Anesthesia for Bariatric Surgery

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Anesthesia for Bariatric Surgery: Goals and Objectives
• Define “ideal” and “lean” body weight for appropriate drug dosing and ventilator management.
• Select the optimal position for an obese surgical patient for direct laryngoscopy and to maximize “safe apnea time”.
• Recognize the risk factors for a “difficult” airway in obesity.
• Identify which morbidly obese patients require a rapid sequence induction and which do not.
• Choose the safest airway management technique for the obese patient.

Why is “Ideal Body Weight” Important?
• Controlled ventilation (Vt) is based on “Predicted” or Ideal Body Weight (IBW)
• Anesthetic drugs are administered by IBW or Lean Body Weight (LBW); Not actual total body weight (TBW)

<table>
<thead>
<tr>
<th>Anesthetic Drug</th>
<th>Weight Type</th>
</tr>
</thead>
<tbody>
<tr>
<td>Vecuronium</td>
<td>IBW</td>
</tr>
<tr>
<td>Rocuronium</td>
<td>IBW</td>
</tr>
<tr>
<td>Cis-Atracurium</td>
<td>IBW</td>
</tr>
<tr>
<td>Propofol (induction)</td>
<td>LBW</td>
</tr>
<tr>
<td>Fentanyl</td>
<td>LBW</td>
</tr>
<tr>
<td>Sufentanil</td>
<td>LBW</td>
</tr>
<tr>
<td>Remifentanil</td>
<td>LBW</td>
</tr>
<tr>
<td>Succinylcholine</td>
<td>TBW</td>
</tr>
<tr>
<td>Sugammadex</td>
<td>TBW (IBW, LBW)</td>
</tr>
</tbody>
</table>
There is no physiologic basis for IBW

"Ideal Body Weight" – in 1942 Metropolitan Life Insurance Co. published height and weight tables associated with lowest mortality rates among policy holders!

Uninsured (with health problems) were excluded *

* Met Life not representative of general population - between 1911-1937 life expectancy for Met Life policyholders increased +17.0 years vs +11.5 years for entire US population

Met Life - Ideal Body Weight Tables

- Data only from insured, healthy adults 25-59 year old
- Height and weight obtained while applicants wore shoes and clothing
- No standardized measuring equipment
- Self-reported height and weight accepted
  - women underestimated weight
  - men overestimated height

Ideal Body Weight Tables
Metropolitan Life Insurance Company (1942-1943)

Ideal Body Weight (kg) Formulas

**MEN**

- Height (cm) – 100
- Height (cm) -102
- 50 kg (60 in) + 2.3 kg/in
- 52 kg (60 in) + 1.9 kg/in
- 56.2 kg (60 in) + 1.41 kg/in
- 22 x M^2

**WOMEN**

- Height (cm) – 110
- Height (cm) - 105
- 45.5 kg (60 in) + 2.3 kg/in
- 49 kg (60 in) + 1.7 kg/in
- 53.1 kg (60 in) + 1.36 kg/in
- 22 x M^2

Ideal Body Weight (kg) (IBW) = (22)(m^2)


Lean Body Weight (LBW) in a normal weight patient

(Men) LBW = 80% IBW
(Women) LBW = 75% IBW
What is “OBESITY”?

Fat comprises greater than normal percentage of body weight

Why are 2 out of 3 American women “overweight”?

Body Mass Index (BMI = kg/m²)

- 18.5 - 25: Ideal, Normal, Desirable, Predicted, Healthy
- 25 - 29: Overweight
- 30 - 39: Obese
- > 40: Morbid Obesity
- > 50: Super-Obese
- > 60: Super-Super-Obese

World Health Organization Classification by BMI (1998)

<table>
<thead>
<tr>
<th>Classification</th>
<th>BMI (kg/m²)</th>
<th>Risk of co-morbidities</th>
</tr>
</thead>
<tbody>
<tr>
<td>Underweight</td>
<td>&lt; 18.5</td>
<td>Low</td>
</tr>
<tr>
<td>NORMAL range</td>
<td>18.5 – 24.9</td>
<td>Average</td>
</tr>
<tr>
<td>Obese</td>
<td>≥ 30.0</td>
<td>Increased</td>
</tr>
<tr>
<td>Class I</td>
<td>30.0 – 34.9</td>
<td>Moderate</td>
</tr>
<tr>
<td>Class II</td>
<td>35.0 – 39.9</td>
<td>Severe</td>
</tr>
<tr>
<td>Class III</td>
<td>≥ 40.0</td>
<td>Very severe</td>
</tr>
</tbody>
</table>

Average Weight for American Adults (1998)

Janmahasatian Formula

For men:

\[ LBW (kg) = \frac{9270 \times TBW (kg)}{6680 + (216 \times BMI (kg/m²))} \]

For women:

\[ LBW (kg) = \frac{9270 \times TBW (kg)}{8780 + (244 \times BMI (kg/m²))} \]

LBW in Obesity (BMI > 30 kg/m²)

IBW + 20 - 30%
June 17, 1998

National Heart, Lung, and Blood Institute (NHLBI) declared previous BMI standards too lenient

Changed “over-weight” cutoffs from BMI (>27.8 men, >27.3 women) to >25 for both men and women

Overnight prevalence of “overweight” increased from 33% to 59% (men) and 36% to 51% (women)

Without gaining a pound, Americans with a “normal” BMI on June 16, 1998 woke up the next day to learn that their health was now in danger

By simply changing the definition, the number of over-weight adults in USA increased by 35.4 million in one day!

BMI measures weight

BMI is not a direct measure of obesity!

Distribution (and type) of fat is most important

Metabolic Syndrome

- Waist circumference: >102 cm (men) and >88 cm (women)
- Serum triglycerides: ≥150 mg/dl
- HDL cholesterol: <40 mg/dl (men) and <50 mg/dl (women)
- Systolic blood pressure: >130 mmHg and/or diastolic blood pressure ≥85 mmHg or on treatment for hypertension
- Fasting serum glucose: ≥110 mg/dl or on treatment for diabetes
Visceral (central) fat is an endocrine organ releasing peptides, metabolites, hormones, FFA, cytokinase, and other compounds throughout the body.

**BMI**

<table>
<thead>
<tr>
<th>BMI</th>
<th>Underweight</th>
<th>Overweight</th>
<th>Obese I</th>
<th>Obese II</th>
<th>Obese III</th>
</tr>
</thead>
<tbody>
<tr>
<td>18.5 or less</td>
<td>Underweight</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
</tr>
<tr>
<td>18.5 - 24.9</td>
<td>Normal</td>
<td>Increased</td>
<td>High</td>
<td>Very High</td>
<td>Very High</td>
</tr>
<tr>
<td>25.0 - 29.9</td>
<td>Overweight</td>
<td>Increased</td>
<td>High</td>
<td>Very High</td>
<td>Very High</td>
</tr>
<tr>
<td>30.0 - 34.9</td>
<td>Obese I</td>
<td>High</td>
<td>Very High</td>
<td>Very High</td>
<td></td>
</tr>
<tr>
<td>35.0 - 39.9</td>
<td>Obese II</td>
<td>Very High</td>
<td>Very High</td>
<td></td>
<td></td>
</tr>
<tr>
<td>40 or greater</td>
<td>Obese III</td>
<td>Extremely High</td>
<td>High</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**MYTH:**

Being overweight/obese is *always* bad for your health.

**Obesity Paradox** is the medical hypothesis that obesity may be protective and associated with greater survival in certain groups of people.

**Obesity Paradox**

[Graph showing 60 day hospital mortality by BMI categories.]

Cancer survival (years)

Pad all pressure points and support extremities

Indications - LMA
- Short (<1 hr) elective procedures
- ASA-PS 1 or 2 patients

To be used in:
- Spontaneously breathing patients
- Supine or lithotomy positions only

LMA: Contra-indications
- Decreased pulmonary compliance (present in all obese patients)
- High risk of aspiration

FRC (ERV) decreases with increasing BMI

… obese patients should not be allowed to breathe spontaneously for anything other than the shortest procedure.”

Potential Risk Factors for Gastric Aspiration in Obesity
- Delayed gastric emptying
- Decreased pH gastric fluid
- Increased gastric fluid volume
- High incidence hiatal hernia and GERD
- Diabetic with gastroparesis
- Increased abdominal pressure (laparoscopy, lithotomy)
- Previous gastric banding


Approximately 2.9 million anaesthetics in UK
- 42% pts who experienced a major airway complication (death, brain damage, emergency surgical airway, or ICU admission) were obese
- Obese pts had 2X risk of serious airway problems during anesthesia
- "Severe" obesity 4X more likely to have airway problems

Morphobly obese at increased risk of regurgitation and aspiration (50% of deaths in NAP-4)

Obese patients had increased frequency of aspiration associated with use of supraglottic devices (LMAs)….
• ETT achieves the best protection against aspiration and can enable increased pressure during ventilation

• second-generation SGAs with improved seal may be safer in obesity – but (in 2011) no evidence available

Published May 16, 2011

Role of 2nd Generation SGAs in Obesity?

Are the airways of morbidly obese patients “difficult”

Answer: Yes and No!

What is a Difficult Airway?

“difficult airway .... clinical situation in which a conventionally trained anesthesiologist experiences problems with face mask ventilation and/or tracheal intubation”

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Published May 16, 2011

A comment on NAP4 from The Society of Bariatric Anaesthetists (SOBA)
Nightingale CE, et al.

• SOBA recommends tracheal intubation for patients with BMI > 35 kg/m²
• ETT should be the default airway (in obesity) with justification for the use of a SGA


... intubation “problems” are 3 times more likely to occur in obese compared to normal weight patients!

Jay B. Brodsky, MD
Anesthesia for Bariatric Surgery
Face Mask Ventilation (MV)

<table>
<thead>
<tr>
<th>Grade</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Ventilated by mask</td>
</tr>
<tr>
<td>2</td>
<td>Ventilated by mask with oral airway/adjunct with or without muscle relaxant</td>
</tr>
<tr>
<td>3</td>
<td>Difficult ventilation (inadequate, unstable, or requiring two providers) with or without muscle relaxant</td>
</tr>
<tr>
<td>4</td>
<td>Unable to mask ventilate with or without muscle relaxant Total cases</td>
</tr>
</tbody>
</table>


“Intubation” Difficulty Score (IDS)

1. Number of additional attempts at intubation
2. Number of additional operators
3. Number of alternate intubation techniques used
4. Glottic exposure (Grade 2-4 Cormack-Lehane view)
5. “Lifting force” applied during laryngoscopy
6. Need to apply external laryngeal pressure
7. Position of the vocal cords at intubation

IDS < 5 = not difficult
IDS ≥ 5 = difficult


Potential “Difficult” Tracheal Intubation Predictors

**ABNORMAL FACIAL ANATOMY and/or DEVELOPMENT**
- Small mouth and/or large tongue
- Dental abnormality, prominent incisors, poor dentition
- Prognathia
- Acromegaly
- Congenital syndrome (e.g., Treacher-Collins)

**INABILITY TO OPEN MOUTH**
- Masseter muscle spasm
- Temporo-mandibular joint dysfunction
- Facial burns
- Post-radiation fibrosis
- Scleroderma

**CERVICAL IMMOBILITY/ABNORMALITY**
- Short neck or obesity + large neck circumference
- Poor cervical mobility (e.g., arthrosis spondylitica)
- Previous cervical spine and/or neck surgery
- Presence of cervical collar
- Post-radiation fibrosis

**PHARYNGEAL and/or LARYNGEAL ABNORMALITY**
- High or anterior larynx
- Deep vallecula (inability to reach base of epiglottis with blade)
- Anatomic abnormality of epiglottis/hypopharynx (e.g., tumor)
- Subglottic stenosis
- Obstructive Sleep Apnea

**Stanford Anesthesia Residents – Direct Laryngoscopy**

100 Consecutive Morbidly Obese Patients

- **1st attempt**: 92% (92/100)
- **2nd attempt**: 5% (5/100)
- **3rd attempt**: 2% (2/100)
- **Failed**: 1% (1/100)


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**Direct Laryngoscopy (Cormack-Lehane View)**


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**What Should You Look For?**

- Always be prepared for a difficult tracheal intubation

Mallampati Score II/IV

- **Neck Circumference > 60 cm**

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**Routine Position Anesthetic Induction – Supine**

- Increased intra-abdominal pressure
- Reduced chest wall compliance
- Decreased lung volumes

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378/379 pts (4 studies) successfully intubated by conventional direct laryngoscopy!

All 4 studies stated... “magnitude of obesity did not influence laryngoscopy difficulty!”
**Pre-oxygenation**

Normally patients are pre-oxygenated with 100% oxygen via a tight-fitting facemask for:
- 3 min at tidal volume ventilation
- 8 vital capacity breaths within 60 s

**Safe Apnea Period (SAP)**

Time from any given SpO2 90 - 92%

**Position and SAP and SpO2 Recovery Times in Morbidly Obese Patients**

<table>
<thead>
<tr>
<th></th>
<th>Safe Apnea</th>
<th>Recovery Time</th>
<th>Lowest SaO2 %</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>178±55</td>
<td>80±30</td>
<td>83±4</td>
</tr>
<tr>
<td></td>
<td>123±24</td>
<td>206±64</td>
<td>82±5</td>
</tr>
<tr>
<td></td>
<td>153±63</td>
<td>97±41</td>
<td>83±4</td>
</tr>
</tbody>
</table>

Data is Mean ± Standard Deviation.

**FRC and SAP inversely proportional to BMI**

FRC and SAP inversely proportional to BMI

**Obese patients desaturate rapidly** – time from anesthetic induction to assisted ventilation should be minimised, and efforts should be made to increase “Safe Apnea Period” (SAP)

**Transnasal Humidified Rapid-Insufflation Ventilatory Exchange (THRIVE)**

Nasal Oxygen Insufflation and SAP

- Morbidly obese patients
- 25° head-up position
- Pre-oxygenation with facemask - FiO₂ 1.0 at 10L/min for 3 min
- Paralyzed with succinylcholine

- 5 L/min nasal O₂ during laryngoscopy
- 16/17 pts – SpO₂ 100% after 4 mins apnea

Standard Preoxygenation (N=20)  
Buccal Oxygenation (N=20)


Positive Pressure Face Mask and P-LMA Ventilation and SAP

<table>
<thead>
<tr>
<th>FM (n=52)</th>
<th>PLMA (n=48)</th>
</tr>
</thead>
<tbody>
<tr>
<td>SAP (seconds)</td>
<td>265.0±48.2</td>
</tr>
<tr>
<td>Range</td>
<td>96–320</td>
</tr>
<tr>
<td>Recovery time (seconds)</td>
<td>49.7±6</td>
</tr>
<tr>
<td>Range</td>
<td>36–68</td>
</tr>
<tr>
<td>Lowest SpO₂</td>
<td>63.4±7</td>
</tr>
<tr>
<td>Range</td>
<td>43–79</td>
</tr>
</tbody>
</table>


3.5 mm id RAE tube

- 40 patients, BMI 30-40 kg m²
- Face-mask preoxygenation until ET-O₂ = .8
- 20 pts - 10 L/min O₂ via buccal RAE tube
- Intubation with Glidescope 150 secs after paralysis
- Maintained laryngoscopy until SpO₂ < 95%, or 750 secs (12.5 mins) elapsed


“Ideal” Position for Morbidly Obese Patient

Improves view during direct laryngoscopy

Increases safe apnea time
Mechanical Ventilation and Obesity

Reduce atelectasis during and after anesthetic induction

• \( \text{FiO}_2 < 0.8 \) - may prevent absorption atelectasis/hypoxia

• Positive-pressure ventilation during induction - increases "safe apnea period" for intubation

• Recruitment maneuver (RM) immediately after intubation using a sustained (8-10 seconds) pressure > 50 cm H\(_2\)O

Supine

Increased intra-abdominal pressure (IAP)
decreased chest wall compliance and lung volume

Lithotomy

Further reduction in chest wall compliance and lung volumes

Trendelenburg

Greatest reduction in chest wall compliance and lung volumes

Effects of Capnoperitoneum during Laparoscopy

Respiratory Mechanics

- Peak Inspiratory Pressure (PIP) Increased
- Respiratory Compliance Decreased
- Ventilator Changes (to reduce PIP and CO\(_2\))
- Respiratory Rate Increased
- Tidal Volume Decreased
- Minute Ventilation Increased

Avoid Lung Overdistention

• Tidal volume ventilation (6 - 8 ml/kg/"IBW")
  - use even smaller VT for "protective lung ventilation"
  - avoid larger VT and/or high ventilatory pressures

• Increase ventilator rate for excessive hypercapnia
  - adjust ventilator to maintain physiologic end-tidal CO\(_2\)
  - consider “permissive hypercapnia”

• Keep end-inspiratory (plateau) pressure < 30 cm H\(_2\)O

Figure NT-Wolle BM. The physiologic effects of pneumoperitoneum in the morbidly obese. Annu Surg 2005; 241:219-226

Anesthesia for Bariatric Surgery
Keep lungs expanded

- **PEEP (10 cm H₂O)**
  - Monitor for adverse effects of PEEP: bradycardia, hypotension
  - Hypotension or decreasing SpO₂ may be due to PEEP increasing pulmonary shunt fraction

- Prevent re-occurrence of atelectasis with intermittent recruitment maneuvers (RM)

### Maintain post-operative lung expansion

- CPAP or BIPAP immediately after tracheal extubation
- Keep patient’s upper body elevated
- Supplemental nasal or mask oxygen
- Maintain good pain control (limit opioids)
- Use incentive spirometry
- Encourage early ambulation

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Is there a “best” anesthetic for morbidly obese patients?
Desflurane is least fat soluble - less deposition in fat - faster recovery from anesthesia

<table>
<thead>
<tr>
<th>Solubility of Inhaled Anesthetics</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Desflurane</strong></td>
</tr>
<tr>
<td>Fat</td>
</tr>
<tr>
<td>Blood</td>
</tr>
<tr>
<td>Brain</td>
</tr>
<tr>
<td>Heart</td>
</tr>
<tr>
<td>Liver</td>
</tr>
<tr>
<td>Kidney</td>
</tr>
<tr>
<td>Musc.</td>
</tr>
</tbody>
</table>


**Remifentanil**

<table>
<thead>
<tr>
<th>Table 2. Recovery profile (min): duration to achieve required stages of post-anesthesia recovery from ending of surgery and discontinuation of propofol infusion</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Group R</strong></td>
</tr>
<tr>
<td>---------------------------------------------------------------</td>
</tr>
<tr>
<td>Response to verbal command</td>
</tr>
<tr>
<td>Spontaneous respiration</td>
</tr>
<tr>
<td>Adequate respiration</td>
</tr>
<tr>
<td>S/A</td>
</tr>
</tbody>
</table>

*Values are mean ± SD; *P<0.05 compared with Group F.*
Remifentanil

• Ultra-short acting opioid – half life 3-6 mins - hydrolyzed by non-specific blood and tissue esterases
• Quick recovery – no respiratory depression
• Blunts hemodynamic and cardiac responses to surgery

Administered by bolus or infusion

Remifentanil

Administered with either propofol infusion or inhalational anesthetic (isoflurane)

Ideal for MO/OSA patients – eliminates concern about opioid induced post-operative respiratory depression

?? Increased post-operative pain
?? Increased nausea and vomiting

Dexmedetomidine

– Centrally acting alpha-2 agonist - hypnotic/ anxiolytic/ sympatholytic/ analgesic effects
– Minimal respiratory depression
– Cannot be used alone
– Loading dose can cause hypotension, especially when volume depleted
– Causes relative bradycardia
– Long duration (30-90 min)
– Expensive

Table 2. Polypeptides Need for Propofol, Remifentanil and Duration of Body Methylolation Phases. Time from Tanning Off the Stool/Barium to Patient’s Medication, First Spontaneous Eye Opening, Following Skin Grafts, Dextrinization, and the Duration of the Polypeptide Core (ICU) Stay.

<table>
<thead>
<tr>
<th>Time</th>
<th>Control</th>
<th>Dex 0.2</th>
<th>Dex 0.4</th>
<th>Dex 0.8</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hour</td>
<td>(n = 200)</td>
<td>(n = 200)</td>
<td>(n = 200)</td>
<td>(n = 200)</td>
</tr>
<tr>
<td>Recovery from surgery</td>
<td>0.5</td>
<td>0.5</td>
<td>0.5</td>
<td>0.5</td>
</tr>
<tr>
<td>Time to surgery start</td>
<td>0.5</td>
<td>0.5</td>
<td>0.5</td>
<td>0.5</td>
</tr>
<tr>
<td>Time to eye opening</td>
<td>19.3</td>
<td>19.3</td>
<td>19.3</td>
<td>19.3</td>
</tr>
<tr>
<td>Time to first step after surgery</td>
<td>0.5</td>
<td>0.5</td>
<td>0.5</td>
<td>0.5</td>
</tr>
<tr>
<td>Pain in hospital ward</td>
<td>0.5</td>
<td>0.5</td>
<td>0.5</td>
<td>0.5</td>
</tr>
<tr>
<td>Duration of the ICU stay (min)</td>
<td>0.5</td>
<td>0.5</td>
<td>0.5</td>
<td>0.5</td>
</tr>
</tbody>
</table>

Dexmedetomidine infusion rate of 0.2 g/kg/h is recommended to facilitate early recovery while minimizing adverse perioperative cardiovascular side effects.