Perioperative Care of the Obese Patient in the Operating Room & Intensive Care Unit: Pearls & Pitfalls

Ana Fernandez-Bustamante, MD, PhD, FASA; Dabneth Chatterjee, MD

2024 CRASH conference
Vail, Colorado
February 26th, 2024

Learning Objectives

- Discuss strategies for preoperative optimization of obese patients scheduled for surgery.
- Review current recommendations for anesthetic care of an obese patient receiving glucagon-like peptide-1 receptor agonists (GLP-1 RA).
- Summarize the recent literature on airway management and mechanical ventilation in obese patients.
- Explain the pharmacological principles affecting perioperative drug-dosing in obese patients.
- Describe the eligibility criteria and postoperative outcomes following bariatric surgery in adolescents and adults.

Disclosures

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Department of Defense FY22 Restoral Funding (PI)
UCHealth Clinical Effectiveness and Patient Safety award (PI)

No conflicts of interest

Preoperative Optimization of Obese Patients

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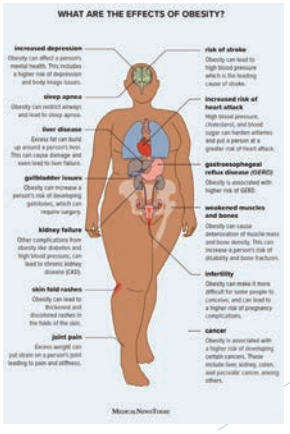
Case scenario

48yo male scheduled for L4-L5 laminectomy:

- Allergies: Penicillin - Does not remember reaction (childhood)
- HPI: Low back pain
- PMH:
  - Occasional GERD.
  - Lower lumbar pain: currently on admin tasks since he can no longer lift weights 2/2 back pain
- Physical exam:
  - 175 cm / 5ft 7in, 159 kg / 351 lbs, BMI 55
  - BP 145/90 mmHg, HR 92 bpm, RR 16 bpm, SpO_2 92 % RA
  - Airway: Mallampati 3, thick neck, full cervical ROM
  - Cardiac: Distant sounds, s1s2
  - Pulmonary: Distant sounds bilaterally, CTA
- Tests
  - EKG: none
  - Labs: none

Preoperative optimization



Preoperative optimization

Preoperative cardiovascular optimization

- If you don't have time…
- Exercise tolerance (METS)

- Adjust your care accordingly

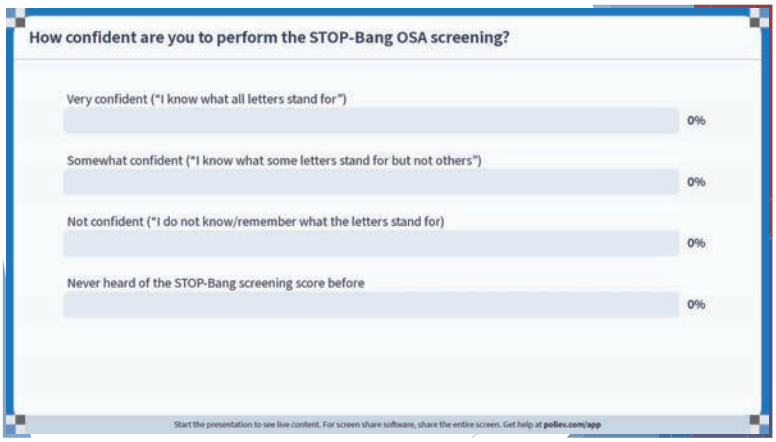
Preoperative cardiovascular optimization

- If you have time…
- Work up:
  - EKG?
  - TTE w/wo stress?
- Optimize
- Pre-habilitation?

Alam, M.J., Banerjee, S.K. (2020). Obesity-Induced Cardiovascular Complications and Therapeutic Intervention. https://doi.org/10.1007/978-3-030-47336-5_2

Preoperative respiratory optimization

- Physical exam + STOP-Bang
- Bicarbonate levels?
- Formal / Home OSA testing



STOP-Bang screening risk of OSA

STOP

S	So you **snore** loudly (louder enough to be heard through closed doors or louder than talking)?	Yes	No
T	Do you often feel **tired**, fatigued or sleepy during the daytime?	Yes	No
O	Has anyone **observed** you stop breathing or choking or gasping during your sleep?	Yes	No
P	Do you have or are you being treated for high blood **pressure**?	Yes	No

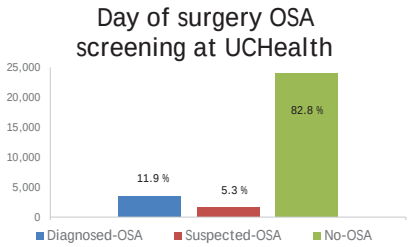
Bang

B	**BMI** more than 35?	Yes	No
a	**Age** – over 50 years old?	Yes	No
n	**Neck** circumference – is it greater than 17" if you are a male or 16" if you are a female?	Yes	No
g	**Gender** – are you a male?	Yes	No

Low risk	Score 1-2
Medium risk	Score 3-4
High risk	Score ≥5

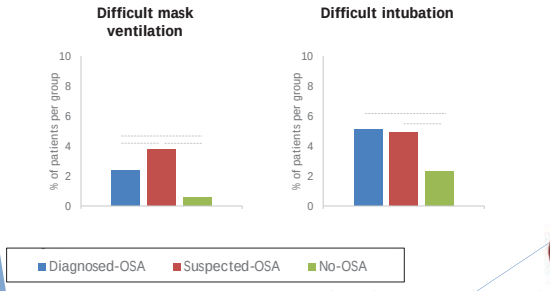
https://www.mdcalc.com/calc/3992/stop-bang-score-obstructive-sleep-apnea

Day of surgery risk screening of OSA… does it matter?



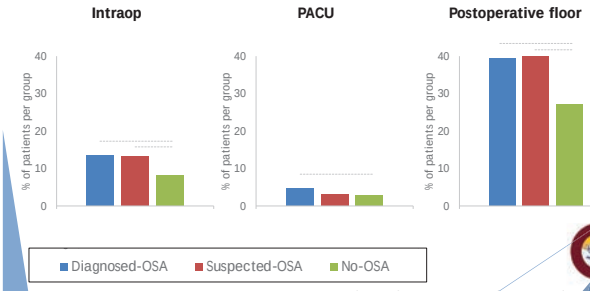
(Fernandez-Bustamante *et al.*, A & A 2017)

Day of surgery risk screening of OSA… → Difficult airway



(Fernandez-Bustamante *et al.*, A & A 2017)

Day of surgery risk screening of OSA… → Incidence of hypoxemia (SpO_2≤85%)



(Fernandez-Bustamante *et al.*, A & A 2017)

Day of surgery risk screening of OSA…

→ After adjusting for other confounding factors, the incidence of perioperative adverse respiratory events in patients with suspected OSA was *similar* than those already diagnosed with OSA

→ and it was worse at community centers

(Fernandez-Bustamante *et al.*, A & A 2017)

Home OSA testing by the Pre-Procedure Services at the University of Colorado Hospital

Dr. Angela Selzer
UCH Pre-Procedure Services
Medical Director

Home OSA Testing

- Criteria for home testing:
  - High risk via STOP-BANG
  - Insurance Coverage
  - No prior sleep study
  - Able to operate a smartphone
  - Surgery five or more days out
- Send patient home from PPS visit with WatchPat ONE test
- Results read by Sleep Medicine within 3 business days

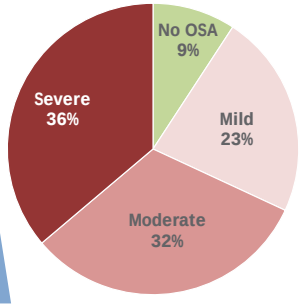
Home OSA Testing

OSA severity classification	Apnea Hypopnea Index (AHI) (Events/hour)
Normal	0-4
Mild OSA	5-14
Moderate OSA	15-29
Severe OSA	30+

Dr. Katherine Green
UCH Sleep Center
Medical Director

Home OSA Testing results at UCH (Dec 2022-Dec 2023)

141 patients tests completed



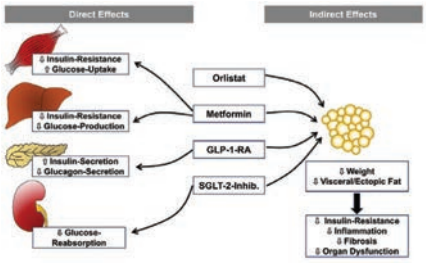
- Ideally, treatment established by day of surgery
- Beneficial to confirm diagnosis
  - Negative (~10%) or Positive (~90%)
  - 2/3 with Mod/Severe OSA will benefit from therapy during perioperative hospital stay

Other preoperative optimization

- Non-prescription medications and social history
  - Analgesics
  - Weight loss
- Diabetes
  - Glycemia
  - Hemoglobin A1C levels

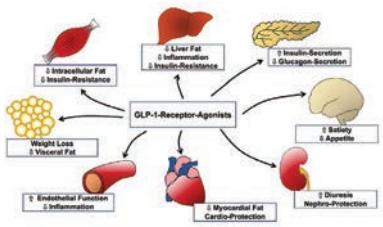
Patients on Glucagon-like peptide-1 receptor antagonists (GLP-1 RA)

GLP-1 Receptor Antagonists	
Generic	**Brand**
Semaglutide	Ozempic, Wegovy, Rybelsus
Dulaglutide	Trulicity
Liraglutide	Victoza, Saxenda
Exenatide	Bydureon Bcise, Byetta



(Senn and Fischli, Medical Therapy; In: Visceral and Ectopic Fat, 2023)

Patients on Glucagon-like peptide-1 receptor antagonists (GLP-1 RA)



- Frequent side effects nausea/vomiting, diarrhea
- Concern of delayed gastric emptying risk of aspiration

(Senn and Fischli, Medical Therapy; In: Visceral and Ectopic Fat, 2023)

Current ASA recommendations for patients on GLP-1 RA medications

- Consider holding the last dose (DOS if daily, last week if weekly)
  - Bridge Rx if diabetic
- On DOS:
  - If GI symptoms (e.g., severe nausea/vomiting, abdominal bloating, or abdominal pain on DOS → delay elective surgery *vs.* discuss risk of pulmonary aspiration
  - No GI symptoms and GLP1 RA held as advised → proceed as usual
  - No GI symptoms but GLP1 RA not held as advised → "full stomach" precautions with appropriate discussion of risk
    - Proceed as usual if preop optimal gastric ultrasound shows evidence of empty stomach
  - Usual fasting recommendations

Take home message

- Evaluate obesity-associated multiorgan disease, possibly undiagnosed or asymptomatic.
- Investigate functional exercise capacity and determine risk/benefit of further cardiovascular testing.
- Screen risk for OSA → STOP-Bang, home OSA testing if available.
- For patients taking glucagon-like peptide-1 receptor agonists (GLP-1 RA), request holding last dose if possible and consider increased risk of delayed gastric emptying and pulmonary aspiration.

Perioperative Drug Dosing in Obese Patients

Debnath Chatterjee, MD, FAAP
Professor of Anesthesiology, Children's Hospital Colorado

Disclosures

- None

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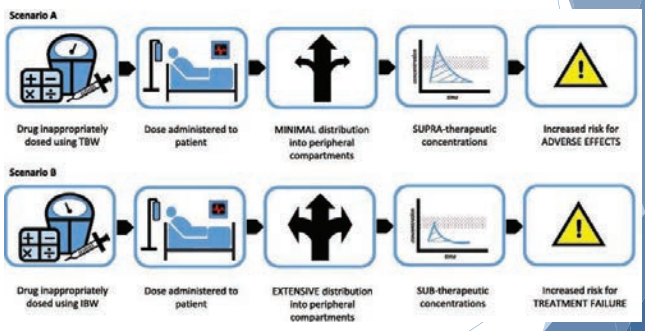
Obesity Pharmacology

- Lack of evidence-based guidelines
- Extrapolation from adult studies
- Obese patients are more likely to receive drugs outside the recommended dose range

Why do we care?



Erstad BL, et al. Crit Care. 2021; 25:77

Body Scalars for Drug Dosing

Total body weight | Ideal body weight | Lean body weight

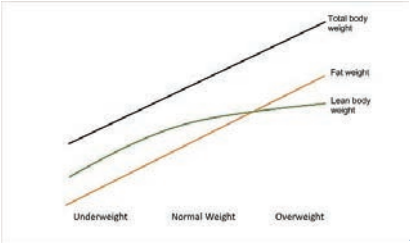
Body Scalars for Drug Dosing

Total body weight	Actual body weight
Ideal body weight (IBW)	Optimal body weight associated with maximum life expectancy
IBW (men)	50 kg + 2.3 x (Height [inches] – 60)
IBW (women)	45.5 kg + 2.3 x (Height [inches] – 60)
IBW (children)	BMI at 50th percentile x Height $[m]^2$

Roberts M, Moon T. OpenAnesthesia.org. 2023

Lean Body Weight

- Difference between TBW and fat mass
- Includes vital organs, bones, muscles, extracellular fluid
- Fat mass and lean mass do not increase proportionally



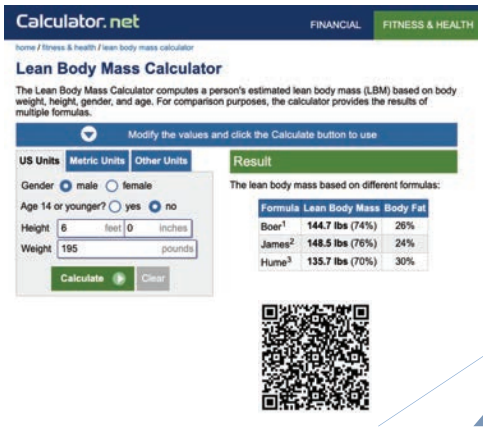
Janmahasatian S, et al. *Clinical Pharmacokinetics*. 2005; 44:1051-65

Lean Body Weight

Boer formula
James formula
Hume formula
Peter's formula

LBW (men)	[9270 x TBW (kg)] / [6680 + (216 x BMI (kg/m^2))]
LBW (women)	[9270 x TBW (kg)] / [8780 + (244 x BMI (kg/m^2))]

Roberts M, Moon T. OpenAnesthesia.org. 2023



Adjusted Body Weight

- An empirical IBW based metric with different correction factors
- ABW = IBW + correction factor x (TBW –IBW)
- Commonly used to dose drugs with some fat distribution

Obesity Pharmacology

Loading dose	Volume of distribution (Vd)	Lipophilic drugs dosed per TBW Hydrophilic drugs dosed per IBW
Maintenance dose	Drug clearance (CL)	Increased in obese patients
Elimination half- life $t_{1/2}$	Vd and CL	Depends on the drug

Roberts M, Moon T. OpenAnesthesia.org. 2023

Induction Agents

Drug	Optimal dosing scalar
Propofol	Induction dose based on LBW- similar time to loss of consciousness as TBW with less hypotension Infusion based on TBW- correlates with ⇧ V_d and clearance
Etomidate	Conflicting data for optimal dosing scalar LBW bolus dosing likely provides adequate loss of consciousness while reducing side effects compared to TBW dosing
Ketamine	LBW dosing reduced opioid consumption

Roberts M, Moon T. OpenAnesthesia.org. 2023

Opioids

Drug	Optimal dosing scalar
Fentanyl Hydromorphone Remifentanil	LBW dosing TBW dosing increases risk of respiratory depression

Roberts M, Moon T. OpenAnesthesia.org. 2023

Neuromuscular Blockers

Drug	Optimal dosing scalar
Rocuronium Vecuronium	IBW dosing provides similar time to intubating conditions as TBW dosing
Succinylcholine	TBW dosing because of increased Vd and increased pseudocholinesterase activity Max dose 150 mg

Roberts M, Moon T. OpenAnesthesia.org. 2023

Reversal Agents

Drug	Optimal dosing scalar
Sugammadex	TBW dosing avoids underdosing
Neostigmine	TBW dosing (up to 5 mg max dose)

Roberts M, Moon T. OpenAnesthesia.org. 2023

Antibiotics

Drug	Optimal dosing scalar
Cefazoline	2 grams is the standard dose in adults 3 grams should be used in patients > 120 kg
Vancomycin	Loading dose- 10 mg/kg of TBW Subsequent dosing based on drug levels
Piperacillin-Tazobactam	Dosing based on renal function (eGFR)

Roberts M, Moon T. OpenAnesthesia.org. 2023

Vasopressors

Drug	Optimal dosing scalar
Dopamine Epinephrine Norepinephrine	Most vasopressors are hydrophilic with limited Vd and rapid clearance IBW dosing or non-weight-based dosing

Roberts M, Moon T. OpenAnesthesia.org. 2023

VTE prophylaxis

Drug	Optimal dosing
Unfractionated heparin	5000 units every 8 hours 7500 units every 8 hours if BMI ≥ 50 kg/m^2
Enoxaparin	Higher dose than non-obese patients 40 mg twice daily; higher doses if BMI ≥ 50 kg/m^2 Anti-Xa monitoring

Erstad BL, et al. Crit Care. 2021; 25:77

Take Home Messages

- Different body scalars- TBW, IBW, LBW
- Lipophilic drugs should be dosed per TBW (succinylcholine)
- Hydrophilic drugs should be dosed per IBW (NM blockers)
- Opioids should be based on LBW and titrated to effect

CRASH

Guiding the future of patient care

Airway management and Ventilation of Obese Patients

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Professor of Anesthesiology, University of Colorado School of Medicine

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Anesthesiology
UNIVERSITY OF COLORADO ANSCHUTZ MEDICAL CAMPUS

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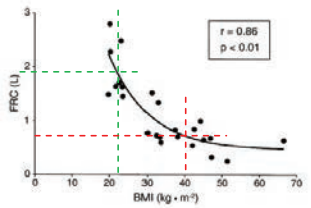
Case scenario

Functional Residual Capacity (FRC) decreases with increasing BMI

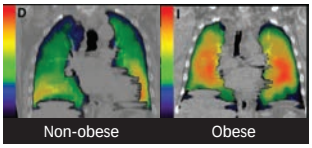
FRC of morbidly obese is ~50% lower than normal BMI



(Pelosi *et al.*, Anesth & Analg, 1998)

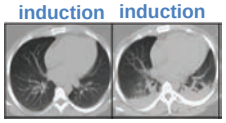
FRC is below closing capacity (CC) in the obese

Upright

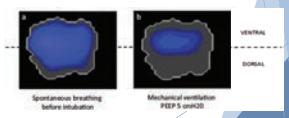


(Rutting *et al.*, J Appl Physiol, 2019)

Before induction **After induction**



(Reinius *et al.*, Anesthesiology 2009)



(De Jong *et al.*, Intensive Care Med, 2020)

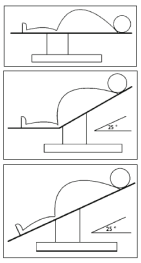
Planning

(Apfelbaum, Anesthesiology 2022)

Measures to improve ventilation in obese surgical patients

before **mechanical ventilation**

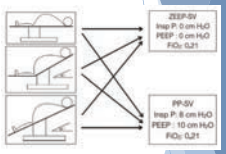
during mechanical ventilation



Effect of position and positive pressure ventilation on FRC in morbidly obese patients

- N=17, BMI≥40 kg/m^2 (50±8 kg/m^2)
- Spontaneously breathing
- Randomized crossover trial:

  3 positions: Supine, 25˚ Beach chair, 25˚ Reverse Trendelenburg
  2 ventilation methods: ZEEP-SV, PP-SV
- FRC: helium dilution method



	Supine	Beach chair	Reverse Trendelenburg	Ventilation strategy specific
ZEEP-SV	2145 (438) mL	2219 (477) mL	2282 (501) mL	2215 (481)[#] mL
PP-SV	2573 (515) mL	2456 (442) mL	2684 (473) mL	2571 (477)[#] mL
Position specific	2359 (519)[ab] mL	2338 (469)[ac] mL	2483 (521)[bc] mL	–

FRC greater with PP-SV than ZEEP-SV at each position
FRC at Reverse Trendelenburg, greater than supine or Beach chair

(Couture *et al.*, Can J Anesth 2018)

Mask ventilation of obese surgical patients in the semi-sitting *vs.* supine position

- N=36, BMI≥30 kg/m^2 (36±3 kg/m^2)
- Anesthetized + paralyzed
- Two-hand mask ventilation
- PCV: PIP 15 cmH_2O, PEEP 0 cmH_2O, RR 15 bpm, I:E 1:1
- Randomized positions: supine, 25˚ semi-sitting

For the same PIP, mask ventilation achieves a VT greater by ~2 ml/kgLBW in the semi-sitting position, compared to supine

	Supine (n=36)	25˚ Semi-sitting (n=36)	P value
Exhaled tidal volume (ml/kgLBW)	7.6±2.4	9.3±2.7	<0.001
Minute volume (ml/kgLBW/min)	113.4±35.7	139.6±40.7	<0.001
Peak inspiratory pressure (cmH2O)	15.3±0.4	15.5±0.5	0.008
Insufficient or dead space ventilation, n(%)	1 (3)	0 (0)	0.314

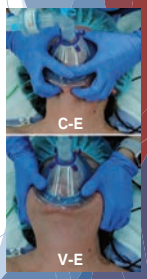
(Chang *et al.*, Eur J Anaesthesiol 2021)

Effectiveness of two different two-handed mask ventilation techniques on anesthetized obese adults

- N=81, BMI>30 kg/m^2 (37±4.9 kg/m^2)
- Anesthetized (not paralyzed)
- Randomized crossover: Two-hand mask ventilation C-E clamp *vs.* V-E clamp
- PCV: PIP 20 cmH_2O, PEEP 0 cmH_2O, RR 10 bpm, I:E 1:2

Parameter	C-E technique	V-E technique
VTe (ml)	371 (345) [295, 447]	720 (244) [666, 773]
VTe (ml kg^{-1}), AW	3.5 (3.49) [2.8, 4.3]	6.7 (2.6) [6.1, 7.3]
VTe (ml kg^{-1}), PBW	5.9 (5.77) [4.6, 7.2]	10.9 (4.2) [10.0, 11.9]
Ventilatory failure (%)	44 [34, 55]	0 [0, 5]

V-E clamp mask ventilation achieves greater VT than C-E clamp and is less likely to fail



(Fei *et al.*, B J Anaesth 2017)

Measures to improve ventilation in obese surgical patients

before **mechanical ventilation**

- Reverse Trendelenburg > semi-sitting > supine
- Positive Pressure support, CPAP
- V-E clamp mask holding

during mechanical ventilation

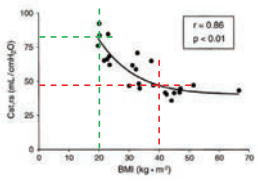
Measures to improve ventilation in obese surgical patients

before mechanical ventilation

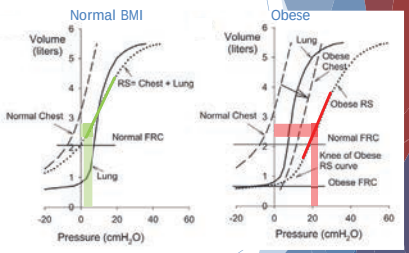
during **mechanical ventilation**

Mechanical ventilation of obese patients: respiratory system compliance (C_{RS})

Compliance decreases with increasing BMI

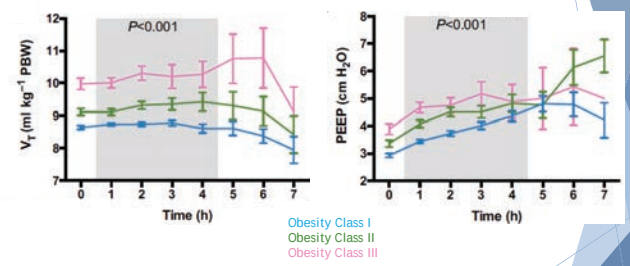


(Pelosi *et al.*, Anesth & Analg, 1998)



(Behazin *et al.*, J Appl Physiol, 2010)

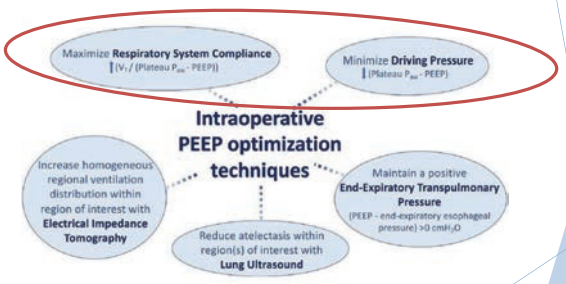
The worldwide LAS VEGAS study (2018): obese surgical patients, ventilated with greater VT



more frequent intra- and post-operative complications

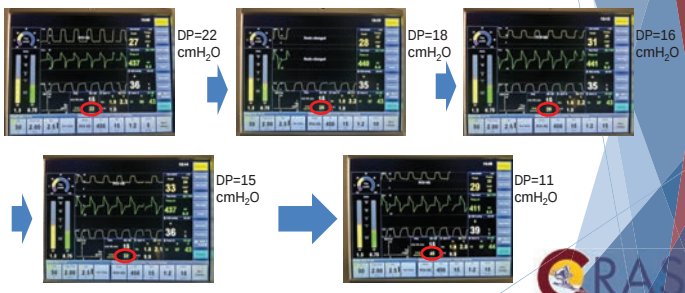
(Ball *et al.*, PROVE Network, BJA 2018)

Individualizing PEEP methods



(Fernandez-Bustamante *et al.*, Anesthesiology, 2021)

Practical application of individualized PEEP in an obese patient in the T-burg position



(Deep neuromuscular blockade, hemodynamic stability)

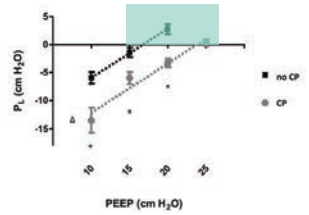
Fixed PEEP (low/high) *vs.* EIT-guided PEEP in obese patients

- Secondary analysis, single center (PROBESE + new patients)
- N=90, BMI≥35 kg/m², ≥2h abdominal surgery, ARISCAT score ≥26
- VCV: VT 7 mL/kgPBW, RR for normocapnia, FiO_2 ≥0.4 for SpO_2 ≥92%
- Randomized to:
  - High PEEP (n=21): PEEP 12 cmH_2O, standardized RM
  - Low PEEP (n=44): PEEP 4/5 cmH_2O, no standardized RM
  - EIT-guided PEEP (n=25): standardized RM + EIT-selected PEEP for most homogeneous aeration distribution
- PaO2/FiO2 before extubation (primary), EIT ventilation distribution

EIT-guided individualized PEEP levels (cmH_2O)	
Average	18.5
Median	18
IQR	16-22
Range	10-26

(Simon *et al.*, Anesthesiology, 2021)

Fixed PEEP *vs.* transpulmonary pressure-optimized PEEP



- PEEP levels of >15 cmH_2O before and >20 cmH_2O during capnoperitoneum were needed to achieve the goal of a PLee >0 cmH_2O.
- EIT measurements suggested an optimal PEEP level 10-15 cmH_2O before and 20-25 cmH_2O during capnoperitoneum, respectively.
- No oxygenation differences after extubation PEEP titrated to P_L >0 cmH_2O *vs.* PEEP=10 cmH_2O.

PEEP 10 cmH_2O is insufficient to achieve P_L >0 cmH_2O in obese patients, before and after peritoneum insufflation

(Eichler *et al.*, Obes Surg, 2018)

Take home message to improve airway management and ventilation of obese patients

before mechanical ventilation

- Reverse Trendelenburg > semi-sitting > supine
- Positive Pressure support, CPAP
- V-E clamp mask holding
- HFNC

during mechanical ventilation

Take home message to improve airway management and ventilation of obese patients

before mechanical ventilation

during mechanical ventilation

- VT based on PBW
- Consider individualized PEEP to improve oxygenation and compliance

Last but not least… Before extubation

- Head-up position as early as possible (rather than supine)
- Check for facial and laryngeal edema
- Aim for normocapnia (patient's baseline)
- Consider nasal trumpet at extubation
- Plan ahead for possible CPAP needed postoperatively

CRASH

Guiding the future of patient care

Childhood Obesity Adolescent Bariatric Surgery

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Disclosures

- None

Learning Objectives

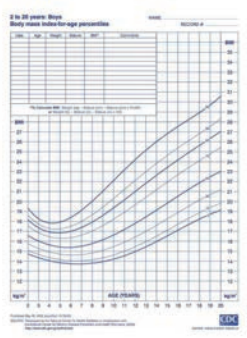
- Discuss strategies for preoperative optimization of obese patients scheduled for surgery.
- Review current recommendations for anesthetic care of an obese patient receiving glucagon-like peptide-1 receptor agonists (GLP-1 RA).
- Explain the pharmacological principles affecting perioperative drug-dosing in obese patients.
- Summarize the recent literature on airway management and mechanical ventilation in obese patients.
- Describe the eligibility criteria and postoperative outcomes following bariatric surgery in adolescents and adults.

Definitions

Maladaptive increase in body fat stores

$$\text{BMI} = \frac{\text{Weight (kg)}}{(\text{Height in m})^2} \text{ or } \frac{\text{Weight (lbs)}}{(\text{Height in inches})^2} \times 703$$

BMI-for-Age Percentile



BMI-for-Age Percentile

Healthy weight	5th-85th percentile
Overweight	85th-95th percentile
Obese	>95th percentile
Severe obesity	>120% of 95th percentile (99th percentile) or BMI > 35

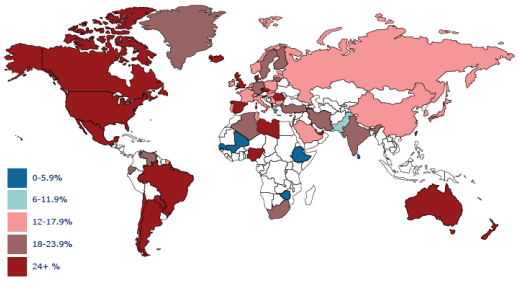
Severe Obesity

Class I	BMI ≥ 95th percentile for age or BMI ≥ 30*
Class II	BMI ≥ 120% of 95th percentile or BMI 35 – 39*
Class III	BMI ≥ 140% of 95th percentile or BMI ≥ 40

* whichever is lower

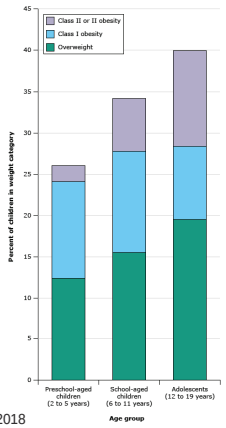
Skinner AC. JAMA Pediatr 2014

Global Prevalence



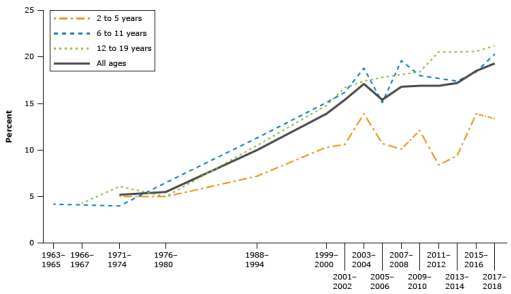
International Obesity Task Force

U.S. Prevalence



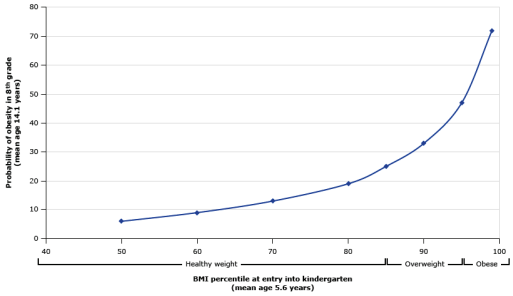
Skinner AC, et al. Pediatrics. 2018

U.S. Trends

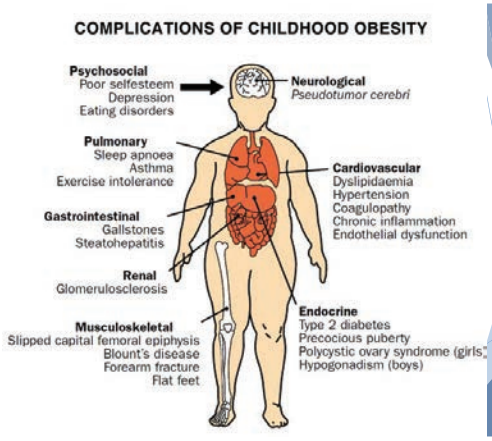


NHANES survey. CDC

Tracking of Childhood Obesity



Cunningham SA, et al. NEJM. 2014



Adolescent Bariatric Surgery

Indications for Adolescent Bariatric Surgery

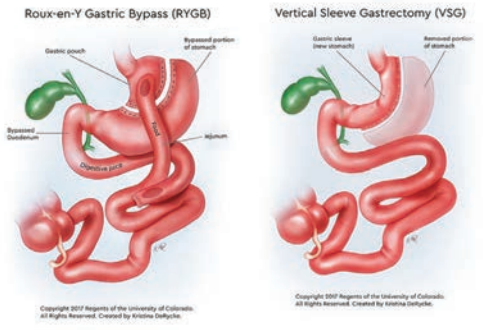
- BMI ≥ 35 or 120% of 95th percentile (Class II) with a major comorbidity(OSA, T2D, IIH, NASH, SCFE, GERD or HTN)
- BMI ≥40 or 140% of 95th percentile

Pratt JSA. Surg Obes Relat Dis. 2018

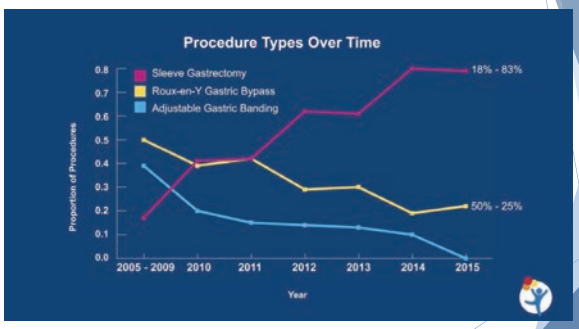
Contraindications

- MEDICALLY CORRECTABLE CAUSE OF OBESITY
- ONGOING SUBSTANCE ABUSE PROBLEM
- PSYCHIATRIC CONDITION THAT PREVENTS ADHERENCE TO REGIMEN
- CURRENT OR PLANNED PREGNANCY WITHIN 12-18 MTHS

Pratt JSA. Surg Obes Relat Dis. 2018

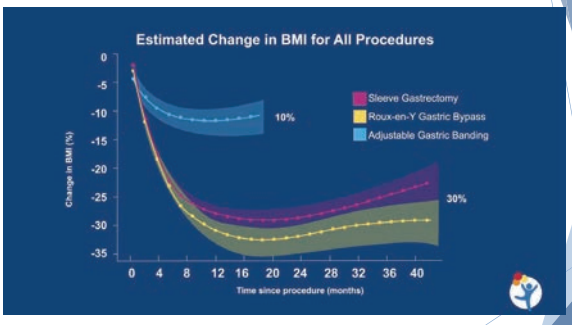


Effectiveness of Bariatric Procedures Among Adolescents



Inge T, et al. PCORnet Study. Surg for Obesity and Related Diseases. 2018

Effectiveness of Bariatric Procedures Among Adolescents

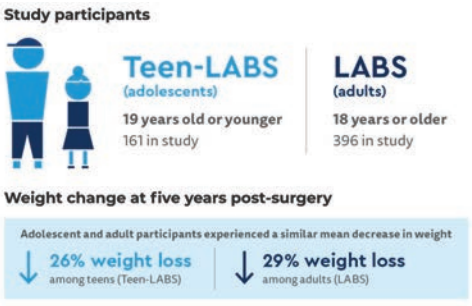


Inge T, et al. PCORnet Study. Surg for Obesity and Related Diseases. 2018

Preoperative Assessment

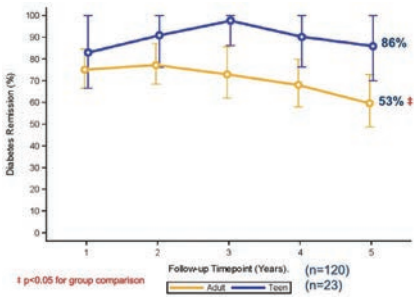
- ABILITY TO COMMIT TO RESPONSIBILITIES BEFORE AND AFTER SURGERY
- PHYSICALLY AND EMOTIONALLY READY FOR SURGERY
- MEDICAL AND SURGICAL EVALUATION
- BEHAVIORAL EVALUATION WITH PSYCHOLOGIST
- NUTRITION EVALUATION W/REGISTERED DIETITIAN
- LAB WORK
- SPECIALISTS AS NEEDED

Five-Year Outcomes in Adolescents vs Adults



Inge TH. NEJM 2019

Remission of Diabetes



Adolescents

Adults

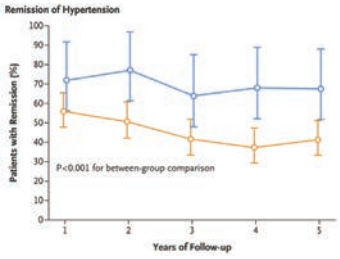
Inge TH. NEJM 2019

Medication Use for Diabetes

	Teen LABS		LABS	
	Baseline	5 years	Baseline	5 years
Oral meds for Diabetes	88%	0%	79%	26%
Insulin for Diabetes	20%	0%	22%	4%

Inge TH. NEJM 2019

Remission of Hypertension



68% of adolescents

41% of adults

51% more likely

Inge TH. NEJM 2019

Remission of Hypertension

	Teen LABS	LABS
Baseline	57%	68%
5 years	11%	33%

Inge TH. NEJM 2019

Micronutrient Deficiency

	Teen LABS		LABS	
	Baseline	2 years	Baseline	2 years
Low Ferritin	2%	48%	2%	29%
Low Vitamin B12	0%	4%	1%	4%
Low Vitamin D	25%	38%	36%	24%

Inge TH. NEJM 2019

Complications

Total : 544 patients	Number	%
Deaths	0	0
Subsequent operative interventions	18	3.3%
Venous thromboembolism	2	0.4%
Any 30-day adverse events	24	5.1%

Inge T, et al. PCORnet Study. Surg for Obesity and Related Diseases. 2018

Take Home Messages

- MBS is a proven, effective treatment for severe obesity in adolescents
- MBS significantly improves cardiovascular risk factors, causes remission of type 2 diabetes, improves OSA, etc.
- Both RYGB and VSG are effective options
- A multi-disciplinary team approach is critical