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/m^2 Overweight 25 – 30 kg/m^2 Obese 30-35 kg/m^2

  Morbidly Obese 36 – 54 kg/m^2 Super Morbidly Obese >55 kg/m^2

  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
    - 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
    - Anesth Analg. 2003 Aug;97(2):595-600
- Ezri 200 MO pts (BMI>35)
  - Mallampati score, not BMI correlated with difficulty
    - Can J Anaesth. 2003 Feb;50(2):179-83

Physiologic Changes

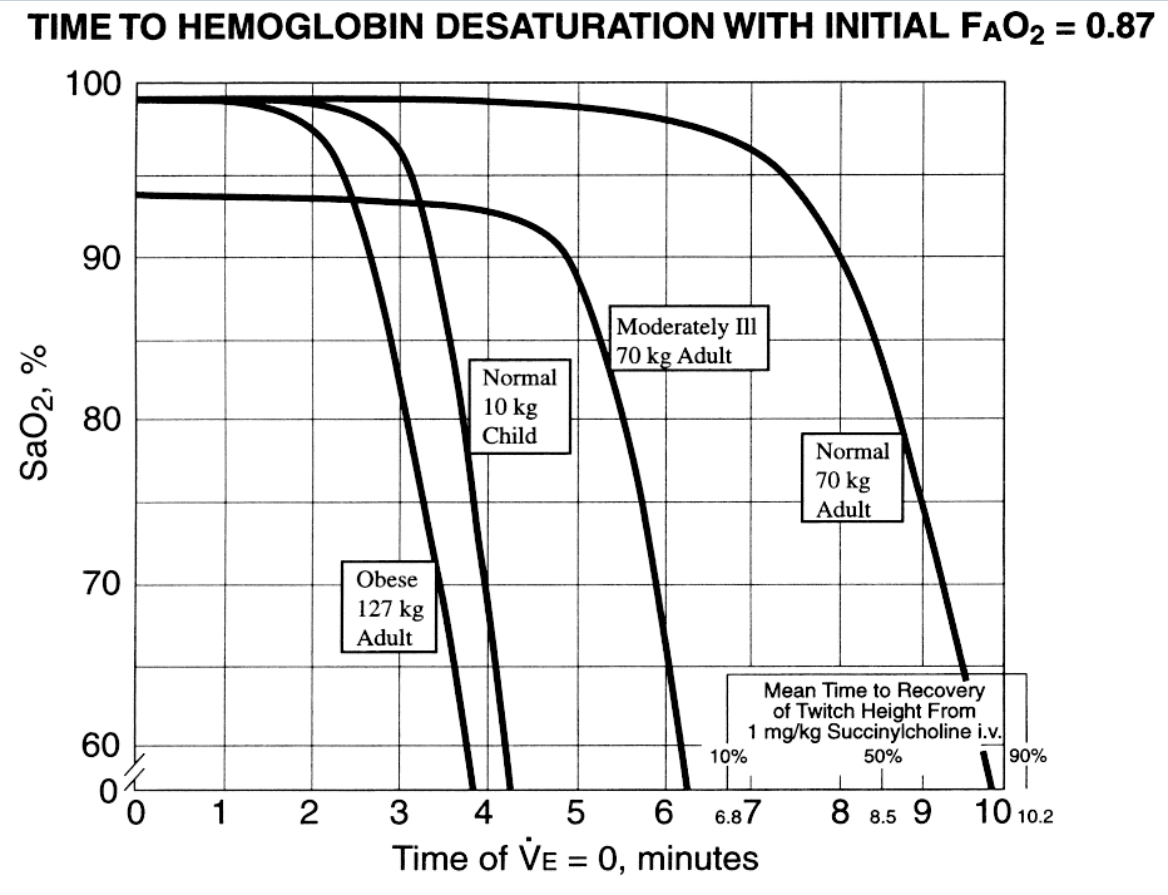
- Increased intra-thoracic pressure
- Increased intra-abdominal pressure
- Hyperkinetic circulation
- Increased blood volume
- Obstructive Sleep Apnea (OSA)
- Obesity Hypoventilation Syndrome (OHS)

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



Anesthesiology 1997, 87:979

Airway Management

- Difficult
  - Bag mask ventilation
  - Direct Larnygoscopy
  - Surgical airway
- RSI vs Facilitated Intubation
  - Increased risk of gastric aspiration
  - Double setup
- Awake Fiber-optic Intubation (AFOI)

ALWAYS HAVE A BACKUP PLAN

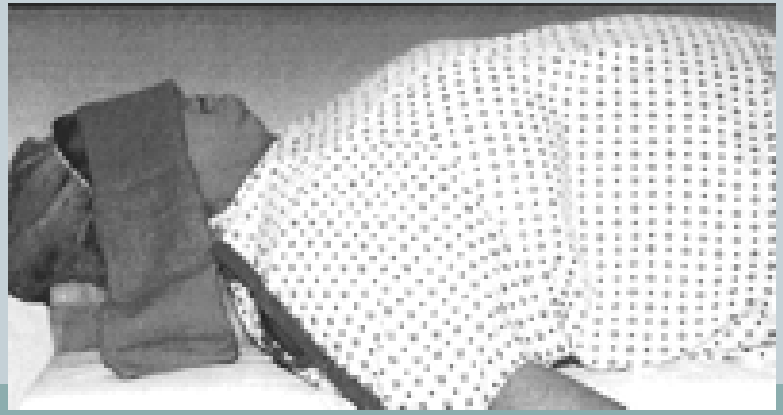
Pharmacologic Considerations

- 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

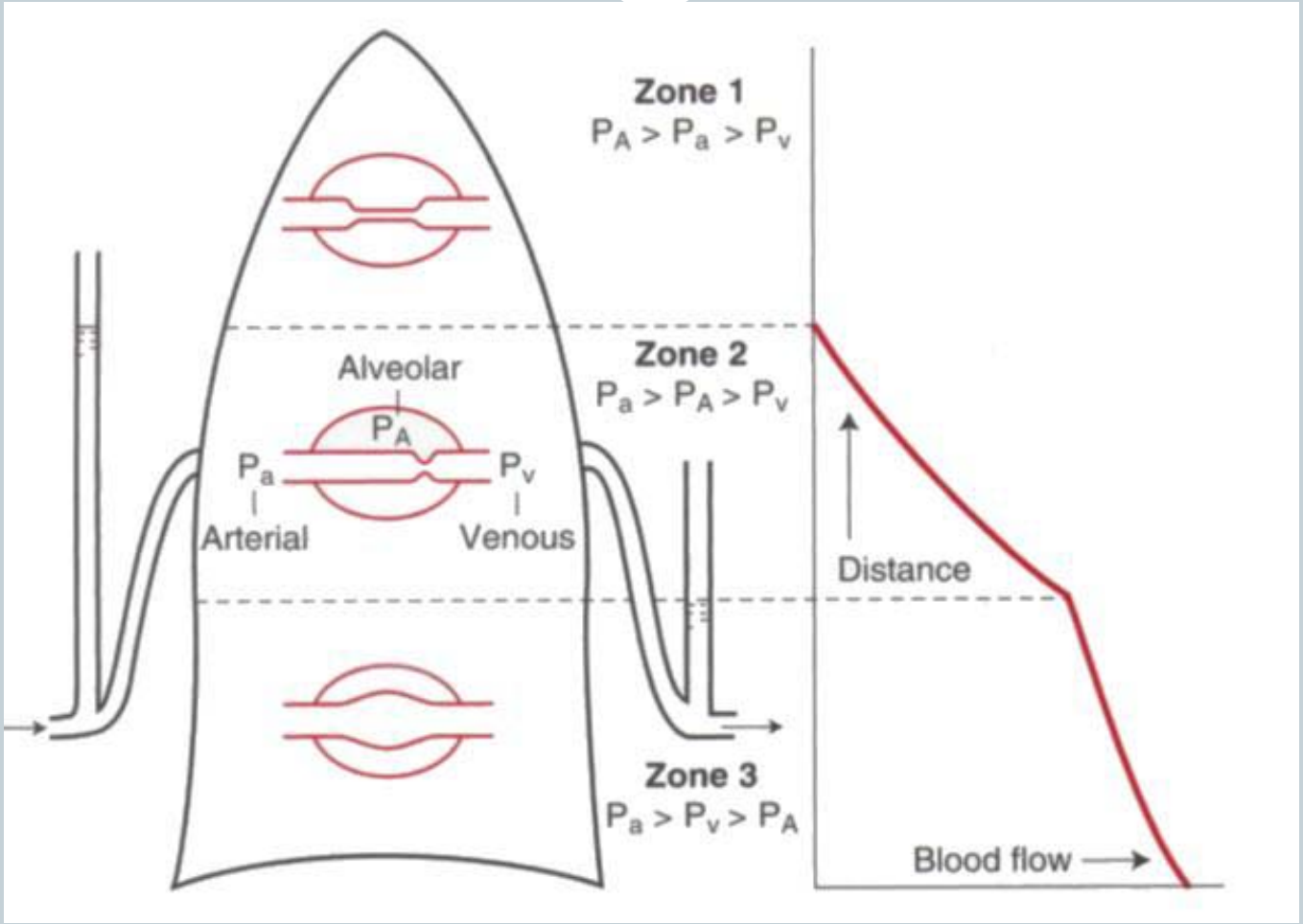
Positioning

- 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

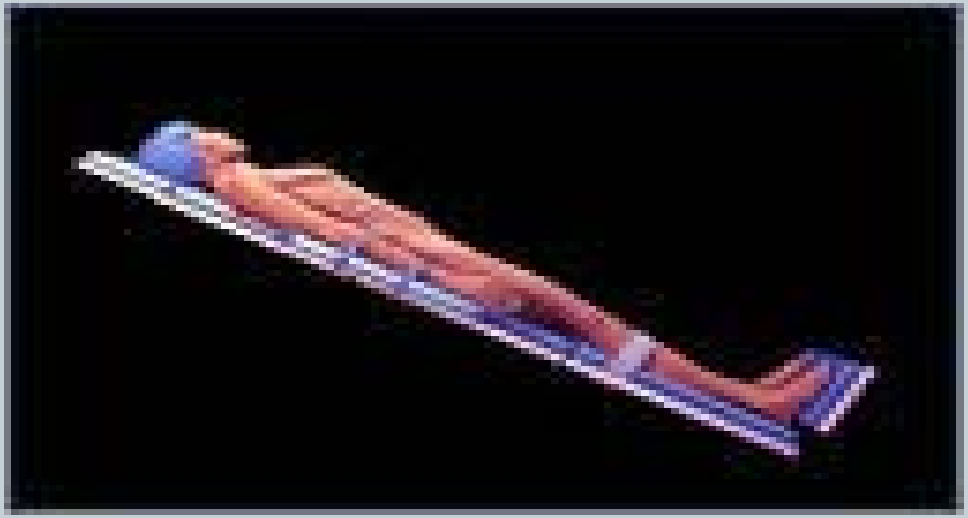


Respiratory

- 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

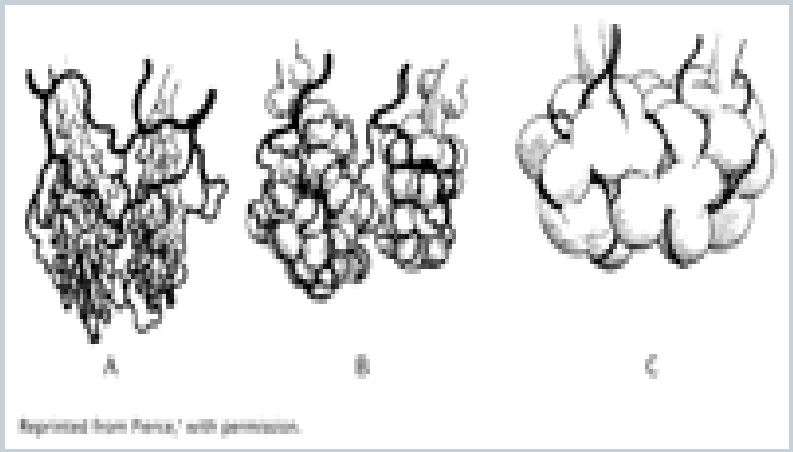
Respiratory

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



Respiratory

- 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 H20 / 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

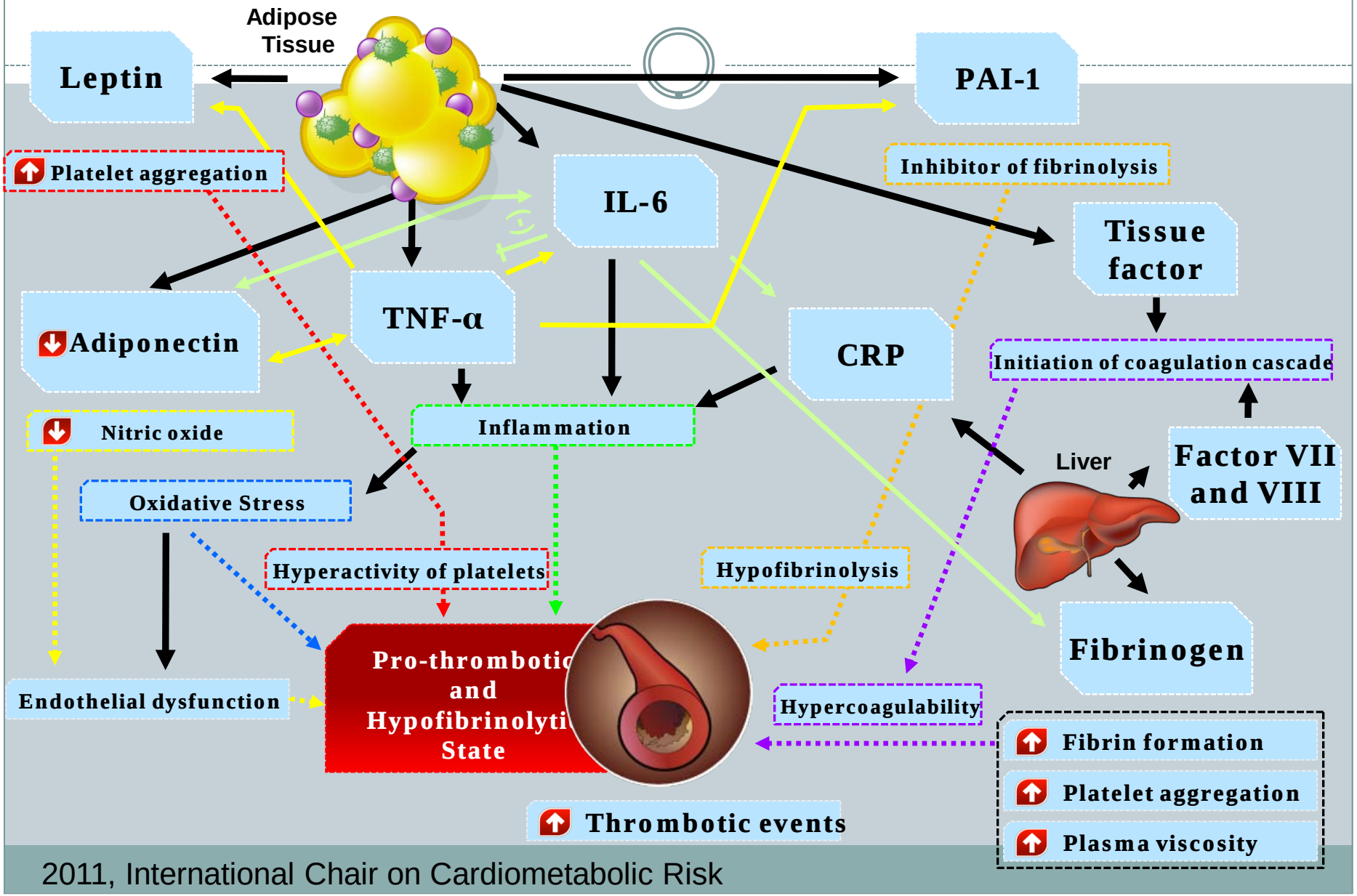
- Ventilator Weaning
  - NIPPV
    - Improved peak expiratory flow rate
    - Increased forced vital capacity
    - Decrease rate of post extubation failure
    - Decrease mortality in hypercarbic patients
    - El Sohl et al. 62 morbidly obese pts in MICU -> 16% absolute risk reduction in resp failure when NIV instituted immediately post extubation

Non-invasive ventilation for prevention of post extubation respiratory failure in obese patients. Eur Respir J. 2006;28:588-595.

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



Hematological

- Prophylaxis
  - No universal concensus
  - 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%
  - Continuous intravenous heparin infusion prevents peri-operative thrmboembolic events in bariatric surgery patients. Obes Surg. 2005 Oct;15(9):1221-4.

Hematological

- 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

Pharmocokinetics

- 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 disribution
      - 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

Clearance

- Hepatic Clearance
  - Hepatic oxidative metabolism
    - Increased activity of Cytochrome P450 enzymes
    - Kotlyar and Carson -> provided evidence showing:
      - Increased Hepatic CYP2E1
      - Decreased Hepatic CYP3A4A
        - Effects of obesity on cytochrome P450 enzyme system. Int J Clin Pharmacol Ther. 1999;37:8-19

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.

DOSING

Drug	Initial	Maint.
Lidocaine	TBW	IBW
Digoxin	IBW	IBW
Corticosteroids	IBW	IBW
Aminoglycosides	AW	AW
Vancomycin	AW	AW
Succinlycholine	TBW	---

Drug	Initial	Maint
Vecuronium	IBW	IBW
Fentanyl	TBW	TBW
Phenytoin	TBW	TBW
Droctrecogin alpha	ABW	ABW
Heparin*	ABW	-----
Enoxaparin*	TBW	TBW

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)

Pharmacology

- 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?
      - Fi02 < 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

SCCM / A.S.P.E.N Guidelines

- 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

Society of Critical Care Medicine (SCCM)
American Society for Parental and Enteral Nutrition (A.S.P.E.N)

SCCM / A.S.P.E.N Guidelines

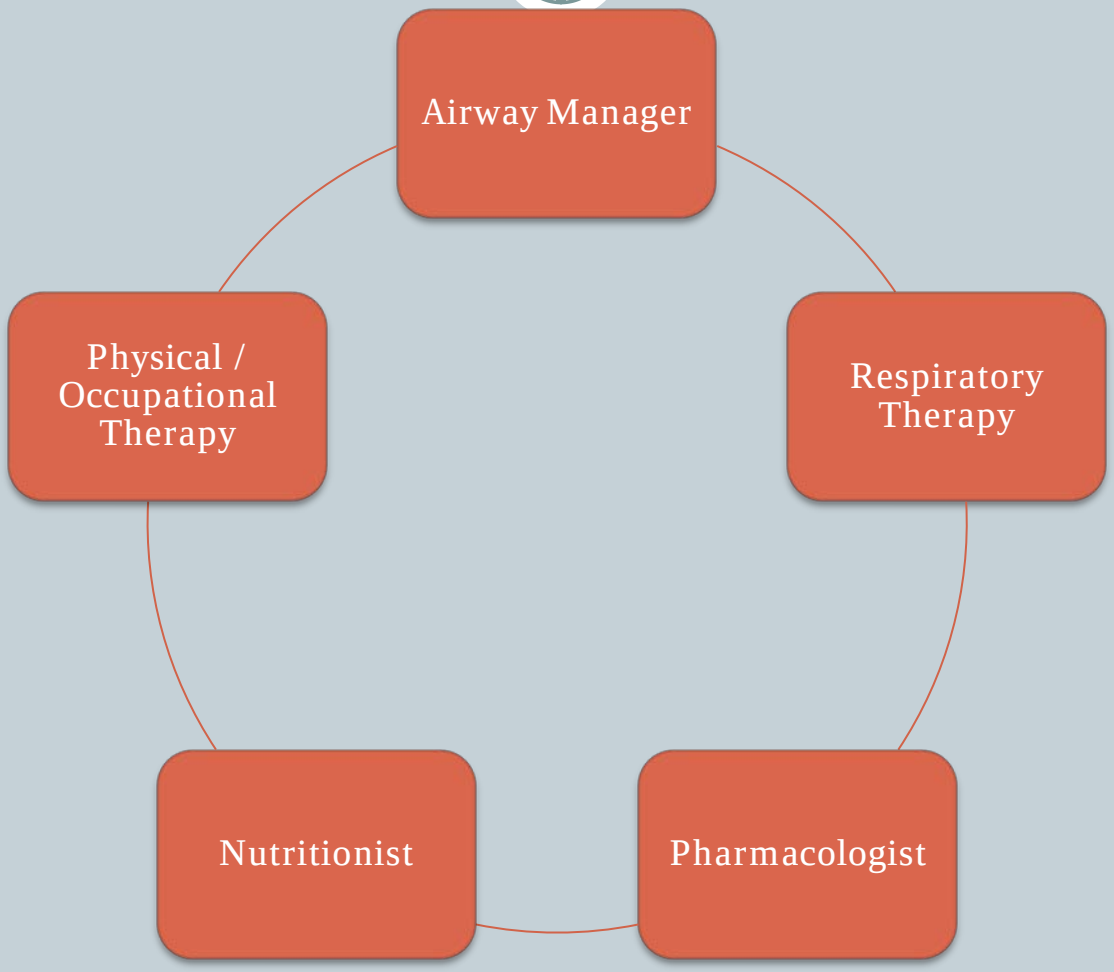
- Nutritional Assessment:
  - If available, indirect calorimetry to determine resting metabolic rate
  - If indirect calorimetry unavailable, use Ireton-Jones (1992) or Penn State (1998) predictive equations
- Nutritional Support:
  - If hemodynamically stable with functional GI tract use enteral nutrition
  - 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.

SCCM / A.S.P.E.N Guidelines

- 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

- McClave SA, et al. Guidelines for the provision and assesment of nutrition support therapy in the adult critically ill patient: Society of Critical Care Medicine and American Society for Parenteral and Enteral Nutrition. JPEN J Parenter Enteral Nutr. 2009; 33:277-316.

Multidisciplinary Critical Care



Questions?

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

-Wolfe's Third Law