

Anesthesia for Bariatric Surgery

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Scope of Problem

- Sydney, Australia. Associated Press, February 2014
- "An obesity pandemic threatens to overwhelm health systems around the globe with illnesses such as diabetes and hypertension, experts at an international conference warned on Sunday.
- "This insidious creeping pandemic of obesity is now engulfing the entire world" Paul Zimmet, Chairman of the International Conference of Obesity attended by 2,500 experts and health officials.
- The World Health Organization says that more than 1 Billion adults are overweight and 300 Million of them are obese.

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Prevalence of Obesity (2018)

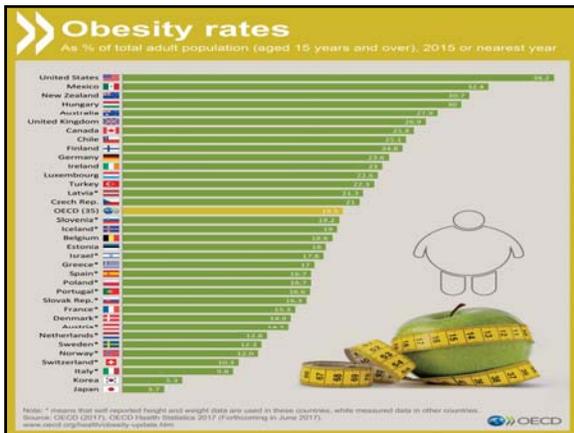
- Approx. 11% of US children are overweight
- More than 50% of adult Americans are overweight (BMI \geq 25)
- Nearly 25% of adults Americans are obese (BMI \geq 30)

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Obesity Skyrockets Across the Globe NBC News, May 29, 2014



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Centers for Disease Control (2018)

- Reveals that 36.5% of adults in the US are obese
- Deaths due to co-morbidities caused by obesity are reported to be 300,000 per year, with a total cost of care of \$147 billion.

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Cost of Obesity

- Total cost of overweight and obesity is \$99.2 B
- \$6.99 B for heart disease related to overweight/obesity
- \$63.14 B for type 2 diabetes related to overweight/obesity
- \$17.2B for osteoarthritis related to overweight/obesity
- \$3.23 B for hypertension related to overweight/obesity

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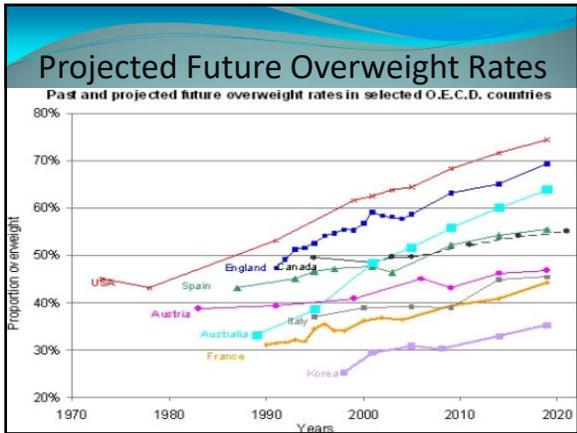
Cost of Obesity

- Lost productivity:
 - \$39.3 M – workdays lost
 - \$62.7 M – physician office visits
 - \$239M – restricted activity days

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University of Washington Study

- 80% of men 50-54 are overweight or obese and 73% of women age 60-64.
- One controversial study suggests obesity accounts for about 18% of all deaths.
- “Being overweight or even obese is a growing, unchecked problem in the U.S. today. We are looking at a major public health epidemic that must be stopped” Dr Ali Mokdad, Professor of Global Health at IHME.

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Definitions

- Obesity is an increase in body weight beyond the limitation of skeletal and physical requirement, as the result of an excessive accumulation of fat in the body.
- Morbid obesity is the condition of weighing 2 or 3, or more times the ideal weight; so called because it is associated with many serious and life threatening disorders.

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Definitions

• Category	BMI
• Normal weight	18.6-24.9
• Overweight	25.0-29.9
• Obese Class 1	30.0-34.9
• Obese Class 2	35.0-39.9
• Morbid Obesity	40.0-49.9
• Super Obese	>50

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Demographics

• Race	Men	Women
• Non-Hispanic White	33.6%	35.5%
• Non-Hispanic Black	37.5%	56.9%
• Non-Hispanic Asian	11.2%	11.9%
• Hispanic	39.0%	45.7%

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Ideal Body Weight Defined

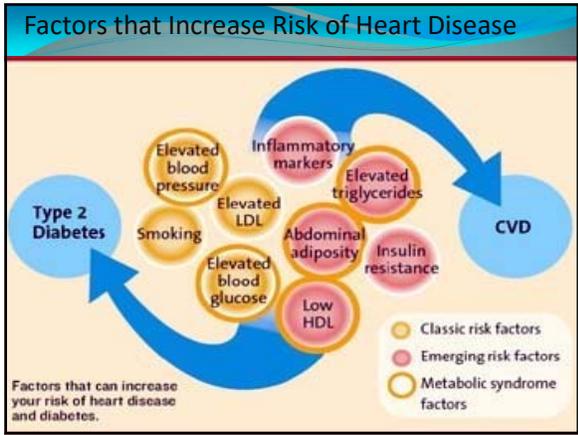
- Adult males: $IBW = \text{height (cm)} - 100$
- Adult females: $IBW = \text{height (cm)} - 105$

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Body Mass Index

- BMI = $\frac{\text{weight (kg)}}{\text{height (m}^2\text{)}}$
- OR
- BMI = $\frac{\text{wt. in kg (wt in lbs. x 0.45359237)}}{\text{ht in m}^2 \text{ (ht in ins. x 0.0254)}^2}$

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Risks Associated With Obesity

- Increased risk of developing CAD, DM, DJD, hypertension, gallbladder disease, obstructive sleep apnea, socioeconomic and psychological impairment
- Risk of developing above is related to BMI:
 - BMI 25-30 low risk
 - BMI 40 very high risk

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Obesity and the Cardiovascular System

- Hypertension
- Ischemic heart disease
- Left/right ventricular impairment or failure

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Obesity and the Cardiovascular System

- 50%-60% of all obese patients have mild to moderate systemic hypertension
- Increased extracellular fluid volume results in hypervolemia and increased cardiac output
- Increase CO of 0.1L/min per Kg of fat
- Each Kg of fat has 3000m of blood vessels

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Obesity and the Cardiovascular System

- Pulse rate in obese patients is usually within normal limits; the resultant increase in CO has to come from an increase in stroke volume
- Stroke volume is increased by an increase in the size of the left ventricle
- Ultimately, left ventricle becomes dilated

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Obesity and the Cardiovascular System

- Ventricular dilatation results in:
 - Increased LVEDV – LVEDP
 - Increased PAOP
 - Decreased compliance
 - Decreased cardiac reserve
 - Poor exercise tolerance
- Consequently, you develop a fixed CO and must increase HR to meet metabolic demands - - Ischemia!

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Obesity and the Cardiovascular System

- Additionally, as a result of going from the sitting to the supine position you:
 - An 11% increase in O₂ consumption
 - A 35% increase in CO
 - A 36% increase in CI
 - A 18% decrease in arteriovenous oxygen difference

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Obesity and the Cardiovascular System

- A 31% increase in mean pulmonary artery pressure
- A 44% increase in pulmonary wedge pressure
- A 21% decrease in peripheral resistance
- A 6% decrease in the heart rate

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Obesity and the Pulmonary System

- Increased pulmonary blood volume and flow predisposes to pulmonary hypertension
- Pulmonary hypertension exacerbated by:
 - Hypoxic pulmonary vasoconstriction
- Ultimately results in right ventricular failure

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Obesity and the Pulmonary System

- Additionally:
 - Reduced FRC, ERV, TLC
 - Increased RV (2° gas trapping), VO₂, CO₂ production
 - Decreased chest wall compliance (2° added weight and increased pulmonary blood volume)
 - Predisposition to hypoxia and hypercarbia

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Obstructive Sleep Apnea

- S Snoring
- T Tired
- O Observed- apnea during sleep
- P Blood pressure
- B BMI more that 35
- A Age >50
- N Neck circumference > 40 cm
- G Gender- male

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Obesity and the Hepatic System

- 90% of morbidly obese patients have histologically abnormal livers
- 75% have hepatic steatosis
- 20%-30% of obese patients have increased liver function tests
 - ALT most common
- ALT and aspartate aminotransferases return to normal after surgery

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Obesity and the Hepatic/Renal Systems

- Despite changes in the liver, there is no correlation between routine liver function tests and the capacity of the liver to metabolize drugs.
- Increased renal clearance of drugs 2° increase renal blood flow and glomerular filtration rate

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Indications for Bariatric Surgery

- BMI > 40
- BMI > 35, when obesity is associated with severe DM or life threatening cardiopulmonary problems

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Indications for Bariatric Surgery

- In addition:
 - Proven attempts at medically supervised weight loss of < 5-10% excess body weight
 - Weight gain after at least 6 months of diet modification, exercise, and medical Rx
 - Non-improvement in co-morbid conditions during period of weight loss attempts.

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Inge's Guidelines for Teenagers

- BMI > 50
- BMI > 40 with a major medical condition: type 2 diabetes, sleep apnea, or significant cardiovascular disease.

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Types of Bariatric Surgery

- Malabsorptive:
 - Jejunio ileal bypass
 - Biliopancreatic bypass
- Restrictive:
 - Gastric banding
 - Vertical banded gastroplasty
- Combination:
 - Roux-en-y gastric bypass

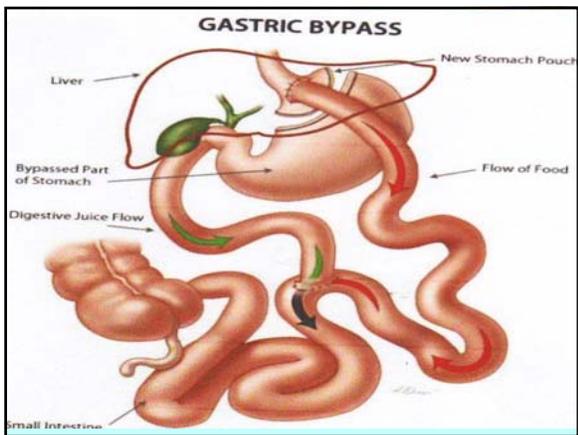
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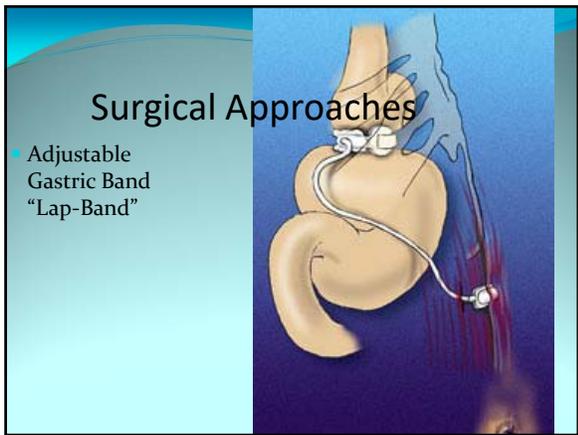
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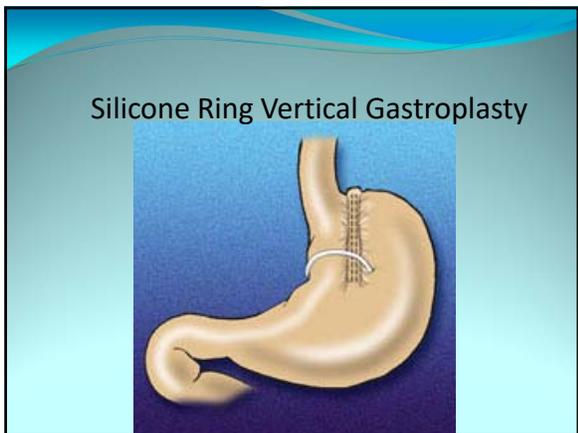
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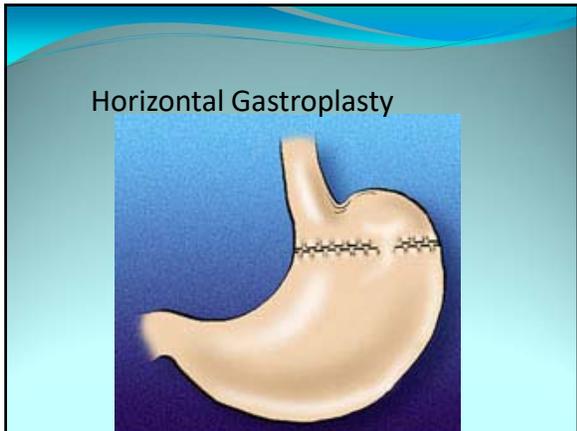
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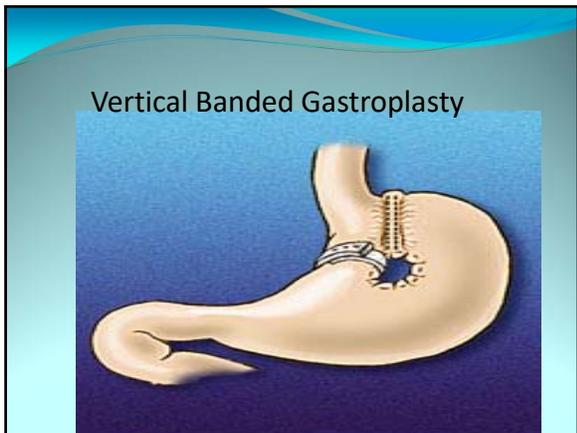
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Anesthesia Considerations

- Preoperative:
 - Cardiopulmonary
 - Metabolic
 - Altered pharmacokinetics
 - Airway
 - Preoperative medications
- Cardiopulmonary
 - Evaluate for systemic and pulmonary hypertension, signs and symptoms of right and left ventricular failure and ischemic heart disease

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Anesthesia Considerations

- Pulmonary hypertension:
 - Diagnose with echocardiogram and tricuspid regurgitation
 - Exertional dyspnea, fatigue, and syncope
 - EKG – right ventricular enlargement
 - tall precordial R waves
 - right ventricular strain
 - right axis deviation

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Preoperative

- ASA 3
- Calculation of Lean Body Mass for dosing
- Screen for Severity of Penicillin allergy
- Careful Airway Examination: Mouth opening, thyromental distance, sterno-mental distance, and neck circumference at the level of the thyroid cartilage. Upper lip bite test
- Upper arm shape, IV accessibility, airway mask ability
- GERD
- OSA- Bring CPAP machine

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Anesthesia Considerations

- The higher the pulmonary pressure, the more sensitive the EKG
- However, the EKG is frequently of low voltage and SIGNIFICANTLY underestimates the degree of RV and LV failure
- CXR – may show underlying lung disease
 - prominent pulmonary arteries

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Anesthesia Considerations

- Avoid hypoxemia and nitrous oxide because they can worsen pulmonary vasoconstriction
- Volatile anesthetics may be beneficial because they are bronchodilators and decrease hypoxic pulmonary vasoconstriction

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Anesthesia Considerations

- Cardiac failure:
 - Increased jugular venous pressure, added heart sounds (S₃), pulmonary crackles, hepatomegaly, and peripheral edema
- Arterial Blood Gases:
 - Evaluate CO₂ retention
 - Provide guidance for perioperative oxygen
 - Guide for weaning patient from ventilator

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Anesthesia Considerations

- Metabolic disorders:
 - May have long term nutritional abnormalities with decreased B₁₂, Fe, Ca, and folate
 - If patient has had a rapid weight loss and presents for repeat surgery – evaluate for decrease protein, abnormal electrolytes, and coagulation abnormalities
 - Correct electrolytes and coagulation abnormalities with Vitamin K or FFP

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Anesthesia Considerations

- Altered pharmacokinetics
 - Obese has increased volume of distribution 2° increases in size of the fat organ, lean body mass, blood volume, cardiac output, and reduced total body water
 - Increased V_D is particularly important when administering lipophilic drugs
 - Generally, water-soluble drugs have a smaller V_D and are effected less by obesity

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Anesthesia Considerations

- Hypnotics and benzodiazepines
 - Generally very lipophilic
 - Dose according to TBW
- Opioids (Narcotic Sparing)
 - Lipophilic
 - Dose according to TBW, except for Remifentanil (IBW)

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Anesthesia Considerations

- Non-depolarizing muscle relaxants
 - Generally are water soluble
 - Dose according to IBW except for (Cis- atracurium (TBW)
- Succinylcholine
 - Plasma cholinesterase increases in proportion to body weight
 - Dose according to TBW
- For all NMBs use peripheral nerve stimulator

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Anesthesia Considerations

- Airway and intubation:
 - Usual a/w assessment including circumference
 - “Ramp patient up” with towels
 - Bed in reverse trendelenburg
 - Rapid sequence induction with cricoid pressure
 - Consider “awake look”/fiber optic intubation
 - Have difficult a/w cart readily available
 - Glide scope

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Airway Assessment

Upper Lip Bite Test
very predictive
of difficulty in
airway
management.

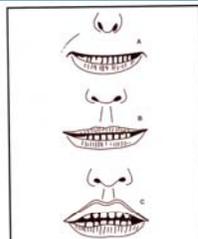


Figure 1. Schematic frontal view of the upper lip bite test. A, class I lower incisors biting the upper lip, making the mucosa of the upper lip totally invisible. B, class II, the same biting maneuver revealing a partially visible mucosa. C, class III, the lower incisors fail to bite the upper lip.

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“A Comparison of Preoperative Airway Assessment Techniques: The Modified Mallampati and the Upper Lip Bite Test” Hester et al, AANA Journal/June 2007/ Vol. 75, No. 3

- The upper lip bite test (ULBT) provides a simple, easily interpreted assessment that has now been demonstrated in 2 studies to be a reliable predictor of intubation difficulty. The ULBT is limited to patients who are able to follow commands, have teeth, and are able to move the mandible.

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Anesthesia Considerations

- Preoperative medications:
 - Continue all regular meds except insulin and oral hypoglycemics.
 - Diuretics ±
 - Antibiotics – particularly if open procedure
 - Aspiration prophylaxis
 - PE prophylaxis – heparin, LMWH
 - Pneumatic stockings for all patients

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Anesthesia Considerations

- Intraoperative
- Positioning:
 - Know maximum weight for your OR table
 - Increased incidence of pressure sore and nerve palsies in obese – particularly super obese and diabetics
 - Brachial plexus, lateral femoral cutaneous, sciatic, and ulnar nerves
 - All preoperative nerve paresthesias and palsies should be carefully documented

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Anesthesia Considerations

- Monitors:
 - Dictated by the physical condition of the patient
 - Standard monitors
 - Arterial line indicated for hx of hypertension, superobese, poorly fitting BP cuff 2° conical shaped arms, multiple blood sampling
 - Central lines contingent upon cardiopulmonary status

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Anesthesia Considerations

- Intra-operative maintenance:
 - Volatile anesthetics
 - All are OK. Desflurane has increased incidence of N & V but has a rapid and consistent recovery profile
 - Sevoflurane – only good qualities
 - N₂O – Avoid. Patient may need increased FiO₂, 2° increased O₂ consumption and CO₂ production
 - NMB necessary to facilitate adequate mech. vent. and facilitate intra-abdominal working space for the surgeon

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Anesthesia Considerations

- Ventilation:
 - Use tidal volumes of 6-8 ml/kg based on IBW.
 - Tidal volumes > 6-8 ml/kg based on IBW does not increase arterial O₂ tension and just leads to hypo-capnia and barotrauma
 - If necessary, use PEEP to try and increase arterial O₂ tensions
 - Respiratory rate to maintain normo-carbia
 - Pressure cycled ventilation/Use Maximum Vital Capacity Manuever
 - Utilize FIO₂ of .80

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Ventilation

- Use CPAP during induction.
- Recruitment: *Vital capacity maneuver* after intubation by using sustained (8-10 seconds) of pressure > 40 cm of water.
- Use PEEP (10-12 cm H₂O)
- Avoid lung over-distention
- Keep end inspiratory pressure less than 30
- Use CPAP or BiPAP immediately after extubation.
- Keep upper body elevated
- Maintain good pain control
- Early ambulation

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“PEEP During Induction of General Anesthesia Increases Duration of Non Hypoxic Apnea in Morbidly Obese Patients”, Gander, S. et al; Anesthesia and Analgesia 100(2), February 2005

- Application of PEEP (10 cms H₂O) during induction of general anesthesia increases nonhypoxic apnea duration by 50% or one minute.
- Increases FRC, decreases intrapulmonary shunt.

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“Prevention of Atelectasis in Morbidly Obese Patients during General Anesthesia and Paralysis: A Computerized Tomography Study” Anesthesiology 2009: 979-987; Reinius, H. et al.

- 40 Patients studied
Anesthetic management standardized
- Results: A recruitment maneuver (breath at 55 centimeters water pressure for 10 seconds plus 5 of PEEP significantly reduced the amount of atelectasis and improved oxygenation for a prolonged period of time.

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Anesthesia Considerations

- Fluid requirement:
 - Adequate hydration must be maintained to avoid acute tubular necrosis
 - Averages 2-3 L for a 2 hr. procedure (1st hr. = 2x calculated fluid deficit + maintenance for 1hr.). Generally give the same amount of fluid for the 2nd hr.
 - Use Goal Directed Fluid Therapy- CHEETAH

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Anesthesia Considerations

- Combined technique:
 - Continuous epidural not necessary if laparoscopic procedure. However, in the event that open procedure is done, epidural is very beneficial for post-operative analgesia. TAP blocks also an option
- Miscellaneous:
 - Assist surgeon with placement of intragastric balloon to size gastric pouch

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Anesthesia Considerations

- Before gastric division be sure all tubes are removed from esophagus to prevent inadvertent stapling or transection of tubes
- With surgeon perform leak test of anastomosis. Insure that endotracheal tube cuff is completely inflated to prevent the methylene blue from entering the pulmonary tree. Methylene blue can cause chemical pneumonitis if aspirated.
- After pouch is created, use TV monitor to advance NGT to avoid disrupting anastomosis

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Anesthesia Considerations

- Post-operative:
 - Early ambulation and adequate analgesia critical to prevent atelectasis and pulmonary embolus – particularly with open procedures
 - Aggressive pain mgt – particularly if open procedure
 - If hx of obstructive sleep apnea, consider overnight stay in ICU
 - Consider CPAP/BiPAP mask if necessary. Indicted for disrupting anastomosis but never demonstrated clinically

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Anesthetic Game Plan

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Holding Area

- Heparin 5,000 units SQ
- Unisyn 3 grams IV within 30 minutes of surgery start
- Bicitra 30 mls PO
- Ranitidine 50 mgm IV push slow for itching prophylaxis
- One liter fluid bolus prior to induction

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Induction

- Proper Positioning: Patient's head and shoulders are elevated until a straight line can be drawn from the sternal notch to the external auditory meatus.
- Pre-oxygenate with HOB elevated thirty degrees. Maintain 5-10 cms H₂O PEEP (except for patients with GERD) until ETO₂ is > 90%.
- Cricoid pressure.

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Positioning and Technique Options for Morbid Obesity

- Upright awake
- Beach chair asleep
- Ramp asleep
- Supine
- Prone awake
- FO
- DL
- DL
- VAL, SGA
- FO

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“Morbid Obesity and Tracheal Intubation”
Brodsky, Jay et al; Anesthesia and Analgesia 94:3:732-736, 2002

- Sleep apnea and a neck circumference > 40 cms or 19 inches was predictive of difficult intubations.

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“Prediction of Difficult Mask Ventilation”, Langeron, O et al: Anesthesiology 92:5, May 2000

- Variables leading to increased risk for DMV included: Presence of Beard, BMI> 26, Edentulous, Age>55, History of Snoring.

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Letters to the Editor: Anesthetic Considerations for Bariatric Surgery: Positioning is Important for Laryngoscopy. Anesthesia and Analgesia 96:6: 2003

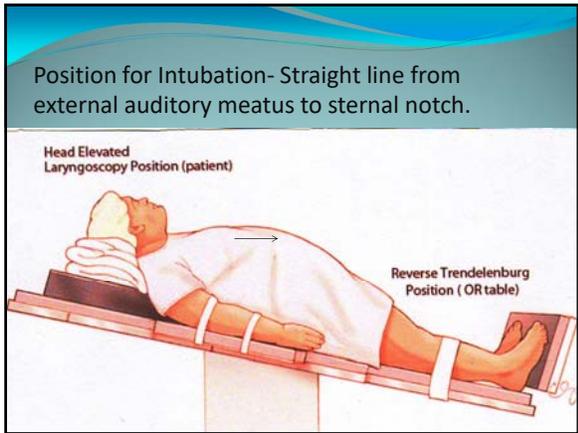
- “It is essential that the morbidly obese patient be placed with the head, upper body, and shoulders significantly elevated above the chest, so that an imaginary horizontal line should connect the patient’s sternal notch with the external auditory meatus

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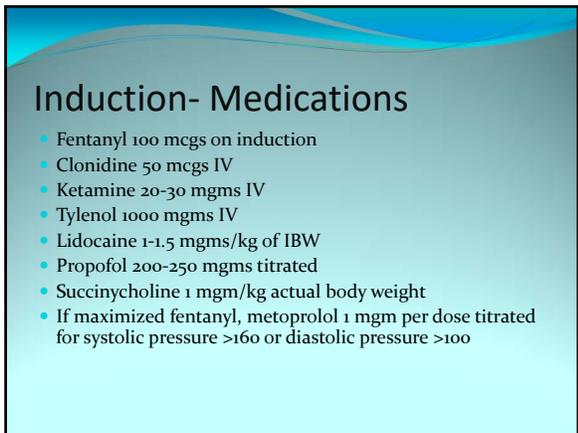
“Preoxygenation is More Effective in the 25 degree Head-up Position than in the Supine Position in Severely Obese Patients” Dixon, B.et al. Anesthesiology 2005:102:1110-1115

- Preoxygenation in the 25 degree head-up position achieves 23% higher oxygen tensions, allowing a clinically significant increase in the desaturation safety period.

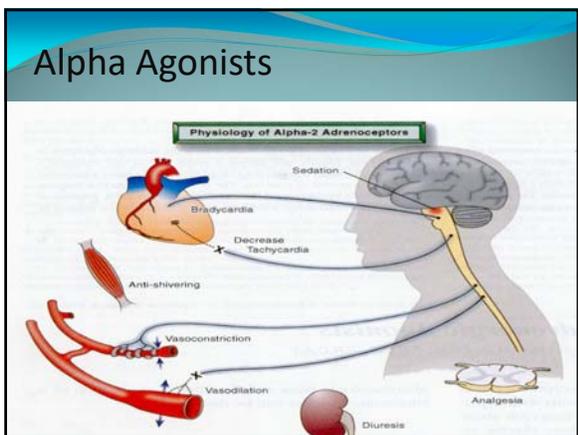
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Alpha2 Adrenoceptor Mediated Response

- CNS
 - Sedation
 - Anxiolysis
 - Analgesia

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Mediated Response

- Cardiovascular
 - Vasoconstriction
 - Vasodilation
 - Bradycardia
- Respiratory
 - Ventilation
 - Bronchodilation

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Mediated Responses

- Endocrine
 - Norepinephrine Release
 - Insulin Release
 - Cortisol Release
 - Growth Hormone Release
- Gastrointestinal
 - Salivation
 - Bowel Motility

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Alpha2 Sedation

- Dose Dependent
- Minimal Respiratory Depression
- Arousable
- ↓ Anesthetic and Analgesic Requirements
- Reversible (Atipamizole)
- Amnesia?

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Alpha2 Benefits

- No Respiratory Depression
- ↓ Anesthetic Requirements
- ↓ Analgesic Requirements
- BP control without Tachycardia
- Sedation, Anxiolysis, Analgesia
- ↓ Oxygen Demand
- ↓ Shivering

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Alpha2 Patient Selection

- High Sympathetic Activity
- Agitated/Anxious
- With Discomfort/Pain
- **NOT**
- Low Blood Pressure
- Hypovolemia
- Conduction Defects

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Alpha2 Dosing

- Dexmedetomidine
 - 10 minute loading infusion at .5-1 mcg/kg
 - .2-.7 mcg/kg/hr infusion
 - Effects in 5-10 minutes
- Clonidine
 - 10 minute loading infusion at 3-5 mcg/kg
 - One time up front dose of 1 mcg/kg
 - .3 mcg/kg/hr infusion
 - Effects in 5-10 minutes, 60-90 minutes P.O.
 - Intrathecal, epidural, Bier block, P.O., IV

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Intubation

- Discuss risk of difficulty prior to induction- have difficult airway cart in room.
- Appropriate LMA sizes should be in room
- Record # of DL attempts and grade the view
- Post intubation: Place OG tube to empty stomach and remove it completely. Never leave any tubes in the esophagus or stomach.
- Glide scope available

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Maintenance

- Zemuron: Loading dose .6 mg /kg IBW and .1-.2 mg/kg IBW /dose q 30 minutes
- Decadron 8 mg IV/Scopolamine patch/Haldol 2 mg
- Mg 2 gm in 250 cc- 100 cc/hour.
- Pressure cycled ventilation/ PEEP of 5
- Fluids: 3-5/kg/hr
- Maintain urine output at 50cc/hr
- Temperature via nares/upper body warming blanket
- Desflurane at end tidal of 5. 5.5. FIO₂ of 80%
- Precedex .5 mcgs/kg/hour

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Extubation

- Neostigmine 5 mg IV/Robinul 1 mg IV
- Sugammadex 400mg
- Toradol 30 mg IV
- Zofran 4 mg IV
- Check train of four for adequate reversal
- Extubation should be conducted with head of bed elevated thirty degrees.
- Observe patient for 5 minutes prior to transfer

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Complications

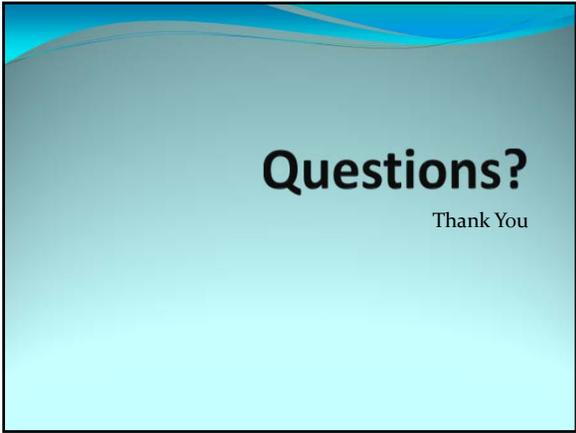
- Peritonitis (Leak)
- Obstruction
- Dehiscence
- Respiratory Failure
- PE
- Mesenteric Bleeding

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ERAS (Enhanced Recovery After Surgery)

- NPO 3 hours prior to surgery
- Carb loading drink 2 hours prior to surgery
- Lyrica PO preoperatively
- The Phase 1 Bariatric diet will be initiated 2 hours after arriving on the clinical unit
- Patient will start sipping fluids prior to GI test
- PO or PR Tylenol upon arrival to unit with morphine only for break through pain
- On POD 1 will have oxycodone 5-10 mg PO PRN

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