Abstract

Medical Nutritional Therapy (MNT) plays an integral part in the management of patients with Crohn’s disease (CD) in the hospital setting. Approximately 85% of hospitalized CD patients have protein energy malnutrition. Malnutrition in patients with CD increases the risk of in-hospital mortality and length of stay. Nutritional deficiencies are also common, resulting from reduced nutrient intake, malabsorption, drug-nutrient interactions and overall systemic inflammation. Deficiencies in vitamin B12, vitamin D, folate and iron can result in decreased quality of life in patients with CD. Hospitalized patients with CD are often medically unstable upon admission and require nutrition support. Relapse rates are also high for CD patients. As evidenced by this case study, improvement in MNT to identify known nutrition-related problems while the patient is in the hospital may help reduce readmission rates and improve the overall quality of life for patients with CD.

Introduction

Crohn’s disease (CD) belongs to a group of conditions known as Inflammatory Bowel Disease (IBD). CD is an autoimmune disease that causes chronic inflammation, ulceration and thickening of the intestinal wall. The disease affects any part of the Gastrointestinal (GI) tract from mouth to anus. However 80% of patients have disease concentrated in the ileum\(^1\). Ulcerative Colitis is another type of IBD that typically affects the lining of the large intestine and rectum, and has distinct endoscopic/pathological findings compared to CD. Due to the fact that CD affects more of the alimentary canal, it is associated with greater nutritional insult than Colitis\(^2\). Currently CD affects 700,000 Americans. It is most prevalent amongst adolescents and young adults, affecting both men and women equally\(^3\). The disease is more commonly seen in Caucasians and persons of Jewish descent\(^4\). The etiology of the disease remains uncertain. Genetic factors are thought to play a role as 20% of patients have a first degree relative with disease\(^4\) and 71 distinct genetic loci have been identified that are associated with risk of CD\(^5\). The
The link between smoking and CD has been well documented and research shows overuse of NSAIDS may be another risk factor. Nutritionally alterations in gut bacteria and a diet high in refined sugars have been linked to CD risk but results remain tentative.

Nutrition is an integral part of the medical management of CD. In 1932 when CD was initially described in a medical journal, the predominant presentation was weight loss. It is estimated that around 85% of hospitalized patients have protein energy malnutrition and vitamin/mineral deficiencies are common due to decreased nutrient intake, absorption and nutrient loses. Many factors put a patient at risk for malnutrition and nutrient deficiencies including drug-nutrient interactions, disease location, disease severity, symptoms and certain dietary restrictions. Patients are usually treated non-operatively with corticosteroids or 5-aminosalicylic acid’s (5-ASA) to reduce inflammation. Ultimately 50% require resection of the inflamed or damaged bowel during the course of their disease. However 50% of those undergoing resection will relapse. Risk factors associated with relapse include the severity of disease at diagnosis and the presence of perianal fistulas. Short bowel syndrome (SBS) is a disorder of malabsorption that can occur when a patient has large portions of the small intestine removed. CD is one of the most common causes of SBS and 5-10% of patients with CD are at risk for developing the syndrome. Research demonstrated that the largest number of CD patients at risk for SBS are those who had multiple series of repeated laparotomies with large sections of the bowel removed to control postoperative intra-abdominal sepsis.

Due to its effect on intestinal absorption, nutrition support is indicated to improve the overall nutritional state of the patient. Enteral nutrition or Total Parenteral Nutrition (TPN) are chosen based on the current condition of the patients gut and the patients overall status while in the hospital. Research supports the use of enteral nutrition to improve the malnourished state of CD patients. However it is inconclusive if nutrition support can reduce relapse rates or intestinal inflammation in adults. Current recommendations for medical nutrition therapy (MNT) are dependent on many factors, but take into consideration the patients altered nutrition status, the
severity of the disease, stool output, malabsorption, medication regimen, medical/surgical history, weight status and quality of life\textsuperscript{18}. Recent research demonstrates that energy requirements are not increased in patients with CD compared to the general public\textsuperscript{19}. However CD patients have increased protein needs due to losses from inflammation, catabolism with GI infections and increased needs with surgery\textsuperscript{2}. In diseases like CD that are characterized by inflammation, protein catabolism is evident. Therefore a greater intake of protein in the diet is warranted to decrease whole body protein wasting\textsuperscript{20}.

\textbf{Vitamin/Mineral Deficiencies}

The effects of long-term inflammation of the intestinal mucosa and bowel resections can put patients at risk for impaired absorption of nutrients and resulting nutrient deficiencies. Other risk factors for nutrition deficiencies in CD patients include reduced oral intake, side effects from medications and overall systemic inflammation. The location of the disease or resection has a large impact on nutrient deficiencies as areas of the small intestine are key sites for vitamin/mineral absorption (see appendix, diagram 4). Several nutritional deficiencies are commonly noted with CD patients as detailed below.

Deficiency of vitamin B12 has been reported in 20\% of patients with CD\textsuperscript{21}. Breakdown of vitamin B12 occurs in the acidic environment of the stomach where the vitamin then binds to Intrinsic Factor (IF) released by parietal cells of the stomach. The vitamin B12-IF complex aids in the absorption of vitamin B12 in the terminal ileum\textsuperscript{22}. As a result inflammation of the stomach and/or terminal ileum, as well as resection of the terminal ileum/stomach can put one at risk for developing vitamin B12 deficiency. Older age is also a risk factor as parietal cell function can decrease with age\textsuperscript{23}. B12 deficiency with other factors can lead to anemia, commonly seen in CD patients. The use of intramuscular injections in CD as opposed to oral supplementation is recommended by most clinicians to prevent inadequate absorption of B12 through the GI tract\textsuperscript{2}. 
Deficiency of vitamin D has been found in 25% of adults with CD\textsuperscript{24}. Research suggests that malabsorption of vitamin D is the main mechanism for deficiency in CD patients. Vitamin D deficiency coupled with long-term steroid use can result in a reduction in bone mass. Steroids have been linked to impaired osteoblast function/apoptosis, reduced calcium absorption in the gut and increased renal excretion of calcium\textsuperscript{25}. Compared to the general public, patients with CD are at higher risk for developing osteopenia/osteoporosis and have a 40% greater risk of a fracture\textsuperscript{26}.

Iron deficiency anemia is a commonly seen manifestation of CD. Prevalence rates of iron deficiency anemia vary from 35-90% of patients with IBD\textsuperscript{27}. Research demonstrates that the correction of anemia with iron supplementation is well tolerated, does not exacerbate IBD symptoms and greatly improves the quality of life in patients with IBD\textsuperscript{28}.

Drug nutrient interactions can have an affect on vitamin/mineral deficiencies in CD patients. Sulfasalazine (5-ASA) is a drug commonly taken by patients with IBD to decrease inflammation. The drug acts directly in the intestine and has been found to have immunosuppressive activity by inhibiting cytokine synthesis\textsuperscript{29}, prostaglandin and leukotriene synthesis\textsuperscript{30} and impairment of white cell adhesion and function\textsuperscript{31}. However treatment with this drug can exacerbate folate (vitamin B9) deficiency as the drug binds folate in the gut, blocking absorption. Folate deficiency can result in megaloblastic anemia as it plays an important role in the development of red blood cells\textsuperscript{32}.

**Protein Energy Malnutrition**

Protein energy malnutrition is a broad term but generally refers to an inadequate intake of protein and calories over an extended period of time. Several factors contribute to protein energy malnutrition in CD such as decreased oral intake, maldigestion, malabsorption, enteric loss of nutrients through chronic diarrhea and increased nutrient needs during inflammatory states\textsuperscript{33}. Fistulizing CD and bowel surgery have been identified as clear risk factors for protein energy malnutrition in IBD patients\textsuperscript{33}. Older age is also a risk factor as 85% of hospitalized IBD are
determined to be protein malnourished\textsuperscript{34}. Malnutrition is associated with an increased risk of in-hospital mortality and an increased length of stay in IBD patients\textsuperscript{33}. Most CD patients are malnourished even when the disease is not active. The Malnutrition Universal Screening Tool (MUST) is generally recommended for identifying risk of malnutrition in the adult population and is commonly used in the hospital setting\textsuperscript{35} (see appendix, diagram 2). However research suggests that the use of a Subjective Global Assessment (SGA) is a more useful tool for screening IBD patients for malnutrition\textsuperscript{36} (see appendix, diagram 3). Unlike the MUST, SGA takes into account weight change history, oral intake, GI symptoms and overall functional capacity when the patient enters the hospital setting.

**Case Study**

The patient is a 75 year-old Caucasian male, who is a retired manager at a manufacturing company in Charlotte, North Carolina. He has a 35-year history of CD and admits to regularly smoking in the past. The patients extensive history of CD has lead to multiple hospital admissions for syncope related to dehydration and poor intake, as well an ileostomy procedure within the past 10 years. Also noted is a history of iron deficiency anemia (treated with supplementation) and malnutrition on previous admissions over the past 3 years. The patient was admitted with a 2-week history of abdominal pain that became worse over the past 2 days. On admission to the Caromont Regional Medical Center Emergency Department (ED) he was found to have perforation of the terminal ileum with severe Crohn’s terminal ileitis, sepsis and high fever. A laparotomy with ileocolectomy and creation of end-ileostomy and mucous fistula was preformed shortly after admission. Otherwise known as an ileostomy, this is a procedure in which the small bowel is brought to the surface of the skin to form a stoma, thereby bypassing the area of the intestine affected by CD. Fecal matter is redirected through the stoma versus the colon. A mucous fistula is a non-working stoma (does not pass feces). Its purpose is to discharge mucous or gases from the non-functioning part of the colon. After the surgery was performed the patient was in
critical condition in the Caromont Regional Medical Center Intensive Care Unit (ICU). During the hospital stay the patient was also found to have cardiomyopathy as evidenced by an abnormal electrocardiogram (EKG). The diuretic Lasix was prescribed to decrease fluid retention and limit \(\text{strain on the heart.}\)

The nutrition assessment gathered information on pertinent nutrition related history, physical findings and anthropometric data. The patient was found to have a weight loss of 18 kg over a year despite consuming 2-3 Boost supplements (8 fl oz each) a day. Boost is a dietary supplement made by Nestle Nutrition that provides essential nutrients and calories for times when a patient is not able to meet all their nutrition needs through food. He had a long history of poor intake and appetite, relying mostly on the Boost supplements to meet his nutrient needs (see appendix, diagram 1 for patient nutrient needs and Boost supplement intake). The patient was also taking iron supplements to treat chronic iron deficiency anemia in which he complained of general weakness and fatigue. On examination he had bruises and sores over all four extremities. Anthropometric data found the patient to be 71 kg on admission with a BMI of 22. The patient was considered underweight per current recommendations for older adults (\(\geq 65\) years) to maintain a healthy BMI between 23-29\(^3\). His usual body weight was 89 kg and has therefore had a 20% weight loss over the past year. Upon initial examination the doctor suggested the patient may have protein energy malnutrition. Using the MUST criteria (see appendix, diagram 2) the patient was classified as being at high risk for malnutrition related to low BMI, greater than 10% unplanned weight loss and acute illness with poor dietary intake over 5 days. The SGA (see appendix, diagram 3) was not used in the hospital however the assessment would have predicted that the patient was severely malnourished due to a weight loss greater than 10%, a dietary intake meeting less than 70% of needs, daily GI symptoms, bedridden functional capacity and an acute disease type.

Based on the nutrition-related findings, the nutrition diagnosis determined by the registered dietitian was inadequate protein energy intake related to GI/oral complaints, alteration
in GI tract structure and/or function and sedated on ventilator as evidenced by decreased oral intake prior to admission, loss of skin integrity/skin breakdown/delayed wound healing. The most pressing nutrition-related problem on assessment appeared to be the patient’s malnutrition and weight loss. Nutrition interventions were based on improving the patient’s current malnutrition status and signs/symptoms related to malnutrition. The initial diet recommendations were to start the patient on TPN at 50% of needs due to the risk of refeeding syndrome. Refeeding syndrome is defined as severe fluid and electrolyte shifts that can occur in malnourished patients that are reintroduced nutrition during oral, enteral or parenteral refeeding after a period of starvation\textsuperscript{38}. TPN is recommended in CD patients who meet the following criteria: cannot tolerate adequate enteral feedings, presence of an obstruction and/or stricture, a distal fistula that precludes feeding, and severe SBS\textsuperscript{2}. The patient presented with all 4 criteria and was at significant risk for refeeding syndrome. Beginning TPN at half rate and monitoring potassium, phosphorus and magnesium can help to prevent the onset of refeeding syndrome\textsuperscript{39}. The goal of therapy was to transition the patient from TPN to enteral nutrition to a modified solids diet and eventually tolerating oral intake well. Nutrition monitoring/evaluation entailed closely watching the patient’s weight, vitals and dietary intake to ensure that the patient was tolerating treatment well.

In conjunction with the wound team (a group of nurses specializing in the treatment of wounds in the hospital), skin integrity and bruise/sores were monitored weekly for signs of improvement with improvement in nutrition status while in the hospital.

Upon discharge from the hospital the patient appeared to be medically and nutritionally stable. The patient had improvement in dietary intake, appetite and stool output. The patient met all nutrition goals in a timely manner and was able to consume approximately 75% of his calorie/protein needs through oral nutrition. His weight appeared to remain stable but was difficult to determine as the patient was also taking the diuretic Lasix, resulting in increased fluid elimination. The patient was discharged to an acute rehab facility per physician and occupational therapist recommendations. Ten days later the patient was readmitted to the Caromont Regional
Medical Center ED with significant dehydration, acute kidney injury and electrolyte imbalances. Doctors identified that the patient had a deficiency in both vitamin B12 and vitamin D through a routine blood test. The patient’s weight also dropped 10kg from his weight on his first hospital admission weight 3 weeks prior. The patients BMI in the ED at the time of the second admission was 18.9. The patient also admitted to a poor appetite and poor dietary intake over the previous 10 days.

**Discussion**

CD is complex disease with a high hospital readmission rate. Data suggests that approximately one in five patients with IBD will be readmitted within 30 days of discharge and the rates of readmission are twice as great in CD patients compared to Ulcerative Colitis. CD can also be difficult to treat in the hospital because patients are often medically unstable. According to Dr. Richard Curtis (head of Gastroenterology at Newton-Wellesley Hospital in Boston and specialist in IBD), “Crohn’s disease is hard to treat in the hospital, as the main goal is to stabilize the patient. A lot of the work occurs in the outpatient setting when the patient is in remission”. However despite the difficulties in treating a hospitalized CD patient, it is evident from this case study that treating nutrition-related problems in the hospital can play an important role in improving the quality of care for CD patients. In particular nutrition-related problems that entail both macronutrient (protein, energy) and micronutrient (vitamins, minerals, electrolytes) concerns. As demonstrated by the outcomes of the case and research, steps can be taken to improve the quality of nutrition-related care for CD patients in the hospital setting to promote healing and decrease readmission rates.

When the patient was first discharged he had significant improvement in dietary intake, appetite, vitals, skin (severity of sores reduced) and overall felt stronger, likely due to standard operating protocols at the hospital. The hospital had policies (MUST) set in place that were aimed at identifying patients with malnutrition, especially in the older adult population. Physicians and
dietitians were also up to date on identifying protein-energy malnutrition in susceptible patients. The malnutrition alert lead to a dietitian consultation to improve the patient’s nutritional status. As a result of the malnutrition alert the dietitians were able to improve the quality of care during the patient’s hospital stay and after his discharge. Unfortunately, the patient returned not long after discharge in a worse state then when he left. Due to his age and illness severity, hospital nutrition support, nourishment and standard malnutrition protocols were not enough.

As a result of the nature of the disease CD has nutritional implications. Considering the area of the GI tract affected and the type of GI surgery performed can help to identify possible vitamin/mineral deficiencies in CD patients. Also taking into consideration other factors that may put a patient at risk for nutrient deficiencies such a steroid use, oral intake, high stool output and systemic inflammation. Upon readmission it was discovered that the patient had a vitamin B12 and vitamin D deficiency. It was unclear why physicians did not identify this on first admission, however it was assumed that it was due to the critical state of the patient at the time. As evidenced by the patient’s primary affected area of disease (ileum), the patient was at significant risk for deficiency of these vitamins (see appendix, diagram 4). A dietitian identifying these deficiencies when a CD patient first enters the hospital can improve the quality of life for patients. Vitamin B12 can lead to anemia, resulting in significant lethargy and weakness22. Vitamin D deficiency can put one at risk for osteopenia/osteoporosis or fractures, especially when coupled with long-term steroid use25. Steroid use has been found to impair osteoblast function/apoptosis, reduce calcium absorption in the gut and increase renal excretion of calcium in IBD patients26. As the patient complained of weakness, general fatigue, poor appetite and is at risk of bone fractures due to his age34, identification of these deficiencies early on while in the hospital could help to improve the patients’ quality of life and outcomes. Identifying other common deficiencies (such as folate and iron) and/or possible deficiencies based on the area of the GI tract most affected is a way for the dietitian to make a difference in the lives of hospitalized CD patients.
For patients undergoing bowel surgery, in particular bowel resections, considering vitamin/mineral or electrolyte deficiencies is important. The patient received an ileostomy on first admission, which resulted in a non-functioning colon. Upon readmission the patient had high stool output, electrolyte imbalances and was having difficulty following a low sodium diet (complained of weakness). The site in the GI tract for sodium absorption occurs in the colon (see appendix, diagram 4). Reconsidering the inclusion of a low sodium diet here may help to improve patient status. Lastly it is important to consider a patient’s overall severity of disease and current condition when considering risk for nutrient deficiencies.

Despite identification of protein energy malnutrition early on, the patient continued to lose weight. On his second admission the patient had a BMI of 18.9, considered underweight for an older adult (healthy BMI range of 23-29 for older adults). On his second admission the physician indicated that he would not be able to reverse the ileostomy due to the patient’s age and illness severity. As a result improved quality of care will depend on nutrition support and alleviating the patients current malnutrition status. Most hospitals use universal screening tools such as the MUST. The SGA was not used in this case study however it would have been beneficial. Compared to the MUST, the SGA can help to identify a need for more extensive nutritional care as it takes in to account GI symptoms and overall functional capacity. In patients with continued malnutrition and weight loss, nutrition support at home may be beneficial. Research supports the use of enteral nutrition in improving malnutrition status in CD patients. Evidence also suggests that enteral nutrition may induce remission in adults. However most significant results with enteral nutrition have been found in children. As demonstrated by the patient’s inadequate nutrient intake while at home (see appendix, diagram 1), oral intake with supplementation would not be adequate to meet the patient’s nutrient needs. Discussion with the patient before discharge from the hospital about beginning home enteral nutrition would help to improve the patient’s malnutrition status and possibly the disease process. In addition the patient was not referred to an outpatient dietitian upon discharge. Connection with an outpatient dietitian
may help to improve malnutrition status, as diet counseling that encourages increased energy and protein intake has also been found to help maintain remission and improve the clinical course of patients with CD\textsuperscript{46,47}. Overall communication and coordination of care with other providers about patient malnutrition risk can help to improve the care the patients receive in the hospital and upon discharge.

After presentation of this case to the dietitians at Caromont Regional Medical Center, changes were made to the MNT for CD patients. The clinical dietitians agreed with the supporting research to identify deficiencies in Vitamin D, Vitamin B12, Folate and Iron. It has now become a standard protocol to request these labs upon admission of a patient with CD. In an effort to decrease malnutrition rates and decrease readmissions, the clinical dietitians also agreed to improve the communication amongst the department and other providers.

**Future Directions**

Future areas of research to improve the quality of care for CD patients include the use of long-term or supplemental nutrition support. As previously described long term or supplemental nutrition support at home or the hospital may be of benefit for patients to help improve malnutrition and induce remission\textsuperscript{43,44}. However most of the research is in children. More research into the use of enteral nutrition especially in the older adult population is warranted. In particular focusing on the impact of nutrition support on reducing malnutrition rates, vitamin deficiencies and improving the course of disease in CD patients. As more information comes out on how to treat CD, dietitians can play a key role in improving patient outcomes and overall quality of life for CD patients admitted to the hospital.
Appendix

Diagram 1:

<table>
<thead>
<tr>
<th></th>
<th>Patient Nutrient Needs</th>
<th>Boost Supplement (8 fl oz)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Calories</td>
<td>1889 kcals/day (MSJ x 1.3)*</td>
<td>240 kcal</td>
</tr>
<tr>
<td>Protein</td>
<td>71-107 gm/kg (1-1.5 gm/kg)</td>
<td>10 gm</td>
</tr>
<tr>
<td>Fluid</td>
<td>1889 ml/day (1ml/kcal)</td>
<td>237 ml</td>
</tr>
</tbody>
</table>

*Mifflin St. Jeor (MSJ) Equation:
(Men) BMR = 10 x weight(kg) + 6.25 x height(cm) - 5 x age(y) + 5
(Women) BMR = 10 x weight(kg) + 6.25 x height(cm) - 5 x age(y) - 161

Diagram 1: Patient nutrient needs are estimated based on patients weight on admission, severity of illness, and a stable condition. MSJ is used with an activity factor of 1.3 as the patient presented as malnourished and has increased nutrient needs due to his weight loss. Increased protein needs of 1-1.5 gm/kg are recommended for CD patients. As the diagram demonstrates the patient would only be consuming 480-720 kcals and 20-30 gm protein a day with the Boost supplementation. The patient would be unable to meet his nutrient needs at home through poor dietary intake and 2-3 Boost supplements per day.

Diagram 2:

Diagram 2: Malnutrition Universal Screening Tool (MUST)\(^\text{18}\).
Diagram 3:

<table>
<thead>
<tr>
<th>Criteria</th>
<th>Well Nourished</th>
<th>Moderately Malnourished</th>
<th>Severely Malnourished</th>
</tr>
</thead>
<tbody>
<tr>
<td>Unintentional weight loss (last 6 months)</td>
<td>Loss &lt;5%</td>
<td>Loss 5-10%</td>
<td>Loss &gt; 10%</td>
</tr>
<tr>
<td>Dietary intake</td>
<td>Meets needs</td>
<td>70-90% of needs</td>
<td>&lt;70% of needs</td>
</tr>
<tr>
<td>Gastrointestinal symptoms (anorexia, nausea, vomiting, diarrhea, taste change)</td>
<td>No symptoms</td>
<td>Intermittent</td>
<td>Daily</td>
</tr>
<tr>
<td>Functional capacity</td>
<td>Normal</td>
<td>Reduced</td>
<td>Bedridden</td>
</tr>
<tr>
<td>Disease type</td>
<td>Remission</td>
<td>Smoldering</td>
<td>Acute</td>
</tr>
</tbody>
</table>

Diagram 3: Subjective Global Assessment, reprinted 2,3.

Diagram 4:

Diagram 4: Vitamin and mineral absorption 49. Note vitamin D and B12 absorption in the ileum and sodium in the large intestine.
References

(1) Peppercon, Mark, and Sunanda Kane. “Clinical Manifestations, Diagnosis and Prognosis of Crohn's Disease in Adults”. *UpToDate* (2014).


(4) “What are the Treatments for Crohn’s Disease”. Digestive Disease Center at Beth Israel Deaconess Medical Center. Accessed November 11, 2014.


(17) DeLege, Mark. “Nutrition and Dietary Interventions in Adults with Inflammatory Bowel Disease.” *UpToDate* (2014).


(41) Richard Curtis M.D., interview, October 10th 2014.


