Ventilation Strategies in Obese Patients

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The Future is BIG!
Managing the obese patient
Objectives
Obesity

- A condition of excessive body fat
- Associated health conditions include:
  - Hypertension
  - Coronary artery disease
  - Diabetes mellitus
  - Obstructive sleep apnea
  - Hyperlipidemia
  - Gallbladder disease
Obesity vs. Overweight

- **Obesity**
  - An abnormally high percentage of body weight as fat

- **Overweight**
  - An increased body weight above a standard related to height
Obesity

- **Android obesity**
  - Truncal distribution of adipose tissue
  - Associated with an increase in oxygen consumption and an increased incidence of cardiovascular disease

- **Gynecoid obesity**
  - Adipose distribution in the hips, buttocks, and thighs

*Intra-Abdominal fat is particularly associated with cardiovascular risk and left ventricular dysfunction*
TYPES OF OBESITY – Are you an Apple or a Pear??

**Apple/Android**
- Excess Fat on the Abdomen
- Common in Men
- Significant correlation with Metabolic Syndrome.

**Pear/Gynoid**
- Excess Fat on the things and buttocks
- Common in Women
- Non significant correlation with Metabolic Syndrome.
BMI Classification

<table>
<thead>
<tr>
<th>BMI</th>
<th>Classification</th>
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</thead>
<tbody>
<tr>
<td>&lt; 18.5</td>
<td>underweight</td>
</tr>
<tr>
<td>18.5–24.9</td>
<td>normal weight</td>
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<tr>
<td>25.0–29.9</td>
<td>overweight</td>
</tr>
<tr>
<td>30.0–34.9</td>
<td>class I obesity</td>
</tr>
<tr>
<td>35.0–39.9</td>
<td>class II obesity</td>
</tr>
<tr>
<td>≥ 40.0</td>
<td>class III obesity</td>
</tr>
</tbody>
</table>
Obesity
Effects on Respiratory System

- Decreased chest wall compliance
- Decreased lung compliance
- Decreased FRC
  - Primarily a result of reduced expiratory reserve volume
  - Reduced FRC can result in lung volumes below closing capacity in the course of normal ventilation
Obstructive Sleep Apnea

- Up to 5% of obese patients have clinically significant obstructive sleep apnea.
- Apnea is defined as 10 seconds or more of total cessation of airflow despite continuous respiratory effort against a closed glottis.
Obesity
Effects on Blood Volume

- Total blood volume is increased in the obese, but on a volume-to-weight basis, it is less than in nonobese individuals (50 ml/kg compared to 70 ml/kg).

- Most of this extra blood volume is distributed to the fat organ.
Cardiac output increases as much as 20 – 30 ml/kg of excess body fat secondary to ventricular dilatation and increasing stroke volume.

The increased left ventricular wall stress leads to:

- Hypertrophy
- Reduced compliance
- Impaired left ventricular filling
- Obesity cardiomyopathy
Obesity
Effects on Gastrointestinal System

- Gastric volume and acidity are increased
  - Most fasted morbidly obese patients presenting for elective surgery have gastric volumes in excess of 25 ml and gastric fluid pH less than 2.5 (the generally accepted volume and pH indicative of high risk for pneumonitis should regurgitation and aspiration occur).

- Gastric emptying may actually be faster in the obese, but because of their larger gastric volume (up to 75% larger), the residual volume is larger.
Obesity and Diabetes

- Impaired glucose tolerance in the morbidly obese is reflected by a high prevalence of type II diabetes mellitus as a result of resistance of peripheral fatty tissues to insulin.

- Greater than 10% of obese patients have an abnormal glucose tolerance test, which predisposes them to wound infection and an increased risk of myocardial infarction during periods of myocardial ischemia.
Obesity
Effects on the Airway

- Anatomic changes that contribute to potential for difficult airway management
  - Limitation of movement of the atlantoaxial joint and cervical spine by upper thoracic and low cervical fat pads
  - Excessive tissue folds in the mouth and pharynx
  - Short thick neck
  - Suprasternal, presternal and posterior cervical fat
  - Very thick submental fat pad

- Obstructive sleep apnea
  - Predisposes to airway difficulties during anesthesia
  - OSA patients have excess tissue deposited in their lateral pharyngeal walls which may not be recognized during routine airway examination
Figure 2. Patient in ramp position prior to anesthetic induction.
Obesity
Effects on Drug Distribution

- Volume of Distribution in Obese patients is affected by:
  - Reduced total body water
  - Increased total body fat
  - Increased lean body mass
  - Altered protein binding
  - Increased blood volume
  - Increased cardiac output
Obesity
Effects on Drug Elimination

- Hepatic clearance is not usually effected
- Renal clearance of drugs is increased in obesity because of increased renal blood flow and glomerular filtration rate
Obesity
How does it effect drug dosing?

- Highly Lipophilic
  - Barbiturates and benzodiazepines have an increased volume of distribution

- Less Lipophilic
  - Little or no change in volume of distribution with obesity

- Increased blood volume in the obese patient decreases the plasma concentrations of rapidly injected intravenous drugs.

- Fat has poor blood flow and doses calculated on actual body weight could lead to excessive plasma concentrations.

* Review Barash et al table 47-5*
Obesity
Preoperative Evaluation

- Previous anesthetic experiences
- Attention should focus on the cardiorespiratory system and airway
- Signs of cardiac failure
  - Elevated jugular venous pressure
  - Pulmonary crackles
  - Peripheral edema
- Signs of pulmonary hypertension
  - Exertional dyspnea
  - Fatigue
  - Syncope
Neck circumference

- The single biggest predictor of problematic intubation in morbidly obese patients
- 40 cm neck circumference = 5% probability of a problematic intubation
- 60 cm neck circumference = 35% probability of a problematic intubation

A larger neck circumference is associated with the male sex, a higher Mallampati score, grade 3 views at laryngoscopy, and obstructive sleep apnea
Obesity
Induction of General Anesthesia

- Adequate preoxygenation
  - Rapid desaturation because of increased oxygen consumption and decreased FRC
  - Positive pressure ventilation during preoxygenation decreases atelectasis formation and improves oxygenation

- Patient position
  - The head-up (reverse tredelenburg) position provides the longest safe apnea period during induction of anesthesia
Obesity
Patient positioning

- **Supine**
  - Causes ventilatory impairment and inferior vena cava and aortic compression

- **Trendelenburg**
  - Further worsens FRC and should be avoided

- **Reverse Trendelenburg**
  - Increased compliance results in lower airway pressures

- **Prone**
  - Detrimental effects on lung compliance, ventilation and arterial oxygenation
  - Increased intra-abdominal pressure worsens IVC and aortic compression and further decreases FRC
Obesity
Ventilating the obese patient

- Tidal volumes greater than 13 ml/kg offer no added advantage
  - Increasing tidal volume beyond 13 ml/kg increases PIP without improving arterial oxygen tension

- Positive end-expiratory pressure (PEEP) is the only ventilatory parameter that has consistently been shown to improve respiratory function in obese patients
  - PEEP may reduce venous return and cardiac output
Dietary Consumption Available to Population

1961  2003