL CAVO-PULMONARY CONNECTION)



Eagle S., Daves S. JCVA 25(2):220-234, 2011

FONTAN PALLIATION: CONSIDERATIONS IN THE PARTURIENT

- **Avoid** aortocaval compression
- **Avoid** spinal anesthesia
- **Avoid** Prostaglandin F analogs



- Maintain trans-pulmonary gradient
- Maintain HR
- Single Ventricle function
  - Give volume, but cautiously
  - Inotropes (dobutamine, epinephrine if needed)
- May not tolerate Valsalva

Eagle S., Daves S. JCVA 25(2):220-234, 2011

Table I Obstetric drugs, their cardiovascular side effects and precautions in women with congenital heart disease

	Cardiovascular side effects	Contraindications and precautions
Drugs to treat premature contractions		
β-Mimetics (i.e. hexoprenaline)	Tachycardia, arrhythmias	Obstruction of left-sided atrio-ventricular valve Propensity for arrhythmias
Atosiban (oxytocin antagonist)	None	None
Drugs for induction of labour		
Misoprostol	Coronary vasospasm, arrhythmias	
Oxytocin	Systemic hypotension	Only low-dose continuous infusion or small repeated bolus
Drugs to control postpartum bleeding		
Oxytocin	Systemic hypotension	Only low-dose continuous infusion or small repeated bolus
Prostaglandin F analogues	Increase in pulmonary pressures	Pulmonary hypertension, right ventricular failure

M Greutmann and P Pieper. European Heart Journal (2015) 36, 2491–2499

QUESTION 1: A 21YO WOMAN WITH EISENMENGER SYNDROME SECONDARY TO AN UNCORRECTED ASD PRESENTS IN LABOR AT 29 WEEKS EGA. AFTER DOSING A LABOR EPIDURAL WITH BUPIVICAINE: BP 60/40, P60, SAO2 88%. THE NEXT MOST APPROPRIATE STEP IS:

A. Inhaled nitric oxide
B. Vasopressin + epinephrine
C. Normal saline bolus
D. Milrinone

QUESTION 1: A 21YO WOMAN WITH EISENMENGER SYNDROME SECONDARY TO AN UNCORRECTED ASD PRESENTS IN LABOR AT 29 WEEKS EGA. AFTER DOSING A LABOR EPIDURAL WITH BUPIVICAINE: BP 60/40, P60, SAO2 88%. THE NEXT MOST APPROPRIATE STEP IS:

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D. Milrinone

QUESTION 2: A 27YO PARTURIENT WITH HYPERTROPHIC CARDIOMYOPATHY PRESENTS IN LABOR. AFTER DOSING HER LABOR EPIDURAL: BP 62/38 HR 71 SAO_2 98%. WHICH IS IS THE MOST APPROPRIATE TREATMENT?

A. Epinephrine
B. Reverse Trendelenberg position
C. Phenylephrine
D. Inhaled nitric oxide

QUESTION 2: A 27YO PARTURIENT WITH HYPERTROPHIC CARDIOMYOPATHY PRESENTS IN LABOR. AFTER DOSING HER LABOR EPIDURAL: BP 62/38 HR 71 SAO_2 98%. WHICH IS IS THE MOST APPROPRIATE TREATMENT?

A. Epinephrine
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QUESTION 3: WHICH OF THE FOLLOWING IS MOST LIKELY TO IMPROVE CARDIAC OUTPUT IN A 34-WEEK PARTURIENT WITH FONTAN PHYSIOLOGY?

A. Phenylephrine
B. Supine position
C. Furosemide
D. Dobutamine

QUESTION 3: WHICH OF THE FOLLOWING IS MOST LIKELY TO IMPROVE CARDIAC OUTPUT IN A 34-WEEK PARTURIENT WITH FONTAN PHYSIOLOGY?

A. Phenylephrine
B. Supine position
C. Furosemide
D. Dobutamine

THANK YOU

Anesthetic Considerations for Adults with congenital heart disease presenting for non-cardiac surgery

Susan Eagle, MD

Vanderbilt University

Nashville, TN

At the conclusion of the presentation, the learner should be able to:

1. Describe the anatomy/physiology of common congenital heart lesions in adults.
2. Explain the long-term effects of repair or palliation in the adult congenital heart patient.
3. Discuss the Perioperative considerations for patients with ACHD.

Congenital Heart Disease in the Adult Population:
Considerations for Non-Cardiac Surgery

Susan Eagle, MD
Associate Professor
Cardiothoracic Anesthesiology
Vanderbilt University

Vanderbilt Heart
Division of Cardiothoracic Anesthesiology

At the conclusion of this activity, participants should be able to:

- Understand the pathophysiology and surgical repair of common types of congenital heart lesions in the adult patient
- Understand the long-term physiologic effects of unrepaired, repaired/palliated lesions in the adult congenital heart patient
- Understand the perioperative management of adults with unrepaired, repaired/palliated lesions congenital heart lesions

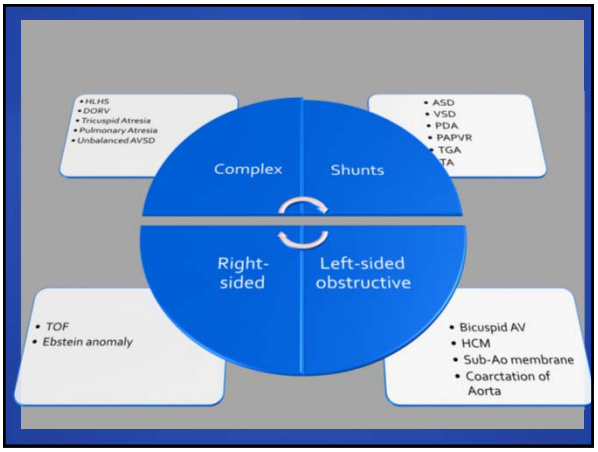
Vanderbilt Heart
Division of Cardiothoracic Anesthesiology

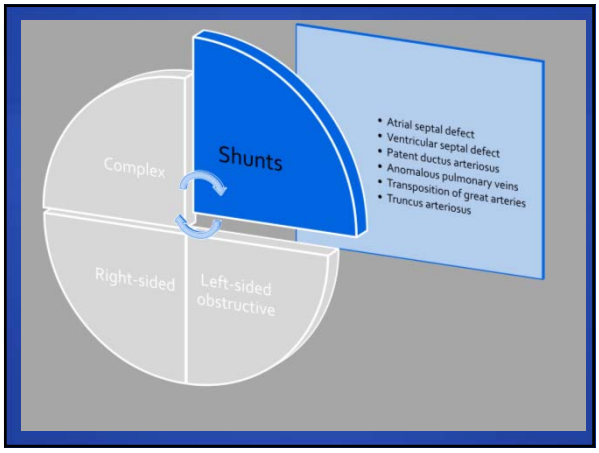
What is your anesthetic strategy for an emergency cesarean section?

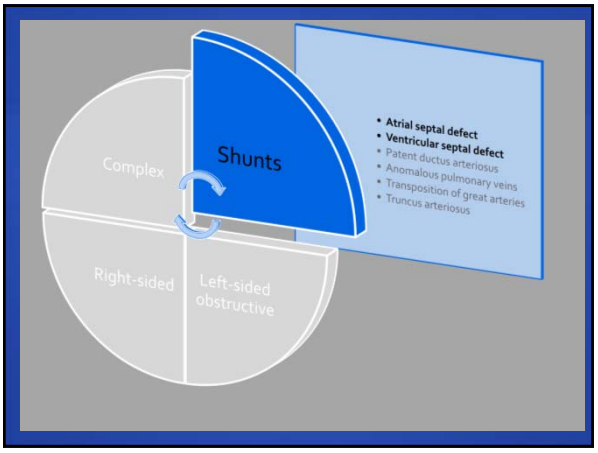
- 23 yo G1P0, 38 week IUP presents in labor
- Tricuspid atresia and Fontan palliation

Your management?

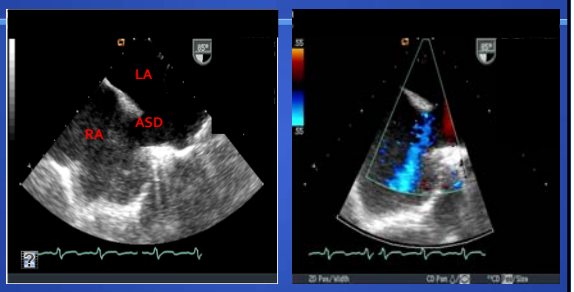
Vanderbilt Heart
Division of Cardiothoracic Anesthesiology

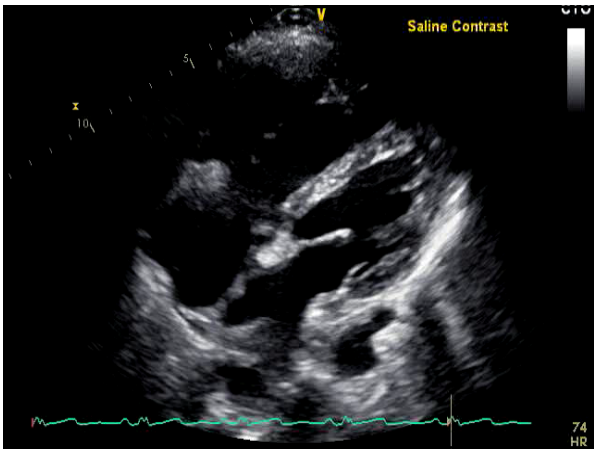




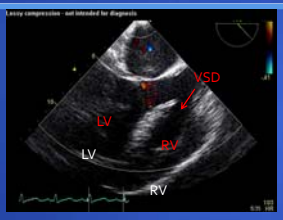


Shunts: Atrial Septal Defect



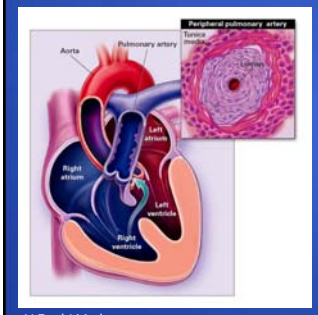


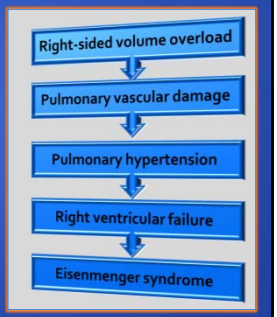
Ventricular Septal Defects: Associated Pathology



- Conotruncal defects
  - Tetralogy of Fallot
  - Transposition of Great Arteries
- Left-sided obstructive lesions
  - Sub-aortic stenosis
  - Coarctation of the aorta
- Right-sided obstructive lesions
- Trisomy 21 (AVSD)
- Post-repair conduction block

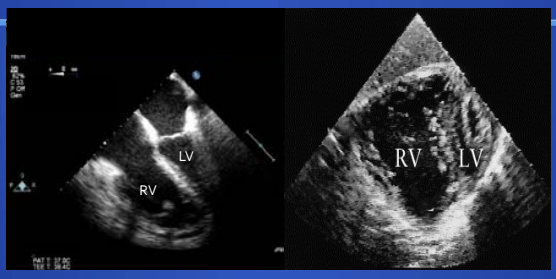
Unrepaired Shunts: Pulmonary hypertension / Eisenmenger





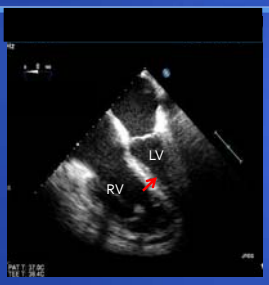
N Engl J Med 2000; 342:334 - 342

Shunts: Pulmonary Hypertension



Shunts:

Avoid anything that causes leftward shift of the ventricular septum!

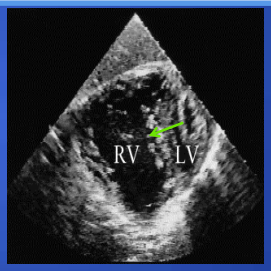


- Right ventricular dilation
  - RV failure
  - Volume overload
  - Increased pulmonary artery pressures
  - Bradycardia
- Decreased SVR
  - Anesthesia

SHUNTS + Pulmonary Hypertension: Pre-Induction

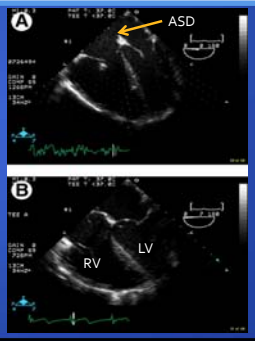
- De-air / filter intravascular lines
- Avoid hypercarbia
  - Cautious (or no) premedication
- Pre-induction arterial line
  - Avoid pulmonary artery catheters

**Can they lie flat?



SHUNTS: Induction of Anesthesia

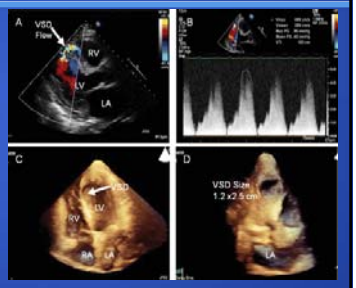
- Increase systemic vascular resistance
  - Phenylephrine or Norepinephrine or Vasopressin
- Avoid hypercarbia and hypoxemia
  - Consider rapid sequence induction
- Maintain or increase heart rate
  - etomidate or ketamine
  - *cautious* use of narcotics



Strumpher J. JCVA 25(4):687-704,2011

Shunts: Basic Intraoperative Management

- Adequate ventilation with lowest airway pressure
  - pCO2 ~30 mmHg, pH 7.45
- Adequate anesthesia / analgesia
- Normothermia



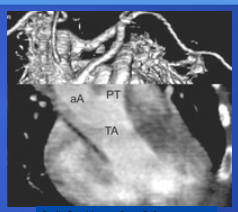
Eur J Echocardiogr. vol. 10(4):569-571, 2009

Shunts + Pulmonary HTN: Intraoperative Management

Decrease Pulmonary Vascular Resistance	Improve Right Ventricular Function
▪ Inhaled agents • Nitric oxide 10-50 ppm • Epoprostanol (prostacyclin, PGI2) • Milrinone ▪ Diuretics	▪ IV Inodilators • milrinone • dobutamine • epinephrine ▪ Increase SVR ▪ Vasopressin ▪ Maintain heart rate!

Pulmonary Hypertension: A common ACHD theme

- Truncus arteriosus
- Patent ductus arteriosus
- Atrioventricular septal defects
- Aortopulmonary window
- Anomalous pulmonary venous return
- Transposition of great arteries with VSD



RadioGraphics, 23, S147-S165, 2003

Circulation 2007;115;1039-1050

CASE

- A 32 yo woman with a 1.5cm ASD presents for an appendectomy.
- +Orthopnea
- Distended jugular veins
- BP 104/72 HR103 SaO2 98%
- Which is the most appropriate strategy for induction of anesthesia?

A) Fentanyl
B) Ketamine
C) Propofol
D) Sevoflurane

CASE

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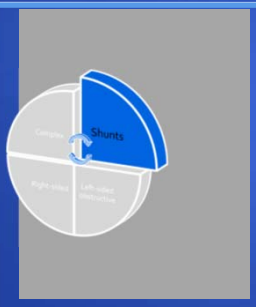
- BP 104/72 HR103 SaO2 98%
- Which is the most appropriate strategy for induction of anesthesia?

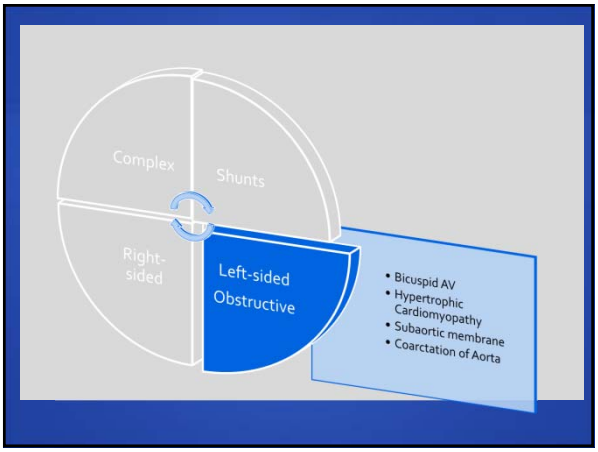
A) Fentanyl
B) Ketamine
C) Propofol
D) Sevoflurane

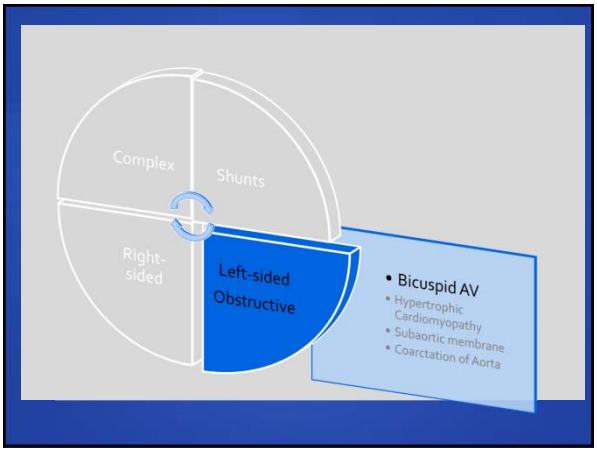
ANSWER: B) Ketamine

Shunts (adult, unrepaired): *The Basics*



- Increase SVR
- Decrease PVR
- Support RV
- Maintain or increase HR



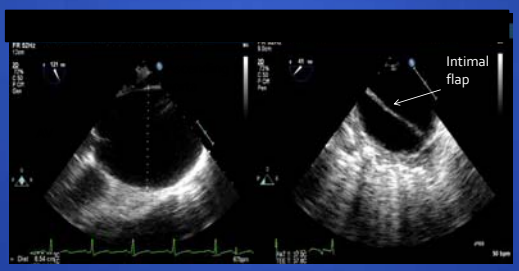


Bicuspid Aortic Valve

Bicuspid Aortic Valve: Associated Conditions

- Coarctation of aorta
- Interrupted aortic arch
- Patent ductus arteriosus
- Williams syndrome
- Turner syndrome
- Congenital left main coronary artery stenosis
- Endocarditis
- Familial aortic dissection
- Cystic medial necrosis

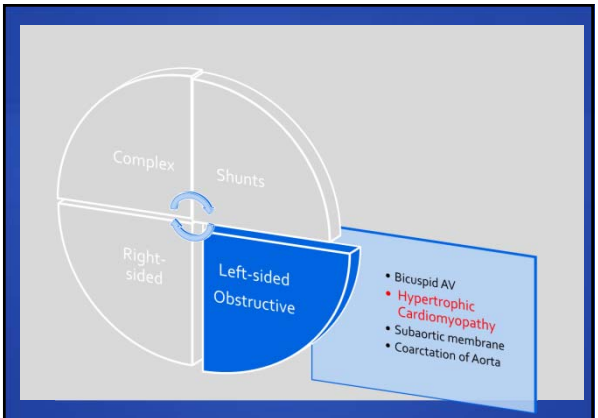
Bicuspid Aortic Valve: Aortic Aneurysm/Dissection



Bicuspid Aortic Valve: Aortic Stenosis

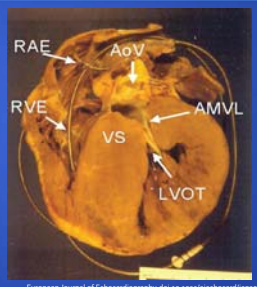
- Obstruction throughout systole
- Left ventricular hypertrophy
- Usually LVEF > 60%
- Diastolic dysfunction
- ~50 yo

J Am Coll Cardiol. 2010 Jun 22;55(25):2789-2800



Hypertrophic Cardiomyopathy: Dynamic LVOT Obstruction

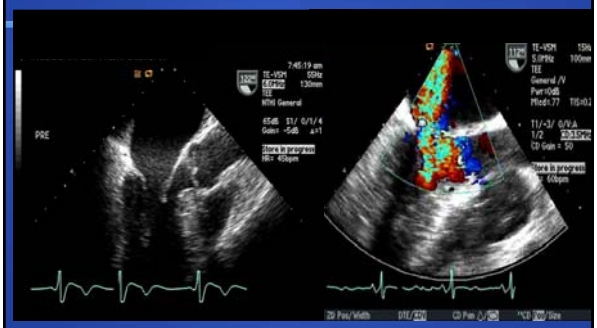
- Diastolic dysfunction
- Left ventricular hypertrophy
- Usually LVEF > 60%
- LVOT obstruction
  - mid to late systole
- Arrhythmias/ sudden death



European Journal of Echocardiography doi:10.1093/ejechocard/jen303

Hypertrophic Cardiomyopathy: 'SAM'

Hypertrophic Cardiomyopathy: 'SAM' and MR

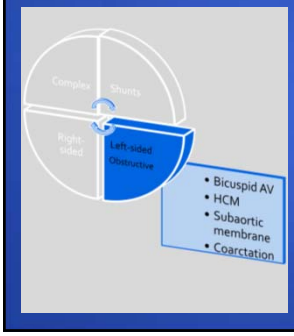


Congenital LVOT Obstruction: Perioperative Management

- Pre-induction arterial line
- Transcutaneous defibrillator patches
- Increase systemic vascular resistance
  - phenylephrine /NE/ vasopressin
- Hydrate (HCM)
- Normal sinus rhythm
- Low-normal heart rate
  - Narcotic induction
- Avoid spinal anesthesia
- **Epinephrine* may *worsen* dynamic LVOT obstruction*

Gallagher JD. Anesthesiology. 2006 Sep;105(3):631

Left-sided obstructive lesions: *The Basics*



- Increase SVR
- Decrease HR
- Hydrate (HCM)

CASE

- Following induction with propofol, a 52 yo man with HCM becomes hemodynamically unstable:
- BP 58/25 P99 SaO2 99%
- Which of the following is the next most appropriate step?

A) Vasopressin
B) Dobutamine
C) Epinephrine
D) Milrinone

CASE

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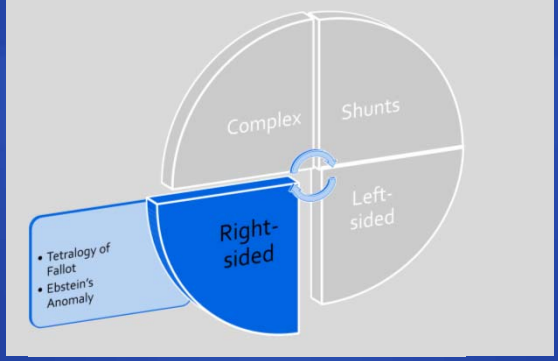
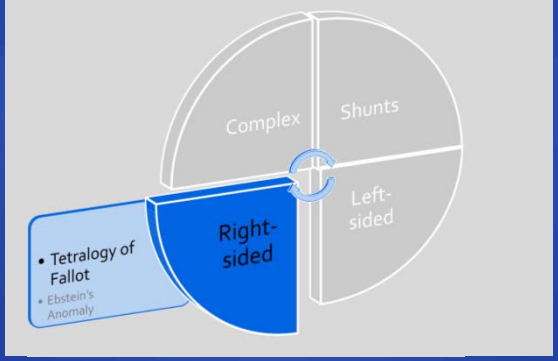
- BP 58/25 P99 SaO2 99%
- Which of the following is the next most appropriate step?

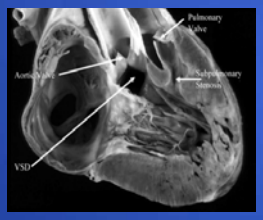
A) Vasopressin
B) Dobutamine
C) Epinephrine
D) Milrinone

ANSWER: A) Vasopressin





Tetralogy of Fallot

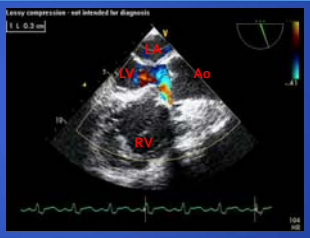


- VSD
- RVH
- Overriding Aorta
- RVOT obstruction

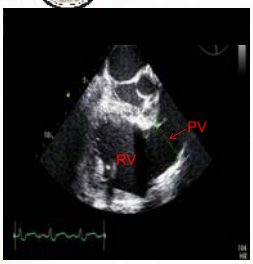
Fund. of Ped. Cardiology 1st ed. 2006

Repaired TOF

- VSD patch
- Overriding Aorta
- *Dilated RV

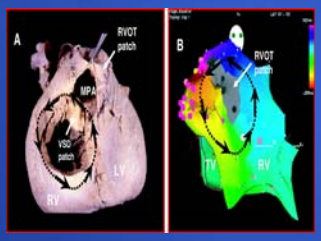


TOF repair: Pulmonary Insufficiency



Vanderbilt Heart
Division of Cardiothoracic Anesthesiology

TOF Repair: Electrophysiologic Effects

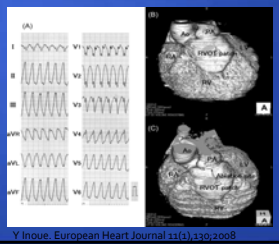


- RBBB
- Re-entrant monomorphic VT (QRS > 180 ms)
- Sudden death

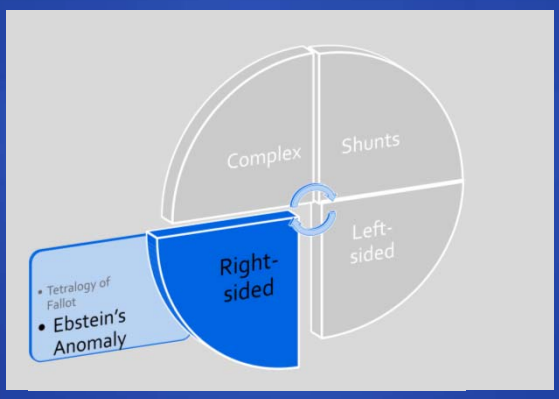
Walsh E P , Cecchin F Circulation 2007;115:534-545

Repaired TOF: Perioperative Management

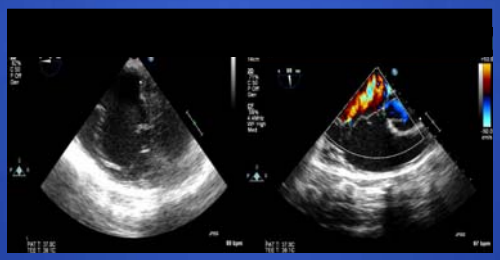
- De-air / filter intravascular access
- Arrhythmia management
  - ECG: QRS > 180 ms?
  - Pacemaker / ICD management
  - Transcutaneous defibrillator pads
- Support RV function
  - Milrinone
  - Dobutamine
  - Epinephrine



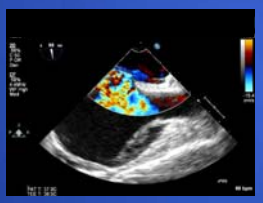
Y Inoue. European Heart Journal 11(1),130;2008



Right-sided lesion: Ebstein's Anomaly



Ebstein's Anomaly



- 'Atrialized' RV
- Tricuspid regurgitation
- Accessory conduction pathways (>50%)
  - Wolff-Parkinson-White
  - Supraventricular tachycardia
- ASD or PFO (>50%)
  - +/- cyanosis
- PAH is *rare*

CASE

- An active 35 yo woman with history of Tetralogy of Fallot repair presents for a ACL repair.
- Which is the most likely finding?

A) Dilated left ventricle
B) Dilated right ventricle
C) Pulmonary hypertension
D) Mitral regurgitation

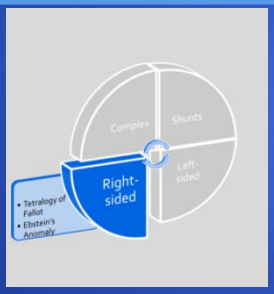
CASE

- An active 35 yo woman with history of Tetralogy of Fallot repair presents for a ACL repair.
- Which is the most likely finding?

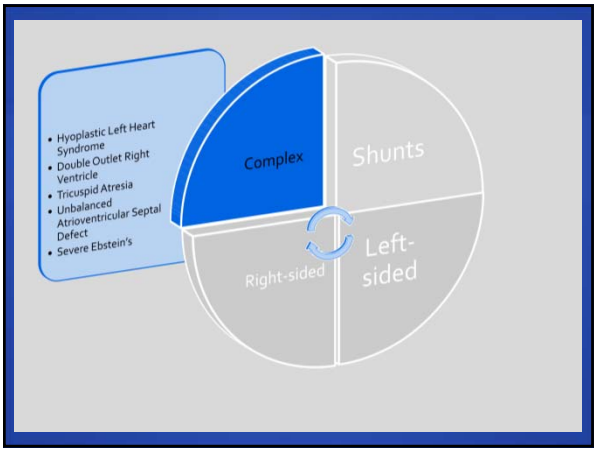
A) Dilated left ventricle
B) Dilated right ventricle
C) Pulmonary hypertension
D) Mitral regurgitation

ANSWER: **B) Dilated right ventricle**

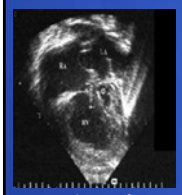
Right-sided lesions: *The Basics*



- Right ventricular support
- Pulmonary HTN is rare
- Associated ASD/VSD
- Accessory pathways
  - Ventricular (TOF)
  - Atrial (Ebstein's)

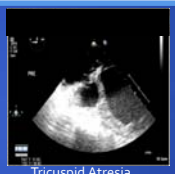


How do you palliate these lesions?

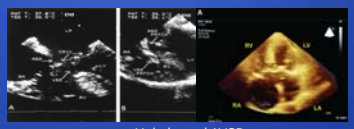


Hypoplastic Left Heart Syndrome

DORV



Tricuspid Atresia

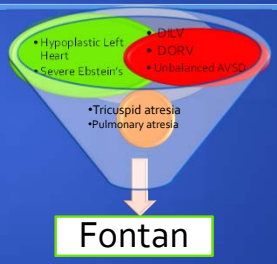


Unbalanced AVSD

RadioGraphics, 23, S147-S16, 2003
Eur J Cardiothorac Surg 2005;27:67-73
Ann Thorac Surg 1995;60:530-537
Echocardiography. 2006 Mar;23(3):225-31

Different lesions… same result

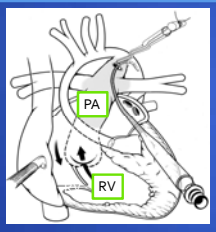
- Systemic ventricle
- Establish pulmonary blood flow

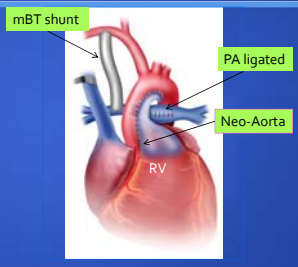


Fontan

Eagle S., Daves S. JCVA 25(2):220-234, 2011

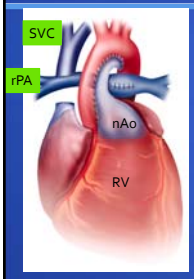
Norwood Stage I: Create Systemic Ventricle and Establish Pulmonary Blood Flow

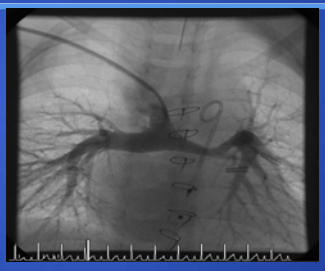




D Drinkwater. Ann Thorac Surg 2001;72:2081-2087
Arch Dis Child Fetal Neonatal Ed 2005;90:F97-F102

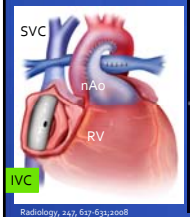
Stage II Hemi-Fontan:
Gradually increase pulmonary flow

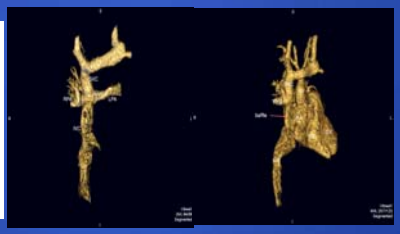




Eagle S., Daves S. JCVA 25(2):220-234, 2011
Radiology, 247, 617-631,2008

Stage III: Fontan (Total Cavo-Pulmonary Connection)



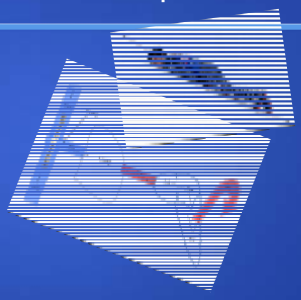


Radiology, 247, 617-631,2008

Eagle S., Daves S. JCVA 25(2):220-234, 2011

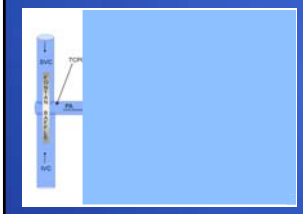
Fontan: Maintain Cardiac Output

- Maintain trans-pulmonary gradient (CVP-LAP)
  - Euvolemia
  - Maintain venous tone
    - CVP ~ 15 mmHg
  - Low pulmonary vascular resistance
  - Maintain SV function
  - Decrease afterload



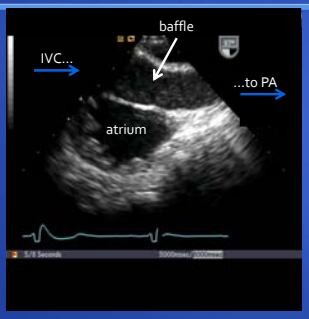
Eagle S., Daves S. JCVA 25(2):220-234, 2011

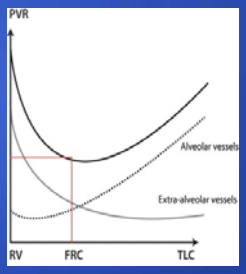
Fontan Management: #1: Augment Venous Return



- Pre-induction hydration
- Optimize mechanical ventilation
- Limit laparoscopic pneumoperitoneal pressures <15 cm H_2O
- Avoid spinal anesthetics
  - Epidural / Forceps delivery

FONTAN: What about mechanical ventilation??



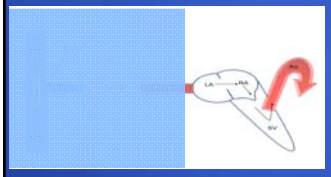


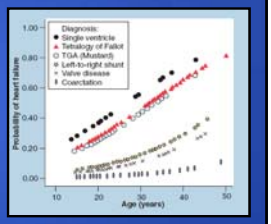
Fontan Management: #2 : Decrease pulmonary vascular resistance

- pCO_2 ~30-35 mmHg
  - Judicious premedication
  - MAC?
- Decrease PVR
  - Milrinone, dobutamine, epoprostanol
  - Adequate analgesia
  - Normothermia

Haseyama K. et al.; J Thorac Cardiovasc Surg 2006;132:1232-1233

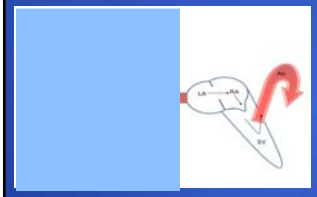
Fontan Management: #3: Maintain (systemic) ventricular function





Norozi, K., et al., Am J Cardiol.97(8)1238-43:2006

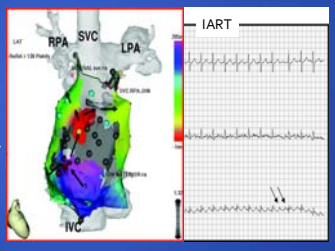
Fontan Management: #3: Maintain (systemic) ventricular function



- Balanced anesthetic induction
  - Consider Fentanyl + (Etomidate or Ketamine)
- Inodilators
  - Milrinone, dobutamine
- Decrease systemic afterload

The Failing Fontan: Arrhythmias

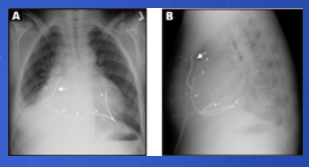
- Supraventricular tachycardia
  - Atrial fibrillation
  - Intraatrial reentrant tachycardia
- Perioperative ICD or pacemaker management



Walsh, E. P. et al. Circulation 115:534-545, 2007

The Failing Fontan: Unique causes of hypoxemia

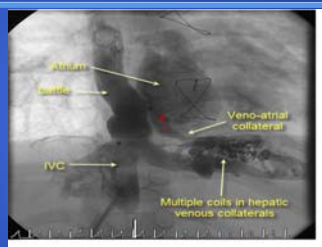
- Single ventricle failure
- Protein-losing enteropathy
  - pleural effusions
  - ascites
- Pulmonary embolus
- Plastic bronchitis



Haseyama K. et al.; J TCVS132:1232-1233, 2006
Circulation 115: 534-54, 2007

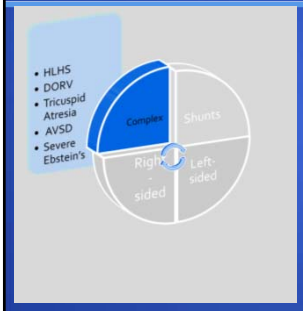
The Failing Fontan: Unique causes of hypoxemia

- Decompressing collateral veins
- Fenestration
- Pulmonary arteriovenous malformations



Eagle S., Daves S. JCVA 25(2):220-234, 2011

Complex lesions, post-Fontan: *The Basics*



- Maintain trans-pulmonary gradient
  - Augment preload
  - Decrease PVR
    - 'Best PEEP'
  - Maintain single ventricle function
    - Decrease SVR

CASE

- 23 yo G1P0, 38 week IUP presents in labor; 8 cm dilated; fetal monitoring: late decelerations
- Tricuspid atresia and Fontan palliation
- BP130/65 P128 SaO_2 91%
- Your anesthetic strategy for an emergency cesarean section?

A) Spinal
B) Epidural
C) GETA
D) MAC/local anesthesia
E) Cancel the case

CASE

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B) Epidural
C) GETA
D) MAC/local anesthesia
E) Cancel the case

ANSWER: **C) GETA**

Thank you!

QUESTIONS?

Vanderbilt Heart
Division of Cardiothoracic Anesthesiology

CURRICULUM VITAE
Matthew L Lyon, MD FACEP

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Vice Chairman for Academic Programs and Research
Director, Section of Emergency and Clinical Ultrasound
Director, Emergency Observation Unit
Director, Emergency Ultrasound Fellowship
Department of Emergency Medicine
Medical College of Georgia
Georgia Regents University
Augusta, GA

Executive Director
Center for Ultrasound Education and Research
Medical College of Georgia
Augusta University

President
Georgia College of Emergency Physicians

Board of Directors
Southern Alliance for Physicians CME

Board of Directors,
Georgia Emergency Medicine Political Action Committee (GEMPAC)

Associate Editor, Internal and Emergency Medicine Journal

Advisor, IncubatorX, Augusta University Student Organization

Education

Undergraduate	Georgia Institute of Technology, Atlanta, Georgia, 9/90-6/95 Major: Mechanical Engineering Cooperative Plan, Highest Honors
Medical School	Medical College of Georgia, Augusta, Georgia, 8/95-5/99 Doctorate of Medicine
Internship	Medical College of Georgia, Augusta, Georgia, 7/99-6/00 Internal Medicine
Residency	Medical College of Georgia, Augusta, Georgia, 7/00-6/03 Emergency Medicine
Board Certification	Diplomat of the American Board of Emergency Medicine

2004 – Present.

Fellow, American College of Emergency Physicians,
October 2006 – Present.

American Registry of Diagnostic Medical Sonographers
October 2003 – 2007

Professional Experience

Learning Assistant, 1993 – 1994, Georgia Institute of Technology, Atlanta, GA

Co – Operative Engineer, 1991 – 1994, Georgia Power Company, Augusta, GA

Research Assistant, 1994 – 1995, Georgia Tech Research Institute, Atlanta, GA

Clinical Assistant, 1998 – 1999, Gracewood State Hospital and Schools, Gracewood, GA

Staff Emergency Physician, 2002 – 2003, Emanuel Medical Center, Swainsboro, GA

Staff Emergency Physician, 2002 – 2003, Burke Medical Center, Waynesboro, GA

Staff Emergency Physician, 2002 – 2004, Wills Memorial Hospital, Washington, GA

Assistant ED Medical Director, 2002 – 2003, Wills Memorial Hospital Washington,GA

Assistant Professor, 2003 – 2007, Dept. of Emergency Medicine, Med. College of GA

Associate Director, 2004 – 2006, Section of Emergency Ultrasound
Department of Emergency Medicine, Medical College of Georgia

Medical Director, 2003 – Present, Emergency Department Observation Unit,
Department of Emergency Medicine, Medical College of Georgia

Medical Director, 2009 – 2011, "The Clinic" at Walmart.

Director, 2006 – Present, Section of Emergency and Clinical Ultrasound
Department of Emergency Medicine, Medical College of Georgia

Director, 2005 – 2012, Emergency Ultrasound Medical Student Rotation (EMED 5008)
School of Medicine, Medical College of Georgia

Director, 2008 – Present, Emergency Ultrasound Fellowship
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Board of Directors. Georgia College of Emergency Physicians. 2008 – Present.

Vice Chairman for Academic Programs, 2010 – Present, Department of Emergency Medicine,
Medical College of Georgia

Secretary-Treasurer, Georgia College of Emergency Physicians. 2011-2013.

GHSU Educational Innovation Institute Scholar, 2011

Bedside Cardiac Ultrasound

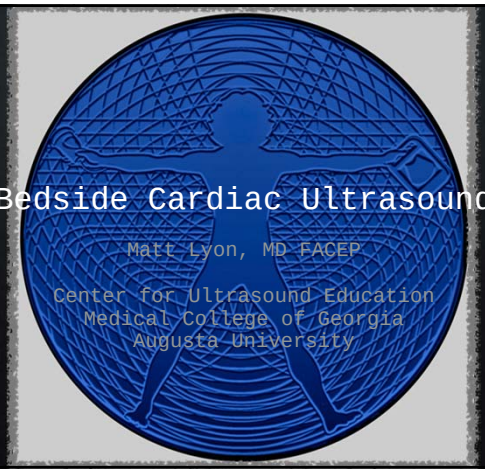
Matt Lyon, MD

Augusta University

Augusta, GA

At the conclusion of the presentation, the learner should be able to:

1. Cite the indications of bedside Cardiac Ultrasound.
2. Assess the EF and correlate to clinical condition.
3. Assess the fluid status and correlate to clinical condition.



Bedside Cardiac Ultrasound

Matt Lyon, MD FACEP

Center for Ultrasound Education
Medical College of Georgia
Augusta University

Disclosure

I have no conflicts of interest and nothing to disclose.

Learning Objectives

- Interpret heart structures using ultrasound
- Cite the indications of bedside cardiac ultrasound
- Assess the ejection fraction and correlate to clinical condition
- Assess the fluid status and correlate to clinical condition

Learning Objectives

- How to look at the IVC and Heart to make an assessment of the patient

Why Use Ultrasound?

Bedside, clinician-performed

More sensitive than physical exam

- Quickly eliminate life threatening diagnosis

Guide resuscitation

- Differentiate shock state
- Goal-Directed therapy

Clinical US

Clinical Ultrasound	billing code
• Performed by the treating physician	**Cardiology "Echo"**
• Bedside / repeatable	• Cardiologist "specialist"
• Guide therapy / integrate in to clinical practice	• Bedside - wait on interpretation
• "Limited" in scope	• "Complete" in scope

Disadvantages & Pitfalls

- Limited windows
  - Limited by distance, bone & air
- Operator Dependent
  - Image acquisition
  - Image interpretation
  - Clinical integration

Cardiac Ultrasound

Clinical Applications

Assessment of Patients:

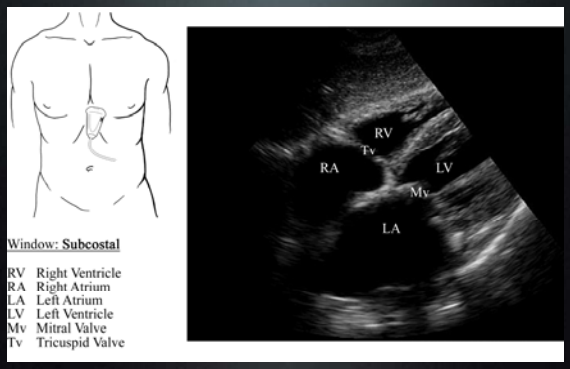
- Chest Pain
- Dyspnea
- Trauma
- Cardiac arrest / Peri-arrest resuscitation
- Unexplained Hypotension
- Unexplained Syncope

Cardiac Windows

- Subcostal / Subxiphoid (4 and 5 chamber and IVC)
- Parasternal (long and short)
- Apical (2, 4, and 5 chamber)

- Why 3 Cardiac Windows?

Subcostal



Subcostal

Cardiac Ultrasound

Video

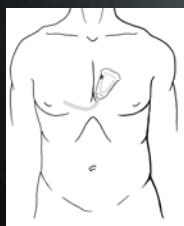
Inferior Vena Cava

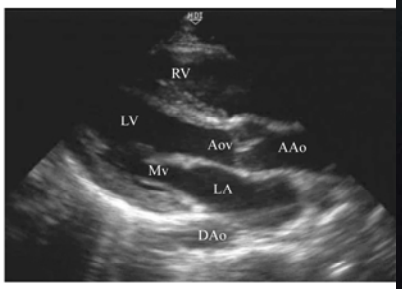
- Patient Position
  - Flat/supine
- Probe Location
  - Epigastrium
  - Angle towards spine

IVC

Cardiac Ultrasound
Video

Parasternal Long





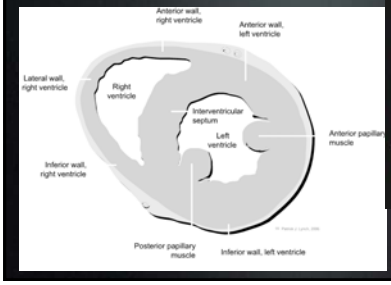
Window: **Parasternal Long**

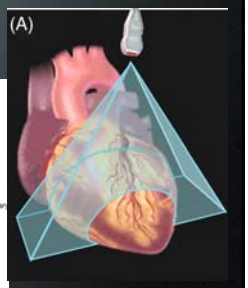
RV	Right Ventricle
LA	Left Atrium
LV	Left Ventricle
Mv	Mitral Valve
Aov	Aortic Valve
DAo	Descending Aorta
AAo	Ascending Aorta

Parasternal Long

Cardiac Ultrasound
Video

Parasternal Short





Parasternal Short

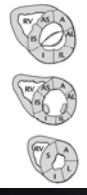
Cardiac Ultrasound
Video

Parasternal Short

Segment Model for Wall Motion Abnormalities

A	Anterior	- LAD
AL	Anterolateral	- LAD
AS	Aneroseptal	- LAD
IL	Inferolateral	- Circumflex Artery
I	Inferior	- RCA
IS	Inferoseptal	- RCA
RV	Right Ventricle	

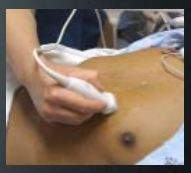
Window: **Cardiac Parasternal Short**



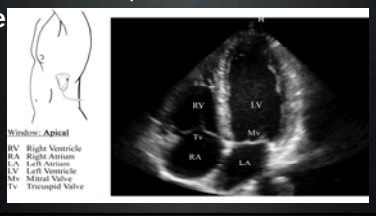
Parasternal Short

- Parasternal Short Axis
  - Left Ventricle

Apical



- Probe Location
  - Place probe at PMI with indicator pointed towards **Le**



Apical

Cardiac Ultrasound

Video

Cardiac Ultrasound

Clinical Case Presentation

- 46 YO Male 2 hours post surgery in the ICU
  - Intubated / Mechanical Ventilation
  - Hypotensive
  - Extensive medical history
  - During evaluation: Cardiac arrest - PEA
- How can bedside US help in the resuscitation?

Peri-Arrest

Why use ultrasound in cardiac arrest?

- Accuracy of pulse check is limited

Ochoaa F, et al. Competence of health professionals to check the carotid pulse. Resuscitation. 1998;37(3).

- Pulse palpation is unreliable
  - Not giving CPR when needed 14%
  - Giving CPR when not needed 36%

Tibballs J, et al. Reliability of pulse palpation by healthcare personnel to diagnose pediatric cardiac arrest. Resuscitation. 2009;80(1).

- Limited interruption of CPR

Peri-Arrest

- Cardiac Arrest

Peri-Arrest

- Cardiac Arrest

Peri-Arrest

- Cardiac Arrest

Peri-Arrest

- Cardiac Arrest

Peri-Arrest

- Ultrasound is highly useful in differentiating cause of arrest
- PEA and cardiac activity intensifies search for

EKG **ECHO**	Asystole Standstill	PEA Standstill	PEA **Contraction**	VF Standstill	VF **Contraction**
Survived	0	0	12 (67%)	0	8 (53%)
Died	65 (100%)	20 (100%)	6 (33%)	51 (100%)	7 (47%)

Blaivas M, Fox J. Outcome in Cardiac Arrest Patients Found to Have Cardiac Standstill on Bedside ED Echocardiogram. Academic Emergency Medicine. 2001;8(6).

Peri-Arrest

Pulseless Electrical Activity (PEA)

- Best defined by ultrasound
- Rapid identification of readily treated reversible causes
  - Hypovolemia (severe)
  - Tension pneumothorax
  - Acute MI
  - Acute massive pulmonary embolism

Hypovolemia

Central Venous Pressure (CVP)

- Measure of the pressure in the thoracic vena cava
- Good approximation of Right Atrial Pressure
- Can be used to differentiate shock states

- US marker of CVP:
  - IVC variation with respiration

IVC size variation

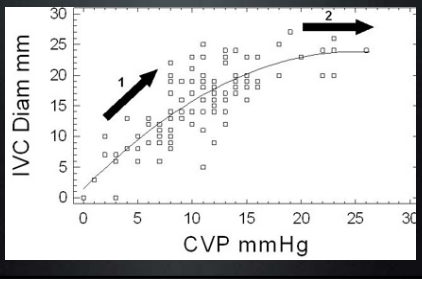
IVC collapses during inspiration

IVC dilates during expiration

Cardiac Ultrasound Video

IVC Variation

- Maximum diameter and variation vary according to IVC (right atrial) pressure



IVC Variation and CVP

IVC Diameter	Inspiratory Change	Estimated RAP (mm Hg)
<1.5 cm (small)	Complete Collapse	0-5
1.5-2.5 cm (normal)	Decrease > 50%	5-10
2.5 cm (normal)	Decrease about 50%	10-15
>2.5 cm (dilated)	Decrease < 25%	15-20
Dilated, with dilated hepatic veins	No change	>20

IVC Variation and CVP

IVC Diameter Expiration	IVC Diameter Inspiration	CVP (approx pressure)
Small, Slit Like	Complete Collapse	Very Low (0-4)
Small to Normal Size	Complete Collapse	Low (4-8)
Normal Size	Collapses 25 – 75%	Normal (8-12)
Large (approaching 20 – 25 mm)	Collapses < 25%	High (12-18)
Large (maximal size)	No Collapse	Very High (>20)

IVC Variation and CVP

Low CVP

Cardiac Ultrasound Video

IVC Variation and CVP

Normal CVP

Cardiac Ultrasound Video

IVC Variation and CVP

Elevated CVP

Cardiac Ultrasound Video

IVC Variation and CVP

Elevated CVP

Cardiac Ultrasound Video

Back to the Case

Differential Diagnosis of PEA

- Hypovolemia
- Tension pneumothorax
- Acute MI
- Acute PE
- Pericardial effusion/tamponade

Case

- Clinical US

Case

- Clinical US

Pericardial Effusion

- Accumulation of fluid in pericardial sac
  - Pericardium relatively fixed volume
    - Increasing pericardial fluid volume decreases venous return to right atrium decreasing cardiac output
  - Pericardial Tamponade

Pericardial Effusion

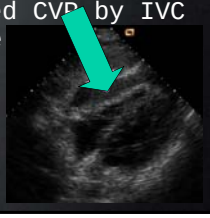
- Size may be deceiving
  - Big does not always mean bad (emergency - tamponade)
  - Small does not always mean insignificant

Cardiac Ultrasound

Video

Pericardial Tamponade

- Right Atrium – Late diastolic inversion
- Right Ventricle – Early diastolic collapse
- Evidence of elevated CVP by IVC m[illegible] the p[illegible]



Pericardial Tamponade

Is this tamponade?

Cardiac Ultrasound

Video

Pericardial Tamponade

Is this tamponade?

Cardiac Ultrasound

Video

Pericardial Tamponade

Is this tamponade?

Cardiac Ultrasound

Video

Pericardial Tamponade

Is this tamponade?

Cardiac Ultrasound

Video

Pericardial Effusion

How do you know if it is tamponade?

Check the IVC

	Sensitivity	Specificity	PPV	NPV
RA diastolic collapse	55%	88%	10%	99%
RV diastolic Collapse	48%	95%	38%	99%
IVC Plethora	**97%**	66%	7%	**99%**

Schiller, N, et al. Echocardiographic evaluation of the pericardium. Up to Date.

Case - Pericardial Effusion

Is this pericardial tamponade?

Check the IVC

Cardiac Ultrasound

Video

Case - Pericardial Effusion

Is it pericardial tamponade?

Hypotension
Pericardial Effusion
Dilated IVC
Elevated CVP

Cardiac Ultrasound

Video

Case Presentation

- 50 YO male with Lupus and AIDS
- Sudden onset of dyspnea
- Vital signs: hypotension and tachycardia (shock)

- How can bedside US help in the resuscitation?

Cardiac Ultrasound

Unexplained Hypotension/Shock

- Severe hypovolemia
- Cardiac tamponade
- Septic shock
- Global cardiac dysfunction
- Massive pulmonary embolism

Hypotension/Shock

- How well filled is the heart?
  - Assess the IVC size and collapsibility.
- Is there pericardial fluid?
  - Look for tamponade.
- Is the heart hyperkinetic?
  - Is the heart empty or volume overloaded?
- Is the heart hypokinetic?
  - How bad? Which ventricle? Evidence of ischemia?
- When no cardiac indicators are seen, US of the thorax and abdomen should be considered

Hypotension/Shock

Discussion of Cardiac Function

- Estimation of ventricular function
  - Qualitative Measurement
  - Quantitative Measurement

Ventricular Function

Qualitative Measurement

- Simplest method
- Visualize endocardial border between diastole and systole
  - >50% change= normal
  - <50% change= diminished

Ventricular Function

Qualitative Measurement – Normal EF

Cardiac Ultrasound

Video

Ventricular Function

Qualitative Measurement

Cardiac Ultrasound

Video

Ventricular Function

Qualitative Measurement

Use descriptive terms

Description	Ejection Fraction
Hyperdynamic	>> 55 %
Normal	> 55 %
Mild Impairment	45 – 55 %
Moderate Impairment	30 – 44 %

Ventricular Function

Hyperdynamic Ventricular Function

- Kissing Papillary Muscle Sign

Cardiac Ultrasound

Video

Significant hypovolemia

Ventricular Function

Qualitative Measurement – Normal EF

Cardiac Ultrasound

Video

Ventricular Function

Qualitative Measurement

Cardiac Ultrasound

Video

Ventricular Function

Qualitative Measurement

Cardiac Ultrasound

Video

Ventricular Function

Qualitative Measurement

Cardiac Ultrasound

Video

Ventricular Function

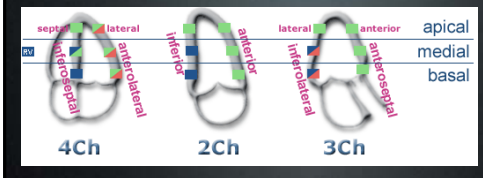
Qualitative Measurement

Look at the individual walls. Which walls are you not seeing?

Cardiac Ultrasound

Video

Wall Evaluation



Cardiac Ultrasound

Video

Parasternal Short

- Parasternal Short Axis
  - Left Ventricle

Ventricular Function

Quantitative Measurement

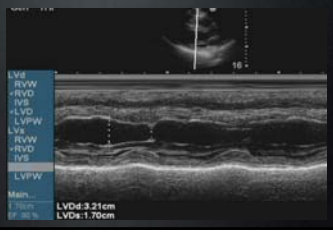
- Several methods of calculating EF
- Each with advantage / disadvantage

LV Dimensional Method

- Parasternal Long Axis Measurement
- Place M-mode line through LV below the mitral leaflets
- Line should be [illegible] axis of ventri

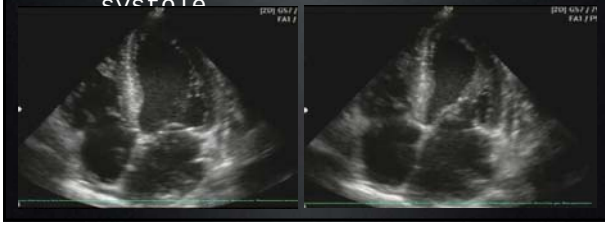
LV Dimensional Method

- Measure the internal dimension in systole and diastole
- Calculation program calculates the EF



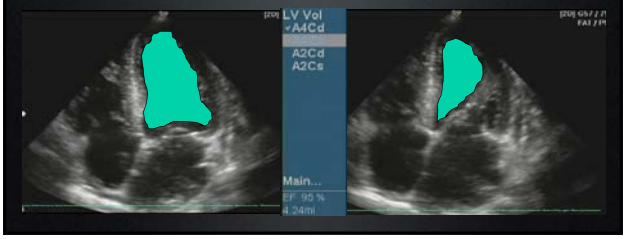
2-D Method of Simpson

- Apical 2 and 4 chamber view
- Trace the ventricular cavity & papillary muscle in diastole & systole



2-D Method of Simpson

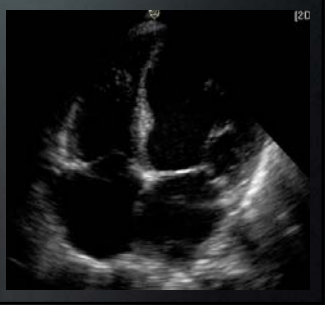
- Systole and diastole in apical 4 and 2 chamber



Chamber Size

Normal Measurements

Chamber	Size
Right Ventricle	< 30 mm
Right Atrium	< 35 mm
Left Atrium	< 40 mm
LV ED diameter	40 – 55 mm



Unexplained Hypotension

Category of Shock	Cardiac Function	IVC
Septic	Hyperdynamic LV (hypodynamic)	Narrow IVC IVC collapses with inspiration
Cardiogenic	Hypodynamic LV	Dilated IVC IVC does not collapse
Hypovolemic	Hyperdynamic LV	Narrow IVC IVC collapses with respiration
Obstructive (cardiac tamponade)	Pericardial Effusion Diastolic collapse of RV	Dilated IVC IVC does not collapse
Obstructive (PE)	Dilated RV Dilated RA	Dilated IVC Minimal IVC collapse

Unexplained Hypotension

IVC	CVP	Other Findings	Potential Cause
Small Complete Collapse	Low	Hx. Vomiting/Diarrhea Hyperdynamic LV	Dehydration
Small Complete Collapse	Low	Hx. Trauma Blood in peritoneum	Hemorrhage
Small Complete Collapse	Low	Hx. Fever Hyperdynamic LV	Septic Shock
Dilated Little Collapse	High	Hx. Uremia Pericardial Effusion	Pericardial Tamponade
Dilated Little Collapse	High	Hx. Chest Pain Hypodynamic LV	Cardiogenic Shock
Dilated Little Collapse	High	Hx. Acute Dyspnea Dilated RV/RA	Massive PE
Dilated			

Cardiac Ultrasound

Back to Cases

Cardiac Ultrasound

Hypotension, Chest Pain

Cardiac Ultrasound

Video

Cardiac Ultrasound

- IVC
  - Dilated
  - Little Collapse
- CVP
  - High
- Heart
  - Tachycardic
- LV function
  - Poor squeeze

Cardiac Ultrasound

Video

Cardiogenic Shock

Cardiac Ultrasound

Hypotension, Chest Pain, Fever

Cardiac Ultrasound

Video

Cardiac Ultrasound

- IVC
  - Collapsed
  - Slit Like
- CVP
  - Very Low
- Heart
  - Tachycardic
- LV function
  - Hyperdynamic
  - EF > 55%

Cardiac Ultrasound

Video

Cardiac Ultrasound

- IVC
  - Collapsed
  - Slit Like
- CVP
  - Very Low
- Heart
  - Tachycardic
- LV function
  - Hyperdynamic
  - EF > 55%

Cardiac Ultrasound

Video

Septic Shock

Cardiac Ultrasound

Hypotension, Chest Pain, Syncope, SOB

Cardiac Ultrasound

Video

Cardiac Ultrasound

- IVC
  - Dilated
- CVP
  - High
- Heart
  - Tachycardic
- LV function
  - Hyperdynamic
- RV/RA
  - Dilated (R>L)

Cardiac Ultrasound

Video

Obstructive Shock - PE

Cardiac Ultrasound

Hypotension, Chest Pain, Trauma

Cardiac Ultrasound

Video

Cardiac Ultrasound

- IVC
  - Dilated
  - No Collapse
- CVP
  - High
- Heart
  - Tachycardic
  - Pericardial Effusion
- LV function
  - Hyperdynamic

Cardiac Ultrasound

Video

Cardiac Ultrasound

- IVC
  - Dilated
  - No Collapse
- CVP
  - High
- Heart
  - Tachycardic
  - Pericardial Effusion
- LV function
  - Hyperdynamic

Cardiac Ultrasound

Video

Obstructive Shock - Tamponade

Cardiac Ultrasound

Conclusion

- Bedside Cardiac US can have a dramatic effect on clinical practice
- Overview of how to integrate into clinical practice
- Knowledge of normal anatomy, limitations, and clinical integration

Bedside Cardiac Ultrasound

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A video of the full version of this presentation can be found at http://youtu.be/-hCr_agrNYs

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