Obesity in Anesthesia

Presented by:
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The evolution of man
Over the past several decades, obesity has grown into a major global epidemic. In the United States (US), more than two-thirds of adults are now overweight and one-third is obese.

(Hammond & Levine, 2010).
We’re Number 1!!

America’s Rising Obesity Rate

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<tr>
<td>Percent of obese Americans</td>
<td>15%</td>
<td>22%</td>
<td>31%</td>
<td>34%</td>
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Obesity rates have increased substantially over the past 20 years and are highest in the US

U.S. Adult Obesity Rate, 2008-2015

Obesity rate (BMI of 30+) among U.S. adults, based on self-reported height and weight

2008: 35.5%
2009: 26.5%
2010: 26.6%
2011: 26.1%
2012: 26.2%
2013: 27.1%
2014: 27.7%
2015: 28.0%

Source: OECD Health Data 2012
Fig. 7.1 Age-standardized prevalence of obesity in men aged 18 years and over (BMI ≥ 30 kg/m²), 2014
Prevalence of overweight and obesity in schoolchildren aged 10-16 years, as defined by body mass index, 2001-2002

Source: The International Association for the Study of Obesity

www.xyen.co.uk
Figure 3. Prevalence of obesity among youth aged 2–19 years, by sex and age: United States, 2011–2014

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<thead>
<tr>
<th></th>
<th>All</th>
<th>Males</th>
<th>Females</th>
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<tr>
<td>2–19 years</td>
<td>17.0</td>
<td>16.9</td>
<td>17.1</td>
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<tr>
<td>2–5 years</td>
<td>8.9</td>
<td>9.2</td>
<td>8.6</td>
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<tr>
<td>6–11 years</td>
<td>17.5</td>
<td>17.8</td>
<td>17.5</td>
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<tr>
<td>12–19 years</td>
<td>20.5</td>
<td>20.1</td>
<td>21.0</td>
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*Significantly different from those aged 2–5 years.

SEDENTARY LIFESTYLE

IT'S THIS COOL NEW VIDEO GAME WHERE YOU PLAY A HEALTHY KID SHOVELING SNOW FOR MONEY...
The Vicious Cycle Of Childhood Obesity

Healthy Child

Obese Adult
Coronary artery Disease
Diabetes
Pulmonary disease
High medical bills
Mortality

Video Games
High Fat Foods

Severely Obese Child

Mildly Obese Child

Moderately Obese Child

Asthma, Diabetes, & Musculoskeletal Disease Prevent Exercise and Bring On Depression & Low Esteem

Extra 20-50 Lbs. - Exercise uncomfortable & painful

Extra 10 Lbs. - Inhibits Movement

The other kids view 1/2 of me

No Action

For my sake, please stop
Prevalence

- Socio-economic status
- Prevalence in certain regions
A Hafty Increase

In 1980, 857 million people were overweight or obese; that number rose to 2.1 billion people in 2013, a study shows.

Global obesity rates

Top 10 countries ranked by number of obese people in 2013, in millions

- U.S. 86.9
- China 62.0
- India 40.4
- Russia 29.2
- Brazil 26.2
- Mexico 24.9
- Egypt 21.8
- Germany 17.1
- Pakistan 16.7
- Indonesia 15.1

Source: Institute for Health Metrics and Evaluation

The Wall Street Journal
Prevalence\textsuperscript{a} of Self-Reported Obesity Among U.S. Adults by State and Territory, BRFSS, 2015

\textsuperscript{a}Prevalence estimates reflect BRFSS methodological changes started in 2011. These estimates should not be compared to prevalence estimates before 2011.
Mixed Messages
Great demand of care for morbid obesity for healthcare as a whole
Significance of problem

- Between 1998 and 2006 prevalence of obesity up 37%
- Obese patients spend on average 40% more
- 21% of US healthcare expenses
Are we helping?

- Less likely to do routine visits
- Possibly unaware of Comorbidities
Definitions

- Overweight BMI > 25
- Obese I BMI > 30
- Obese II BMI > 35
- Morbid obesity BMI > 40 (or BMI 35 with severe co-morbidities)
- Super Obese BMI > 50
Co-Morbidities of Obesity

- HTN
- CAD
- OSA
- CVA
- DM
- Heart failure/dysrhythmia
- OA/DJD
- DVT/PE
- Pulmonary HTN, Restrictive lung disease
- Kidney concerns
- GERD
- Infertility/Miscarriage
- Depression/Anxiety
Obesity and OSA are associated with a spectrum of comorbidities such as coronary artery disease, heart failure, stroke, and metabolic syndrome, which result in increased morbidity and mortality.

(Chau, Mokhlesi, & Chung, 2013)
Hypertension

- Obesity is associated with renin-angiotensin system
- Increased sympathetic nervous system activity
- Sodium reabsorption and fluid retention
- Hyperinsulinemia/Insulin resistance
- Free fatty acids
Coronary Artery Disease (CAD)

- Cardio-metabolic syndrome
- Atherosclerosis
- Workload on heart LVH, Metabolic demand
Kidney

Inflammation

“Adipokines”, TNF-α, IL-6, endothelin-1, CRP

Lipotoxicity
↑ Fat acid metabolism
↑ Lipid peroxidation products

Apoptosis
Fibrosis

Overweight/Obesity

Insulin resistance
Glucosuria
DM

↑ RAAS

Kidneys compression

↑ Leptin

↑ SNS

Renal vasodilation
Glomerular hyperfiltration

↑ Sodium tubular reabsorption
↓ Pressoric Natriuresis
Volume expansion
Atherosclerosis

Proteinuria

Glomerular sclerosis

Hypertension
Vasoconstriction

Chronic kidney disease
Renin Angiotensin-Aldosterone System

Regulation of aldosterone secretion by the renin–angiotensin–aldosterone (RAA) pathway.

Aldosterone helps regulate blood volume, blood pressure, and levels of Na⁺, K⁺, and H⁺ in the blood.

1. Dehydration, Na⁺ deficiency, or hemorrhage
2. Decrease in blood volume
3. Decrease in blood pressure
4. Juxtaglomerular cells of kidneys
5. Increased renin
6. Angiotensinogen
7. Increased angiotensin I
8. Lungs (ACE = Angiotensin Converting Enzyme)
9. Increased angiotensin II
10. Adrenal cortex
11. Increased aldosterone
12. In kidneys, increased Na⁺ and water reabsorption and increased secretion of K⁺ and H⁺ into urine
13. Increased blood volume
14. Blood pressure increases until it returns to normal
15. Vasoconstriction of arterioles
16. Increased K⁺ in extracellular fluid
Heart failure/rhythm disturbances

**Excessive Adipose Accumulation**
- Sleep Apnea/Obsesity Hypoventilation Syndrome
- Hypoxia/Anklyosis
- Pulmonary Arterial Hypertension
- Pulmonary Venous Hypertension
- RV Hypertrophy and Enlargement
- RV Failure
- No Change in Heart Rate
- ↑Fat-Free Mass
- ↓Systemic Vascular Resistance
- ↑Circulating Blood Volume
- ↑LV Stroke Volume
- ↑Cardiac Output
- LV Enlargement
- LV Hypertrophy
- LV Systolic Dysfunction
- LV Diastolic Dysfunction
- LV Failure

**Cardiomyopathy**
- Normal heart
- Dilated cardiomyopathy
- Hypertrophic cardiomyopathy

- Inadequate
- Adequate

- Insufficient diet
- Dietary derangement
- Excessive wall
Osteoarthritis/ DJD

- Chronic pain
- Limited exercise tolerance
DVT/PE

- Obese at increased risk
- Polycythemia
- Inflammatory mediators
Restrictive Lung Disease

- Decreased chest wall compliance
- Diaphragm forced cephalad
Pulmonary Hypertension

- Walls of pulmonary arteries become stiff and thick
- Reduction in blood flow
- Increased workload on RV to move blood through
- RV enlargement and heart failure
Insulin Resistance
GERD

Factors associated with the development of gastro-oesophageal reflux disease:
It's frustrating to watch everyone else's dreams come true while knowing your own are slipping farther and farther away from becoming reality.
Bariatric Surgery
Bariatric Surgery

- Gastric bypass, Gastric banding, or Gastric Sleeve Gastrectomy

- Surgery if BMI > 40 and failed CONSERVATIVE TREATMENTS
Following Bariatric Surgery improvements shown:

- CAD, OSA, DM control, HTN, Depression, Sexual Performance

- Surgery less costly for insurance than lifelong expenses for Co-Morbidities

- Easy way out?
Caring for a Morbidly Obese patient
Caring for a Morbidly Obese Patient

- Specialty equipment
- Pre-op workup  Pre-oxygenation/Intubation concerns
- Drug/Fluid considerations
- Post op Potential Issues
Pre-op screening

- Preoperative evaluation to address Comorbidities
  NOT DAY OF SURGERY!

- CV disease
- Pulmonary status
- Endocrine status
- Kidney functional status
- Airway
Outpatient setting

- 58 year old patient scheduled for knee arthroscopy at outpatient surgery center. 5’9”, 295lbs, uses CPAP at night.

- Should this patient be flagged at this facility?

- What’s policy at facility? Is there a policy?
While OSA patients routinely undergo outpatient procedures safely, limits need to be placed on what is considered an acceptable ambulatory patient (Sullivan, 2015)
Let's dive right in!

Capstone Overview
Evaluation of the Influence of BMI and OSA on Anesthetic Outcomes

Rebecca Sullivan MHS, CRNA, DNAP (c) ; Thomas W. Cline, MBA, Ph.D.

The movement in health care is to relocate surgical services to the ambulatory setting, yet the overall health condition of Americans has worsened. Over 30% of American adults are considered obese with a Body Mass Index (BMI) of 30 kg/m² or greater1. Obstructive sleep apnea (OSA) has a particularly high prevalence in the obese and overweight population2; however it can remain undiagnosed in up to 80% of surgical patients until the time of surgery3,4. Patients with OSA are more likely to have adverse effects such as desaturation, need for supplemental oxygen, require additional monitoring, have a potentially difficult airway, and a higher risk of death when exposed to anesthesia5.

Poor planning can place an OSA patient at high risk for intraoperative and postoperative airway issues, hypoxic events and longer PACU length of stays, which can decrease the efficiency of the surgical center. The endoscopy suite in particular proves challenging to anesthesia with the demand for an adequately anesthetized spontaneously breathing patient while sharing the airway with the endoscopist.

The purpose of the study was to determine if a relationship exists between oxygen saturation, length of PACU stay, or the need for additional interventions in patients with BMI greater than 35 and/or diagnosis of OSA while having an Esophagogastroduodenoscopy (EGD) at an outpatient facility.

Methods

• A stratified sample of patient charts was reviewed in this retrospective study.
• The sample consisted of 392 patients having an EGD procedure at Excela Square Surgical Center.
• Exclusion criteria included pregnancy and age less than 18.
• Data collection included: patient demographics, anesthetics administered, physical status, medical history, and PACU length of stay.

Results

• The OSA patients had a significantly lower oxygen saturation intraoperatively than did non-OSA patients, t=2.08, df=44.6, p=0.043 (one tailed).
• No significant relationship was revealed between OSA diagnosis or BMI and PACU length of stay.
• No significant interventions were reported during study.
• The study did determine that BMI increases were associated with a lower oxygen saturation.
• The patients physical status, or the health rating, was determined as most significant in relationship to lowest oxygen saturation. (One way ANOVA F(2,389)=3.29, p=0.038.

Discussion/Future Studies

Future studies could analyze use of OSA assessment tools such as STOP-Bang questionnaire and their ability to properly identify high risk candidates of OSA preoperatively. Additionally, the effectiveness of Continuous positive airway pressure (CPAP) or High flow humidified nasal cannula (HFNC) could be evaluated for their effectiveness perioperatively in oxygenation of obese and OSA population.

References

The purpose of the study was to determine if a relationship exists between oxygen saturation, PACU length of stay, or the need for additional interventions in patients with BMI greater than 35 and/or diagnosis of OSA while having an EGD procedure in an outpatient facility.
Study Methodology

- Outpatient setting
- IRB approval Excela Health and St. Vincent College
- 392 patients having EGD procedure performed April through September 2016 at Excela Square Norwin
- Retrospective data collection
- Exclusion criteria included pregnancy and age less than 18
Appendix A
Data Collection Tool

<table>
<thead>
<tr>
<th>ID</th>
<th>BMI</th>
<th>AGE</th>
<th>PS</th>
<th>SEX</th>
<th>OSA</th>
<th>SMOKER</th>
<th>ASTHMA</th>
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<tr>
<th>Versed</th>
<th>Fentanyl</th>
<th>Lidocaine</th>
<th>Propofol</th>
<th>Ketamine</th>
<th>Other medications</th>
<th>Highest recorded O2 setting</th>
<th>Lowest recorded O2 set.</th>
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<thead>
<tr>
<th>Surgeon</th>
<th>MDA</th>
<th>CRNA</th>
<th>Procedure length (min)</th>
<th>Procedure details</th>
<th>Procedure interventions</th>
<th>PACU LOS</th>
<th>Pacu interventions</th>
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Remarks

**Definitions:**

- **BMI:** Actual BMI recorded under appropriate column
- **Smoker:** 0=Non-smoker 1=Smoker 2=Ex-smoker 3=Smokeless tobacco
- **Asthma:** 0=No history of asthma 1=Asthma history
- **Surgeon/MDA/CRNA:** Caregivers initials will be used, for potential trends only
  (Surgeon= GI proceduralist, MDA= Anesthesiologist, CRNA= Certified Registered Nurse Anesthetist and Student Anesthetist when applicable)
- **Procedure Details:** 1=EGD, 2=EGD with Biopsy, 3= Balloon Dilatation, 4= Control of Bleeding
- **Procedure Length:** Time in Minutes from recorded procedure start time to stop time
- **Procedure intervention:** Bag mask ventilation, placement of airway, spasm or procedure early stop related to patient airway issue
- **Medications:** Values are the dosage in Mg unless otherwise noted
- **Other medications:** Any additional medications given not listed in a specific column
- **Lowest Recorded O2 set:** Recorded in percentage
- **PACU LOS:** Time in minutes from anesthesia end to PACU discharge time.
- **PACU intervention:** Any additional airway assistance or supportive care. Intervention specifically stated in column
- **Remarks:** Any details deemed important by researcher regarding specifics of case
Results

- OSA
- BMI
- PACU length of stay analysis
Study Statistical Breakdown
Only 31% of study patients had OSA diagnosis.

OSA patients had significantly lower Oxygen saturation (M = 93.5, SD = 3.76) than did non-OSA patients (M = 95.1, SD = 6.03).

PACU length of stay was no statistically significant difference between OSA and non-OSA groups.
BMI Results

**Negative relationship** determined between BMI and Oxygen saturation

BMI categories (<35, 35-40, and >40) and Lowest Oxygen Saturation and PACU length of stay as the outcome variables. **Neither test emerged significant**
Smoker vs Nonsmoker

- Lowest Oxygen saturation emerged significant, \( t = 2.12, df = 343, p = 0.034 \) (two-tailed).
- Smokers showed lower levels of Oxygen saturation (M = 93.21, SD = 13.17) than did non-smokers (M = 95.22, SD = 3.9). No significance was found in PACU length of stay.
A bivariate, Pearson correlation matrix was computed with Oxygen saturation and four drugs: Versed, Fentanyl, Lidocaine, and Propofol.

Only one correlation emerged marginally significant: Propofol and Oxygen saturation, $r = 0.088, p = 0.081$.

Higher levels of Propofol are associated with marginally higher Oxygen saturation levels.
A bivariate Pearson correlation matrix was computed with PACU length of stay and four drugs: Versed, Fentanyl, Lidocaine, and Propofol.

One correlation emerged statistically significant: Fentanyl and PACU length of stay, $r = 0.151$, $p = 0.003$. Higher levels of Fentanyl are associated with longer PACU length of stay.
Physical status and oxygen saturation

The results indicate PS captures a majority of the variance in lowest Oxygen Saturation, not BMI.

Physical status is statistically related to lowest Oxygen Saturation.
Study limitations

- STOP-Bang data could have proved useful in this study.
- No time of day or PACU nurse was retrieved.
- Patients baseline oxygen saturation was not recorded.
- Cerner technology only allowed for review of q5minute vitals signs.
- No airway interventions documented.
Implications for Future practice

- Patients with elevated BMI and OSA (suspect with STOP-Bang)
  - Must treat differently with care
  - Support ventilation and oxygenation
    - CPAP OR HFNO
- Adapt anesthetic
  - Fentanyl increased dosage showed longer PACU stay
  - No difference with Ketamine anesthetic (minimal subjects-7)
  - No difference with Versed administration
  - Higher Propofol dosages correlated with higher oxygen saturation levels
Society of Anesthesiologists (ASA) suggests patients with OSA are observed for prolonged periods after surgery, and some patients may be candidates to receive Continuous Positive Airway Pressure (CPAP) in the PACU.
High flow humidified nasal oxygen (HFNO)

- High flow humidified nasal cannula (HFNC) are designed to administer heated and humidified air/oxygen mixtures at high flows (up to 60 liters/min).
- These HFNC systems enhance patient comfort and tolerance compared with traditional oxygenation systems while washing out nasopharyngeal dead space and providing Positive End Expiratory Pressure (PEEP).

Back to the program!
OSA

- See it on chart all the time...no biggie right?!!
- 300lb patient says" I don't snore"??!!
- Screening tools:
  - Approximately 18 million people in US who have an increased risk during surgery r/t undiagnosed OSA!
  - OSA patients are approximately 15% of surgical population
Stop Bang Questionnaire

- In the surgical population, a STOP-Bang score of 5–8 identified patients with high probability of moderate/severe OSA.

- The STOP-Bang score can help the healthcare team to stratify patients for unrecognized OSA, practice perioperative precautions, or triage patients for diagnosis and treatment.

Obstructive Sleep Apnea (OSA) has a particularly high prevalence in the obese and overweight population (Brenner & Goldman, 2014).

Despite documented correlation, OSA can remain undiagnosed in up to 80% of surgical patients until the time of surgery* 

(Gharibeh & Mehra, 2010; Memtsoudis, Stavros G, Besculides, Melanie C., Mazumdar, 2013).
Obesity results in a threefold increase in difficulty with mask ventilation as well as increased risk of difficult intubation compared to those of normal BMI.

Patients with obesity are sensitive to the respiratory depressant effects of anesthetic agents due to the propensity for airway collapse, sleep deprivation and blunting of physiologic response to hypercapnia and hypoxemia.

(Chau, Mokhlesi, & Chung, 2013).
Studies show most critical period for patients with OSA is post op...

- Monitoring not as vigorous
- Effects of sedatives and anesthetics may persist
- Protection of the upper airway
- Sleep deprivation
- Pain or breathing concerns
Anesthesia considerations for Morbidly Obese patient population

- Airway Management
- Positioning
- Narcotics/sedatives
- Fluid Management
- Medication Management
Preop and induction

- Difficult airway/mask
- Obtain consent for awake intubation/post op ventilation
- Pre-mEDIATE
- Pre-oxygenation
- Positioning
- Extra staff in room
Intraoperative Management

- Pharmacological dosing
- Fluid management
- Ventilation concerns
- Extubation
Volume of Distribution

- \( V_d = \) amt of drug/plasma concentration

- small \( V_d = \) relative confinement of drug in iv space thus leading to high plasma concentration

- high \( V_d = \) lower concentration in plasma

- can be altered by co-morbidities- obesity, renal failure
BMI = kg/ht m2
- 5'2 123kg
  - 62in x 2.54cm = 157.48cm / 100 = 1.57 m
  - 1.57 x 1.57 = 2.46 m²
  - 123kg / 2.46 m² = 50 BMI

Ideal vs low body weight
- IBW (LEAN) BMI approx. 20 BMI 5' = 100 lb
- LBW = BMI 30
Fluid calculations

Specific to surgical and patient needs not true body weight

Lipid soluble drugs use real weight

Low vd drugs (muscle relaxants) use IBW

What do we do with BMI?
Intraop goals

- Volatile agents in obesity? Which is better?
- Do not overdo it with narcotics or benzos!!
- Minimal reserve, maintain O2 saturation and normocapnia
- Maintain normal VSS... no tachy, hypertensive episodes
- Extubation criteria must be met
Final take home message

• Take more time to evaluate, prepare and arrange HELP!

• How you manage patient may have profound effect on post op course

• Multiple, often undiagnosed co-morbidities

• 1 out of 5 patients is obese
References


