Obesity in the Critically Ill Patient

Kristina Sullivan, MD
Associate Professor
Department of Anesthesia and Perioperative Care
Division of Critical Care Medicine

Objectives

• Review the definition of obesity
• Briefly discuss the trends in obesity among American men and women
• Discuss possible changes in the organ systems related to obesity
• Examine outcomes data for obese patients in the ICU
• Acknowledge challenges in the care of obese patients

Definition of Obesity

Prevalence and Trends

2007-2008:
32.2% of American Men = obese
35.5% of American Women = obese
4.2% of men = extremely obese
7.2% of women = extremely obese

2011-2012
34.9% of American Adults (age > 20)

Overweight, obesity, and extreme obesity are associated with increased all cause mortality among the general population

JAMA 2010; 303 (3): 235-241
NEJM 2006; 355 (8): 763-778
JAMA 2014; 311 (8): 806-814
Prevalence and Trends

- A large retrospective database study investigating outcomes in the ICU related to obesity acquired weight data that were available for 19,669 out of 21,790 patients
- This study revealed that the prevalence of obesity in the ICU is 31.1% which is very near that of the general population

*BMC Emer Med. 2004; 4(1):3*

Obesity and the CV System

- Increase in body weight causes increase in blood volume
  - increased stroke volume
  - heightened wall tension
  - eccentric LV hypertrophy
  - systolic and diastolic dysfunction
- Sleep apnea and obesity hypoventilation syndrome
  - lead to pulmonary hypertension and RV failure

American College of Chest Physicians: Pulm, Crit Care, Sleep Update Article 2011

Obesity and the Pulmonary System

- Functional residual capacity and expiratory reserve volume are reduced
- Atelectasis worsens ventilation/perfusion matching and leads to hypoxemia
- Soft tissue around the thorax and abdomen reduce chest wall compliance
- Mechanical loading of the diaphragm occurs when supine

American College of Chest Physicians: Pulm, Crit Care, Sleep Update Article 2011
Obesity and the Pulmonary System

• Anatomic changes in the airways
  – Upper airway caliber decreases due to parapharyngeal fat deposition
  – Airways tend to be more collapsible
• Total respiratory compliance may decrease nearly 50% in morbid obesity (BMI >40 kg/m²)
• Increase in oxygen consumption by the respiratory muscles
  ➔ Decreased respiratory reserve

Obesity and the GI System

• Possible increased incidence of gastroesophageal reflux disease
  – Increased intraabdominal pressure (IAP)
  – ? Increased risk of aspiration
• Fatty liver disease

Obesity and the Renal System

• Weight-based creatinine clearance estimating formulas have been developed to accommodate obese patients, but none of them have been validated
• when CRRT is chosen, the best method to appropriately calculate the dose of dialysis is not well established

Obesity and the Immune System

• Adipocytes play a role in complex inflammatory and immunomodulatory cascades
• Macrophages, leukocytes, preadipocytes, and adipocytes are all found in adipose tissue
• The composition of cell types become altered in obesity ➔ macrophages may represent up to 50% of cellularity of adipose tissue
• Macrophages elaborate proinflammatory cytokines and chemokines
• Preadipocytes promote further macrophage activation and differentiation
Obesity and the Immune System

- Adipocytes express signaling molecules known as adipokines
  - Leptin → facilitates the development of a prothrombotic state
  - Adiponectin → anti-inflammatory properties → decreased among obese people
- Obesity represents a chronic prothrombotic, pro-inflammatory state

American College of Chest Physicians: Pulm, Crit Care, Sleep Update Article 2011

Obesity and the Endocrine System

- Increased incidence of diabetes

Case Report

71 year old obese man with a history of transitional cell carcinoma of the bladder presented for recurrent disease that was unresponsive to BCG. A radical cystectomy with neobladder construction was scheduled. The patient was placed in lithotomy position in stirrups. The procedure took 7 hours. There were no operative complications.


Case Report

The post-operative creatinine rose from 1.2 mg/dL to 2.2 mg/dL. There were no remarkable postoperative changes in the total blood count. During the next 2 days, the patient’s creatinine phosphokinase (CK) level rose to 4250 IU/L (nl = 60–400 IU/L). Although the patient demonstrated good urine output, his creatinine level gradually rose to 5.0 mg/dL on day 4. The patient developed shortness of breath and decreased level of consciousness. He was then transferred to the intensive care unit. He was intubated and sedated. Hemodialysis was initiated.

Questions

• Was this patient’s mortality higher than his non-obese counterparts in the ICU?

• What issues related to his obesity complicated his case?

Was this patient’s mortality higher than his non-obese counterparts in the ICU?

Are other ICU LOS and DMV affected?

RESULTS:

- Obesity is not associated with increased ICU mortality
- Obesity may be associated with lower hospital mortality

Effect of obesity on intensive care morbidity and mortality: A meta-analysis


RESULTS:

- Obesity in critically ill patients is not associated with excess mortality
- Obesity is associated with prolonged duration of mechanical ventilation and ICU length of stay

Intensive Care Med 2009; 35: 1152-1170

The impact of obesity on outcomes after critical illness: a meta-analysis

Charles W. Hargis Jr
John D. Hargis
Wisla C. Lee
Karon A. Johnson
Jason Miller
Natalie Miller
Peter J. Pescovitz
Dale M. Needham
**RESULTS:**
- Unadjusted analyses suggested extremely obese patients have improved mortality
- Association not significant once adjustment for confounders
- Extremely obese patients (BMI > 40) have longer DMV and ICU LOS

_CHEST_ 2011; 140 (5): 1198-1206

**CONCLUSIONS:**
- Morbidly obese people have similar risk for death as nonobese if respiratory failure alone
- Morbidly obese people have increased mortality when multiple organs fail

_CHEST_ 2013; 141 (1): 48-54

**RESULTS:**
- Crude analysis ➔ obese (including BMI > 40) patients had lower hospital mortality (primary outcome)
- After adjusting for baseline characteristics and sepsis interventions association non-significant

_Critical Care_ 2013; 17:872

**CONCLUSIONS:**
- In ARDS, obesity is associated with increased development of AKI (not explained by severity of illness)
- Increasing BMI associated with decreased all-cause 60-day ARDS mortality
- Proportion of ARDS patients with AKI who died decreased as BMI increased, but within each weight category patients with AKI had increased mortality (60-day)

_Crit Care Med_ 2012 Vol. 40, No 9 2601-2608
What factors may play a role in the mortality paradox?

- Immune modulators
  - Ex: Leptin and interleukin-18
- Confounding factors
  - Age
  - Type of infection
  - Fluids, Drugs
  - Increased clinical attention

What issues were complicated by his obesity?

Complicated Issues

1. Airway
2. Dialysis Access
3. Mechanical Ventilation
4. Pharmacologic Considerations
5. Positioning/Turning

Clinical Commentary

**Clinical Approach to the Critically Ill, Morbidly Obese Patient**

Am J Respir Crit Care Med. March 1, 2004 vol. 169 no. 5 557-561
Airway

- Limited neck mobility
- Limited mouth opening
- Difficult airway associated with the following:
  - MP score of ≥ 3
  - Neck Circumference > 50 cm
- Reduction in functional residual capacity impairs the capacity of obese patients to tolerate periods of prolonged apneas
- Percutaneous trach considered a poor choice

Vascular Access

- Usual landmarks are obscured
- Distance from skin to vessel much greater
- Consider early PICC placement
- Strongly recommend using ultrasound to increase the probability of successful catheter placement, reduce complications, and decrease the need for multiple insertion attempts

Mechanical Ventilation

- Initial TV at 8 mL/kg of ideal body weight
- 6 mL/kg of ideal body weight if patient has ARDS
- Follow peak airway pressures and plateau pressures in conjunction with ABGs
- Esophageal manometry
- Consider higher levels of PEEP (reverse atelectasis and increase FRC)
- Adequately sedate patients preferably with a short acting sedative

Pharmacologic Considerations in Obese Patients

- Larger volume of distribution for lipophilic drugs
- Increased clearance of hydrophilic drugs
- No evidence based methods for appropriate dosing strategies for critically ill patients with BMI > 40 kg/m²
- Cytochrome P450 (3A4) metabolism is decreased
- Glucuronidation is usually increased
- If possible, consult a pharmacist regarding dosages of medications
Pharmacologic Considerations

- **TBW** = Total body weight
- **IBW** = Ideal body weight
  - For men: IBW = 51.65 kg + 1.85 kg/inch of height greater than 5 feet
  - For women: IBW = 48.67 kg + 1.65 kg/inch of height greater than 5 feet
- **DW** = dosing weight
  \[(IBW + 0.4 \times (TBW - IBW))\]

Pharmacologic Considerations

- **TBW**
  - succinylcholine, rocuronium, unfractionated heparin, enoxaparin, vancomycin, fentanyl loading dose
- **IBW**
  - digoxin, beta blockers, PCN, cephalosporins, linezolid, corticosteroids, H2-blockers, vecuronium, fentanyl, midazolam, lorazepam, induction dose propofol
- **DW**
  - Aminoglycosides, fluoroquinolones

LMWH \(\rightarrow\) variable absorption in severe obesity \(\rightarrow\) factor 10a monitoring is suggested

Positioning/Turning

- Use a bariatric bed if available
- Check frequently for pressure sores
- Check for rhabdomyolysis in obese patients (long procedures or operations under general anesthesia)

Thoughts

- Obese patients present unique challenges to healthcare teams
- While there may be no increase in mortality, there may be an increased use of critical care resources and cost
- Future studies need to address this factor
Conclusions

• Data suggests that obesity does not result in increased ICU mortality
• In extreme obesity, duration of mechanical ventilation and ICU length of stay may increase
• Cost efficient means of caring for obese patients need to be considered