Pulmonary Disease & Nutrition

Sodexo Intern Class 2016
Tuesday, January 19th

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Objectives

- Review anatomy of the respiratory system
- Define the relationship between nutrition and pulmonary function/disease
- Define Refeeding Syndrome
- Differentiate nutrition care strategies for spontaneously breathing patients vs. mechanically ventilated patients
- Identify up-to-date common practices to be used during the nutrition assessment, evaluation and implementation of adult patients with pulmonary diseases
Gross Anatomy of Lungs

- Base, apex (cupula), costal surface, cardiac notch
- Oblique & horizontal fissure in right lung results in 3 lobes
- Oblique fissure only in left lung produces 2 lobes
**Inhalation**
Diaphragm contracts (moves down)

**Exhalation**
Diaphragm relaxes (moves up)
## Inspiration

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<th>Sequence of events</th>
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<td>① Inspiratory muscles contract (diaphragm descends; rib cage rises)</td>
<td>Ribs elevated and sternum flares as external intercostals contract</td>
<td>External intercostals contract</td>
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<tr>
<td>② Thoracic cavity volume increases</td>
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<tr>
<td>③ Lungs stretched; intrapulmonary volume increases</td>
<td>Diaphragm moves inferiorly during contraction</td>
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<td>④ Intrapulmonary pressure drops (to −1 mm Hg)</td>
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<td>⑤ Air (gases) flows into lungs down its pressure gradient until intrapulmonary pressure is 0 (equal to atmospheric pressure)</td>
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## Expiration

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<td>2. Thoracic cavity volume decreases</td>
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<td>Ribs and sternum depressed as external intercostals relax</td>
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<td>3. Elastic lungs recoil passively; intrapulmonary volume decreases</td>
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<td>4. Intrapulmonary pressure rises (to +1 mm Hg)</td>
<td>Diaphragm moves superiorly as it relaxes</td>
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<td>5. Air (gases) flows out of lungs down its pressure gradient until intrapulmonary pressure is 0</td>
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<td>External intercostals relax</td>
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**Figure 22.13.2**
Bronchi, Bronchial Tree, and Lungs

- Larynx
- Primary bronchi
- Secondary bronchi
- Tertiary bronchi
- Bronchioles
- Cardiac notch
- Pulmonary artery
- Pulmonary vein
- Alveolar duct
- Alveoli
Functions of the Respiratory System

- **Ventilation**
  - Movement of air in & out of the lungs
    - Inhale: muscles contract, take in $O_2$
    - Exhale: passive process, give off $CO_2$
  - Normal, relaxed breathing = ___8-16 BPM_______
  - Abnormal, unrelaxed breathing, shortness of breath (SOB) = ___RR>25 bpm_______
Functions of the Respiratory System

- **Respiration**
  - Movement of gases between air & blood

- **Maintenance of homeostasis**
  - Gas exchange
  - Regulation of blood pH
  - Surfactant synthesis
  - Mucociliary clearance
Respiratory Membrane

Figure 22.9.c, d
Breathing Facts

- The average resting adult...
  - Breathes in ~250mL of O₂ every minute
  - Breathes out ~200mL of CO₂ every minute
  - ~500-700 mL of air is exchanged during an average breath

What is the vocabulary word for average breath capacity?
Ventilatory Parameters/Terms

- Minute volume (Ve) = Vt x RR
  - **Tidal volume** → 200cc----700cc
    - Hypopnea < 200cc
    - Hyperpnoea > 600cc
  - **Respiratory rate** → 8---20bpm
    - Bradypnea --- < 8
    - Tachypnea --- > 30
    - Orthopnea --- upright breathing
Efficiency of Ventilation

- Evaluated with PaCO$_2$
  - PaCO$_2$ > 45 mm Hg: hypoventilation
  - PaCO$_2$ < 35 mm Hg: hyperventilation

- **Tachypnea** is different than hyperventilation!!!
Tachypnea ≠ Hyperventilation
Etiologies Of Tachypnea

- Fever
  - Increase in metabolic rate
    - Every 1 degree increase in temperature causes an 1.5 liter increase in minute ventilation
- Pain
- Hypoxemia
- Shock
- Metabolic acidosis
  - Compensatory mechanism
Pulmonary Disease

A disease that affects the organs of the respiratory system, and/or compromises the act of breathing.
Diagnosis of Pulmonary Disease

- Breath Sounds
- Pulmonary Function Tests (PFTs)
- Chest X-Ray
- Bronchoscopy
Breath Sounds

- **Abnormal**
  - **Crackles**: discontinuous, explosive “popping”
  - **Wheezes**: continuous, heard at the end of inspiration
  - **Stridor**: intense, continuous, monophonic wheezes
  - **Stertor**: harsh, discontinuous crackling sounds; low-pitched snoring sound
Pulmonary Function Tests (PFTs)

- Spirometry
- Lung Volume Measurement
- Lung Diffusion Capacity

Capacities and Volumes
Chest X-Ray (CXR)

- X-ray of chest, lungs, heart, large arteries, ribs & diaphragm that identifies:
  - Collapsed lung
  - Collection of fluid in/around the lungs
  - TB
  - Tumor
  - Cancer
  - Pneumonia
  - Infiltrates
Normal Chest X-ray
Asthmatic - with significant air trapping

Note flatten diaphragm
Late stage ARDS with basilar Pneumocèle
Pneumothorax
Pulm Fibrosis
Left main-stem intubation

Hyper inflated Lung
Bilateral Pulmonary Contusions - Post Trauma 48hrs
Fluid induced ARDS
Normal body habitus  Obese body habitus
RUL Lobar Pneumonia
with central bronchiectasis
End-stage cavitation
CXR on 1/9/2014
Bronchoscopy

- Surgical technique for viewing the interior of the airways to:
  - Diagnose
  - Object Removal
  - Biopsy
  - Culture
Airways Before VDR
Airways 48 hrs. post VDR Utilization
Types of Pulmonary Disease

Acute

Restrictive

Chronic
Smokers Lowered Respiratory Efficiency

Smoker is easily “winded” with moderate exercise

- nicotine constricts terminal bronchioles
- carbon monoxide in smoke binds to hemoglobin
- irritants in smoke cause excess mucus secretion
- irritants inhibit movements of cilia
- in time destroys elastic fibers in lungs & leads to emphysema
  - trapping of air in alveoli & reduced gas exchange

Every thirteen seconds someone dies from a smoking-related disease.
ACUTE Pulmonary Disease

- Pneumonia
  - Inflammation of the lung
  - Signs/symptoms: cough, chest pain, fever, difficulty breathing
  - Leading cause of death among the elderly and/or people who are chronically/terminally ill
  - Caused by infection, chemical/physical injury, aspiration
Mucus Plugging
Dependent hemorrhagic injury
Liver like appearance
Pneumonia Induced ARDS
Diffusive White Out

Film from next day
ACUTE Pulmonary Disease

- **Aspiration Pneumonia**
  - Entrance of foreign material into bronchial tree
  - **Risk factors**: reduced consciousness, dysphagia, supine body position, large bore NG feeding tubes, large volume tube feedings, GERD, delayed gastric emptying
  - **Prevention**: elevate HOB 30-40 degrees, continuous feeding infusion, small bowel feeding
Acute Respiratory Distress Syndrome (ARDS)

- Underlying clinical events lead to...

- Cascade of events involving uncontrolled inflammatory responses, and release of proinflammatory agents →

- Compromised antioxidative system

- Life threatening, usually requires mechanical ventilation & ICU management
**RESTRICTIVE Pulmonary Disease**

- A disorder that limits the ability of the lungs to expand
  - Atelectasis:___________________________
  - Flail chest: _________________________
  - Pulmonary contusion:_________________
  - Pneumothorax:_______________________
  - Pulmonary edema:____________________
  - Pleural effusion:_____________________
  - Pulmonary embolism:_________________
Cystic Fibrosis (CF)
- Genetic disease affecting exocrine glands
- **Respiratory complications**
  - Thick, sticky secretions; attracts bacteria
  - Prednisone, high-dose ibuprofen, ABX
  - Cough, excessive sputum production, lung scarring
- **GI complications**
  - Thick secretions block the pancreatic duct
  - ↑ risk of developing DM
  - Thick liver secretions → ↓ bile flow → liver damage
85-90% are pancreatic insufficient
- Poor wt gain, poor growth
- Vitamin (A,D,E,K) & mineral deficiencies
- EFAD
- Pancreatic enzyme therapy

Defining energy needs is challenging
- 110-200% DRI’s (energy & protein)
- Greater fat intake (~40%)

Many individual variables

Annual RD assessment
Chronic Obstructive Pulmonary Disease (COPD)

- Incurable disease that results in progressive obstruction & inflammation of the airways

- More than 24 million people in the U.S. have COPD
  - Smoking cigarettes is #1 risk factor

- 3rd leading cause of death in the U.S.
Chronic Obstructive Pulmonary Disease (COPD)

- Airways & air sacs lose elastic quality
- Walls between air sacs are destroyed
- Walls become swollen
- Airways become clogged from greater mucus production
Chronic Obstructive Pulmonary Disease (COPD)

- **Umbrella Term**
  - Chronic Bronchitis
  - Emphysema
    - Various stages of both

- **Symptoms:**
  - Daily cough
  - Coughing up mucus or phlegm
  - Difficult/labored breathing
  - SOB during normal physical activity
  - Wheezing or chest tightness
Chronic Obstructive Pulmonary Disease

- progressive airflow limitations caused by an abnormal inflammatory reaction to the chronic inhalation of particles

- chronic bronchitis and emphysema

- Signs of COPD are consequences of the anatomical changes caused by the disease:
  - barrel chest
  - pursed-lip breathing
  - productive cough
  - cyanosis.
COPD
Bronchitis

- Swollen, tight airways; more mucous may form
  - Difficult to breathe
- Normal wt, or overweight; edematous

Emphysema

- Walls & tiny air sacs are damaged
  - Cannot push all of the used air out of their lungs
- Air remains trapped, less $O_2$-rich air
- Difficulty exhaling, limited energy
- Thin, underweight; and/or significant wt loss
Global Initiative for Chronic Obstructive Lung Disease

- Raise awareness; improve prevention & treatment of COPD around the world
- Collaboration of NHLBI, NIH & the WHO
- Programs & guidelines have been created by worldwide leading experts
  - Ongoing evaluation/yearly review
- World COPD Day
  - 3rd Wednesday in November
Malnutrition

- Prevalent in patients with lung disease
- Frequent states of starvation & stress →
- Catabolic effects on skeletal muscle
  - Impairs pulmonary function
  - Increases susceptibility to infection
  - Lowers exercise capacity – ↓ ability for ADL’s
  - Increases risk for mortality & morbidity
### Albumin and Prealbumin – NOT indicators of nutritional status in a hospital setting

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<tr>
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<th>Causes of Hypoalbuminemia</th>
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<tr>
<td>Dehydration</td>
<td>Overhydration</td>
</tr>
<tr>
<td>Blood transfusions</td>
<td>Inflammation / infection / metabolic stress</td>
</tr>
<tr>
<td>Exogenousous albumin</td>
<td>Nephritic syndrome</td>
</tr>
<tr>
<td>Marasmus</td>
<td>Burns</td>
</tr>
<tr>
<td></td>
<td>Trauma/post-operative states</td>
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<tr>
<td></td>
<td>Best rest</td>
</tr>
<tr>
<td></td>
<td>Zn deficiency</td>
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### Albumin and Prealbumin – NOT indicators of nutritional status in a hospital setting

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<td>- Severe renal failure</td>
<td>- Post-surgery</td>
</tr>
<tr>
<td>- Corticosteroid use</td>
<td>- Infection/metabolic stress/inflammation</td>
</tr>
<tr>
<td>- Oral contraceptives</td>
<td>- Dialysis</td>
</tr>
<tr>
<td></td>
<td>- Significant hyperglycemia</td>
</tr>
<tr>
<td></td>
<td>- Liver disease/hepatitis</td>
</tr>
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<td>- Hyperthyroidism</td>
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(a) Normal fluid balance

(b) Edema caused by insufficient protein in bloodstream
Prealbumin

- Not a sole indicator of nutrition status, especially in critical/VDRF patients
  - Rapidly ↓ with acute-phase response
    - Infection, inflammation, trauma, surgery, cancer
  - ↓ with liver compromise, untreated hyperthyroid
  - ↑ with acute/chronic renal failure & steroid therapy

- **Recommended use:**
  - Only when able to “track the trend”
  - Post-ICU stay and/or acute illness
  - **Goal = improvement**, not necessarily “normal” serum levels
Test your knowledge! Case study

- Martha is an 85 yr old female who has just had major surgery known as an open laparotomy and GI resection. After surgery she had a heart attack and goes into respiratory failure and is placed on a ventilator. The doctor reviews her blood levels and finds her albumin is 1.4 (normal range 3.4-5.4 g/dl). The doctor recommends 3 g/kg of body weight of protein to improve her “nutritional status.”

- What would you say to the doctor?
Malnutrition $\rightarrow$ Pulmonary Failure

- $\downarrow$ surfactant synthesis & secretion $\rightarrow$ $\uparrow$ work of breathing
- Catabolism of respiratory muscles $\rightarrow$ $\downarrow$ Lean body mass (LBM) $\rightarrow$ $\downarrow$ strength
- Lack of fuel for the remaining muscles $\rightarrow$ $\downarrow$ endurance

$\downarrow$ strength $+\downarrow$ endurance $\rightarrow$ $\uparrow$ fatigue
Pulmonary Disease → Malnutrition

- $\uparrow$ Work of Breathing (WOB) $\rightarrow$ $\uparrow$ REE

- $\downarrow$ Dietary Intake/Appetite
  - Dyspnea $\rightarrow$ difficulty swallowing/chewing
  - Mouth breathing, mucous production &
    Side effect of medications $\rightarrow$ alters taste

$\uparrow$ WOB/REE + $\downarrow$ Dietary Intake = Negative energy balance/Malnutrition
Nutrient Requirements For Spontaneously Breathing Patients

- Calories via predictive equation(s)
  - **Ireton-Jones** (use dry wt/No AIBW; No factors)
    - Non-Obese: 629 – (11 x age) + (25 x kg)
    - Obese: 629 – (11 x age) + (25 x kg) – 60
  
  - **Mifflin-St. Jeor** (use dry wt/No AIBW; stress factors 1.1-1.5)
    - Male: 5 + 10 (wt in kg) + 6.25 (ht in cm) – 5 (age)
    - Female: -161 + 10 (wt in kg) + 6.25 (ht in cm) – 5 (age)

- 25-30 kcal/kg IBW if +1 or greater edema
Helping Our Patients to Counteract Common Problems…

1. Eat when energy levels are highest
2. Eat several small, nutrient-rich meals
3. Choose foods that are easy to chew
4. Eat slowly & chew foods thoroughly
5. Prepare foods that appear palatable
6. Avoid foods that cause gas or bloating
7. Limit salt
Additional Recommendations…

- 8. Drink liquids ~2 hours before a meal or at the end of the meal
- 9. Limit caffeinated beverages
- 10. Breath carefully, sit properly with good posture while eating
- 11. Rest before meals
- 12. If continuous home O₂ is prescribed, wear nasal cannula while eating
Key Interview Questions

- How many meals per day?
  - At what times

- Average intake per meal?
  - How much and what do their meals consist of
  - Appetite better/worse at one meal vs. another

- Dyspnea while prepping and/or eating?

- Weight status/changes
Sarah is a 68 yr old female, with poor dentition and chronic SOB secondary to COPD. She reports anorexia when she does not use her nasal cannula, but is determined not use it because the oxygen tank is too heavy to pull around.

- Craft a meal that would be appropriate for Sarah, using the food models.
- What recommendations would you use to educate Sarah?
Jason is a 57 yr old, edentulous male admitted with congestive heart failure and a fluid restriction of 1500 ml per day. He has an affinity for fluids because he does not like pureed foods and cannot chew most foods.

- What steps would you take before crafting a meal for Jason?
- Craft a meal that would be appropriate for Jason, using the food models.
- What recommendations would you use to educate Jason?
#1 Goal of Nutrition Therapy

- Provide adequate energy to...
  - Circumvent Refeeding Syndrome
  - Avoid and/or treat malnutrition
  - Reduce loss of lean body mass
  - Improve pulmonary status
Refeeding syndrome

- Discovered around 1945 when World War II ended and the prisoners of war returned home.
- Within 4 days of the reintroduction of food, the prisoners would show rapid onset of heart failure that led to death.
- Reintroduction of food would severely disrupt the metabolic equilibrium that allowed the prisoner to survive during starvation.
Refeeding Syndrome

- Condition seen in malnourished patients undergoing initiation of feeding
  - Oral, enteral and/or parenteral
- Resulting metabolic consequences:
  - Severe electrolyte & fluid shifts
  - Altered glucose metabolism
  - Vitamin deficiencies
  - Signs/Symptoms of refeeding syndrome: Dyspnea, cardiac arrhythmia, lethargy, muscle weakness, edema, and cardiac failure
- Noteworthy association w/ morbidity & mortality
Who is at risk for Refeeding…

- Prolonged fasting
- Recent significant weight loss
- Chronic alcoholism
- Prolonged IVF repletion (w/out Dextrose)
- Anorexia Nervosa
- Oncology patients
- Some post-op patients
Associated Complications

- **Shift of fat → carbohydrate metabolism**
  - Glucose load → insulin release → ↑ cellular update of glucose, Phos, Mg, K⁺ & H₂O

- **Fluid shifts → fluid intolerance**
  - Cardiac failure, dehydration, fluid overload, hypotension, renal failure, sudden death

- **Thiamine deficiency**
  - Carbohydrate refeeding ↑ thiamine utilization

- **Hypo- Phos, Mg, K⁺**
A 75-year old man with a known history of chronic alcohol dependency is found unresponsive at his home. The family reports he has lost 50 lbs within 2 months. An IV fluid with 800 grams of dextrose is started. After approximately 12 hours, the patient becomes confused and violent. A nurse also notices the patient has nystagmus and gait ataxia.

- What is the patient's diagnosis? What syndrome is he at risk for?
What is your diagnosis and treatment for this patient? Choose your answer below.

A. Pellagra – treat with Niacin
B. Scurvy – treat with vitamin C
C. Wernickes Encephalopathy – treat with thiamine
Optimizing Nutrition-related Management

- **Before initiating any form of dextrose**
  - Correct electrolyte abnormalities
  - Manage vitamin & trace element deficiencies
    - ~50-250 mg Thiamine, 30 minutes prior
    - Oral thiamine ~100 mg tablets, once daily
    - Consider 5 mg Folate, daily
  - Carefully restore volume
    - ~800 mL/day, initially

- **Slow calorie repletion**
  - Limit carbohydrate to 50-150 g/day, initially
  - ~15kcal/kg per day and/or ~1000kcal daily
Strategies to Achieve Our Goals

- Nutrition Risk Screening, don’t be fooled...
  “Body composition studies using a variety of methods have shown that depletion of fat-free mass occurs in a substantial proportion of patients with COPD, even in the absence of weight loss.”

- Most patients with COPD admitted to the hospital will be at nutritional risk

- Evaluate all patients with acute or chronic pulmonary disease
Respiratory Insufficiency/Failure

- Respiratory insufficiency is a common feature of critical illness
- Cannot independently sustain:
  - Oxygenation
  - Carbon dioxide removal
  - Acid-base balance
- Patients require assistance via mechanical ventilation
  - Non-Invasive vs. Invasive
Mechanical Ventilation

“A Registered Dietitian should understand the different modes of ventilation and ventilator settings to determine if nutrition support is appropriate”
Non-Invasive Ventilation (NIV)

- **Goal**: delivery of ventilator support without the need for an invasive, artificial airway

- Modalities that provide assistance using a nasal pillow, nose mask or full-face mask
  - BiPAP (Bi-level positive airway pressure)
  - CPAP (Continuous positive airway pressure)
  - Optiflow

Can these patients eat?
Invasive Ventilation

Goal: To provide ventilation for patients who cannot breath on their own
- A tube is inserted into the trachea
- Many different modes...

Intubation with a tube through which air is directly delivered
- Endotracheal Tube vs. Tracheostomy Tube
- Short-term vs. Long-term
Invasive Ventilation via Endotracheal Tube (ETT)

- Placed w/ anesthesia
  - Emergency
  - Intensive care

- Short-term use
  - ~14 days
Invasive Ventilation via Tracheostomy Tube

- Surgical procedure to open a direct airway
- Sometimes acute, but mostly chronic/elective
  - Long term ventilation (>14 days)
  - “Tracheal Toilet”
Nutrition & Mechanical Ventilation

- Patients are NPO and require alternate means of nutrition support
  - **Enteral Nutrition Support**
    - Used when the patient has a functioning gut
      - via NGT, Dobhoff, OGT, PEG, PEJ, G/J
  - **Parenteral Nutrition (PN) Support**
    - Used when the patient does not have a functioning gut
    - Supplemental Peripheral PN or Total PN
Before We Feed, We Must First Assess!

- **Weight**
  - It's important to compare current weight with usual and ideal body weight.
  - Assessment should NOT be solely based on wt.
    - $\text{H}_2\text{O}$ retention/edema is common in this population.

- **Protein**
  - ~20% total calories.
  - 1.2-1.5 g/kg *initially*, adjust for stress and/or repletion.
  - Positive nitrogen balance is desirable for repletion.
Nitrogen Balance

The “traditional” method of determining minimum levels of human protein and amino acid requirements

Nitrogen Balance = “Nitrogen in” - “Nitrogen out”

“Nitrogen in” = total grams of protein from enteral and/or parenteral nutrition

“Nitrogen out” = urine, stool, skin, wounds, dialysis, etc.
**Nitrogen Balance Equation**

\[
\text{Nitrogen IN} - \text{Nitrogen OUT} \\
\text{24 hr protein intake} - (24 \text{ hr UUN + 4})
\]

**How do we convert protein into Nitrogen??**

- 95 g protein from PN = ____g of Nitrogen - 20g UUN + 4 fecal, etc. = ________________ : What does this mean?
- 95 g protein from PN = ____g of Nitrogen - 8g UUN + 4 fecal, etc. = ________________ : What does this mean?
Interpreting Nitrogen Balance

- (−) nitrogen balance = protein catabolism
- (+) nitrogen balance = protein synthesis

Goal = (+) 2-4 grams

Keep in mind...nitrogen balance is very difficult to attain in critically ill patients and therefore may not be a realistic goal and/or value to obtain.
~Nutrient Requirements (critically ill patients)

- **Carbohydrate**
  - ~45-60% total calories
  - $\leq 3-4 \text{ mg/kg/min}$ in critically ill... **WHY?**

- **Fat**
  - ~20-25% total calories
  - $<1 \text{ gm/kg}$ of IV lipids in critically ill... **WHY?**

- **Fluid**
  - Remember “the big picture”
A quantifiable amount of REE is attributed to work of breathing (WOB)

Pulmonary disease/failure accounts can account for \( \geq 25\% \) of REE

A.N.D Evidence Analysis Library

- RD’s should assess energy needs of individuals with COPD, based on indirect calorimetry (IC) measurements
- Studies report that the total daily energy needs of individuals with COPD are highly variable
Indirect Calorimetry (IC)

- Measures $O_2$ consumption & $CO_2$ elimination
  - Performed by Respiratory Therapists
  - Measuring device connects to the ventilator
- Calculates energy expenditure using the weir equation:
  - $EE = (3.94 \times VO2) + (1.1 \times VCO2)$
- IC report provides:
  - REE (at time of measurement; varies hourly & daily)
  - Substrate utilization/Respiratory Quotient (RQ)
Indications for Use of IC

- Acute/chronic respiratory distress/disease
- Malnutrition with altered body composition
- Multiple and/or neurological trauma
- Lack of response from current Nutr Rx.
- Failure to wean from the ventilator
- Large, open wounds
- Sepsis
Improving Accuracy of IC

- Resting, supine position >30 min before
- Quiet, thermo-neutral environment
- Usual patterns of voluntary muscle activity
- Delay study for: anesthesia, HD/PD, painful procedures, unstable vent, setting changes

Patients with Enteral feedings:
- Bolus feeds: Complete study within 1 hour of last feeding
- Continuous feeds: Ensure stability for at least 12 hrs before and throughout the study
Factors that ↓ the Accuracy of IC

- FiO$_2$ $\geq$ 60
- PEEP > 12cm H$_2$O
- Hyper/Hypo-ventilation
- Leak in system, or presence of chest tube
- HD, PD, or CRRT in progress
Respiratory Quotient (RQ)

- Measure of substrate utilization
  - Ratio of Co2 produced to O2 consumed

- **Goal RQ = ~0.85**
  - Mixed substrate utilization

- RQ < 0.8 **may** indicate underfeeding
  - Lipid oxidation
  - ? Increase in total calorie delivery

- RQ > 1.0 **may** indicate of overfeeding
  - Glucose oxidation
  - Decrease total calories and/or CHO delivery
Interpretation of RQ…
Take it with a Grain of Salt!

- Many factors exist that may discredit RQ

- Every person has their own “metabolic fingerprint”

- Underlying chronic disease affects substrate use

- Stress response, acid/base disturbances, metabolism of pharmacologic agents all can acutely skew the RQ
Which “Predictive Equation” Should I Use?!?!?!
Nutrition is NOT an exact science

“The most valuable tool in caring for these patients is a clinical team that uses EE calculations as a starting point, but relies on clinical experience and individualization of patient management to enhance outcome”
Things that make you go Hmmmm!

“3 population factors in modern critical care that are changing the metabolic state, and therefore the prediction models for metabolism”

- Growing incidence of obesity
- Increasing age
- ↑ incidence of SIRS among the critically ill
Energy Expenditure Equations

What is the most accurate for estimating EE in critically ill patients with obesity?

(ASPEN Core Curriculum 2012)

- Ireton-Jones (1992)
- Penn State 2003b
- Penn State 2010 (Modified)

“Further research is needed in critically ill patients with obesity”
Predictive Equations
(VDRF/critically ill)

- **Ireton-Jones 1992** *(actual weight)*
  \[ \text{Kg(5) – age(10) + gender(281) + trauma(292) + burn(851) + 1925} \]

- **Penn State 2003b** *(age < 60 & BMI < 30)*
  \[ \text{RMR} = \text{Mifflin}(0.96) + T_{\text{max}}(167) + V_{E}(31) - 6212 \]

- **Penn State 2010 (m)** *(age >/= 60 & BMI >/= 30)*
  \[ \text{RMR} = \text{Mifflin}(0.71) + T_{\text{max}}(85) + V_{E}(64) - 3085 \]
Predictive Equation **FACTORS**
(VDRF/Critically Ill)

- **Penn State Equation (2003 & “m”):**
  - $V_E$: minute ventilation (L/min)
  - $T_{\text{max}}$: maximum temp (°C) over the last 24 hrs
  - Wt: actual (kg)

- **Penn State Equation (1998):**
  - Wt: if >125%IBW use ABW (kg)

- **Ireton-Jones:**
  - Sex: male=1, female= 0
  - Trauma: trauma=1, **no** trauma= 0
  - Burn: burn= 1, **no** burn= 0
**Recommendations Summary:**

Adult Weight Management Determination of RMR

“Estimated energy needs should be based on RMR. If possible, RMR should be measured (e.g., indirect calorimetry). If RMR cannot be measured, then the Mifflin-St. Jeor equation using **actual** weight is the most accurate for estimating RMR for **overweight and obese** individuals.”

**Rating = Strong, Conditional**
Estimating Needs for Critically Ill, Obese Patients

“These guidelines are intended for the adult medical & surgical critically ill patient populations expected to require an ICU stay of > 2 or 3 days.”

- Permissive underfeeding or hypocaloric feeding
- **Energy** *(BMI > 30)*
  - 11-14 kcal/kg actual wt or 22-25 kcal/kg IBW
- **Protein**
  - >/= 2.0 g/kg IBW *(BMI 30-40)*
  - >/= 2.5 g/kg IBW *(BMI >/= 40)*

**Rating = Grade D**
Factors that Influence Ventilator Weaning

Fluid dynamics:
- Hyponatremia
- Hypokalemia
- Hypophosphatemia
- Hypomagnesemia
- Acidosis
- Alkalosis

Endocrine:
- Hypothyroid
- Adrenal
- Steroids

Airway Protection:
- Awake
- Coughing
- Swallowing

Cardiovascular:
- Pulmonary edema
- Diastolic dysfunction
- Volume overload

Nutrition:
- Protein production
- Muscle function

Pain
- O2 delivery capacity

Gastrointestinal:
- Aspiration pneumonitis
- Ascites, abdominal packs
- Wounds - splinting
Nutrition Impacts

Ventilator Weaning…

- Adequate nutrition is a prerequisite for ventilator weaning

- Overfeeding & underfeeding → inability to wean patients from the ventilator

- Feeding regimens during the weaning phase should focus on optimizing nutrient delivery without excessive calories
Avoid Overfeeding/
Minimize CO₂ production

According to AND’s *Manual of Clinical Practice*, it is best to replete energy needs, BUT avoid overfeeding as “excess calories are more significant in the production of CO₂ than the CHO:fat ratio.”

- ↓ total calories to reduce adverse vent effects
- S/S of overfeeding: ↑BGs, ↑LFTs, ↑PaCO₂, GI intolerances (emesis, diarrhea, ↑residuals)
Nutrition Support Recommendations

- **Enteral nutrition is the preferred route**
  - Standard/Polymeric formula unless another disease process indicates otherwise
    - Fiber-free formula if on pressors and/or paralytics

- **Evaluate potential for refeeding syndrome**
  - Refeeding syndrome can occur within 1-3 days of initiating dextrose via enteral and/or parenteral (in a malnourished patient)
Factors that Influence Ventilator Weaning

**Fluid dynamics:**
- Hyponatremia
- Hypokalemia
- Hypophosphatemia
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- Protein production
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**Gastrointestinal:**
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**Pain:**
- O2 delivery capacity
Fluid Dynamics/Altered Lab Values
Impacts Vent Weaning…

- **Low Potassium**
  - Impairs respiratory muscle function
  - Weakness, poor muscle strength – could lead to muscle necrosis and paralysis

- **Low Magnesium**
  - Impairs respiratory muscle function
  - Weakness, poor muscle strength
  - Cardiac complications

- **Low Phosphorous**
  - Rhabdomyolysis
  - Cardiac and ventilatory failure
  - Hemolysis
“Normal” Arterial Blood Gases

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>pH</td>
<td>7.35-7.45</td>
</tr>
<tr>
<td>PaCO₂</td>
<td>35-45 mmHg</td>
</tr>
<tr>
<td>HCO₃</td>
<td>22-26 mEq/L</td>
</tr>
<tr>
<td>PaO₂</td>
<td>&gt;70 mmHg</td>
</tr>
<tr>
<td>O₂ sat</td>
<td>95-99%</td>
</tr>
</tbody>
</table>
“Abnormal” Arterial Blood Gases

- **pH**
  - pH < 7.35 = acidosis
  - pH > 7.45 = alkalosis

- **PaCO<sub>2**
  - >48 = hypoventilation
  - <35 = hyperventilation

- **HCO<sub>3**
  - >28 = excess base
  - <21 = not enough base
Respiratory Acidosis

- Caused by hypoventilation
  - Contributing factors: diseases of the airways and chest, drugs, severe obesity (obesity hypoventilation syndrome)
  - Resulting from the inability of the lungs to eliminate sufficient quantities of CO₂
  - Disrupts the bodies acid-base balance
    - Body fluids become too acidic

- Symptoms: confusion, fatigue, lethargy, SOB
Respiratory Alkalosis

- Caused by hyperventilation
  - Contributing factors: Anxiety/panic, stress, severe pain, infection, bleeding
  - Disrupts the body’s acid-base balance
    - Body fluids become too basic

- Symptoms: dizzy & light-headedness, weakness, numbness, tingling, confusion, SOB
Test your knowledge! Case study

- Lewis is a 32 yr old male s/p hemicolecctomy POD#3. He is positive for an ileus and has a NG output of 2L of light green output. He also reports SOB and a nasal cannula is assigned. He is TPN-dependent.

- **Labs:**
  - Sodium 138 (135 – 145 mEq/L)
  - CO2 32H (22 – 26 mEq/L)
  - Chloride 89L (96 – 106 mEq/L)
  - PaCo2 51H (35 – 45 mm Hg)
  - Blood pH 7.50H (7.35 – 7.45)
Test your knowledge! Case study

- Based on Lewis’s labs what acid-base disorder do you diagnosis him with?

- Why are his labs abnormal?

- How could you adjust his TPN to improve his labs?
Factors that Influence Ventilator Weaning

Fluid dynamics:
- Hyponatremia
- Hypertension
- Hypokalemia
- Hypophosphatemia
- Hypomagnesemia

Airway Protection:
- Awake
- Coughing
- Swallowing

Cardiovascular:
- Pulmonary edema
- Diastolic dysfunction
- Volume overload

Endocrine:
- Hypothyroid
- Adrenal
- Steroids

Nutrition:
- Protein production
- Muscle function

Gastrointestinal:
- Aspiration pneumonitis
- Ascites, abdominal packs
- Wounds - splinting

Pain
- O2 delivery capacity
Benefits of enteral feedings

- Supports maintenance of the functional integrity of the gut
- Supports components of the gut barrier function
- Maintains normal gallbladder function – reduces risk of cholecystitis
- Maintains gut-associated lymphoid tissues (immune function)
  - IgA prevent bacterial adherence and translocation. IgA production is reduce when intraluminal nutrients are not present
Benefits of enteral feedings

- Reduced infectious complications associated with:
  - Pneumonia
  - Sepsis
  - IV sepsis
  - Intra-abdominal abscess

- Economical
Nausea/Emesis
- Possible risk of pulmonary aspiration, pneumonia, sepsis, ARDS, etc.

? Delayed gastric emptying caused by:
  - Hypotension, sepsis, stress, anesthesia/surgery, opiate analgesic meds, excessive/rapid TF infusion

Suggested interventions:
  - Reducing/discontinuing narcotics
  - Administration of prokinetic agent
  - Reduce the rate of infusion by 20-25mL/hr
  - Switch to low-fat, isotonic formula
Gastrointestinal Impacts
Vent Weaning (2 of 3)

- **Diarrhea**
  - ~Abnormal volume or consistency of stool
  - Rule out common causes:
    - Medications
      - Liquid medications in a sorbitol base
      - Prolonged use of broad spectrum antibiotics
## Sorbitol Content of Selected Medications

<table>
<thead>
<tr>
<th>Generic Name</th>
<th>Trade Name</th>
<th>% Sorbitol (w/v)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Acetaminophen elixir</td>
<td>Tylenol</td>
<td>35.0</td>
</tr>
<tr>
<td>Amantadine</td>
<td>Symmetrel</td>
<td>72.0</td>
</tr>
<tr>
<td>Cimetidine</td>
<td>Tagamet</td>
<td>46.1</td>
</tr>
<tr>
<td>Doxycycline</td>
<td>Vibramycin</td>
<td>70.0</td>
</tr>
<tr>
<td>Furosemide</td>
<td>Lasix</td>
<td>35.0</td>
</tr>
<tr>
<td>Guafenesin/codeine</td>
<td>Robitussin AC</td>
<td>35.0</td>
</tr>
<tr>
<td>Hydroxyzine</td>
<td>Vistaril</td>
<td>116.0</td>
</tr>
<tr>
<td>Indomethacin</td>
<td>Indocin</td>
<td>35.0</td>
</tr>
<tr>
<td>Isoniazid</td>
<td>Generic</td>
<td>70.0</td>
</tr>
<tr>
<td>Metoclopramide</td>
<td>Reglan</td>
<td>028.0–42.0</td>
</tr>
<tr>
<td>Nortriptyline</td>
<td>Aventyl</td>
<td>64.0</td>
</tr>
<tr>
<td>Pseudoephedrine/triprolidine</td>
<td>Actifed</td>
<td>49.0</td>
</tr>
</tbody>
</table>
Medications Associated with Increased Incidence of Causing Diarrhea

- Ampicillin
- Bisacodyl
- Caffeine
- Clindamycin
- Colchicine
- Digoxin
- Erythromycin
- Hydralazine
- Lactulose
- Magnesium-containing preparations
- Metoclopramide
- Methotrexate
- Penicillamine
- Procainamide
- Neomycin
- Quinidine
- Theophylline
Diarrhea

- Abnormal volume or consistency of stool

Rule out common causes:

- Medications
  - Liquid medications in a sorbitol base
  - Prolonged use of broad spectrum antibiotics

- Infection/inflammation

- Fecal impaction and/or ileus

- Characteristics of the TF formula (osmolarity, fat content)

- Need for addition and/or subtraction of fiber

- Allergen or intolerance to EN (lactose, etc)
Gastric Residual Volume (GRV)

- Elevate HOB 30-45°, unless medical contraindication exist
- Check every 4-8 hrs
- If >/= 250mL after 2nd check, a promotility agent should be considered for adults
- If >500mL, TF should be held for reassessment
Factors that Influence Ventilator Weaning

**Fluid dynamics:**
- Hyponatremia
- Hypernatremia
- Hypokalemia
- Hypomagnesemia
- Acidosis
- Alkalosis

**Endocrine:**
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- Adrenal
- Steroids

**Airway Protection:**
- Awake
- Coughing
- Swallowing

**Cardiovascular:**
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- Diastolic dysfunction
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**Nutrition:**
- Protein production
- Muscle function

**Gastrointestinal:**
- Aspiration pneumonitis
- Ascites, abdominal packs
- Wounds - splinting

**Pain:**
- O2 delivery capacity
Ventilator Weaning

- The patient must be able to:
  - Ventilate
  - Oxygenate
  - Protect his/her airway

- Two steps to ventilator weaning
  1. Withdrawal of mechanical ventilation
  2. Removal of the tube (extubation/decannulation)
VDRF Feeding Stages

1. **Acute Repletion:**
   - Replenish muscle glycogen stores
   - Reverse catabolism and/or maintain $+N_2$ balance

2. **Pre-Weaning:**
   - Maximize protein stores
   - Weight maintenance

3. **Weaning:**
   - Provide energy substrates to cover increased needs
   - Avoid excess CO$_2$ production/overfeeding

4. **Post-Weaning:**
   - Maintain nutrient needs despite anorexia and/or dysphagia
PO Progression Post Weaning

- SLP/swallow function eval ordered once the patient has been successfully weaned off of the ventilator

  - Bed-side assessment

  - Modified Barium Swallow/Videofluoroscopic Exam
    - Test done in the radiology department to determine swallowing function
Dysphagia (1 of 2)

- Difficulty chewing or swallowing
- Poor swallow puts the patient at risk for aspiration
  - When food/fluid enters the airway below the level of the vocal cords →
    - chest infection/aspiration pneumonia
    - prolonged hospital stay
    - malnutrition
    - Mortality – reduce oxygenation, infection risk, etc.

- Guide To Dysphagia - 3D Animations of Swallowing:
  [https://www.youtube.com/watch?v=adJHdrQ4CRM](https://www.youtube.com/watch?v=adJHdrQ4CRM)
Dysphagia (2 of 2)

- **Esophageal Dysphagia**
  - Food/liquid stops in the esophagus

- **Oropharyngeal Dysphagia**
  - Difficulty moving food to the back of the mouth

- Liquids are the most difficult to manage/swallow
  - Pudding-thick → Honey-thick → Nectar-thick → Thin

  - **Dysphagia - How to thicken tea with Resource ThickenUp Clear:**
    https://www.youtube.com/watch?v=LB4NfbVQ308
Dysphagia (3 of 3)

- Modified-Consistency Diets
  - Dysphagia 1 (Pureed) → Dysphagia 2 (Mechanically soft) → Dysphagia 3 (Advanced /Soft) → Regular Diet
Test your knowledge! Case study

- Margaret is a 87 yr old female, recently extubated 12 days ago with ongoing dysphagia. She has been eating ~50% of her meals, and has lost 7 lbs in 12 days. She has refused all oral supplements.

- What would you do first?
  - Encourage po and check back in 3 days
  - Compare meal completions to nutritional needs
  - Review supplements again w/ the patient

- What else could you do to increase Margaret’s nutritional intake?
RD’s Role Post Vent Weaning

- Once PO consistency is determined per SLP...
  - RD determines the need for therapeutic modifiers to ensure adequate nutrition

- Discuss meal trials w/ SLP
  - Is the patient hungry? How much has the patient eaten during trials? Do they need assistance?

- Assess appropriateness of alternate nutrition support based on current rate/provision vs. %PO, and adjust accordingly
  - Continuous → Nocturnal → Boluses → Discontinuation of TF
  - ? Need for oral supplements
Milk Consumption & Mucous Production

A.N.D Evidence Analysis Library

- Research reports that consumption of milk does not significantly change various lung function parameters.
- People who believe that milk increases mucus formation are more likely to report changes in sensory perceptions related to mucus after drinking milk than those who do not hold the same belief.
- Limiting dairy food consumption can lead to low intake of many nutrients, including calcium.

“Further research is needed”
Nutrition Diagnosis Statements for Pulmonary Patients

- Increased Nutrient Needs related to: recent surgical intervention...
- Inadequate Oral Food/Beverage Intake related to: lack of access / ventilator dependence...
- Swallowing Difficulty related to: mechanical vs. motor cause...
- Altered Nutrition-related labs related to: pulmonary dysfunction...
Questions??
References (1 of 4)


References (3 of 4)


References (4 of 4)


- AND Nutrition Care Manual- Pulmonary.

- NHLBI/WHO Global Initiative for Chronic Obstructive Lung Disease (GOLD); 2001-2006-2008 ([www.goldcopd.com](http://www.goldcopd.com))