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Case Study #3: Case 31 (Nutrition Support in Sepsis and Morbid Obesity)

Disease and Pathophysiology

1. Mr. McKinley's admission orders indicate he is being treated for probable sepsis and SIRS. Define these conditions. (3 points)

Sepsis is an immunosuppressive response that prevents the body from sufficiently responding to an infection. It can cause many abnormalities, such as hypoperfusion leading to organ dysfunction and eventually failure. Furthermore, septic shock is when sepsis reaches severe status and the corresponding hypotension cannot be reversed with fluid resuscitation. Systemic inflammatory response syndrome (SIRS) is not necessarily caused by an infection, but can be a condition caused by sepsis. SIRS can also occur after trauma, major surgery, or conditions such as myocardial infarction. Complications of SIRS can cause multiorgan distress syndrome, which is also called multisystem organ failure (Nelms, Sucher, & Lacey, 2014).

2. Describe the metabolic alterations that occur as a result of sepsis and the systemic inflammatory response. Using the medical record information, identify the specific criteria that are consistent with the diagnosis of sepsis. (4 points)

The physiological changes that occur which indicate metabolic stress caused by sepsis and SIRS are profound. Initially, when a patient's immune system recognizes the antigens, the body will respond by releasing pro-inflammatory cytokines, altering cellular metabolism, increasing production of acute-phase proteins, and influencing the immune system and corresponding hormone release. Fibronectin, C-reactive protein, cerulosplasmin, and serum amyloid A are all positive acute-phase proteins used to indicate metabolic stress. Cytokines that regulate the release of these proteins include interleukins (IL-1, IL-6), leukotrienes, tumor necrosis factor, and interferons. IL-6 specifically can decrease acute phase proteins such as albumin and pre-albumin, thus having a negative effect on protein synthesis. Hypotension and hypoperfusion combined with an imbalance of coagulation factors can also cause many issues. For example, high levels of nitric oxide during the inflammatory response can increase vascular permeability, allowing for fluid to shift into third compartments. Cytokines act on target cells, resulting in side effects such as loss of appetite, fever, inflammation, hyperglycemia, and catabolism of essential tissues (Nelms, Sucher, & Lacey, 2014).

The hormone cortisol, released in times of stress and injury, can trigger a shift to mobilize free fatty acids, increase gluconeogenesis, and decrease protein synthesis. This is coupled by a catabolism of skeletal muscle and potential hyperglycemia. The increased gluconeogenesis utilizes protein as a source of glucose, and specifically the amino acid alanine. The result is a breakdown of muscle tissue in order to supply adequate substrate to the liver to form energy. Also, glutamine, a non-essential amino acid that is important for metabolic and immunologic pathways, may have a rate of synthesis that is inadequate to supply the increased metabolic requirements. Therefore, increased serum lactate and negative nitrogen balance are relevant markers. Eventually the body shifts from the inflammatory response to an anti-inflammatory response. Often times at this point patients experience MODS/MSOF (Nelms, Sucher, & Lacey, 2014).

The initial indicators of sepsis include an increased white blood cell count (>12,000 mm^3), increased heart rate (>90 beats per minute), increased respiratory rate (>20 breaths per minute), and either a fever (>100.4 F) or hypothermia (<96.8 F). Increased inflammatory markers like c-reactive proteins, fibrinogens, and other acute-phase proteins is also an indicator. Abnormal organ function occurs in later stages, and corresponding labs will indicate accordingly (Nelms, Sucher, & Lacey, 2014).

Mr. Mckinley meets many of the criteria which are consistent with the diagnosis of sepsis. His white blood cell count is extremely high (23.5 x 10^3/mm^3). He has high (5.8 mg/dl) serum levels of c-reactive proteins, and low levels of albumin (1.9 g/dl), prealbumin (11 mg/dl), and hemoglobin (12.5 g/dl). His fibrinogen levels are high (525 mg/dl). He has a high respiratory rate (23 breaths per minute). His serum lactate levels are high (4.2 mEq/L) and his urine is positive for ketones, proteins, and glucose, which indicates metabolic alterations. His fever (102.5 F), low ferritin levels (14 mg/ml), and high transferrin levels (385 mg/dl) indicates an infection because his body has higher iron needs to create enzymes involved with his body's immune response, and the bacteria themselves utilize the body's iron. Other criteria that indicate sepsis in some people but may not in Mr. McKinley are his high blood glucose level and the presence of glucose in his urine, considering the fact that he has type 2 DM and stopped taking his medication to control it (Nelms & Roth, 2014).

3. Mr. McKinley had a Roux-en-Y gastric bypass 4 months ago and has lost approximately 100 lbs. Describe this procedure. Identify the most probable nutritional concerns associated with this specific procedure and rapid weight loss. (3 points)

The Roux-ex-Y gastric bypass surgery is one of the most common bariatric procedures used for rapid weight loss. It is a restrictive-malabsorptive procedure which reduce the volume of food and liquids that the patient can consume at one time. The stomach and duodenum are bypassed, and a small pouch is created which restricts food intake and subsequently increases early satiety. This also inhibits the amount of food digestion that can occur, and therefore greatly reduces nutrient absorption. Stomach, liver, gallbladder, and pancreatic secretions still enter the jejunum and mix with the contents that leave the previously mentioned surgically created pouch (Nelms, Sucher, & Lacey, 2014).

The most probable nutritional issues are caused by nausea and vomiting related to this procedure. They occur due to ingestion of food that exceeds the amount that the new food pouch can withstand. They can also be caused by dumping syndrome, which involves nausea, flushing, bloating, and diarrhea are common in gastric bypass patients. These can lead to electrolyte imbalances and dehydration. Nutrient issues are very common as a result of the surgery due to the forced decrease of food intake along with less absorption ability. Fat soluble vitamins ADEK, B12, folate, iron, and calcium are nutrients that need to be carefully monitored. Long term supplementation may be necessary to prevent complications (Nelms, Sucher, & Lacey, 2014).

Concerns also arise with rapid weight loss. One in specific is cholelithiasis. Rapid, significant weight loss can lead to an excess amount of fat being broken down and the liver has to deal with it by excreting the cholesterol and fat through bile. This can result in a buildup and calcification of “sludge” in the gallbladder or a connected duct (Spoek, 2016).

Understanding Nutrition Therapy

4. Should Mr. McKinley receive nutrition support? Explain the rationale for your decisions. (3 points)

Mr. McKinley should receive nutrition support in order to support his body during this time of stress. He is in a hypermetabolic state, and on a ventilator. Nutrition therapy will help modulate his body’s inflammatory response, reduce the catabolism of skeletal muscle, maintain an adequate immune response, and also maintain the epithelial mucosal surface of his lumen, which can act as a barrier and hopefully suppress the continued colonization of bacteria (Spoek, 2016) (Nelms, Sucher, & Lacey, 2014).

5. Define refeeding syndrome. How will Mr. McKinley’s recent 100-lb weight loss affect your nutrition support recommendations? (4 points)

Refeeding syndrome describes many alterations that may occur during nutritional repletion of starved patients. Reintroducing carbohydrates orally results in a shift from ketones to glucose as the primary energy source, requiring large quantities of phosphorous and may increase needs for magnesium, potassium, and thiamin. Ultimately this leads to a drop in serum phosphorous because as glucose is up-taken into cells phosphorus can accompany it. This potentially results in hemolysis, impaired cardiac function, impaired respiratory function, or even death. Hypomagnesimia can cause symptoms including tremors, muscle twitching, cardiac arrhythmias, and even paralysis. Refeeding syndrome can result in hypokalemia due to levels of potassium shifting from the extracellular fluid to the intracellular fluid in the case of hypermetabolism combined with increased anabolic needs. Impaired cardiac function can occur as a result of hypokalemia. Lastly, thiamin deficiencies may result in Wernicke’s encephalopathy (Nelms, Sucher, & Lacey, 2014).

Because of the Roux-en-Y bypass surgery performed four months prior to admission, Mr. McKinley’s weight loss is most likely caused by a decrease in his food intake. Due to the surgery, possible contributing factors to the patient’s weight loss include nausea and vomiting when consuming food beyond the capacity of his now smaller stomach pouch. Considering possibility of refeeding syndrome, it is important to be sure not to feed the patient too quickly or too soon. Monitor electrolyte levels and watch for imbalances. This protocol avoids the slew of issues that include hypomagnesimia, hypokalemia, and thiamin deficiencies. It is crucial to avoid overfeeding and the possible complications resulting from increased CO_2 production and hyperglycemia. The RD should utilizing the concept of permissive underfeeding. Also, lower omega-6 fatty acid intake may provide reduced substrate for pro-inflammatory mediator synthesis. An initial limit on the intake of carbohydrates will prevent hyperglycemia, which is further complicated by Mr. McKinley's type 2 DM. Permissive under-eating also reduces DNA damage, nutrient oxidation, and lastly a suppressed instance of hypermetabolism (Nelms, Sucher, & Lacey, 2014).

Nutrition Assessment

6. Assess Mr. McKinley's height and weight. Calculate his BMI and % usual body weight. (3 points)

Height = 5'10" (177.8 cm)   Weight = 325 Lb (147.7 kg)

BMI = 147.7kg/1.778m^2 = 46.7 **Class III Obesity**

IBW = 106 + 6(10) = 166lb / 2.2 = 75.5 kg

%UBW = 325/425 = (0.765)100 = 76% UBW

Due to Mr. McKinley's class III obesity status, ideal body weight will be used to determine protein. His energy requirements will be calculated using his actual body weight (Nelms & Roth, 2014) (Spoek, 2016).

7. Identify any abnormal biochemical indices and discuss the probable underlying etiology. (5 points)

Mr. McKinley has many abnormal lab values, however directly correlating some of them to sepsis/SIRS is challenging because many of them may be due to pre-existing conditions like type 2 DM, hypertension, hyperlipidemia, and the fact that he had Rou-en-Y gastric bypass surgery 4 months ago. He does however have many biochemical alterations that are directly related to sepsis. His white blood cell count is extremely high (23.5 x 10^3/mm^3) due to his immune system fighting the infection. He has high serum levels of c-reactive proteins (5.8 mg/dl) due to being in an inflammatory disease state, resulting in his low levels of albumin (1.9 g/dl) and prealbumin (11 mg/dl). He is also low in total protein levels, but that is likely because of his decrease in food intake combined with increased metabolic needs for protein. His fibrinogen levels are high (525 mg/dl) which indicates an imbalance of coagulation factors. He has a high respiratory rate (23 breaths per minute), most likely caused by fluid accumulation in his lungs due to the inflammatory response increasing vascular permeability. His serum lactate levels are high (4.2 mEq/L) and his urine is positive for ketones, which both indicate metabolic alterations caused by sepsis. His fever (102.5 F) indicates an infection. Also, low hemoglobin levels (12.5 g/dl), low ferritin levels (14 mg/ml), and high transferrin levels (385 mg/dl) indicate an infection because the bacteria is utilizing all of his iron while at the same time his immune system needs more of it for enzymes involved in metabolic reactions and the immune system response. Mr. McKinley has elevated ammonia levels (35 micromoles/liter) which may indicate that the liver is not able to efficiently convert ammonia from the catabolism of proteins into urea. He also has elevated ALT (38 U/L) and AST (37 U/L) in his blood, which are liver enzymes that may indicate hepatic injury when at higher than normal levels. Combined with the fact that he has elevated direct bilirubin levels (0.7 mg/dl), which means the bile has been conjugated by the liver but is having a problem getting to and being stored by the gallbladder. These all may indicate that he is on his way to liver failure. But abnormal lab values like that could also mean he could have cholelithiasis, or gallstones from the vast amount of adipose that was broken down when he lost all of that weight after his surgery (Spoek, 2016). Other criteria that indicate sepsis in some people but may not in Mr. McKinley are his high blood glucose level (185mg/dL) and glucose in his urine, considering the fact that he has type 2 DM and stopped taking his medication to control it. He also has an elevated triglyceride level of 245mg/dL, where a normal level would be between the range of 40-160mg/dL for men. This abnormal indices can also be correlated to his obesity. However, it can be noted that triglycerides increase under the circumstances of metabolic stress in order to liberate free fatty acids as substrate for fuel. Mr. McKinley also has protein in his urine, which is likely due to being in an extremely stressed metabolic state (Nelms & Roth, 2014).

8. Determine Mr. McKinley's energy and protein requirements. Explain the rationale for the method you used to calculate these requirements. (5 points)

By A.S.P.E.N. Guidelines, energy requirements would be 11-14 kcal/kg actual body weight. This is due to Mr. McKinley's obese weight status and BMI of 46.7. It is indicated to use the previously mentioned range of energy intake when the patient has a BMI between 30 and 50. For protein, the same guidelines indicate utilizing **up to** 2.5 g/kg IBW (based on a BMI > 40). Protein requirements are higher in order to maintain positive nitrogen balance in a hypermetabolic state. Also, higher protein intake is indicated due to Mr. McKinley's low visceral protein levels (Spoek, 2016).

Actual Body weight = 325 lb, therefore 147.7 kg x (11-14 kcal) = 1624.7-2067.8 kcal/day

Protein = 75.5 kg IBW x (2.5g/kg) = 188.75 grams protein/day. Meaning we can feed **up to** this level of protein.

Mr. McKinley experiences shortness of breath, an elevated respiratory rate, and a lowered partial pressure of carbon dioxide. Therefore is it not indicated to use other methods of determining energy requirements, like indirect calorimetry (Spoek, 2016) (Nelms & Roth, 2014).

Nutrition Diagnosis

9. Choose two high-priority nutrition problems and complete a PES statement for each. Please use appropriate nutrition diagnostic terminology from Appendix C2 in your textbook. (5 points)

Inadequate protein energy intake related to decreased PO tolerance as evidenced by an albumin level of 1.9 g/dl, prealbumin level of 11 mg/dl, and total protein level of 5.8 g/dl.

Impaired nutrient utilization related to sepsis as evidenced by elevated serum lactate level of 4.2mEq/L and blood glucose levels of 185mg/dL.

Nutrition Intervention

10. Outline the nutrition support regimen you would recommend for Mr. McKinley. This should include formula choice (and rationale), rate initiation, rate advancement, and goal rate. (10 points)

With regard to nutritional interventions for metabolic stress and critical illness, enteral nutrition is indicated. The sepsis, ventilator, and resulting decreased tolerance of a PO diet would lead one to believe that nutritional needs cannot be met through the oral route. Enteral nutrition is the most cost effective option, and is associated with reduced infectious complications along with shorter stays in the hospital. Due to the Roux-en-Y bypass surgery that Mr. McKinley underwent four months prior to admission, the best route would be a nasojejunal feeding tube considering that the majority of the stomach and the entire duodenum are not being used. Nutrient support to consider for the patient includes vitamin C, vitamin E, selenium, copper and zinc for their antioxidant roles, as proposed by the Host Response to Injury Collaborative Research Program. This same protocol also dictates 100mg IV vitamin C every 8 hours, 400 mcg IV selenium daily, and 1500IU vitamin E every 12 hours for a week or until discharged. Also, supplementation of DHA and EPA fatty acids may benefit Mr. McKinley, as those have shown positive results in ill patients (Nelms, Sucher, & Lacey, 2014) (Spoek, 2016).

The formula we would recommend to use for Mr. McKinley's enteral feeding is Peptamen Bariatric. It contains EPA and DHA which help modulate pro-inflammatory mediators. It contains high levels of protein in comparison to caloric content, and is superior for use in obese patients in critical care. It also has a carbohydrate level which is suitable for use in individuals that have issues controlling their blood glucose levels. Mr. McKinley is obese, has sepsis, and has type 2 DM, all of which are reasons this formula is a good choice (Nestle, 2015).

Although the text says 1 ml/kcal fluid should be a baseline, we are recommending a slightly higher amount because of the high protein intake.

The rate is as follows:
ENN= 1624.7-2067.8 kcal/day
Protein needs= up to 188.75 grams protein/day
Fluid needs =1624.7-2067.8 ml/day minimum
Peptamen Bariatric = 1 kcal/ml 2000 ml = 2000 kcal
2000 ml/24 hours = 83.3 ml/hour ~ **80 ml/hour = goal rate**
80 ml x 24 hours = 1920 ml per day = **1920 kcal/day**
Protein= 92/1000= .092 x 1920 ml = 176.64 grams of protein per day = **2.34 grams per kg IBW**

Fluid= 84% x 1920 ml = 1612.8 ml fluid + 60 ml free water flush every 4 hours = **1972.8 ml fluid per day**

Start Peptamen Bariatric at 20 ml and advance by 20 ml every 6 hours until goal rate of 80 ml/hr is reached. Provide free water flushes of 60 ml every 4 hours to meet fluid needs.

Nutrition Monitoring and Evaluation

11. Identify the steps you would take to monitor Mr. McKinley's nutritional status in the intensive care unit. (5 points)

For Mr. McKinley's sepsis, treatment priorities include treating the infection with lung-protective ventilation, antibiotics, and with hemodynamic, renal, and metabolic support. Also, intensive insulin therapy, antimicrobial agents, and coagulation-modulating drugs such as activated protein C will help. When nutrition support begins, make sure to monitor electrolyte levels and prevent refeeding syndrome. Ensure that diarrhea does not occur. If it does, decrease advancement of feeding rate until patient can tolerate it. In order to monitor and reevaluate Mr. McKinley's nutritional status, anthropometrics such as his weight and mid-arm circumference can serve as an indicator of metabolic stability. Although weight loss is beneficial for a severely obese patient, the hypermetabolic induced weight loss from the sepsis coupled with potentially low tolerance to oral food intake is not safe. This can ultimately lead to poor protein status and a loss of skeletal muscle. Also, it is prudent to monitor Mr. McKinley's gastrointestinal function. Enteral complications such as clogging or misplacements of the tube can occur. The tube position can be monitored by marking it right under its insertion into the nostril. If the mark becomes exposed and is far from the nostril a nurse will see and can make sure it is readjusted. Clogging of the tube can be avoided by providing the recommended 60 ml free water flushes every 4 hours. Also, hyperglycemia should be monitored and controlled. Urine should be checked for presence of glucose, and well as ketones and proteins. Absence of these from the urine indicate that the body is returning to a healthy state (Nelms, Sucher, & Lacey, 2014) (Spoek, 2016).

Lab values should be used to monitor Mr. McKinley's nutritional status as well. For example, a reduction in the acute phase proteins and c-reactive proteins, and subsequently an increase in visceral protein status (albumin/prealbumin) are markers for progression towards eliminating the infection causing the sepsis. They also indicate that the amount of protein being fed enterally is adequate. Hematocrit, hemoglobin, and ferritin levels would rise, whereas transferrin would decrease, indicating less need to transport iron and an increased ability to store it. White blood cell levels would also drop, indicating that the infection is dissipating. Liver enzyme labs that were elevated (AST and ALT) as well as direct bilirubin should be monitored. If they return to normal levels this can indicate an improvement. A drop in serum lactate will indicate that the body is returning to normal metabolic pathways. A drop in serum blood glucose to normal levels may also indicate that the body is no longer resorting to gluconeogenesis, and the increased protein from the enteral support should put the patient into a positive protein status. However Mr. McKinley does have type 2 DM which should be considered when evaluating blood glucose levels. Lastly, over time Mr. McKinley’s heart rate, respiratory rate, and temperature should return to normal levels (Nelms, Sucher, & Lacey, 2014) (Spoek, 2016).

References

Nelms, M., Sucher, K. P., & Lacey, K. (2014). *Nutrition Therapy & Pathophysiology* (3rd ed.). Boston, MA: Cengage Learning.

Nelms, M. N., Long, S. L. (2014*)*. Nutrition Therapy for Metabolic Stress and Critical Illness. *Medical Nutrition Therapy: A Case Study Approach* (4th ed.) (365-375). Stamford, CT: Cengage Learning.

Nestle. (2015) *Nestle Health Science 2015-2016 Product Guide* (98-99). Vevey, Switzerland

Spoek, K. (2016). Diseases of the Gallbladder and Exocrine Pancreas: Chapter 16 [Powerpoint Slides and Lecture]. San Francisco State University.

Spoek, K. (2016). Metabolic Stress and Critical Illness: Chapter 22 [Powerpoint Slides and Lecture]. San Francisco State University.