All American Hokies

Case Study #2 – Metabolic Stress

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I. Understanding the Disease and Pathophysiology

1. According to Kinetic Concepts Inc, open abdomen is "a technique, also known as laparostomy, in which the fascia is left open intentionally to avoid elevation of intra-abdominal pressure (IAP) and where surgical re-exploration is desirable" (1).

2. JP won't be able to meet his needs with his GI tract in discontinuity. Immediately following surgery he will experience decreased absorption and impaired GI tract function. His nutritional needs will not be met 100% through PO intake and he will most likely be a candidate for parenteral nutrition (2).

3. Anasarca is excessive edema throughout the body. JP may also be experiencing pain and problems urinating as a result of anasarca (3). Serum transferrin, serum albumin, and serum prealbumin labs may be abnormal due to their reaction to inflammation. This could result in misinterpretation of his nutritional status as albumin and prealbumin are markers of protein status (2).

4. The ebb phase is body's first response to injury. This includes a decrease in metabolic rate in response to increased endocrine hormones such as cortisol, catecholamines and glucagon. The body may also experience shock, hypovolemia, and hypoxia during the ebb phase (2). The overall goal for a patient in the ebb phase is to minimize damage that could potentially result in organ failure. This phase can last anywhere from 2 to 24 hours following the injury (4). During the flow phase, metabolic rate is increased along with the secretion of cortisol, catecholamines and glucagon. Cardiac output and blood pressure also escalate, helping to resolve the hypovolemic shock seen in the ebb phase (2). The goal for a patient in the flow phase would be to maintain glucose levels in order to maintain gluconeogenesis, which in turn supplies glucose to essential organs such as the brain for metabolic function. It is also important to monitor blood glucose levels and insulin sensitivity while a patient is in the flow phase (4). The flow phase can last 3 to 4 days after the injury. The recovery or resolution phase is characterized by the start of the healing process. This is evidenced by a return to normal glycemia, the start of anabolic processes, and restoration of lean body mass (2).

5. Acute phase proteins are liver proteins that are modified in the presence of injury or infection. C-reactive protein, α_1-antitrypson, and fibronectin are positive acute phase proteins which increase in number in response to infection. Negative acute phase proteins decrease in number when in the presence of infection; these include immunoglobulin, G and M, complement transthyretin, transferrin, ceruloplasmin, and albumin (2). C-reactive protein (CRP) may be an indicator of the shift from a catabolic to an anabolic state due to its biomarker activity within the body (5). Also, CRP is a non-specific protein, making its measurement a more reliable indicator of imflammation compared to albumin and prealbumin, which react immediately to inflammation and are not recommended as nutrition status markers for patients

experiencing illness and/or stress. Severe infection and sever muscle wasting can also be further addressed when assessing CRP (2).

II. Understanding the Nutrition Therapy

6. During metabolic stress there are changes in nutrient metabolism and nutritional requirements. Metabolic stress causes an increase in catabolism of skeletal muscle or lean muscle mass. This brings about a negative nitrogen balance and muscle wasting. Carbohydrates stop being the main source of energy as branch chain amino acids (BCAA) are oxidized from skeletal muscle to be used as energy during metabolic stress. BCAA's are also broken down to be used as carbon skeletons for glutamine, the glucose-alanine cycle, and as nitrogen. There is also an increase in lipolysis that results in an increase in free fatty acids. Ketones are then formed from oxidized free fatty acids and used as energy for non-glucose-dependent tissues (2). According to ASPEN Board of Directors, 2002 a person suffering from metabolic stress requires 25 to 30 kcal/kg and as much as 2 g/kg/day of protein (5). The person would also require their fat intake to be 15-40% of their total calories and carbohydrates should constitute 60-70% of their energy consumption goal (5).

7. Yes, specific nutrients should be considered when designing nutrition support for a trauma patient. Glutamine is needed to assist in wound closure as its essential role cell growth and multiplication. Trauma and tissue injury result in loss of glutamine therefore intake needs to be increased 2 to 7 times the normal recommendation to be effective in assisting with wound healing. Arginine helps to prevent infections at the trauma site. It stimulates protein production at the site of the wound resulting in improved localized immunity. Requirements increase from 5 grams per day to 17 to 25 grams per day as a result of surgery or trauma such as a gunshot wound. Because fat needs are increased as a result of trauma, omega-3 fatty acids are critical in the healing process due to their ability to decrease inflammation and enhance immune system function (6). Other specific nutrients to consider when designing nutrition support are Vitamin C and zinc due to their antioxidant properties. These nutrients also contribute to re-synthesis of collagen which is vital to wound healing (7).

8. When determining the route for nutrition support in a trauma patient, first an assessment would be made to determine if the patient could obtain adequate nutrition PO. If JP is meeting 75% or more of his nutritional needs, he would not need nutrition support and would be monitored for change in status. If he could not meet his needs PO, we would then assess the function of his GI tract. If his GI tract is functional then enteral nutrition would be initiated. If JP has a nonfunctional GI tract, parenteral nutrition should be initiated. The access routes of TPN would be dependent upon the estimated length of nutrition support. JP should be monitored and reevaluated regularly and returned to PO intake as soon as possible (2).

III. Nutrition Assessment

A. Evaluation of Weight/Body Composition

10. Assessing JPs actual weight would be difficult due to the fact that he is unable to get out of the bed in order to be weighed properly. Due to his severe trauma he will have fluid imbalance altering his weight. He is also often off of the floor for surgery or to have labs tested which would make weighing him difficult (2).

B. Calculation of Nutrient Requirements

11. Ireton-Jones: EEE (V): 2,358 kcals/d

We used the Ireton-Jones equation to estimate J.P.'s EEE based on his ABW because he is ventilator dependent and because his %IBW is greater than 120%.

Mifflin-St. Jeor: REE: 2,689 - 2868.56 kcals/d

We used the Mifflin-St. Jeor equation to estimate J.P.'s REE based on his ABW using a stress factor of 1.5 to 1.6 indicating moderate stress. Again, we used his ABW because his %IBW is greater than 120%.

Protein Needs: 123 - 164 g/day calculated using 1.5 to 2.0 g/kg due to increased protein demands 2° to abdominal GSW.

12. Indirect calorimetry is a way to measure energy output by measuring a patient's oxygen intake and carbon dioxide output (2).

13. Being on a ventilator and critically ill are both indicators that JP would benefit from a metabolic cart. Also, since measurements of indirect calorimetry are highly accurate, using a metabolic cart would help accurately identify JP's needs and decrease the risk of re-feeding syndrome (8).

14. JP's estimated energy needs determined by indirect calorimetry were 3,657 kcals per day on day 4 and 3,765 kcals per day on day 10. Both of the predictive equations severely underestimated JP's energy needs compared to indirect calorimetry. The Ireton Jones equation predicted that JP needed 2,358 kcals per day and the Mifflin St. Jeor equation predicted that JP needed between 2,689 and 2,868.56 kcals per day. The estimated energy needs determined by the predictive equations were similar in kilocalories. However, the difference can be attributed to the fact that the Mifflin St Jeor had an activity factor specific to the degree of trauma whereas Ireton Jones uses the same trauma factor regardless of degree of patient stress. The discrepancy in the predictive equations compared to indirect calorimetry could be due to the fact that predictive equations are calculated using clinical judgment, whereas indirect calorimetry is a completely objective measurement. The predictive equations also used his adjusted body weight, which is 45 # less than his normal weight, but indirect calorimetry does not use weight as a factor when determining caloric needs.

15. JP's RQ on day 4 is 0.76, which is indicative of lipid and protein metabolism and can also indicate hypoventilation. On day 10 JPs RQ value was 0.70. This implies that his body is metabolizing only lipid (2).

16. JP is experiencing many symptoms that contribute to elevated energy expenditure: he is under moderate to severe stress, he is ventilator dependent, he has the potential to become septic, he has had multiple surgeries, he has multiple open wounds, and he's experienced electrolyte loss and GI dysfunction.

C. Intake Domain

17. JP is receiving 170 g and 680 kilocalories of protein from his PN prescription. He is receiving 1800 ml total volume of PN.

18. According to JP's REE on day 4, he expended 3657 kilocalories. Under his current TPN prescription only 18% of his kilocalories are coming from protein. Due to his wounds and severe trauma it is recommended that his protein requirements are increased to 22% of his total kilocalories from TPN. The increase in protein should be done gradually as tolerated and his labs, specifically albumin, transferin and prealbumin, should be monitored daily. This would also increase his caloric consumption which will help fill the gap between his energy intake and his energy expenditure. This will also help raise his RQ value from 0.76 to the desired value of 0.85. Due to the elevated metabolic cart measurement of 107-185 mg/dL blood glucose, the TPN prescription should provide a consistent carbohydrate load in order to stabilize his blood glucose levels to the desired range of 70-110 mg/dL. A limitation that would prevent the health-care team from making significant changes to the nutrition support regimen would be that the nature and severity of JP's injuries will influence the route and composition of nutrition support that he is able to receive.

19. According to the Journal of the American Dietetic Association, "propofol is a lipid-soluble, short-acting IV hypnotic/sedative administered continuously to provide sedation in mechanically ventilated ICU patients" (9). When determining the amount of total calories and lipids needed for the patient, the amount of propofol administered should be taken into consideration due to the fact that it provides 1.1 kcals/ml of lipid. JP is receiving 924 kilocalories of lipids from propofol (9).

20. Enteral nutrition (EN) should be initiated as soon as possible despite the patient's nutritional needs being met thorough parenteral nutrition because EN is less expensive, there are reduced complications, and it is a more natural way of absorbing nutrients. Because he will be absorbing nutrients more effectively, he will

have a faster recovery time and a higher percentage of his nutritional needs will be met. This is the first step in the line of returning him to PO intake. EN will also help to build up the flora in the gut and will help establish GI tolerance (10).

21. Crucial is an enteral formula designed for critically ill patients and it promotes wound healing and GI absorption tolerance. It helps to stimulate immune response and provides nutrients that are beneficial in wound healing (11). JP was given this formula because he is critically ill, is at potential risk for sepsis, and is suffering from multiple wounds and moderate to severe stress. Arginine and omega-3 are provided through Crucial and these nutrients promote proper recovery for trauma patients as previously stated. Crucial provides 1.5 kcal/ml (11). On day 11 of his hospital stay, when EN was initiated, JP received 360 kilocalories from the Crucial formula. This is 16.14% of his total kilocalories.

22. NI-1.2 Increased energy expenditure
NI-1.4 Inadequate energy intake
NI-3.1 Inadequate fluid intake
NI-5.7.3 Inappropriate intake of protein or amino acids, specifically glutamine and arginine

D. Clinical Domain

23. List abnormal biochemical values and describe why they might be abnormal.

Parameter	Normal value	Patient's Values (day four)	Reason for abnormality	Nutrition Implication
Albumin	3.5-5 g/dL	1.4 g/dL	Due to inflammation	Increase protein needs by increasing %AA solution in TPN
Prealbumin	16-35 mg/dL	3.0 mg/dL	Due to inflammation	Increase protein needs by increasing %AA solution in TPN
Glucose	70-110 mg/dL	108-185 mg/dL	Due to insulin resistance secondary to stress	Implement consistent carbohydrates by administering same mL every hour

BUN	8-18 mg/dL	23 mg/dL	Excessive protein catabolism	Increase caloric intake by increasing %AA, Lipid, and CHO TPN
Alkyline Phosphatase	30-120 U/L	540 U/L	Due to high glucose levels and intestinal injury	Implement consistent carbohydrates by administering same mL every hour
C-Reactive Protein	<1 mg/dL	245 mg/dL	Due to inflammation and increased catabolism	Increase caloric intake by increasing %AA, Lipid, and CHO TPN
Transferin	215-365 mg/dL	190 mg/dL	Due to infection and inadequate protein intake	Increase protein and iron needs through increased %AA and iron supplement
AST	0-35 U/L	190 U/L	Due to shock and severe injury	Implement consistent carbohydrates by administering same mL every hour
ALT	4-36 U/L	435 U/L	Due to muscle and intestinal injuries	Implement consistent carbohydrates by administering same mL every hour

25. NC-1.4 Altered GI function
    NC-2.2 Altered nutrition related laboratory values

NC-3.3 Overweight/obesity

IV. Nutrition Diagnosis

26. Select two of the nutrition problems identified in questions 22 and 25, and complete the PES statement for each.

- Altered GI function RT abdominal GSW leading to resection of proximal jejunum AEB enteral formula draining from anastomic leak. (NC 1.4)

- Inappropriate intake of protein or amino acids, specifically glutamine and arginine RT increased protein needs secondary to severe trauma and abdominal wounds AEB low lab values of prealbumin (5 mg/dL), transferrin (160 mg/dL), and total protein (5.1 g/dL). (NI-5.7.3)

V. Nutrition Intervention

27. For each of the PES statements that you have written, establish an ideal goal (based on the signs and symptoms) and an appropriate intervention (based on the etiology).

--EN formula/solution (ND 2.1.1)

- Maintain current EN recommendations of continuous 15mL/hr Crucial formula giving JP 495kcal and 31.02g of Protein
- Add glutamine supplement to the EN
- Increase recommendations slowly by 5mL/hr as anastomic leak heals and EN is tolerated
- Give 200mL flushes q 6hrs

Goals: full recovery of GI function by using the GI tract and providing additional arginine and glutamine; maintain proper hydration status; bring pt to full EN support followed by complete PO

--PN formula/solution (ND 2.2.1)

- Maintain current TPN recommendations of 180g AA solution (720kcals/day of protein), 350g of dextrose (1190kcal/day of CHO), and 250mL of 20% lipid solution 3 days/week (appx. 214kcal/day of lipid) giving a total of 2124kcal/day and 180g P/day
- Glucose oxidation rate of 4.86mg/kg/min

Goals: to promote full recovery of GI tract and stabilize lab values; High protein recommendations will promote wound healing and meet body needs due to trauma; Low lipid intake will raise the RQ to the normal 0.85.

VI. Nutrition Monitoring and Evaluation

28. The standard recommendations for monitoring the nutrition status of patient receiving nutrition support are to monitor the patient's intake and tolerance of nutrition support. Weight should be monitored at least weekly to identify actual

weight loss, and daily to monitor fluid status. Ins and outs should also be monitored along with pertinent lab values such as prealbumin, BUN, electrolytes, nitrogen balance, and blood glucose (2).

29. JP's glucose levels on day 4 were between 107 and 185 mg/dL. Hyperglycemia is a concern for JP because it is indicative of insulin resistance secondary to stress. Because of this he was started on an insulin drip, however exogenous insulin is typically ineffective in managing insulin resistance in a critically ill patient. This is a concern because hyperglycemia in patients who are receiving TPN has been positively correlated with increased rates of morbidity and mortality (2).

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