Case Study #29: Metabolic Stress and Trauma: Open Abdomen
Spring Quarter
California State University, Los Angeles
**PI:**
JP is a 29 YO Hispanic male admitted to through the ER on 03/22.

**CC:**
JP was shot in the abdomen and brought to the ER by a friend. He was vomiting blood and complaining of severe back and stomach pain.

**HPI:**
JP shot in the abdomen and admitted to surgical ICU with GSW to abdomen, sedated and on mechanical ventilation. JP experienced gastric, duodenal, and jejunal injuries, liver laceration, and left pleural effusion.

**PMH:**
Unremarkable medical history; unknown surgical history; unknown medications; NKA.

**FH:**
Information unavailable.

**SH:**
Unknown alcohol use; known tobacco use.
Single; lives with brother’s family (including wife and two children); convenience store clerk; Catholic affiliation.

**PE:**
General: NAD (no appreciable disease/nothing abnormal detected); lying in bed; sedated.
HEENT (head, eyes, ears, nose, throat examination): normocephalic (inspection reveals apparent normal head); PERRL (pupils equal, round, react to light, accommodation)
Cardiac RRR (regular rate and rhythm)
Pulmonary/chest: No wheezes or crackles
Abdominal: Vacuum-assisted closure (VAC) in place, jejunostomy feeding tube in place, moderate distension with appropriate tenderness.
Bowel function: No stool.
Genitourinary: Catheter; cloudy, pale yellow
Extremities: WNL
Peripheral vascular exam: Peripheral pulses throughout
Neurological: Moves all extremities spontaneously-sedated
Skin: warm and dry
Central IV line in place
Mobility: immobile without assistance

**ASSESSMENT:**
29-yo male s/p GSW to the abdomen with emergent exploratory laparotomy; s/p gastric repair, control of liver hemorrhage and restriction of proximal jejunum-jejunostomy feeding tube in place.

**HOSPITAL COURSE:**
Admitted: 03/22:
- Diagnosis: Abdominal GSW
- Medications: Unknown
- Labs: Unknown
- Diet or Nutrition Order: NPO; IV fluid only
• Medical treatment plan: Emergent operating room: exploratory laparotomy, gastric repair, control of liver hemorrhage, and resection of the proximal jejunum were performed. This left his GI tract discontinuous.
• Brief nutrition assessment: N/A
• MNT plan: N/A

Day #2 03/23:
• Diagnosis: Abdominal GSW
• Medications: Unknown
• Labs: Unknown
• Diet or Nutrition Order: NPO; IV fluid only
• Medical treatment plan: Packs removed and bowel continuity reestablished. An abdominal VAC (vacuum-assisted closure) device was placed, and three Jackson Pratt drains were left in place.
• Brief nutrition assessment: N/A
• MNT plan: N/A

Day #3 03/24:
• Diagnosis: Anastomotic leak
• Medications: Unknown
• Labs: Unknown
• Diet or Nutrition Order: NPO; IV fluid only
• Medical treatment plan: Gastrojejunostomy tube inserted; jejunal limb shortened for antegrade intraluminal drainage; retrograde jejunostomy tube placed for drainage
• Brief nutrition assessment: N/A
• MNT plan: N/A

Day #7 03/29:
• Diagnosis: GSW to abdomen; anastomotic leak.
• Medications: Propofol @35 mL/hr
• Labs: See Table in “Case Study Question” section
• Diet or Nutrition Order: NPO, TPN: IV 1800, TPN 3312, Piggyback 360
  o Current Nutrition Support: 3,888 kcal (51 kcal/kg IBW/day) and 194 g protein (g/kg IBW/day)
    ▪ Dextrose: 140 CAA: 60 FAT/L:20 Goal Rate: 135 mL/hr
    o IV Fluid: D5.45@75ml/h - KVO
• Medical treatment plan: abdominal washout; distally placed jejunostomy tube inserted for feeding; VAC change.
• Brief nutrition assessment: 29-yr male s/p GSW to the abdomen with emergent exploratory laparotomy; s/p gastric repair, control of liver hemorrhage and resection of proximal jejunum-jejunostomy feeding tube in place. Ht.
• MNT plan: monitor TPN
THEORETICAL DISCUSSION OF DISEASE PROCESSES:

JP’s diagnosis upon admission was an abdominal gunshot wound (GSW), which is a penetrating abdominal trauma. The standard of care for abdominal GSWs used to be mandatory laparotomy (LAP, a surgical incision through the abdominal wall to access the abdominal cavity), because greater than 90% of patients with peritoneal penetration require operative management. Recently, however, stable asymptomatic patients are screened and may be candidates for nonoperative management (Biffi & Moore, 2010).

Upon admission, a FAST (focused assessment with sonography for trauma) scan was performed in order to visualize hemoperitoneum (the presence of blood in the peritoneal cavity) that may not have been apparent upon the initial physical exam. A positive result indicates need for laparotomy; JP was immediately transferred to the Operating Room (Reardon, 2008).

In the Operating Room, the following procedures were performed (JP likely under Propofol, an anesthetic often given in the ICU):

- Exploratory LAP, a diagnostic procedure in which LAP is used to identify the extent of injury (Wechter, 2014).
- Gastric repair: The treatment of gastric wounds is dependent upon its severity, which is classified according to a 5-level grading system. Treatment of grade I injuries includes unroofing and evacuation with subsequent sutures to close the muscle. Most gastric perforations are grades II and III and are repaired by a two-layer suture technique that minimizes bleeding. Extensive wounds of levels IV and V include significant tissue loss or gastric devascularization. If these are encountered, partial or total gastrectomy is performed. Trauma patients often arrive at the ER with full stomachs; therefore a high level of bacteria is expected. If the gastric perforation with significant bacterial contamination is found, secondary or delayed primary skin closure should be performed (Weinberg & Fabian, 2005). By delaying suturing and by changing the wound dressings over a period of a few days, the wound should clean, the swelling may subside, bleeding may subside, and most importantly, the patient can be monitored to minimize risk of a surgical site infection (Semer, 2001).
- Control of liver hemorrhage: 14% of patients with hepatic injury undergo surgery in order to control bleeding. If there is major bleeding, techniques such as manual compression, topical hemostatic agents (physical agents that promote hemostasis or biologically active agents that enhance coagulation), or packing (applying physical pressure with several abdominal packs) are utilized. Severe injuries necessitate artery ligation and suturing (Jacobs & Christmas, 2014; Peralta, 2013; Stagniti et al., 2003).
- Resection of proximal jejunum, in which the proximal section of the jejunum is removed. This left JP’s GI tract in discontinuity.

JP is left with an open abdomen, in which the fascia of the abdomen is left open in order to avoid intra-abdominal pressure elevation. It also facilitates cleaning to minimize the likelihood of infection (Wake Forest Baptist Medical Center, 2014).

On day #2, JP was returned to surgery during which:

- The packs were removed, indicating that the bleeding had subsided.
- Bowel continuity was reestablished (This is referred to as intestinal anastomosis, or a surgical connection between two disconnected ends, accomplished by sewing or stapling) (Daller, 2014).
- An abdominal VAC device was placed. A VAC is a novel wound closure therapy that is designed to minimize hospitalization stay, increase comfort and improve prognosis. The
device works by applying localized negative pressure to slowly draw the edges of the wound to the center of the site. VAC removes fluid, which can cause swelling and prevent wound closure (fistula development). The VAC improves wound healing by increasing blood flow.

- Three Jackson-Pratt drains were left in place. A Jackson-Pratt drain is a tube that pulls body fluid that collects near a surgery site into a bulb, which can subsequently be emptied and the fluid examined and measured. Initially the fluid is bloody but as the area heals, the fluid changes to light yellow then clear. If fluid leaks from the drain site, the dressing may become wet and an infection may develop. Another possible complication is clot development within the drain, which would block drainage (“Patient Education”).

On day #3, an anastomotic leak (a break along an anastomosis causing fluids to leak) required further surgery (“What is an anastomotic leak?”). A leak can develop due to an incomplete surgical closure, poor wound healing, or as a result of infection, fluid buildup, or unexpected stress. Patients are often monitored post-op for early signs of a leak, which can include pain, bloating, or heat; a leak is also diagnosed with an x-ray displaying the presence of a tracer in inappropriate places. A temporary tube is sometimes placed to drain the site prior to surgical repair of the damaged anastomosis.

In this case, a gastrojejunostomy tube was inserted through the stomach, the jejunal limb was shortened to provide antegrade intraluminal drainage, and a retrograde jejunostomy tube provided additional drainage.

On day #7, abdominal washout is performed, as emergency abdominal operations are often prone to infection. A common practice is to pour saline into the abdomen and remove with suction, which dilutes bacterial load and reduces risk of infection (Degiannis, Bowley, & Westaby, 2005).

A distally placed jejunostomy tube (inserted outside the abdomen and travels from stomach to the small intestine) was placed for feeding (Longstreth, 2012).

In addition, a VAC change was performed during which the adhesive drape, tube, and dressing are removed, the wound is cleaned with saline water, and a new dressing, drape, and tube are applied before the pump is turned back on (“Vacuum-Assisted Closure,” 2013).

These medical procedures are all invasive, serious surgeries. As a result, JP is in the flow stage of metabolic stress, which is marked by increased cardiac output, increased body temperature, increased energy needs, protein catabolism, and hyperglycemia (Nelms et al., 2014). Associated laboratory values that demonstrate JP is in this phase are the positive acute stress biomarkers (BUN_23mg/dL, CRP_245mg/dL, Alk Phosphatase_540U/L, ALT_435U/L, AST_190U/L, CPK_182U/L and Lactate dehydrogenase_750U/L) and negative acute stress biomarkers (Albumin_1.4g/dL, pre-albumin_3.0mg/dL and total protein_5.2g/dL). This stage drastically affects JP’s nutrition needs and the diet order, as detailed in the remainder of this paper.
FINAL NUTRITIONAL CARE PLAN:

Assessment:
Sex: Male
Age: 29
Ht: 70”
Adm Wt: 102.7
Current Wt (day 7): 109 kg BMI: 34.5 kg/m² (Stage 1: Obese)
IBW: 75.45 kg %IBW: 144.5%
UBW: Unknown %UBW: Unknown %weight lost or gained: Unknown
Weight loss unintentional; lower admit weight may be due to trauma and vomiting at intake. Discrepancy in weights may also be due to inaccurate scales.
Visceral Protein status:
• Serum albumin: 1.4 g/dL
• Total lymphocyte count: 15.2 x 10³/mm³

Nutritional Diagnoses:
1. Increased energy expenditure R/T open abdomen and post trauma status AEB metabolic cart measurement of 3657 kcal expenditure.
2. Altered GI function R/T open abdomen and GSW with subsequent surgery AEB lack of bowel sounds, no stool output, and continued wound VAC for open abdomen.
3. Increased nutrient needs (protein) R/T post trauma status and wound healing AEB albumin of 1.9 g/dL (low) and total protein of 5.1 g/dL (low).

DIET HISTORY:
N/A. No information given for this case study.

EVALUATION OF LABORATORY FINDINGS
The patient’s laboratory findings were used to determine the stage of metabolic stress and nutritional needs of the patient. Many of the patient’s biomarkers deviated from the normal healthy range due to poor lifestyle behaviors (indicated in “Social History” section) in addition to the trauma induced by the GSW. Due to the severity of the GSW, biomarkers that assessed acute metabolic stress took president. The following laboratory findings were deemed the most critical to monitor and improve in order to improve wound healing and reduce patient stay.

The patient’s BUN (blood urea nitrogen) increased from 23 mg/dL to 25 mg/dL from the 7th day and 10th day of his hospital stay. This patient’s BUN is higher than the reference values of 8-18 mg/dL. Elevated BUN can be caused by the high protein diet of 2-2.5 g/kg being given to improve wound healing. In addition, the high BUN shows the patient is undergoing protein catabolism as a consequence of metabolic stress (flow phase) (McClave et al., 2009). Despite the high BUN reading, the increased protein intake is necessary to combat excessive protein catabolism, as catabolism inhibits wound healing and increases patient stay.

Patient’s blood albumin level rose from 1.4 g/dL (day 4) to 1.9 g/dL (day 10). Despite the rise, the patient’s albumin levels were still lower than the normal range (3.5-5 g/dL). Anasarca (edema of the whole body) can lead to widespread inflammation and increase plasma volume. The increase in plasma volume can dilute blood albumin, which may account for the decrease. However, blood albumin level decreases are also reflective of metabolic stress and malnutrition (negative acute phase protein). Since low blood albumin can be an indicator of morbidity and...
mortality risk it is important to monitor levels to assess possible increases in risk due to progressive illness or infection (McClave et al., 2009).

The patient’s prealbumin levels were 3 mg/dL (day 4) and 5 mg/dL (day 10). Despite the increase, the patient’s prealbumin is lower than the normal range (16-35 mg/dL). Like blood albumin, prealbumin can be influenced by fluid retention; however, it is a more sensitive biomarker and responds more quickly to the patient’s protein-energy balance and nutritional status (McClave et al., 2009). The patient’s low prealbumin levels indicate protein energy imbalance due increased nutritional needs as a result of the stress reaction of the traumatic injury.

Patient’s CRP (C-reactive protein) was 245 mg/dL (day 4) and 220 mg/dL (day 10), which is much higher than the normal range (<1.0 mg/dL). High C-reactive protein levels are a positive acute phase protein biomarker indicating the patient is still undergoing metabolic stress. There is a positive correlation between CRP levels and trauma/infection making it a useful biomarker for assessing the patient’s metabolic health (McClave et al., 2009). Such a high CRP level reflects the patient’s increased macronutrient and micronutrient needs to minimize catabolism and improve wound healing.

The patient’s blood glucose levels decreased from 164 mg/dL to 140 mg/dL. Despite the decrease the patient’s blood glucose levels are still higher than normal levels (70-100 mg/dL). Elevated physiological glucose levels are caused by increased gluconeogenesis and reduced insulin production, which are caused traits of stress/trauma (McClave et al., 2009). High blood glucose can lead to poor wound healing hence glucose levels should be monitored and insulin may be needed to control their levels.

The patient’s ALT (alanine transaminase enzyme) levels were 435 mg/dL, which is higher than the normal range of 4-36 mg/dL. ALT is a powerful measure of liver inflammation and elevated levels reflect severe liver damage as a result of medication, infection and/or trauma. Like ALT, AST (aspartate transaminase) is another biomarker for assessing liver damage and inflammation although it is less specific as AST is secreted in the kidney, liver, heart and skeletal muscle (McClave et al., 2009). The patient’s AST levels were 190 mg/dL, which is higher than the normal range of 0-35 mg/dL. High ALT and AST levels indicate the patient is in need of proper energy and protein to support healthy and timely healing.

REVIEW OF MEDICATIONS AND FOOD/NUTRIENT INTERACTIONS:

JP is on sliding scale insulin and Propofol. Insulin side effects include hypoglycemia, headache, flu-like symptoms, weight gain, lipoatrophy, itching, or rash (“Insulin for Diabetes,” 2014). Propofol side effects include bradycardia, decreased cardiac output, hypertension, hyperlipidemia, and respiratory acidosis (Drugs.com, 2015).

Patient’s vitals and labs will be monitored to assure that he is not experiencing these side effects and adjustments to medications will be made if he is having adverse effects.

Propofol and alcohol have a moderate drug interaction, but JP will not be consuming alcohol while in the hospital (Drugs.com, 2015). Insulin will be monitored and administered based on the carbohydrates given through TPN.

Weight gain will be controlled through the TPN calculations to avoid overfeeding; however weight maintenance is not the vital concern in a critical condition such as this. Once JP is stable and discharged, he can work with a dietitian to find a healthy weight.
EVALUATION OF PHYSICAL OR CLINICAL FINDINGS:

The patient has several physical and clinical contraindications that can affect diagnosis and management of acute metabolic stress. Patient exhibits hyperglycemia and elevated HbAc1 indicating insulin resistance both as a result of poor diet and metabolic stress induced insulin resistance (McClave et al., 2009). Since elevated blood glucose levels negatively impact wound healing, dextrose infusion via TPN must be closely monitored and if possible reduced to minimum levels to spare protein but no exacerbate hyperglycemia. Therefore, carbohydrates may need to make a smaller percentage of total calories than the usual ASPEN reference value.

The patient has a BMI of 34.5 (Obese Class I). In cases where the critically ill patient is obese, permissive underfeeding or hypocaloric feeding is recommended. The goal PN regimen should not exceed 60-70% of target energy requirements. Permissive underfeeding of obese patients is advised as obesity adversely affects patient care in the ICU and increases the risk of comorbidities (e.g. insulin resistance, sepsis, infection, thrombosis and organ failure). Therefore, achieving some degree of weight loss may increase insulin sensitivity, nursing care and reduce these comorbidities (McClave et al., 2009).

Patient is exhibiting anasarca (widespread swelling and massive edema). Though a common condition in critically ill patient’s it’s presence can affect biochemical lab values and markers necessary to make clinical and nutritional judgments. Due to the increase in fluid volume, hypoalbuminemia can account for the low albumin levels indicated in the lab values. The same dilution can affect prealbumin levels. The patient may appear to be malnourished based on these values while in fact; the patient’s nutritional needs are being met. Due to the anasarca, a multitude of proteins and biochemical markers need to be assessed in order to assess the patient’s nutritional needs.

The patient is suffering from metabolic stress and is burning a mixture of fat and protein at rest AEB indirect calorimeter readings. In addition, low blood total protein concentration and high BUN indicates endogenous amino acids are being broken down in the liver via gluconeogenesis for fuel. Protein catabolism seriously impacts wound healing, which in turn increases hospital stay and increases risk of hospital borne pathogen exposure. In order to prevent the use of endogenous amino acids and proteins as fuel, adequate endogenous amino acids must be supplied.

ENERGY REQUIREMENTS:

Based on the metabolic cart, a form of indirect calorimetry, which is the gold standard for determining caloric needs, the patient has a REE of 3,657 kcals per day.

PROTEIN REQUIREMENTS:

The patient’s admittance weight was 102 kg however; this number does not provide an accurate measure of the patient’s actual body weight as he already suffered from a GSW at the time of admittance. In addition, the patient has a BMI of 34.6. Therefore, to determine protein needs per unit body weight the IBW is used rather than actual weight.

IBW: 106 + 6(10) = 166 lbs / 2.2 = 75.45 kg

Protein for critically ill obese patients should be provided at ≥2.0g/kg of IBW per day for Class I and II patients (BMI 30.0 - 40.0), especially during permissive underfeeding. However, infusions up to 2.5g/kg IBW per day may be necessary to meet increased protein requirements for wound healing and maintain a neutral nitrogen balance.

Protein Needs Per day lower range = IBW x 2.0g/kg/day
= 75.45 kg x 2g/kg/day
= 151 g protein/day

Protein Needs Per day upper range = IBW x 2.5g/kg/day
= 75.45 kg x 2.5g/kg/day
= 189 g protein/day

Protein Needs = 151 - 189 g protein/day

Tolerance of Nutrition Prescription:
- Current Nutrition Prescription: 3,888 kcals
- Current Intake TPN (per Intake/Output chart): 3,312 ml/kg (85%)

**DIET ORDER:**

Current nutrition support: dextrose 140 CAA: 60 FAT/L: 20 Goal Rate 135 mL/hr

Total volume infused = 135 mL/hr * 24 hr = 3240 ml or 3.24 L (goal)

3.24L * 20g/L lipid = 64.8 g lipids * 10 kcal/g = 648 kcal from lipids

3.24L * 60 g protein = 194.4 g * 4 kcal/g = 778 kcal from protein

140 g CHO/L * 3.24 = 453.6g CHO * 3.4 kcal/g = 1,542 kcal from CHO

648 + 778 + 1540 kcal = 2,966 kcal/day

+ Propofol @35 mL/hr adds an additional 924 kcal = **3,890 kcal total** (51 kcal/kg IBW/day). The amount of protein is still 195 g protein or 778 kcal (2.6g/kg IBW/day).

Total volume of TPN on day 7 = 3.312 L based on I/O.

Supplemental Electrolytes:
- Supplemental Na⁺ = 71 to 142 mEq and K⁺ = 71 to 142 mEq
  - Sodium: 1-2 mEq/kg; 71kg x1= 71mEq , 71kg x 2 = 142 mEq.
  - Potassium: 1-2 mEq/kg; 71kg x1= 71mEq , 71kg x 2 = 142 mEq.

**I & O Record: 03/29 0701 - 03/30 0700**

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<tr>
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</tr>
<tr>
<td>IV (mL/kg/hr)</td>
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<tr>
<td>IV piggyback</td>
<td>360</td>
</tr>
<tr>
<td>TPN</td>
<td>3312</td>
</tr>
<tr>
<td>Total Intake (mL/kg)</td>
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<tr>
<td>Urine (mL/kg/hr)</td>
<td>2889 (1.10)</td>
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<tr>
<td>Emesis output</td>
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</tr>
<tr>
<td>Other (JP drains)</td>
<td>1695</td>
</tr>
<tr>
<td>Stool</td>
<td>n/a</td>
</tr>
<tr>
<td>Total Output (mL/kg)</td>
<td>4584 (42.05)</td>
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</table>
Net I/O: +888
Net since admission (03/22): +3721
Serum glucose: 140 mg/dL
Urine sugar: unavailable
Urine acetone: unavailable
Liver enzymes: ALT 435 U/L; AST 190 U/L
DIET THERAPY:

The immediate goals of dietary treatment are as follows:

1. Minimize Catabolism
2. Meet Energy Needs
3. Establish and Maintain Fluid Electrolyte Balance
4. Monitor and Maintain Blood Glucose Levels <150 mg/dL

1. JP’s nutrition prescription provides 195 g protein or 778 kcal, which is 20% of his total nutrient intake (2.6g/kg IBW/day). This amount is slightly over JP’s needs of 2.0-2.5 g/kg/d (103%). Since JP is still in a state of metabolic stress and is partially burning proteins (RQ of .76), we will continue to administer this high rate of protein per TPN until we see scores WNL for the following labs: BUN, ALT, AST, ALK phosphatase, CPK.

2. Per JP’s metabolic cart measurement, he needs 3,657 kcals/day.
   Current nutrition support: dextrose 140 CAA: 60 FAT/L: 20 Goal Rate 135 mL/hr
   Total volume infused = 135 mL/hr * 24 hr = 3240 ml or 3.24 L (goal)
   3.24L * 20g/L lipid = 64.8 g lipids * 10 kcal/g = 648 kcal from lipids
   3.24L * 60 g protein = 194.4 g * 4 kcal/g = 778 kcal from protein
   140 g CHO/L * 3.24 = 453.6g CHO * 3.4 kcal/g = 1,542 kcal from CHO
   648 + 778 + 1540 kcal = 2,966 kcal/day
   Based solely on the original TPN prescription, JP would not be meeting his caloric needs. + Propofol @35 mL/hr adds an additional 924 kcal= 3,890 kcal total (51 kcal/kg IBW/day). The amount of protein is still 195 g protein or 778 kcal (2.6g/kg IBW/day).
   With the added medication, Propofol, JP receives the amount of calories to fulfill his needs based on his metabolic cart measurement (3,657 kcsals). Although this total is slightly over caloric needs, there are no signs of overfeeding, and it will meet JP’s energy requirements.

3. As JP still has no bowel movement or bowel sounds, all feedings will continue in the form of TPN until further updates. Fluid intake is received through: IV 1800 ml/kg, TPN 3312 ml/kg, Piggyback 360 ml/kg. As part of the piggyback, we have suggested supplemental electrolytes, sodium and potassium, to maintain electrolyte balance and prevent refeeding syndrome. Based on the I/O chart, JP is properly hydrated and is retaining approximately 900 ml, as of previous day’s assessment. One factor to take into consideration is that insensible water loss (including VAC water loss) cannot be measured and may account for a portion of the retained values. Additionally, we will continue to monitor serum electrolytes daily to ensure nutrition prescription continues to meet JP’s nutritional goals.

4. Although JP has not been diagnosed with Diabetes, his HBA1C score shows that he has had elevated glucose levels for an extended period of time. In order to meet JP’s total metabolic needs, the nutrition prescription (with Propofol) is based on a lower percentage of carbohydrates (40%) and a higher percentage of fat (40%) than standard practice. Although JP’s blood glucose levels are not WNL, they are decreasing (From 164 mg/dL to 140 mg/dL). We will therefore continue the prescription as is as a provision to help prevent hyperglycemia, while constantly monitoring glucose levels.

   We disagree with the decision to start trickle feedings, as the patient still does not have bowel movement or bowel sounds. As soon as bowel movement or bowel sounds occur, we will initiate trickle feedings to prevent atrophy of villi, bacterial translocation, and cholestasis of the
GI system. Based on JP’s tolerance to trickle feedings, we will attempt to transition JP to EN or oral intake according to the following guidelines:

1. Tube feedings (EN) are tolerated at 60% of goal:
   - Decrease TPN to approximately half, discontinue lipids and decrease dextrose/AA per PN team order
   - Wean off TPN as tube feeding rate advances to goal or per clinical judgment

2. Oral intakes tolerated at 60% of meals consumed
   - Decrease TPN to approximately half, discontinue lipids and decrease Dextrose/AA per PN team order
   - Wean off TPN per clinical judgment
NUTRITIONAL GOALS:

Short Term Goals
Short-term goals for the patient are based around providing nutritional support to optimize wound healing. Severe metabolic stress creates a dynamic dilemma for meeting nutritional needs as they can change rapidly. The diet must meet the ever-changing macronutrient and micronutrient needs of the patient to prevent underfeeding and overfeeding as both can impact wound healing and prolong hospital stay. Wound healing can also be optimized by providing adequate exogenous protein to prevent endogenous protein degradation. In addition, monitoring and controlling circulating glucose levels by limiting dextrose concentrations in the feeding along with insulin infusion if necessary also optimizes wound healing. Finally, hydration status and electrolyte balance of the patient should be monitored by recording and evaluating fluid IN vs. OUT and serum electrolyte concentrations.

I. Minimize Catabolism: continue administering of 2.0-2.5g/kg IBW of protein until biomarkers of protein catabolism and increased exogenous amino acids needs decreases (BUN, ALT, AST, ALK phosphatase, CPK).
II. Meet Energy Needs: Evaluating daily indirect calorimeter readings and adjusting TPN flow and macronutrients to meet these needs to prevent over/under feeding.
III. Establish and maintain fluid and electrolyte balance: Tracking fluid IN vs. OUT and evaluating serum electrolytes.
IV. Monitor and Maintain Blood Glucose Levels <150 mg/dL: If hyperglycemia remains uncontrolled despite lowering dextrose, insulin may be required.

Long-Term Goals
Once the patient exits the flow phase of metabolic stress, the patient will need to address long-term goals in order to maintain optimal health. His lab values showed several biomarkers indicating poor nutrition in the months before the GSW.
I. Blood Glucose Control (HbA1C): Patient should be educated about risks of developing type II diabetes mellitus if blood sugar levels are not controlled.
II. Triglycerides: Patient should be educated on the ill effects of a diet comprised of simple sugars which can raise triglyceride levels as these may impact heart and liver health.
ADIME NOTE:

<table>
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<tr>
<th>Date/Time</th>
<th>Pertinent information provided by patient</th>
</tr>
</thead>
<tbody>
<tr>
<td>Assessment</td>
<td>Unknown alcohol use; known tobacco use. Single; lives with brother’s family (including wife and two children); convenience store clerk; Catholic affiliation.</td>
</tr>
</tbody>
</table>

| Age; Gender; Dx; PMH | Male, 29 y.o, GSW to the abdomen with emergent exploratory laparotomy; s/p gastric repair, control of liver hemorrhage and resection of proximal jejunum-jejunostomy feeding tube in place. |

| Ht; Wt; UBW/%UBW; IBW; %IBW; BMI | Ht: 70”
Admit Wt: 102.7 kg
Current Wt: 109 kg
UBW: Unknown
IBW: 75.45 kg ; %IBW: 144.5%
BMI: 34.5 kg/m^2 (using current wt) (Stage 1: Obese) |

| Labs | BUN: 25 mg/dL (above normal limit of 8-18 mg/dL), albumin: 1.9 g/dL (below normal limit of 3.5-5 g/dL), prealbumin: 5 mg/dL (below normal limit of 16-35 mg/dL), CRP: 220 mg/dL (above normal limit of <1.0 mg/dL), glucose 140 mg/dL (above normal limit of 70-110 mg/dL), ALT: 435 mg/dL (above normal limit of 4-36 mg/dL), AST: 190 mg/dL (above normal limit of 0-35 mg/dL) |

| Meds | None reported. |

| GI | No bowel movement or sounds. |

| I/O | In: 5472 (IV 1,800, TPN 3312, IV Piggyback 360)
Out: 4584 (Urine 2889, Other 1695) |

| Physical Assessment | Vitals: Temp: 99.1 Pulse: 82 Resp rate: 15
BP: 122/78 Wt. 109 kg.
General: NAD (no appreciable disease/nothing abnormal detected); lying in bed; sedated.
HEENT (head, eyes, ears, nose, throat examination): normocephalic (inspection reveals apparent normal head);
PERRL (pupils equal, round, react to light, accommodation)
Cardiac RRR (regular rate and rhythm)
Pulmonary/chest: no wheezes or crackles
Abdominal: VAC in place, jejunostomy feeding tube in
place, moderate distension with appropriate tenderness. Bowel function: no stool. Genitourinary: catheter, cloudy, pale yellow Extremities: WNL Peripheral vascular exam: peripheral pulses throughout Neurological: moves all extremities spontaneously-sedated Central IV line in place Mobility: immobile without assistance

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<th>Warm and dry.</th>
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<td>EER; EPR; Fluid requirements</td>
<td>EER: 3657 kcal/day (Indirect Calorimetry) EPR: 151-189g protein/day (IBW x 2.0g/kg-2.5g/kg) Fluid Needs: 3,657 (1 ml/kcal)</td>
</tr>
<tr>
<td>Current Diet</td>
<td>Unknown.</td>
</tr>
</tbody>
</table>

### Diagnosis

1. Increased energy expenditure R/T open abdomen and posttrauma status AEB metabolic cart measurement of 3657 kcal expenditure.
2. Altered GI function R/T open abdomen and GSW with subsequent surgery AEB lack of bowel sounds, no stool output, and continued wound VAC for open abdomen.
3. Increased nutrient needs (protein) R/T posttrauma status and wound healing AEB albumin of 1.9 g/dL (low) and total protein of 5.1 g/dL (low).

### Intervention

1. Continue to provide TPN based nutrition support of dextrose 140 CAA: 60 FAT/L: 20 Goal Rate 135 mL/hr to ensure adequate energy and protein intake (approximately (51 kcal/kg IBW/day and 2.4g protein/kg IBW/day)
2. Continue Propofol @ 35 mL/hr.
3. Confirm with doctor the continuance of the following lab tests: blood sugar (3 - 4x a day) and serum electrolytes, BUN, creatinine, magnesium, and phosphorous (daily).

### Monitoring/ Evaluation

1. Continue to monitor electrolyte balance and fluid I/O.
2. Continue daily evaluation of metabolic needs and metabolic tolerance to nutrition support daily.
3. Continue to monitor for bowel sounds.

### Signature
References


CASE STUDY QUESTIONS:
I. Understanding the Disease and Pathophysiology

1. The patient has suffered a gunshot wound to the abdomen. This has resulted in an open abdomen. Define open abdomen. The medical record describes the use of a wound “VAC.” Describe this procedure and its connection to the diagnosis for open abdomen.

   An open abdomen wound is an injury to the abdominal cavity with a laceration of skin. Here, a gunshot has punctured the abdomen and has caused serious damage to various organs including the stomach, small intestine, and liver, in the abdominal cavity. Open abdomen can also refer to a procedure. Also known as laparostomy, it is a technique when the fascia of the abdomen is deliberately left open to avoid intra-abdominal pressure elevation as well as to facilitate cleaning and decrease the likelihood of infection. It also allows for surgical re-exploration. Temporary abdominal closure is achieved using a dressing or technology intended to protect exposed viscera.

   Medical records indicated on day 2 a VAC device was placed. A VAC is a novel wound closure therapy that is designed to minimize hospitalization stay, increase comfort and improve prognosis by promoting wound closure. It applies localized negative pressure that draws the edges of the wound toward the center of the site through a dressing positioned over the wound cavity. This pressure removes excess fluid that is associated with inflammation, stimulates cellular growth, and increases blood flow, all working together to increase healing time (Wake Forest Baptist Medical Center, 2014). In this case, the VAC device was placed over the patient’s abdomen to accelerate closure of the open wound post-op.

2. The patient underwent gastric restriction and repair, control of liver hemorrhage, and resection of proximal jejunum, leaving his GI tract in discontinuity. Describe the potential effects of surgery on this patient’s ability to meet his traditional needs.

   Due to the patient’s discontinuous GI tract, it is deemed non-functional and cannot support fluids or food. Therefore, all forms of enteral nutrition (tube feeding) are not feasible. In order to meet the patient’s nutritional and fluid needs when NPO, the patient should undergo TPN (total parenteral nutrition) until the GI tract regains functionality. Some potential effects of surgery are gastric emptying, transit time, malabsorption, maldigestion, vitamin and mineral deficiencies, lipid metabolism issues, etc.

3. The metabolic stress response to trauma has been described as a progression through three phases: the ebb phase, the flow phase, and finally the recovery or resolution. Define each of these and determine how they may correspond to this patient’s hospital course.

   The patient was in ebb phase from admission until day 3. He’s currently in FLOW phase. The metabolic stress response to trauma progresses through three stages. First, the ebb phase occurs in which there is reduced cardiac output, oxygen consumption, basal metabolic rate, and glucose tolerance. Since this phase corresponds to the traumatic and initial post-traumatic period there usually is adequate substrate (oxygen, glucose, fatty acid) to meet the diminished demand of tissue. The ebb phase lasts for up to 48 hours, during which the patient may have lowered energy needs. This patient was in ebb phase from admittance until after day 3 (extended past the 48 hour duration because PT’s body was still dealing with the anastomotic leak that is addressed with additional surgery). The goal in the acute period is to restore blood flow to organs, maintain oxygenation of all tissues, and stop all hemorrhaging. Next, the flow phase begins when the patient stabilizes hemodynamically, and can last from days to weeks after the trauma. During this time, there is increased cardiac output, respiration, hyperglycemia, skeletal muscle catabolism,
and negative nitrogen balance, thus requiring increased energy needs due to elevated metabolic needs. It’s important to ensure sufficient calories and protein to avoid wasting and negative nitrogen balance, reduce cortisol levels, and improve recovery time. With this patient, the flow phase likely begins day 4 or 7 and lasts for several weeks (Finnerty, Mabvuure, Ali, Kozar, & Herndon, 2013).

Finally, during the recovery or resolution phase, anabolism and normal metabolic rate are established. During this time, the patient’s energy requirements will decrease compared to the flow phase. Recovery phase begins after the patient has fully recovered from the trauma, likely several weeks after the initial admittance. The recovery phase will be initiated once the patient is healed, likely after several weeks pass (Finnerty et al., 2013).

4. **Acute-phase proteins are often used as a marker of the stress response. What is an acute-phase protein? What is the role of C-reactive protein in the nutritional assessment of critically ill trauma patients? What other acute-phase proteins may be followed to assess the inflammatory stress response?**

   An acute-phase protein is a protein that is temporarily increased (positive acute-phase proteins) or decreased (negative acute phase proteins) as a response to a stressor such as infection, inflammation or trauma. Examples of positive acute phase proteins include C-reactive proteins, pro-inflammatory cytokines such as TNF-alpha, IL-1, IL-8 and IL-8 and ferritin. Negative acute phase proteins decrease as a result of inflammation and include albumin, transferrin receptors, antithrombin and RBP (Gabay & Krushner, 1999).

   Elevated C-reactive protein (CRP) levels are commonly used as an indicator for inflammatory stress or trauma, as elevated levels are strongly correlated with erythrocyte sedimentation rate (ratio of pro-sedimentation factors such as fibrinogen: negative-sedimentation factors). Higher sedimentation indicates inflammation due to up-regulation of fibrinogen. Therefore, the patient may have increased metabolic stress with nutritional consequences such as PEM, indicating increased energy and protein needs. Addition of omega-3 supplements can also curtail the effects of inflammation (Nelms, Sucher, & Lacey, 2014).

II. **Understanding the Nutrition Therapy**

5. **Metabolic stress and trauma significantly affect nutritional requirements. Describe the changes in nutrient metabolism that occur in metabolic stress. Specifically address energy requirements and changes in the carbohydrate, protein, and lipid metabolism.**

   Trauma and major surgery illicit metabolic responses including altered protein homeostasis, hypermetabolism, sodium and water retention, altered carbohydrate metabolism, and increased lipolysis. Specifically, patients in metabolic stress are in a catabolic state and often have a net negative nitrogen balance, necessitating increased protein. There is increased gluconeogenesis and reduced insulin resistance which can cause hyperglycemia. Fat is mobilized as an energy source at a higher rate, so lipolysis increases and lipogenesis decreases. Thus, there are altered nutritional requirements for patients undergoing metabolic stress (Weissman, 1990).

   Use of indirect calorimetry is the method of choice (gold standard) to establish energy and protein requirements for the critically ill. Measured weight may not be reflective of actual weight due to changes in fluid balance secondary to fluid resuscitation, losses from wounds, and loss of blood. For overweight and obese patients, ideal body weight is often used. Without indirect calorimetry, you should calculate energy requirements by using the factor of 25-30 kcal/kg of ideal body weight for patients with a BMI greater than or equal to 30 kg/m². For normal individuals, calculations are also based on 25-30 kcal/kg of actual body weight per day.
Research indicates that the Penn State equation had the highest accuracy when compared to measured energy expenditure (Nelms et al., 2014).

Permissive underfeeding can be used in patients under metabolic stress. This is when the patient is only given 60-70% of their total energy needs.

Protein requirements should be estimated based on the degree of trauma and stress. Protein is calculated at a baseline of approximately 1.2-1.5 g protein/kg of ideal body weight per day, 1.5-2.0 g/kg for patients with burns, trauma, or healing wounds, and up to 2.0-2.5g/kg for extreme trauma cases.

To prohibit protein sparing, 100 g of carbohydrate is required daily (1 mg/kg/min is often used as the reference for the minimal amount) (Nelms et al., 2014).

6. **Are there specific nutrients that should be considered when designing nutrition support for a trauma patient? Explain the rationale and current recommendations regarding glutamine, arginine, and omega-3 fatty acids for this patient population.**

   Metabolic stress alters some nutrient levels and therefore certain nutrients need to be included in formulas or supplemented separately. Specifically, glutamine at should be given to burn, trauma, and ICU patients at a rate of 0.3 - 0.4 g/kg/day because during critical illness, the body cannot synthesize glutamine at a fast enough rate. Glutamine is the preferred fuel for enterocytes and in addition to helping maintain intestinal integrity, it may support immune cell growth, reduce levels of pro-inflammatory cytokines, and serve as a precursor to glutathione (Nelms et al., 2014). Arginine, often included at 8 - 13 g/L in specialized enteral formulas, is also recommended due to its roles in the immune system as a precursor to nitric oxide (Nelms et al., 2014).

   Omega-3 fatty acids may reduce pro-inflammatory cytokines and therefore 1.4 - 4.5 g/L are included in enteral formulas given to patients undergoing metabolic stress. In addition, vitamin C, vitamin E, selenium, zinc, and pro- pre- and synbiotics are often recommended to critically ill patients (Nelms et al., 2014).

7. **Using current evidence-based guidelines, explain the decision-making process that would be applied in determining the route for nutrition support for the trauma patient.**

   Enteral nutrition should be started early within the first 24-48 hours following admission and be advanced to meet recommended prescription within 72 hours when a patient is hemodynamically stable and has a functioning GI tract. EN should also be started if a patient has had inadequate oral intake for 7-14 days or is expected to have inadequate oral intake for 7-14 days. EN is more cost effective than PN and is associated with reduced infections. Parenteral nutrition should be reserved for cases with prolonged NPO status lasting longer than 7 days, when the patient is malnourished and enteral access cannot be obtained, when enteral nutrition support cannot meet the patient’s needs or is not tolerated, or when a major surgical procedure will prevent the patient from starting enteral nutrition and the patient will enter surgery in a malnourished state (Nelms et al., 2014). If a patient is on TPN, it is important to start trickle feeding as soon as there are bowel movements or bowel sounds. The trickle helps to maintain GI tract health and functionality and prevents cholestasis, villi atrophy, and bacterial translocation (Nelms et al., 2014).

III. **Nutrition Assessment**

8. **Calculate and interpret the patient’s BMI.**
Due to the fact that the patient is in metabolic stress and also because of possible scale errors, measured weight may not be reflective of actual weight. His admitting weight was 102.7 kg and his weight on day 7 was 109 kg. By day 7 the patient is more stabilized. There is only minimal excess fluid retention because of the VAC as well as the Jackson Pratt drains. Using his weight at day 7 (109 kg), his BMI is 34.5 kg/m². This BMI is categorized as Obese Stage I because it is over 30.0 kg/m².

9. **What factors make assessing his actual weight difficult on a daily basis?**
   - Patient is undergoing multiple reconstructive surgeries and has Jackson Pratt drains implanted to reduce buildup of inflammatory fluids that may slightly fluctuate on a daily basis depending on the amount of fluid contained in the drains
   - Excess fluid may be contained in the swollen abdomen (although not likely because of the washout and drainage)
   - Fluid losses from wounds
   - Loss of blood
   - Items on bed may also affect amounts recorded by bed scale
   - JP is immobile, so bed scale cannot be zeroed out for accuracy

10. **Calculate energy and protein requirements for Mr. Perez. Use at least two methods (including the Penn State) to estimate his energy needs. Explain your rationale for using each one. For the Penn State calculation, the minute ventilation is 3.5 L/minute and the maximum temperature is 39.2.**

   I. **RMR (Resting Metabolic Rate)**
   - Method I (Harris Benedict) = 1800 kcal/day (using 75.45kg IBW)
     IBW was selected because estimates based off the patient’s admitted weight, he is classified as the obese stage I. However, this estimate of admitted weight may be inaccurate, as the patient’s admitted weight may have been influenced by fluid losses from GSW. Therefore, his actual weight may in fact be higher thus increasing his BMI.
   - Method II (PENN State) = 2060 kcal/day (using Harris Benedict Method I)

   II. **EER (Estimated Energy Requirements)**
   - Method I (Harris Benedict) = 1,800 kcal x 1.1 (bed confined activity factor) x 1.3 (injury factor) = 2,574 kcal/day
     Activity level of 1.1 was selected for the predictive equation, as patient is bedridden due to VAC placement and multiple surgeries. Injury factor of 1.3 was selected as it reflects an injury factor for major surgery.
   - Method II (PENN State) = 2060 kcal x 1.1 (bed confined activity factor) x 1.3 (injury factor) = 2,940 kcal/day

   **Total Protein Needs:**
   - 2.0-2.5g/kg x IBW (for critically ill obese patient)
   - Protein Needs Per day_lower range= IBW x 2.0g/kg/day
     = 151 g_protein/day
   - Protein Needs Per day_upper range= IBW x 2.5g/kg/day
     = 189 g_protein/day

   **Total Protein Needs = 151 - 189 g protein/day**

11. **What does indirect calorimetry measure?**
   Indirect calorimetry measures the amount of oxygen consumed and carbon dioxide expired. This data is used to calculate energy requirements (Nelms et al., 2014).
12. Compare the estimated energy needs calculated using the predictive equations with each other and with those obtained by indirect calorimetry measurements.

Indirect Calorimetry Measurements
REE = 3657 kcals/day and RQ 0.76
Harris Benedict Equation (IBW, x1.1 Activity Factor, x1.3_Injury Factor) = 2,574 kcal/day
PENN State Equation (IBW, x1.1 Activity Factor, x1.3_Injury Factor) = 2,940 kcal/day

Indirect calorimetry shows the patient has higher caloric needs than both the Harris Benedict Equation and Penn State Equation. This is because the patient is in the Flow Phase of metabolic stress, which represents the highest energy expenditure of all metabolic stress phases. The Harris benedict equation provided the lowest caloric estimation. The Harris benedict equation may have estimated lower caloric needs than the PENN State equation because it does not factor in ventilation rate and maximum temperature. Ventilation rate and body temperature are variables that change based on metabolic stress severity.

13. Interpret the RQ value. What does it indicate?

The RQ, or respiratory quotient, is the ratio of moles of carbon dioxide exhaled to moles of oxygen inhaled. It is calculated as the volume of CO\(_2\)/volume of O\(_2\) measured from the expired air. A result of 1 and above indicates complete carbohydrate metabolism. A RQ of 0.8 - 0.9 indicates protein catabolism, and a RQ of 0.7 indicates fat metabolism (McClave et al., 2009). The PT’s RQ is 0.76, indicating that the patient is chiefly burning fats and proteins but not carbohydrates.

14. What factors contribute to the elevated energy expenditure in this patient?

- The flow phase of metabolic stress
- Initial trauma, wound healing, and elevated weight.
- Increased respiratory rate
- Slight fever (Nelms et al., 2014)

15. Mr. Perez was prescribed parenteral nutrition. Determine how many kcals and grams of protein are provided with his prescription. Read the nutrition consult follow-up and the I/O record. What was the total volume of PN provided that day?

Current nutrition support: dextrose 140 CAA: 60 FAT/L: 20 Goal Rate 135 mL/hr
Total volume infused = 135 mL/hr * 24 hr = 3240 ml or 3.24 L (goal)
3.24L * 20g/L lipid = 64.8 g lipids * 10 kcal/g = 648 kcal from lipids
3.24L * 60 g protein = 194.4 g * 4 kcal/g = 778 kcal from protein
140 g CHO/L * 3.24 = 453.6g CHO * 3.4 kcal/g = 1,542 kcal from CHO
648 + 778 + 1542 kcal = 2,966 kcal/day

Total volume of PN provided that day based in IO chart: 3,312 mL
***Note: + Propofol @35 mL/hr adds an additional 924 kcal= 3,890 kcal total (51 kcal/kg IBW/day). The amount of protein is still 195 g protein or 778 kcal (2.6g/kg IBW/day).

16. Compare this nutrition support to his measured energy requirements obtained by the metabolic cart on day 4. Based on the metabolic cart results, what changes would you recommend to be made to the TPN regimen, if any? What are the limitations that prevent the health care team from making significant changes to the nutrition support regimen?

On day seven of this case, the PT’s EER based on metabolic cart measurements was 3,657 kcal expenditure, with an RQ of .76.
Total amount of dextrose PT is receiving = 453.6g or 1,542 kcal = 40%
Total amount of protein from above = 194.4 g or 778 kcal = 20%
Total amount of lipids= 64.8 g lipids + 924*** (Propofol) = 40%
***Note when + Propofol @35 mL/hr providing additional 924 kcal= 3,890 kcal (51 kcal/kg IBW/day) and 778 kcal or 195 g protein (2.6g/kg IBW/day)

Based solely on the original TPN prescription, JP would not be meeting his caloric needs. With the added Propofol, JP receives the amount of calories to fulfill his needs based on his metabolic cart (3,890 kcals). As JP’s HbA1C score shows that he is hyperglycemic, it is wise to have a low overall percentage of carbohydrates and to add calories with lipid based formulas. He is currently only receiving 40% of total calories from carbohydrates and 40% from lipid (with the Propofol). Lastly, JP is receiving 20% of his calories, 103% of his calculated needs, from protein. This is necessary as JP is showing signs of PEM and needs a rate close to 2 - 2.5g/kg/hr

Limitations include:
• TPN based on formulas available at hospitals. We must use these available formulas and use the formula that best fits JP’s predicted nutritional needs.
  o For example, available formulations of lipid: 10% (1.1 kcal/mL), 20% (2 kcal/mL), or 30% (3 kcal/mL).
• GI tract discontinuity, lack of bowel sounds, and mechanical ventilation prohibit EN and oral feedings.
• Susceptibility is high for overfeeding because of severe stress and GI complications.
• JP has hyperglycemia based on HbA1C results. We do not want to increase sugars, so adjustments should be based on increasing lipids or protein.

We disagree with the decision to start TPN as the patient still does not have bowel movement or bowel sounds.

17. The patient was also receiving propofol. What is this, and why should it be included in an assessment of his nutritional intake? How much energy did it provide?

Propofol is a drug that promotes relaxation and sedation (Nelms et al., 2014). It provides 1.1 kcal/ml lipid solution in TPN, so it does provide additional energy to the patient. It must be accounted for in the nutrition prescription as to not overfeed the patient. This patient is receiving Propofol at 35 ml/hr, which would give him an additional 924 kcal/24 hr day.

18. The RD recommended that trickle feeds be initiated. What is this and what is the rationale? The RD recommended the formula Pivot 1.5 for these trickle feeds. What type of formula is this, and what would be the rationale for choosing this formula?

Trickle, or trophic, feeding is a small amount of enteral feeding to the small bowel of a patient receiving TPN. The energy provided through trickle feedings are not sufficient to be considered in the calculation of the energy provided to a patient, but are provided to stimulate the gut in order to prevent atrophy of villi, bacterial translocation, and cholestasis of the GI system. Trickle feedings are used to supplement TPN and prevent the complications previously described by the lack of GI movement.

We disagree with the decision to start TPN as the patient still does not have bowel movement or bowel sounds.

When the patient starts trickle feeding, they will receive Pivot 1.5.
Pivot 1.5 CAL is a formula designed for metabolically stressed surgical, trauma, burn, and head and neck cancer patients who could benefit from an immune modulating enteral formula (Abbott Nutrition, 2015). Pivot may have been selected because of its high protein content as well as the inclusion or arginine, glutamine, and omega-3’s. The increased protein content will
help to support protein synthesis, tissue repair, and wound healing. The high levels of glutamine, arginine, and omega-3’s help enhance immune function (additional information regarding benefits under question 6).

19. List abnormal biochemical values for 3/29, describe why they might be abnormal, and explain any nutrition-related implications.

<table>
<thead>
<tr>
<th>Lab Value</th>
<th>Normal range</th>
<th>Patient’s Range (3/29)</th>
<th>Pathology</th>
<th>Nutrition-related implications</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sodium</td>
<td>136-145 mEq/L</td>
<td>146 mEq/L</td>
<td>Plasma Sodium levels can fluctuate due to stress caused by metabolic stress, trauma and open wound</td>
<td>n/a as levels do not greatly deviate from normal levels.</td>
</tr>
<tr>
<td>BUN</td>
<td>8-18 mg/dL</td>
<td>23 mg/dL</td>
<td>BUN can be elevated due to high protein diet however; the high protein intake is needed to improve the rate of wound healing. In addition, high BUN can indicate protein catabolism due to metabolic stress</td>
<td>Increasing or maintaining 2.0-2.5g/kg. IBW may be necessary to combat excessive protein catabolism</td>
</tr>
<tr>
<td>Albumin</td>
<td>3.5-5g/dL</td>
<td>1.9 g/dL</td>
<td>Widespread edema can increase plasma volume thus decreasing albumin:plasma ratio. In addition, albumin is a negative acute phase protein therefore in times of metabolic stress this protein is lowered</td>
<td>Low albumin can be a result of malnutrition or PEM however; due to the widespread edema this may not be the case for the current patient. Regardless this biomarker should be monitored as low blood albumin is an indicator of increased risk for morbidity, mortality and increase hospital stay</td>
</tr>
<tr>
<td>Prealbumin</td>
<td>16-35 mg/dL</td>
<td>5 mg/dL</td>
<td>Like albumin, pre-albumin is a negative acute phase protein hence it decreases when a person undergoes metabolic stress. It is also a sensitive measure for protein-energy balance</td>
<td>Acute metabolic stress decreases levels but a lack of protein and/or calories can increase levels. This may indicate the patient’s caloric and protein needs are not being met.</td>
</tr>
</tbody>
</table>
Glucose | 70-110 mg/dL | 140 mg/dL | Hyperglycemia can result due to stress induced insulin resistance due to metabolic stress. In addition, metabolic stress and protein catabolism increases gluconeogenesis, which also increases plasma glucose levels. | Hyperglycemia leads to poor wound healing and longer hospital stay. Prolonged uncontrolled hyperglycemia in the ICU may indicate a need for insulin to control blood glucose levels |
ALT | 4-36 U/L | 435 U/L | May increase as a result of drugs which have toxic liver metabolites but also indicates inflammation/damage to the bone, intestines or liver | Reflects increase energy and protein needs to support health, timely recover and reduced hospital stay |
AST | 0-35 U/L | 190 U/L | Medications can also increase AST as it is a specific enzyme found in the liver. It increases due to liver inflammation and damage due to medications, liver tissue damage or fatty liver development | Reflects increased energy and protein needs to support health, faster wound/tissue healing and reducing hospital stay |
C-Reactive Protein | <1.0 mg/dL | 245 U/L | A positive acute phase protein that reflects metabolic stress and the possibility of trauma and/or infection | High levels of CRP are reflective of increased caloric and protein needs. In addition, high levels can make negative acute phase biomarkers less accurate |
Alk Phosphates | 30-120 U/L | 540 U/L | An indicator of possible infection and cholestasis (poor bile flow from liver) | Increased protein intake may be needed to support the recovery of the liver and when EN is eventually utilized, it may reflect an inability to absorb fats from the diet therefore, MCT may be needed as a fat source |
CPK | 55-170 U/L | 182 U/L | creatine phosphokinase is an enzyme that’s found in heart, brain, and skeletal muscle. High levels indicate | High CPK is an indicator of metabolic stress and tissue damage. This can prove a useful biomarker |
Injury or stress to any of these tissues. | for predicting caloric needs
---|---
HbA1c | 3.9-5.2 % | 7.1 % | Glycosylation of hemoglobin protein in RBC as a result of persistent hyperglycemia | Indicates patient maybe diabetic (DMTI) which can reduce wound healing and may require increased monitoring of TPN macronutrient distribution to prevent excessive hyperglycemia
Lactate dehydrogenase | 208-378 U/L | 750 U/L | An intracellular enzyme that indicates tissue damage | High levels of lactate dehydrogenase reflects increased caloric and protein needs to recover from widespread tissue damage
Triglycerides | 40-160 mg/dL | 274 mg/dL | High triglycerides result from excess simple sugars or fats in the diet. Over time high circulating levels of triglycerides can lead to the development of fatty liver and other liver complications | Uncontrolled triglycerides especially in patient needing long term TPN are at increased risk for developing fatty liver therefore, once patient is in the recovery phase these levels should be monitored and nutritional modification made to the diet to lower them

20. **Current guidelines recommend using a nitrogen balance study to assess the adequacy of nutrition support.**

a. According to the Powell (2012) article, what adjustments should be made to assess for nitrogen losses through fistulas, drains, or wound output? The patient is in a hypermetabolic state and has serious surgeries which has altered macronutrient utilization. Specifically, protein is lost via the loss of abdominal fluid and drainage. If the increased protein loss is not considered when calculating nitrogen balance, the total nitrogen loss is underestimated and therefore there is an overestimation of the amount of protein administration to meet patient needs.

b. A 24-hour nitrogen collection is completed for Mr. Perez with results of UUN 42 g. Calculate his nitrogen balance.

\[
N_2 \text{ balance} = 194.4 \text{ g/6.25} - 42 - 4 = -14.90 \; ; \text{ negative nitrogen balance.}
\]

IV. **Nutrition Diagnosis**

21. Identify the nutrition diagnosis you would use in your follow-up note. Complete the PES statement.

Diagnoses:
1. Increased energy expenditure R/T open abdomen and posttrauma status AEB metabolic cart measurement of 3657 kcal expenditure.

2. Altered GI function R/T open abdomen and GSW with subsequent surgery AEB lack of bowel sounds, no stool output, and continued wound VAC for open abdomen.

3. Increased nutrient needs (protein) R/T posttrauma status and wound healing AEB albumin of 1.9 g/dL (low) and total protein of 5.1 g/dL (low).

V. Nutrition Intervention
1. Continue to provide TPN based nutrition support of dextrose 140 CAA: 60 FAT/L: 20 Goal Rate 135 mL/hr to ensure adequate energy and protein intake (approximately (51 kcal/kg IBW/day and 2.4g protein/kg IBW/day)
2. Continue Propofol @35 mL/hr.
3. Confirm with doctor the continuance of the following lab tests: blood sugar (3-4x a day) and serum electrolytes, BUN, creatinine, magnesium, and phosphorous (daily).

VI. Nutrition Monitoring and Evaluation
23. What are the standard recommendations for monitoring the nutritional status of a patient receiving nutrition support?
   Usually, monitoring is intense the first few days PN is in place, but as the patient reaches goal infusions and becomes stable, monitoring is also decreased. Intake and output are monitored, as well as laboratory tests for hyperglycemia (3-4x/day), and daily monitoring of serum electrolytes, BUN, creatinine, magnesium, and phosphorous. If serum triglycerides are abnormal at baseline, they are monitored weekly. Some more common complications include electrolyte imbalance, under/overfeeding, hyperglycemia, and refeeding syndrome (Nelms et al., 2014).

   Monitoring/Evaluation:
   1. Continue to monitor electrolyte balance and fluid I/O.
   2. Continue daily evaluation of metabolic needs and metabolic tolerance to nutrition support daily,
   3. Continue to monitor for bowel sounds.

24. Hyperglycemia was noted in the lab results. Why is hyperglycemia of concern in the critically ill patient? How was this handled for this patient?
   Stress-induced hyperglycemia can result from increased pro-inflammatory cytokines and glucose-regulating hormones; patients receiving dextrose infusions as part of parenteral nutrition have increased risk. Hyperglycemia can lead to complications in vascular integrity, and conditions like osmotic diuresis, fluid and electrolyte imbalances, hyperosmolar nonketotic coma, worsening skeletal muscle catabolism, impaired wound healing, changes in coagulability, impaired immune function, increased susceptibility to infections, and possible death (Nelms et al., 2014).

   Monitoring/Evaluation:
   1. Continue to monitor electrolyte balance and fluid I/O.
   2. Continue daily evaluation of metabolic needs and metabolic tolerance to nutrition support daily,
   3. Continue to monitor for bowel sounds.

25. What would be the standard guidelines and subsequent recommendations to begin weaning TPN and increasing enteral feeds?
   According to the ASPEN guidelines (Nelms et al., 2014), a PT should be weaned from TPN when:
   1. Tube feedings (EN) are tolerated at 60% of goal:
      o Decrease TPN to approximately half, discontinue lipids and decrease dextrose/AA per PN team order
      o Wean off TPN as tube feeding rate advances to goal or per clinical judgment
   2. Oral intakes tolerated at 60% of meals consumed
o Decrease TPN to approximately half, discontinue lipids and decrease Dextrose/AA per PN team order
o Wean off TPN per clinical judgment

*** Note that as patient is transitioned off of TPN, it is important to watch for signs of hypoglycemia. Ensure that patient is sufficiently absorbing nutrients and blood glucose does not drop below desired levels.