Caring for the Morbidly Obese Patient in the ICU

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Objectives

- Identify factors unique to obesity that impact critical illness
- Discuss specific critical care therapeutic options for patients with obesity
- Recognize the importance of a multi-disciplinary approach to managing the critically ill obese patient
Definitions

The term ‘obesity’ - derived from the latin word obesus, meaning ‘having eaten until fat’

BMI = body wt (kg)/ height 2 (meters)

NML <25 kg/m²  Overweight 25 – 30 kg/m²  Obese 30-35 kg/m²

Morbidly Obese 36 – 54 kg/m²  Super Morbidly Obese >55 kg/m²

Endorsed by WHO and NIH
## Management Topics

- Airway
- Respiratory
- Cardiology
- Hematological
- Pharmacological
- Nutritional Support
Airway Management
Anatomic Considerations

- Increased Tongue Size
- Increased Facial Girth
- Smaller Pharyngeal Area
- Redundant Pharyngeal Tissue
- Increased Neck Circumference
- Increased Breast Size
- Increased Chest Girth
- Increased Abdominal Girth
Data

- Brodsky, 100 MO pts (BMI>40)
  - Large neck circumference and high Mallampati score correlate with difficulty
  - BMI alone did not corralate with difficulty
    - Anesth Analg 2002;94:732-736

- Juvin, 129 obese pts (BMI>35)
  - Only Mallampati score correlated with difficulty
  - But difficult intubation rate was 15.5% in obese patients vs. 2.2% in lean patients

- Ezri 200 MO pts (BMI>35)
  - Mallampati score, not BMI correlated with difficulty
Physiologic Changes

- Increased intra-thoracic pressure
- Increased intra-abdominal pressure
- Hyperkinetic circulation
- Increased blood volume
- Obstructive Sleep Apnea (OSA)
- Obesity Hypoventilation Syndrome (OHS)
Emergent Airway Management

- Life threatening cases in morbidly obese airway management result not from failure to intubate but from failure to ventilate

- Limited pulmonary reserve
  - Reduction in expiratory reserve volume (ERV)
  - Reduced functional residual capacity (FRC)
  - Reduced total lung capacity (TLC)
  - Reduced maximal voluntary ventilation
Hemoglobin Desaturation

Time to Hemoglobin Desaturation with Initial $F_{AO2} = 0.87$

- Normal 70 kg Adult
- Normal 10 kg Child
- Obese 127 kg Adult

Mean Time to Recovery of Twitch Height From 1 mg/kg Succinylcholine i.v.

10% 6.87
50% 8.5
90% 10.2

Time of $V_E = 0$, minutes

SaO2, %

Anesthesiology 1997, 87:979
Airway Management

- **Difficult**
  - Bag mask ventilation
  - Direct Laryngoscopy
  - Surgical airway

- **RSI vs Facilitated Intubation**
  - Increased risk of gastric aspiration
  - Double setup

- **Awake Fiber-optic Intubation (AFOI)**
  
  ALWAYS HAVE A BACKUP PLAN
Pharmacologic Considerations

- Loading dose is usually dosed by Ideal Body Weight (IBW), not Total Body Weight (TBW)

- Notable exceptions
  - Fentanyl load is based on TBW
  - Succinylcholine is based on TBW
Positioning

- Short handled laryngoscope
  - “Stubby” handle
- Ramp Intubation
  - Elevate chest and head
  - Goal is ears at the level of the sternal notch
Ventilator Management
Ventilation / Perfusion
Respiratory

- Physiology
  - PFT’s
    - Restrictive pattern
      - Increased chest wall compression
      - Cephalad displacement of diaphragm
      - Decreased FRC, ERV, TLC
        - V/Q mismatch -> arterial hypoxemia
          - exaggerated in supine position
Respiratory

- **Reverse Trendelenberg**
  - Decrease intrathoracic pressure / unload diaphragm
    - Prevent atelectasis, v/q mismatch, hypoxemia
Ventilator management

- Initial settings
  - Tidal volume (Tv) based on IBW not TBW
    - Avoid alveolar over distension and barotrauma
    - Adjust Tv according to desired plateau pressure and ABGs
Respiratory

- **PEEP**
  - Prevent atelectasis, promote recruitment
  - Pelosi et al, post operative mechanically ventilated obese patients
    - PEEP 10 cm H2O / anesthetized + paralyzed following abdominal surgery
    - Reduction respiratory system elastance and resistance
      - Positive end-expiratory pressure improves respiratory function in obese but not in normal subjects during anesthesia and paralysis. Anesthesiology. 1999;91:1221-1231.
Respiratory

- Ventilator Weaning
  - NIPPV
    - Improved peak expiratory flow rate
    - Increased forced vital capacity
    - Decrease rate of post extubation failure
    - Decrease mortality in hypercarbic patients

- El Sohl et al. 62 morbidly obese pts in MICU -> 16% absolute risk reduction in resp failure when NIV instituted immediately post extubation
Hematological

- Prothrombotic
- Increased Risk DVT/PE
- Moderate to high risk for VTE
  - Obesity, venous stasis, pulmonary htn
  - Increased viscosity, fibrinogen, plasminogen activator inhibitor (PAI-1), decreased fibrinolysis
    - Adipocytes produce PAI-1
    - Decreased capacity of endothelium secretion of tPA
ADIPOSE TISSUE AND SOME OF THE ADIPOKINES/FACTORS INVOLVED IN THE PRO-THROMBOTIC STATE OF INTRA-ABDOMINAL OBESITY

Leptin → Adipose Tissue

Adiponectin ↓

Nitric oxide ↓

Oxidative Stress

Endothelial dysfunction

Hyperactivity of platelets

Pro-thrombotic and Hypofibrinolytic State

Platelet aggregation

Plasma viscosity

Thrombotic events

TNF-α

Nitric oxide

Inflammation

Hypofibrinolysis

Hypercoagulability

PAI-1

Inhibitor of fibrinolysis

Tissue factor

Initiation of coagulation cascade

Liver

Factor VII and VIII

Fibrinogen

Fibrin formation

2011, International Chair on Cardiometabolic Risk
Hematological

- Prophylaxis
  - No universal consensus
  - Combination SCDs, SQ Heparin, LMWH

- Quebbemann et al
  - Prospective Non-controlled
  - 822 pts w/bariatric sx receive prophylaxis w/continuous IV UH at 400 U/hr from pre op-> discharge
  - Incidence of confirmed symptomatic VTE of 0.1%
  - Major bleeding 1.3%

Pulmonary Embolism

- ASBS -> 48% surgeons lost at least 1 pt to fatal PE
- Pts with prior pulm htn -> less tolerant / low reserve
  - Prophylactic IVC filter

Diagnosis

- CTA Chest – weight restrictions
- V/Q scan – sensitivity/specificity
- Echocardiogram

Treatment- standard, lytics held until 10-15 days post-op
Pharmacological

- Pharmacokinetics
  - Body composition
  - Binding of drugs to plasma proteins
  - Permeability of tissue membranes
Pharmacokinetics

- **Volume of distribution (Vd)**
  - No direct association between lipophilicity / hydrophilicity of drug and distribution pattern
    - Lipophilic drugs do not always have large Vd
      - Digoxin, Procainamide
    - Hydrophilic drugs with variable distribution
      - Adipose tissue with 25-50% water content

- **Dose in proportion to excess body weight**
  - Dosing Weight Correction Factor (DWCF)
    - Adjusted Body Wt (ABW)
      - $ABW = DWCF (TBW-IBW) + IBW$
Hepatic Clearance

- Hepatic oxidative metabolism
  - Increased activity of Cytochrome P450 enzymes
  - Kotlyar and Carson -> provided evidence showing:
    - Increased Hepatic CYP2E1
    - Decreased Hepatic CYP3A4A
Clearance

• Renal Clearance
  ○ Creatinine Clearance Equations – inaccurate in obesity
    ▪ TBW overestimates CCr    IBW underestimates CCr
  ○ Cockcroft-Gault
    ▪ GFR= (140-Age) x wt in kg x (0.85 if female)/ 72 x SCr (mg/dL)
  ○ Modifications of Diet in Renal Disease (MDRD) predicts GFR
    ▪ GFR= 170 x (Scr)-0.999 x (age yrs) -0.176 x 0.762 (Female) x 1.18 (black) x (BUN) -0.17 x (Albumin) +0.318
    ▪ Vincent et al. Compared EDTA with MDRD which suggested close approximation
      ○ Renal function in critically ill morbidly obese patients. AM J. Respir Crit Care Med. 2004;169:1332-1333
  ▪ No current studies to validate dosing
  ▪ Clinical utility -> if predicted value is low, beware of high risk for drug accumulation
Dosing

- Determination of what weight to use depends on the drugs’ volume of distribution.
  - If a drug has a large Vd ($\geq 0.7$ L/kg) then an adjusted weight or actual weight should be used.
  - If a drug has a smaller Vd that approximates blood volume then IBW should be used.
ABW, adjusted body weight; IBW, ideal body weight; TBW, total body weight

Male: IBW = 50kg + 2.3kg per inch of height > 5 ft
Female: IBW= 45.5 + 2.3 kg per inch height > 5ft

AW = IBW + 0.4 (TBW-IBW)

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<thead>
<tr>
<th>Drug</th>
<th>Initial</th>
<th>Maint.</th>
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<tr>
<td>Lidocaine</td>
<td>TBW</td>
<td>IBW</td>
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<tr>
<td>Digoxin</td>
<td>IBW</td>
<td>IBW</td>
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<tr>
<td>Corticosteroids</td>
<td>IBW</td>
<td>IBW</td>
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<td>Aminoglycosides</td>
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<td>Vancomycin</td>
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<td>AW</td>
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<tr>
<td>Succinlycholine</td>
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<td>Vecuronium</td>
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<td>Fentanyl</td>
<td>TBW</td>
<td>TBW</td>
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<tr>
<td>Phenytoin</td>
<td>TBW</td>
<td>TBW</td>
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<tr>
<td>Droctrecogin alpha</td>
<td>ABW</td>
<td>ABW</td>
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<tr>
<td>Heparin*</td>
<td>ABW</td>
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<tr>
<td>Enoxaparin*</td>
<td>TBW</td>
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Use IBW for:
- Wt-based drugs with narrow therapeutic index
- Loading and maintenance dosing in wt-based medications when type for weight dosing is unknown.

Titrate wt-based drugs to desired effects
- Use conservatively in non-emergent situations

Monitor:
- Clinical end points, therapeutic serum levels
- Signs and symptoms of drug toxicity

Work closely with Critical Care Pharmacologist
Nutrition

- Limited data to make any specific feeding strategy

- Physiology
  - Increased energy expenditure secondary to increased lean body mass with decreased nutritional intake
  - Elevated basal insulin level which suppress lipid metabolism resulting in increased proteolysis -> rapid muscle loss => early deconditioning

- Increased caloric formula associated with increased CO₂ production -> increased work of breathing => prolonged mechanical ventilation
Nutrition

• Need accurate method to determine energy requirements!

• Methods to measure nutritional needs
  Predictive equations (>200) - limited in obese patients
  Resting Energy Expenditure (REE) – not ideal
  Indirect Calorimetry (IC) = GOLD Standard / availability?
  ○ Limitations in critical care setting?
    • Fio2 < 60%, fluctuating energy expenditure (~30%/Day)

• Which weight to use?
  ○ Actual Body Weight-> possible overestimation
  ○ Ideal Body Weight-> possible underestimation
  ○ Adjusted Body Weight-> not validated in critically ill obese pts
Hypocaloric Nutritional Support in Obese Patients
- Preserved nitrogen balance, decreased morbidity
- Small sample size, lack of mortality benefit
- Not evaluated in renal or liver disease

Provide 60-70% of target energy requirements or 11-15 kcal/kg ABW/day (or 22-25 kcal/kg IBW/day) for pts with BMI >30

Provide protein >2.0 g/kg IBW/day for BMI 30-40 or >2.5 g/kg/day for BMI >40
SCCM / A.S.P.E.N Guidelines

- **Nutritional Assessment:**
  - If available, indirect calorimetry to determine resting metabolic rate
  - If indirect calorimetry unavailable, use Ireton-Jones (1992) or Penn State (1998) predictive equations

- **Nutritional Support:**
  - If hemodynamically stable with functional GI tract use enteral nutrition
  - Bowel sounds, flatus, passage of stool not prerequisites to start feeding
  - If pt supine, under heavy sedation, or intolerant to gastric feeding, consider placing small bowel feeding tube.
- Start enteral nutrition within 24-48 hrs upon admission (ensure adequate resuscitation)
- Tolerance of enteral nutrition, do not hold for gastric residuals < 500ml unless signs of intolerance
- Consider immune-modulating enteral formulations for (major sx, trauma, burns, mechanical ventilation)
- Promotility agents for gastroparesis or high gastric residuals (unless contraindicated)
- Maintain strict glycemic control of 110-150 mg/dL
- Consider parenteral nutrition if intolerant of enteral feedings

Multidisciplinary Critical Care

Airway Manager

Physical / Occupational Therapy

Respiratory Therapy

Nutritionist

Pharmacologist
The emotion generated in scientific discussion increases proportionately with the softness of the data being discussed.

-Wolfe’s Third Law