1: Mr. Hayato was diagnosed with emphysema more than 10 years ago. Define emphysema and its underlying pathophysiology. (Nelms, 659).

- Emphysema is a condition where alveoli of the lungs become thinned and destructed which causes a decreased ability of oxygen transfer to the blood and causes shortness of breath.
- Emphysema causes decreased forced expiratory volume (FEV), meaning that you can inhale easily but not exhale because air gets trapped within the lungs.
- This can lead to dyspnea & orthopnea/difficulty breathing, high CO$_2$ in the blood, and respiratory acidosis.
- At the end stages of the disease, hypoxemia can occur (low O$_2$) in blood, accompanied with extreme exhaustion and fatigue to prevent sufficient oxygen intake.

2: Define the following terms found in the history and physical for Mr. Hayato. (Nelms, glossary & Pub Med Health Online)

Dyspnea: Shortness of breath, difficulty breathing
Orthopnea: Shortness of breath when laying down in the supine position
Pneumothorax: A collection of air in the space around the lung which puts pressure on the lung, preventing it from expanding when breathing. This is also called a collapsed lung.
Endotracheal intubation: Medical procedure where tube is placed into trachea through nose or mouth. Endotracheal intubation is used to hook up to a breathing machine, open the airway for oxygen, remove blockages in airway, or protect the lungs.
Cyanosis: blue-colored mucous membranes and skin due to lack of oxygen supply

3: Identify features of the physician’s physical examination that are consistent with his admitting diagnosis. Describe the pathophysiology that might be responsible for each physical finding.

- General appearance of being acutely dyspenic and in acute respiratory distress
- Shifted trachea (possibly from endotracheal intubation)
- Hyperresonance to percussion over left chest anteriorly and posteriorly.
- Harsh inspiratory breath sounds over right chest with absent signs on left
- Using accessory muscles of chest at reset
- Cyanosis & edema of the skin


- Studies have shown that diets rich in fruits, vegetables and fish might reduce incidence of COPD
  - This is because of the high antioxidants and fiber and fruits and vegetables.
- Diets rich in refined grains, cured and red meats, desserts, and fried foods may increase risk of COPD
- Antioxidants help reduce oxidative damage caused by smoking, pollutants, etc.
- Malnutrition can exacerbate respiratory problems
- Some patients with COPD may benefit from a lower-carbohydrate diet because carbohydrates create the most carbon dioxide when they are metabolized, sometimes making it harder for the patient to breathe.
- Fats create the least amount of C02 and are energy dense so a higher-fat diet may be recommended for someone with COPD, depending on their situation.
- **Respiratory Quotient:** The ratio of carbon dioxide (CO\(_2\)) produced by tissue metabolism to oxygen (O\(_2\)) in a specific tissue.
  - \(\text{RQ} = \frac{\text{CO}_2 \text{ eliminated}}{\text{O}_2 \text{ consumed}}\)
  - Relates to a caloric value for each liter of CO\(_2\) produced, ranging between 1.0 (all CHO oxidation) to 0.7 (all fat oxidation)

5: Do nutrition support and nutritional status play a role in the ability to be weaned? (Nelms, pg. 662).
- Consuming carbohydrates versus fat or protein creates more carbon dioxide production which can prolong the amount of time a person has to be on a ventilator. This is why for nutrition support you want to have a low CHO load.
- Many enteral feedings have been specifically designed for people with respiratory disease (such as Oxepa and Pulmocare) to contain a lower CHO content (30%) and higher fat content (50%).
- Clinical studies have shown that lower carbohydrate formulas decrease CO\(_2\) production but more studies need to be done.
- Because of the high-fat content, it may cause more bloating, GI discomfort, or delayed gastric emptying which may be drawbacks to the lower-carbohydrate, higher-fat formulas.

6: Evaluate Mr. Hayato’s admitting anthropometric data for nutritional assessment.
- **Height:** 5’4” → 64 inches → 1.62 m
- **Weight:** 122 lbs → 55.5 kg
- **BMI:** 20.9 kg/m\(^2\), normal
- **IBW:** 106 + (6.4) = 130 +/- 10% → 117-143 lbs, within ideal body weight range
- **% IBW:** 122/130 x 100 = 94% IBW
  - The patient is at a normal and healthy body weight for his height.
- **UBW:** 135
- **%UBW:** 122/135 x 100 = 90% UBW
  - This patient has lost 10% of their usual body weight recently, however it is not noted in what time period this weight was lost.

7: Determine Mr. Hayato’s energy and protein requirements using the Mifflin-St. Jeor equation, the Ireton-Jones equation, and the COPD predictive equations. Compare them. As Mr. Hayato’s clinician, which would you set as your goal for meeting his energy needs? (Nelms, pg. 60 & 662)

**Mifflin-St. Jeor:**
- REE for Males: 10 W + 6.25 H - 5 Age + 5
  - Pt: 10(55.5 kg) + 6.25(162 cm) - 5(65) + 5
  - REE= 1248 kcals/day
  - AF: 1248 x (1.3 and 1.4)= 1622-1747 kcals
  - Protein (1.0-1.5 g/kg/day): 56-83 g protein

**Ireton-Jones:**
- REE= (5 x weight) - (11 x age) + (244 if male) + (239 if trauma present) + (840 if weight present) + 1784
  - Pt= (5 x 55.5) - (11 x 65) + (244) + (239) + 1784
  - REE= 1830 kcals/day
  - AF: 1830 x (1.3 and 1.4)= 2379-2562 kcals
  - Protein (1.0-1.5 g/kg/day): 56- 83 g protein

**COPD Methods:**
- **Thorsdottir and Gunnarsdottir :**
  - 125-156% above basal energy expenditure
  - Protein: 1.2-1.7 g/kg
Chest Physicians: 25 or 30 x 55.5 kg = 1388-1665 kcals/day
1527 x 125% OR 156% = 1909-2382 kcals/day
Protein: 67-94 grams

25-30 kcals/kg with 20% from protein (or 1.2-1.7 g/kg)
55.5 x (25 or 30 kcals) = 1388-1665 kcals/day
Protein (20%) = 69-83 g

Comparison & Recommendation(s): The lowest calorie recommendations came from the suggestion for COPD patients to consume 25-30 kcals/kg and the highest came from the Ireton-Jones equation accounting in the activity/injury factor. As a clinician, I would recommend that he follows the Thorsdottir and Gunnarsdottir recommendations and consumes 1909-2382 kcals/day with about 67-94 g of protein/day. COPD will raise his REE and his protein needs significantly, which is why I would recommend these ranges.

8: Determine Mr. Hayato’s fluid requirements.
- Between 1909-2382 mL/day or 8-20 cups of fluids/day based on his recommended caloric intake.

9: From the information gathered within the intake domain, list possible nutrition problems using the diagnostic term.
- Increased energy expenditure
- Inadequate energy intake
- Inadequate oral food/beverage intake
- Inadequate fluid intake
- Inadequate protein-energy intake
- Inadequate fat intake
- Inadequate protein intake
- Inadequate carbohydrate intake
- Inadequate fiber intake

10: Evaluate Mr. Hayato’s biochemical indices for nutritional assessment on day 1. (Pagana, 803, 1007, 356).

<table>
<thead>
<tr>
<th>Biochemical Lab</th>
<th>Normal Value</th>
<th>Mr. Hayato’s Value</th>
<th>Nutrition Indication</th>
</tr>
</thead>
<tbody>
<tr>
<td>Transferrin</td>
<td>215-365 (men) mg/dL</td>
<td>170 mg/dL</td>
<td>Low due to possible malnutrition, hypoproteinemia, and/or inflammatory disease</td>
</tr>
<tr>
<td>Uric acid</td>
<td>4.0-9.0 mg/dL</td>
<td>3.9 mg/dL</td>
<td>Possible chronic alcohol consumption or acidosis</td>
</tr>
<tr>
<td>HDL-C</td>
<td>&gt;45 (men) mg/dL</td>
<td>32 mg/dL</td>
<td>Smoking &amp; alcohol lower HDL, malnutrition/hypoproteinemia</td>
</tr>
<tr>
<td>LDL</td>
<td>&lt;130 mg/dL</td>
<td>142 mg/dL</td>
<td>Alcohol consumption, familial LDL lipoproteinemia</td>
</tr>
<tr>
<td>LDH</td>
<td>208-378 U/L</td>
<td>412 U/L</td>
<td>Alcohol use, Pulmonary disease</td>
</tr>
<tr>
<td>LDL/HDL ratio</td>
<td>&lt;3.55 (men) mg/dL</td>
<td>4.4 mg/dL</td>
<td>High-cholesterol diet, stress</td>
</tr>
</tbody>
</table>

11: From the information gathered within the clinical domain, list possible nutrition problems using the diagnostic term.
- Altered nutrition-related laboratory values:
  - decreased transferrin
  - decreased uric acid
o decreased HDL-C
o increased LDL
o increased LDH
o increased LDL/HDL ratio

12: Select two high-priority nutrition problems and complete the PES statement for each.
   • Inadequate food intake related to decreased appetite evidenced by recent involuntary weight loss and current weigh 90% of usual body weight.
   • Involuntary weight loss related to decreased appetite and inadequate intake of calorie-dense foods as evidenced by 13-lb weight loss and 24-hour recall well below recommended calorie intake.

13: Mr. Hayato was started on Isosource HN @ 25 cc/hr continuously over 24 hours. (http://www.nestle-nutrition.com/products/Product.aspx?Productld=f31b74ec-e9ae-465b-ae7a-b10a479d9829)
   a. At this current rate, how many kilocalories and grams of protein should he receive per day?
      25 mL x 24 hours= 600 mL/day
      600 mL x 1.2 kcals/mL= 720 kcals/day
      600 mL/1000 mL= 0.6
      53 g pro x 0.6= 31.8 g protein/day
   b. Calculate his nutrition prescription utilizing this enteral formula. Include goal rate, free water requirements, and the appropriate progression of the rate.
      Needs: 2100 kcals, 80 g protein, 2100 mL H2O
      • 2100 kcals/1.2 kcals/mL= 1750 mL
      • 1750 mL/24 hours=72.9 mL/hour → 75 mL/hour
      • 75 mL x 24 hours=1800 mL total volume
      • 1800 mL/1000= 1.8
      Total kcals:
      • 1800 mL x 1.2= 2160 kcals/day
      Protein:
      • 1.8 x 53 g protein= 95 g protein/day
      Water:
      • 1.8 x 818 mL= 1472 mL H2O
      • Flushes: 2100-1472= 628 mL/6= 105 mL H2O q 4 hours
      CHO load:
      • 1.8 x 160 grams CHO=288 grams CHO/day
      • 288000/55.5 kg/1440 min= 3.6 mg CHO/kg/min
      Prescription:
      Isosource HN @ 75 mL/hour (2160 kcals, 95 g protein, 1472 mL H2O, 3.6 mg CHO/kg/min) with 105 mL H2O flush q 4 hours. Start tube feeding at 25 mL/hr and advance 10 mL every 6 hours until goal of 75 mL/hour is reached.

14: What type of formula is Isosource HN? What is the percentage of kilocalories from carbohydrate, protein, and lipid? Should the patient have been started on a disease-specific formula? Support your responses. What is the rationale for pulmonary formulas? (ncp.sagepub.com/content/19/6/557.abstract)
   • Isosource HN is a high-protein/high-nitrogen standard formula with intact nutrients for standard nutrition support. It is not disease-specific.
   • % kcals from:
      o CHO: 53%
      o Protein: 18%
      o lipid: 29%
Yes, I think the patient should have been started on a disease-specific formula. It was already known that the patient has respiratory problems and so a lower carbohydrate formula should have been used in the beginning because it could have helped him get off of the ventilator faster because he may have had reduced CO₂ output.

Rationale: Providing less carbohydrates will reduce CO₂ production and reduce respiratory quotient (RQ). This is thought to help the respiratory problem with a better outcome. Many are also high calorie to support the increased energy expenditure with a low volume. The high protein also helps reduce lean body mass loss.

15: Examine the patient care summary sheet. How much enteral feeding did the patient receive?

- 25 x 16 = 400 + 100 = 500 mL until the tube feeding was held due to high residuals

16: You read in the physician’s orders that the patient experienced high gastric residuals and the enteral feeding was discontinued. What does this mean, and what is the potential cause of the problem? (http://www.todaysdietitian.com/newarchives/060210p8.shtml)

- Gastric residuals volume is the amount of fluid in the stomach during enteral feeding and is measured to determine if the feeding is being tolerated and being properly digested. If there are high gastric residuals that can mean that the person’s digestive tract isn't working adequately or emptying at a normal rate. The dangers with a high gastric residual volume is regurgitation, choking, vomiting, or aspiration of the formula.
- The potential cause of this problem can be due to the recent stress of the patient’s hospital visit sometimes disrupts digestion. Other issues could possibly be delayed gastric emptying or GI ischemia.

17: Dr. McFarland elected to begin peripheral parenteral nutrition using a formula called ProcalAmine. She began the PPN @ 100 cc/hr and discontinued Mr. Hayato’s regular IV of D5 1/2 NS at TKO. What is ProcalAmine, and how much nutrition does this provide? (http://www.victus.com/eng/ENGLISH_Literature_PDF/Nutritional/parenteral%20nutrition/Y08-550-645_ProcalAmine.pdf)

- ProcalAmine is an IV injection that contains amino acids and helps maintain electrolytes.
- The non-protein energy source is Glycerin.
- For 1000 mL ProcalAmine provides 29 g protein and 245 total kcals
- For 24 hours at 100 mL/hour, ProcalAmine provides 70 g protein and 588 kcals.

18: Was this adequate to meet the patient’s nutritional needs? Explain.

- This is not adequate to meet the patient's needs. He needs far more calories than the PPN is providing, especially with his increased needs due to COPD. The protein is on the lower end and although this would and did sustain him for a few days it is not enough for long-term.

19: Do you feel it was a good idea to begin peripheral parenteral nutrition (PPN)? What are the pros and cons? What are the limitations of using this form of nutrition support? Were other nutrition support options available for the health care team? (http://www.rxkinetics.com/tpntutorial/2_3.html)

- I think that more options could have been done before beginning PPN. With delayed gastric emptying you can try to reduce the feeding rate, switch to a lower-fat formula, administer the tube feeding at room temperature, or give medications that can help with the issue.
- The pros of PN are:
  - allows use of high-osmolality solutions of >900 mOsm/L
  - alternative if GI tract isn't working
- The cons of PN are:
  - many associated risks such as imbalance of lab values and electrolytes
  - liver fatigue
20: On day 4, the enteral feeding was restarted at 25 cc/hr and then increased to 50 cc/hr after 12 hours. You document that the ProcalAmine @ 100 cc/hr was also continued. What would have been the total energy intake for Mr. Hayato?

- 25 mL hour x 12 = 300 mL + (12) 50 = 900 mL/day of Isosource HN
- 900 mL x 1.2 kcals/mL = 1080 kcals from EN
- 100 mL x 24 hours = 2400 mL of ProcalAmine
- 245 x 2.4 L = 588 kcals from PPN
- 1080 + 588 = 1668 kcals/day total

21: Examine the values documented for arterial blood gases (ABGs). (Pagana 115-125)
a. On the day Mr. Hayato was intubated, his ABGs were as follows: pH 7.2, PCO2 65, CO2 35, PO2 56, and HCO3-38. What can you determine from each of these values?

<table>
<thead>
<tr>
<th>ABG</th>
<th>High/Low</th>
<th>Explanation</th>
</tr>
</thead>
<tbody>
<tr>
<td>pH</td>
<td>Low</td>
<td>Respiratory acidosis. High amounts of H+ ion from difficulty breathing and not being able to release enough CO2 that the body produces.</td>
</tr>
<tr>
<td>PCO2</td>
<td>High</td>
<td>Partial pressure of CO2, measurement of ventilation. Respiratory acidosis and short, shallow breaths increase P CO2 levels and if it rises too high coma can result.</td>
</tr>
<tr>
<td>CO2</td>
<td>High</td>
<td>Indirect measurement of HCO3. It is high because HCO3 is high in an attempt to compensate for respiratory acidosis.</td>
</tr>
<tr>
<td>PO2</td>
<td>Low</td>
<td>Indirect measurement of O2 content of arterial blood, measures the pressure. Decreased in patients with O2 diffusion difficulties such as COPD.</td>
</tr>
<tr>
<td>HCO3</td>
<td>High</td>
<td>Measure of the metabolic (renal) component of acid-base balance. Normally as HCO3 rises so does pH level. However, with respiratory acidosis the kidneys attempt to compensate by reabsorbing increased amounts of HCO3, attempting to restore pH to normal.</td>
</tr>
</tbody>
</table>

b. On day 3 while Mr. Hayato was on the ventilator, his ABGs were as follows: pH 7.36, PCO2 50, CO2 29, PO2 60, and HCO3-33. What can you determine from each of these values?

- By day three, the ventilator is working to help breathe and move oxygen in and out. The pH is within normal range and PCO2, CO2, PO2, and HCO3 are still working to balance themselves out. They are getting closer to returning to normal but overshoot to restore pH.

c. On day 5, after restarting enteral feeding and continuing on ProcalAmine, his ABGs were as follows: pH 7.22, PCO2 66, CO2 36, PO2 57, and HCO3-37. In addition, indirect calorimetry indicated a RQ of 0.95 and measured energy intake to be 1,350 kcal. How does the patient’s measured energy intake compare to your previous calculations? What does the RQ indicate?

- All of these labs show that respiratory acidosis became worse again with the enteral feeding and parenteral feeding. The RQ indicates that he was putting out almost as much CO2 as oxygen. An RQ of 1 is purely carbohydrates, so he is metabolizing mostly carbohydrates. He has a high carb load between the enteral feeding and the parenteral feeding. This is causing him to expel a lot of CO2 and go into respiratory alkalosis again.

- Also, his energy intake was estimated at 1,350 kcals/day using indirect calorimetry which is similar to the low end of the American College of Chest Physician's calculated range for the patient (25 x kg). It was also similar to the Harris-Bennedict equation. Ireton-Jones was much higher. With the combination of the EN and the PN the patient was receiving, he was being overfed by about 300 calories. His carb load was also too high at this point which is probably why his RQ was high (high CHO, high CO2 expulsion) and why he was showing ABG values of respiratory alkalosis again.
As Mr. Hayato is prepared for discharge, what nutritional goals might you set with him and his wife to improve his overall nutritional status?

- Increase energy intake, consuming between 1909-2382 kcals/day.
- Increase protein intake to 67-94 g of protein/day.
- Gain 1 lb per week until goal weight of 130 is reached.
- 15 minute walks 5x/week.
- Carbohydrates should not exceed 50% of energy intake.
- Eat at least 5 servings of fruits and vegetables a day for adequate antioxidant intake.
- Consume 8-10 cups of fluid/day.

Works Cited

