Clinical Nutrition Series

Digestive Health Module

Scientific Review, Interpretation and Clinical Considerations

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Proper digestion is critical to maintaining optimal health and well-being. The common saying “it is not what you eat that matters, but what you absorb,” succinctly emphasizes the significance of proper digestive system function for the absorption of essential nutrients, as well as the potential for the absorption of harmful substances. Compromise to any area of the digestive tract can lead to disease and dysfunction both locally in the gastrointestinal (GI) tract and systemically. Additionally, select conditions such as Gastroesophageal Reflux Disease (GERD), Small Intestine Bacterial Overgrowth (SIBO), Irritable Bowel Syndrome (IBS), and Inflammatory Bowel Disease (IBD) are directly correlated with function of the digestive tract. Ironically, the presence of these conditions further impairs digestion and can compound the resulting dysfunction. The health and integrity of the digestive tract is contingent upon a variety of complex factors including overall health, the gut microbiome, immune functions, and various other important factors including the quality of food consumed.
Digestion and Absorption: A Brief Overview

Digestion is a complex process by which ingested food is broken down to its component biomolecules to prepare them to be absorbed, metabolized, and utilized in all cells and tissues in the body. The digestive process begins in the mouth through a combination of chemical and mechanical digestion. Carbohydrate and lipid digestion are commenced in the oral cavity via enzymatic action, as described in Figure 1. The tongue facilitates swallowing by moving food into the esophagus. Then, sequential contractions and relaxation of muscle tissues surrounding the GI tract (or peristalsis) transport the bolus from the esophagus to the stomach, the primary site of protein breakdown into constituent polypeptides. As the ingesta travels from the stomach to the intestines, it interacts with chemicals released by the liver, gallbladder, and pancreas that further facilitate the breakdown and absorption of nutrients including poly- and disaccharides, polypeptides and lipid globules. Any remaining material that was not absorbed or utilized is excreted through the colon. See Figure 1 for a breakdown of the enzymatic digestion of primary nutrients.

The following are the primary functions of the key digestive organs (Byrd-Bredbenner, Moe, Beshgetoor, & Berning, 2012):

- **Oral Cavity**: Mastication breaks the ingesta into smaller particles via mechanical digestion. Salivary glands in the oral cavity secrete saliva, which is comprised of water, mucus, electrolytes and enzymes. Water in saliva moistens the ingesta, while the digestive enzyme amylase initiates the breakdown of carbohydrates. A second digestive enzyme called lingual lipase initiates the breakdown of fats. Mucus in the saliva helps the ingesta particles stick together into a bolus or mass.

- **Esophagus**: When the food bolus enters the esophagus, the peristaltic contractions propel the bolus towards the stomach. Regurgitation is prevented by the upper and lower esophageal sphincters, the latter being a valve between the esophagus and the stomach that closes after the bolus passes to prevent retrograde movement.

- **Stomach**: The stomach prepares the bolus for absorption using a combination of mechanical and chemical digestion. It grinds and mixes the food and exposes the partially digested particles to secretions of gastric juices, hormones and enzymes, including:
  
  - **Mucus**: Contains glycoproteins and bicarbonate. The mucus lubricates the food and protects the gastric lining from erosion by HCl and autodigestion.
  - **Intrinsic factor**: A glycoprotein essential for the absorption of vitamin B12 in the ileum.
  - **Hydrochloric acid (HCl)**: Assists with protein digestion, destruction of microorganisms, denaturation of macromolecules and activation of intrinsic factor. Bacteria are present but sparse in the stomach due to the acidic environment.
  - **Gastrin**: A hormone that stimulates gastric secretions of HCl and pepsinogen by the gastric parietal and chief cells, respectively. It also stimulates gastric peristalsis and encourages cellular growth in the stomach and intestines. As HCl is secreted into the lumen, acidity rises and gastrin secretions are correspondingly inhibited in a negative feedback loop.
o Pepsin: A protease enzyme secreted first in its inactive form as pepsinogen and converted to its active form by HCl. Pepsin is a proteolytic enzyme that degrades proteins into smaller peptide molecules.

o Gastric Lipase: An enzyme secreted by chief cells and contributes to the breakdown of triglycerides.

o Ghrelin: Secreted primarily in the stomach, this hormone is one of the principle hormones that stimulate hunger. When the stomach is empty before a meal, ghrelin is secreted and plasma concentrations rise. As the stomach stretches after a meal, secretion stops.

In the stomach, food becomes a semi liquid mix of acid and food known as chyme. Peristaltic contractions continue to propel the food toward the gastric pylorus where it then enters the duodenum through the pyloric sphincter.

- **Small intestine:** The small intestine is the major site of chemical digestion and nutrient absorption. It has a surface area of about 300 square meters, due to the various folds and microfolds, which make up the microscopic brush border. Most of the enzymes in the small intestine are secreted by mucosal cells in the brush border. As acidic chyme enters the duodenum from the stomach, hormonal action triggers alkaline secretions from the pancreas that begin to raise the pH. The sphincter of Oddi surrounds the pancreatic and bile ducts as they enter the duodenum, and regulates the release of these secretions into the small intestine. The acidic environment of the duodenum is inhospitable to the growth of bacteria and fungi, however, as alkalinity increases along the small intestine, bacterial populations increase in density. The terminal ileum, for example, hosts a bacterial population of approximately $10^4$–$10^8$ colony forming units (CFU)/mg intestinal content (Gerritsen, Smidt, Rijkers, & de Vos, 2011), a density approaching that of the colon (Ahmed et al., 2007). Secretions from the small intestine, pancreas, liver and gall bladder also contribute to the final breakdown of biomolecules that can be absorbed at the brush border of the small intestine.

**The intestinal enzymes include:**

- **Enteropeptidase** (formerly enterokinase): Secretion is stimulated by cholecystokinin (CCK) and secretin. Enteropeptidase activates trypsinogen, forming trypsin for the digestion of proteins.

- **Disaccharidases** (maltase, lactase, and sucrase): Convert disaccharides (maltose, lactose, and sucrose) into monosaccharides (glucose, fructose, and galactose)

- **Intestinal hormones include:**
  - **Secretin:** Controls acidity and secretion of pancreatic enzymes
  - **Cholecystokinin (CCK):** Triggers release of bile in the presence of fat.
  - **Gastric inhibitory peptide (GIP):** A hormone secreted by cells in the intestinal mucosa that blocks the secretion of HCl and increases insulin secretions.
  - **Motilin:** Stimulates peristalsis in the small intestines.
- **Peptide YY**: Slows the movement of food through the digestive tract, decreases appetite and increases satiety after eating.
- **Glucagon-like peptide 1 (GLP-1)**: Secreted in response to food, this hormone will enhance the release of insulin.

- **Pancreas**: The pancreas is one of the major producers of the hormone somatostatin, which inhibits the secretion of other hormones including Glucagon-like peptide 1(GLP-1), insulin, and glucagon. It is also responsible for the release of enzymes that are critical for digestion of macromolecules including protein, carbohydrates, and fats such as:
  - **Pancreatic lipase and colipase**: These are the primary lipid digesting enzymes. They digest fats into free fatty acids and B-monoglycerides.
  - **Trypsin and chymotrypsin**: These proteolitic enzymes are activated by enterokinase and facilitate the breakdown of proteins into smaller peptides and then into single amino acids.
  - **Pancreatic amylase**: This enzyme hydrolyzes large carbohydrate molecules into smaller simple sugars.
  - **Sodium bicarbonate**: Synthesized in the pancreas and released into the small intestine, in response to secretin (produced by the small intestines). Sodium bicarbonate acts to neutralize the acidity of the chyme as it enters the duodenum and prevents damage to the mucosal lining of the small intestine.

- **Liver and gallbladder**: Bile is synthesized in the liver and stored in the gallbladder. In the presence of fat it is released into the small intestines to facilitate the digestion and absorption of lipids.

- **Large intestine**: Primary functions of the large intestine include the absorption of sodium, potassium, and water. The colon hosts approximately $10^{10}–10^{12}$ CFU/mg intestinal content (Gerritsen et al., 2011). These intestinal microbes promote bacterial fermentation, the formation and excretion of feces, and synthesis of select vitamins and short chain fatty acids. Mucus is secreted by the mucosa to help bind the feces together and to protect the intestinal lining from damage and bacterial activity. Between the small and large intestines is the ileocecal valve. This valve prevents retrograde flow of material from the large intestines back into the small intestines. The internal anal sphincter works in concert with the external anal sphincter to assist in the expulsion of the feces in the final step of the digestive process.

In addition to its digestive and absorptive capacities, the GI system also plays a significant role in the modulation of the immune system and inflammatory responses, discussed in detail below. Optimal structural, functional, microbial and biochemical function promote health on many levels, including digestive, immunological and mental health. On the other hand, dysfunction at any stage of the digestive process may lead to disease.

**Clinical Focus: Gastroesophageal Reflux Disease, Small Intestine Bacterial Overgrowth, Irritable Bowel Syndrome, and Inflammatory Bowel Diseases**

Among the most common disorders of the GI tract include gastroesophageal reflux disease (GERD), small intestine bacterial overgrowth (SIBO), irritable bowel syndrome (IBS) and...
inflammatory bowel diseases (IBDs) including ulcerative colitis (UC) and Crohn’s disease (CD). Each of these disorders can have profound effects on quality of life, but interventions that target various modifiable factors including diet, the gut microbiome, immune function, and stress may provide symptom relief and healing.

To ensure a clear understanding of the assessment and treatment strategies outlined, the following are definitions of the selected GI disorders:

**Gastroesophageal Reflux Disease (GERD):** Gastroesophageal reflux disease is a condition in which the stomach contents leak backwards from the stomach into the esophagus. It is commonly referred to as heartburn or acid indigestion. GERD can irritate the esophagus and cause heartburn and other symptoms including a sensation of burning in the upper chest, an acidic taste in the mouth, dry cough, belching, and difficulty swallowing. Symptoms most often occur postprandially and may be triggered by certain foods including alcohol, spicy, fatty or acidic foods. Primary risks are Barrett's Esophagus and esophageal cancer, although GERD can also have an effect on overall digestive health and nutritional status. GERD symptoms of heartburn or regurgitation are experienced by approximately 15-20% of the population weekly, and 10% daily (Lipski, 2012).

**Small Intestine Bacterial Overgrowth (SIBO):** Small intestine bacterial overgrowth occurs when bacteria proliferate in the small intestine, or move up from the large intestine (Lipski, 2012). This occurs most frequently due to suppressed production of HCl in the stomach or altered pancreatic enzyme function (Lipski, 2012). Common predisposing factors include gut motility disorders, structural abnormalities and blockages, systemic diseases such as celiac disease, pancreatic exocrine insufficiency as well as the use of proton pump inhibitors (Siniewicz-Luzenczyk, Bik-Gawin, Zeman, & Bak-Romaniszyn, 2015; Chedid et al., 2014). Patients with SIBO experience excess gas production when bacteria in the small intestine ferment ingested carbohydrates (Ghoshal & Srivastava, 2014). As gas accumulates, bloating and flatulence can occur, leading to abdominal pain and discomfort. Other symptoms and manifestations may include diarrhea, constipation, fatigue, steatorrhea (Lipski, 2012), anemia, interstitial cystitis, restless leg syndrome and rosacea (Chedid et al., 2014). These undesirable bacteria in the small intestine release toxic byproducts and the provoke proinflammatory cytokines (specifically IL-8) as permeability between epithelial tight junctions increases (Ghoshal & Srivastava, 2014). Assessments for SIBO include lactulose or glucose breath testing, as well as direct culture of jejunal aspirates. As discussed above, the terminal ileum hosts approximately $10^4$–$10^5$ CFU/mg intestinal content. The condition is diagnosed via breath testing or when the number of non-pathogenic bacteria in the jejunum reaches $10^5$ CFU/mL of proximal jejunal fluid (Chedid et al., 2014).

- Prevalence for SIBO in the general public is unknown, however SIBO is widely seen in gastroenterology practices and approximately 56% of patients with IBS also have SIBO (Chedid et al., 2014), particularly those patients with diarrhea type IBS (Ghoshal & Srivastava, 2014). This high correlation points to the strong association that exists between these two conditions.
Irritable Bowel Syndrome (IBS): IBS is a functional disorder characterized by a group of symptoms including gas, bloating, abdominal pain and abnormal bowel habits (Lipski, 2012). Generally, patients with IBS experience altered gut motility, visceral hypersensitivity and abnormal brain-gut communication (Ghoshal & Srivastava, 2014). The condition can be debilitating, and while there is no single cause, symptoms may be triggered by stress or from infections, food sensitivities, environmental sensitivities, leaky gut, serotonin imbalance and more (Lipski, 2012). There are several manifestations of IBS including diarrhea prevalent (IBS-D), constipation prevalent (IBS-C) and alternating. Some symptoms of IBS may be similar to those of IBD, but unlike IBD, GI inflammation is not observed in IBS patients via endoscopic methods. Instead, the Rome III criteria outlined below are used to diagnose IBS (Longstreth et al., 2006):

Recurrent abdominal pain or discomfort** at least 3 days/month in the last 3 months associated with two or more of the following:
1. Improvement with defecation
2. Onset associated with a change in frequency of stool
3. Onset associated with a change in form (appearance) of stool

* Criterion fulfilled for the last 3 months with symptom onset and at least 3 months prior to diagnosis
** “Discomfort” means an uncomfortable sensation not described as pain

Irritable bowel syndrome prevalence varies worldwide. A 2016 review estimates that 8% of North Americans experience IBS and that global prevalence ranges from 1.1% in France to 35.5% in Mexico (Sperber et al., 2016). IBS is also thought to be one of the most common symptom complexes seen in primary care (Locke, Zinsmeister, Talley, Fett, & Melton, 2000).

Inflammatory Bowel Disease (IBD): Inflammatory bowel disease is a broad term that describes conditions with chronic or recurring immune response and inflammation of the gastrointestinal tract, including ulcerative colitis (UC), Crohn’s disease (CD), microscopic colitis and ischemic colitis (Danese & Fiocchi, 2006). IBD conditions have a strong genetic component (Rivas et al., 2011) and share may symptoms with IBS such as abdominal pain, bloody diarrhea and cramping among others (Lipski, 2012). However, IBD is a chronic relapsing, remitting disease with associated intestinal inflammation that can be observed via endoscopy or biopsy. The inflammatory bowel diseases can have consequences anywhere along the GI tract from mouth to rectum, and malnutrition/malabsorption are common repercussions of the condition (Lipski, 2012). While IBD is not as prevalent as IBS or GERD, the incidence is increasing worldwide (M’Koma, 2013) and its impact on health and quality of life can be profound. Strict nutritional and medical management of IBD type diseases is required.

Ulcerative Colitis (UC) and Crohn’s Disease (CD) are forms of IBD with distinct pathogenesis, signs, symptoms, and even distinct gut microbial compositions (Fava & Danese, 2011). Most notably, in CD inflammation affects the entire digestive tract, whereas in UC only the superficial layers of the intestinal mucosa in the large intestine are affected (Cho, 2008). Gut dysbiosis appears to plays a significant role in the pathogenesis of IBD.
(Fava & Danese, 2011) particularly in CD as evidenced by the fact that antibiotic therapy will often improve associated symptoms (Greenberg, 2004). Both UC and CD are considered autoimmune conditions, characterized by an abnormal response of the body’s immune system (Centers for Disease Control and Prevention, 2014) and increased permeability of the epithelial lining of the gut. The latter, coupled with reduced levels of protective secretory IgA, can impair microbial clearance and increase translocation of microbes from the gut lumen (Fava & Danese, 2011). This activates immune cells, leading to chronic inflammation (Brown, DeCoffe, Molcan, & Gibson, 2012). Many causes have been considered, however, it appears that onset in susceptible individuals is most likely triggered by food intolerance, infection, antigens in the mucosal lining and/or inflammation in the gut causing reduced blood supply to epithelial tissues (Lipski, 2012).

Associated Conditions
IBD, GERD, SIBO and IBS have been associated with various conditions including:

- **Leaky Gut Syndrome or Increased Intestinal Permeability:** One of the key roles of the epithelial lining of the intestine is to prevent passage of undesirable substances from the lumen into the blood stream. This protective barrier may become compromised as a result of inflammation and/or delayed hypersensitivity reactions, allowing large food particles and non-nutritive substances to pass into the blood. When the gastrointestinal mucosal lining is irritated, the tight junctions between cells (called desmosomes) loosen in a condition referred to as increased intestinal permeability or leaky gut. The intestine is then unable to filter out larger particles, such as bacteria, toxins and undigested food, which pass into the blood stream and activate antibody and cytokine production (Lipski, 2012). As a result of these immune responses inflammation can occur throughout the body. Leaky gut has been associated with a variety of conditions including but not limited to: Crohn’s disease (Hollander, 1999), irritable bowel syndrome (Camilleri & Gorman, 2007), depression (Maes, Kubera, & Leunis, 2008), chronic fatigue syndrome (Maes, Mihaylova, & Leunis, 2007) and various autoimmune diseases (Fasano, 2012; Mowat, 2003; Visser, Rosing, Sapone, Lammers, & Fasano, 2009).

- **Obesity:** An increase in adiposity has been associated with low-grade chronic inflammation throughout the body (Goran & Alderete, 2014). Overweight (BMI, 25-30 kg/m²) and obesity (BMI, > 30 kg/m²) are commonly the result of excess energy intake, however ongoing research suggests that the gut microbiota may also play a significant role in dictating energy metabolism and response to nutrients (Delzenne, Neyrinck & Cani, 2011). In animal studies, changes in gut bacteria have been shown to impact glucose handling, resulting in weight gain, inflammation and oxidative stress, which all contribute to increased intestinal permeability (Delzenne et al., 2011).
  - Being overweight and obese may specifically increase the likelihood of developing GERD (Hampel, Abraham, & El-Serag, 2005) but it is unclear whether it is a precipitating or underlying cause. A potential mechanism may be that obesity increases intragastric pressure. While the precise association and mechanism remains unclear, weight loss may reduce GERD symptoms, although conflicting studies exist in the literature (Festi et al., 2009; Fraser-Moodie et al., 1999). Nandurkar and colleagues (2004) reported that BMI may be associated with GERD.
Depression: Depression is an affective disorder impacting about 20% of the world’s population (Jenkins, Nguyen, Polglaze, & Bertrand, 2016). IBS has been associated with comorbid depressive and anxiety disorders. In fact, the use of tricyclic antidepressants has been shown to improve IBS symptoms (Rahimi, Nikfar, Rezaie, & Abdollahi, 2009). Recent research has begun to link the pathogenesis of depression to the human microbiome as well (Perlmutter & Loberg, 2015; Jenkins et al., 2016). Interestingly, the gut microbiota may influence behavior by impacting serotonin synthesis and uptake of tryptophan, the amino acid precursor to serotonin. With approximately 90% of serotonin being produced in the gut lining, the potential impact of the gut and microbiome on mood is substantial. In IBS in particular, the balance of gut bacteria has been shown to affect both gut and brain serotonin levels (Jenkins et al., 2016). Additionally, serotonin production may be up-regulated in enterochromaffin cells by bacterial byproducts such as short chain fatty acids (Jenkins et al., 2016).

Esophageal cancer: Long-term complications of GERD include Barrett’s Esophagus, a condition in which the esophageal lining becomes similar to the intestinal lining (Moayyedi & Talley, 2006). A 2011 study reported that severity and number of GERD symptoms is inversely associated with adenocarcinoma of the esophagus, but that longevity of symptoms (over 10 years) is positively associated with risk (Nason et al., 2011).

Colon cancer: In UC and CD, prolonged disease duration has been associated with an increased risk for colon cancer (Nguyen et al., 2014; Bernstein, Blanchard, Kliewer & Wajda, 2001; M’Koma, 2013). The risk appears to be influenced by the severity of inflammation within the mucosa (Rutters et al., 2004). With that in mind, therapies to reduce mucosal inflammation may help mitigate risk.

Diverticulitis: The presence of diverticula, or small abnormal pouches, that form in the intestinal lining of the GI denote a condition known as diverticulosis. Diverticulitis occurs
when these diverticula become inflamed or infected. A form of diverticulitis known as SCAD or ‘Segmental colitis associated with diverticulosis’ may occur with inflammatory bowel diseases and infectious colitis (Freeman, 2009). Patients with SCAD typically recover without recurrence and without evidence of lasting inflammatory damage (Freeman, 2009).

• **Non-Alcoholic Fatty Liver Disease (NAFLD):** NAFLD is a condition characterized by fat accumulation in the liver associated with insulin resistance and obesity. Often, this condition is benign, but more severe forms can lead to non-alcoholic steatohepatitis (NASH), liver scarring and liver failure. Recent studies have implicated SIBO and gut dysbiosis in the pathogenesis of NAFLD (Ferolla, Armiliato, Couto, & Ferrari, 2014).

• **Nutritional deficiencies:** Nutritional deficiencies are a common consequence of GI disorders including IBD. Malnutrition and malabsorption can lead to significant complications particularly in the pediatric population, including impaired growth and development (Dos Santos, Silva, & Santana, 2014; Hartman, Eliakim, & Shamir, 2009). In IBD, malnutrition is most commonly caused by symptom-related reduced food intake and inflammation-induced malabsorption during active IBD and in remission (Hartman et al., 2009). In addition to protein malnutrition, micronutrient deficiencies can run the gamut of vitamins and electrolytes depending on severity (Goh & O’Morain, 2003). (Please see the handout “Assessing Nutritional Deficiencies” for more information regarding common nutrient deficiencies and assessment strategies).

• **Low bone mineral density:** Osteoporosis and osteopenia are both prevalent comorbid conditions among patients with Crohn’s disease and ulcerative colitis. Nguyen and colleagues estimate that 18-42% of adults with IBD have osteoporosis and 22-77% have osteopenia (2014). While IBD itself may only modestly impact bone mineral density, corticosteroid use has been more strongly associated with osteoporosis risk (Nguyen et al., 2014). Vitamin D is known to play a key role in bone mineralization pathways and is also a common deficiency related to IBD. Through effects on the intestinal barrier and immune cells, vitamin D may play a key role in IBD therapy (Garg, Lubel, Sparrow, Holt, & Gibson, 2012).

**Gut Microbiome and Immune System Connection**

The GI tract contains approximately $10^{14}$ microorganisms from over 500 species that have important defensive and metabolic functions (Klein, Cohn, & Alpers, 2006). It is widely cited that there are ten times more bacterial cells than human cells in the human body, however, recent preliminary research suggests that the ratio could be closer to one to one (Sender, Fuchs, & Milo, 2016). Regardless of the quantity of bacterial cells, digestive health relies heavily on the integrity and action of the gut microbiome and its influence on systemic metabolism and overall health. Microbial density increases along the GI tract with highest density in the large intestine. Different microbial communities thrive in different segments of the GI, however, the subtleties of how this diversity varies, (i.e. who lives where) is still being elucidated (Gerritsen et al., 2011). The human microbiota is not static, but can change as a result of age, diet, disease, environmental exposure, stress and other factors. The community of microbes in the human gut have a reciprocal relationship with the human immune system; as gut microbes process nutrients and promote the development and
function of the immune system, the immune system in turn shapes the landscape of the microbiome (Kato, Kawamoto, Maruya, & Fagarasan, 2014).

The immune system has evolved as a mechanism to distinguish “self” from “non-self.” This means that the immune system can discriminate between invading pathogenic microorganisms and commensal gut microbes and decide when to respond and when not to. The normal gut microbiota is composed of both beneficial bacteria and potentially harmful bacteria. When the gut microbiota is out of balance, immune dysfunction may occur. Pathogenic microbes can produce toxins that suppress the immune system, and many intestinal and non-GI immune-related disorders (UC, CD, IBS, depression, anxiety, multiple sclerosis, diabetes and obesity) may be caused by or aggravated by dysbiosis. For example, the pathogenic bacteria *Heliobacter pylori* (*H. pylori*) is known to contribute to the development of duodenal and stomach ulcers. *H. pylori* infections cause an inflammatory immune response and altered stomach acid production (Kuipers, 1997; Lipski, 2012). As a result, GERD and leaky gut are common impacts of *H. pylori* infections, as are IBD, IBS, bacterial overgrowth and non-GI autoimmune disorders like type 1 diabetes and rheumatoid arthritis (Lipski, 2012; Maranduba et al., 2015). Treatment of these immune-related digestive conditions aims to reestablish homeostasis of the gut microbiota to promote healthy immunologic responses to pathogens and commensal bacteria (Maranduba et al., 2015).

**Key factors in Gut-Associated Immune Function**

The immune response consists of both innate and adaptive responses. In the GI tract, the innate immune system is composed of Paneth cells and goblet cells that have mostly nonspecific defensive and inflammatory functions, as well as dendritic cells that process and present foreign substances (antigens) to the cells of the adaptive immune system. The adaptive immune system consists of T and B cells that respond in an antigen-specific manner (Klein et al., 2006). This adaptive response is secondary to the innate immune response. The adaptive response of T cells can be pro-inflammatory (e.g. T helper 1 (Th1) or T helper 2 (Th2)), or anti-inflammatory depending upon the context of antigen presentation. In turn, these responses may direct the production of antigen specific antibodies by B cells. A brief discussion of these tissues and immune cells follows, as they relate to the gastrointestinal tract and microbiome.

There is significant cross-talk between host bowel microbiota and the major part of the body’s immune tissues in the GI tract, known as gut-associated lymphoid tissue (GALT) and mucosal-associated lymphoid tissue (MALT). It is estimated that 70% of the body’s lymphoid cells are in the gut (Forchielli & Walker, 2005; Lipski 2012). It follows that the health of these immune tissues in the gut can significantly impact our own health and resilience. Secretory IgA (sIgA) is a group of antibodies in the MALT that communicates the presence of foreign matter in the gut. This is primary intestinal immunoglobulin that protects the intestinal epithelial tissue from enteric toxins and pathogenic microorganisms by preventing bacterial adherence to the GI mucosa and blocking access to epithelial receptors (Brandtzaeg, 2010; Mantis et al., 2011). Secretory IgA is produced by activated B-cell proteins in the mucosa, where it forms immune complexes with microbes and allergens. These immune complexes then stimulate cytokine activity, and the resultant inflammatory process removes the antigens from the body (Lipski, 2012). SlgA has also
been shown to facilitate gut homeostasis by influencing the composition of the microbiota and suppressing bacterial virulence factors (Mantis, Rol, & Corthésy, 2011). Low IgA levels generally result from maturation deficits in B cells. Those with IgA deficits are often asymptomatic, but have a tendency to develop inflammatory gastrointestinal disorders such as celiac disease and allergies, as well as respiratory infections (Mantis et al., 2011). Although we do not completely understand the complexities of the adaptive sIgA response, this suggests that optimal sIgA levels may help to prevent detrimental effects of fluctuations in commensal bacteria.

Another important aspect of gut immune function relates to the balance of specific types of T helper cells. Th1 cells primarily work to activate macrophages at sites of inflammation, but over-activity of the Th1 cells against autoantigens can lead to autoimmunity and further damage (Jäger & Kuchroo, 2010). While Th1 cells primarily deal with eradication of intracellular pathogens, Th2 cells are responsible for ridding the body of extracellular organisms like parasites (Jäger & Kuchroo, 2010). Th2 cells are also involved in inflammation and IgE production in allergic reactions and asthma, and uncontrolled activity of Th2 can contribute to allergies (Jäger & Kuchroo, 2010). In addition, interleukins (cytokines) produced by other types of T helper cells such as Th17 and Th9 have been implicated in autoimmunity, while regulatory T cells (Tregs) control inflammation and self-tolerance (Underhill & Iliev, 2014; Jäger & Kuchroo, 2010). Treg cells also contribute to microbial homeostasis in the gut, and their failure can lead to colitis as they react to commensal bacteria in the gut (Hall et al., 2008). T cell function is influenced by toll-like receptor (TLR) proteins expressed on the surfaces of sentinel cells like macrophages and epithelial cells in the intestine (Hall et al., 2008). When TLRs identify microbial ligands produced by pathogenic and commensal microorganisms, they initiate inflammation pathways in adaptive immunity (Rakoff-Nahoum, Paglino, Eslami-Varzaneh, Edberg, & Medzhitov, 2004). Studies have shown that TLR signaling in the intestine helps to maintain intestinal microbial balance, thereby impacting the pathogenesis of food allergies and contributing to intestinal tissue repair (Rakoff-Nahoum et al., 2004; Hall et al., 2008). Dysregulation of these immune factors in the gut can significantly impact the integrity of intestinal immune responses and subsequent disorders of the GI.

Still another key factor in the interaction between bowel microbiota and the immune system are the epithelial tissue tight junctions (TJs). Intestinal epithelial TJs mediate intestinal diffusion and permeability, and are regulated by a protein known as zonulin (Fasano, 2008), although zonulin itself is a controversial marker of intestinal permeability. (For more on testing for intestinal permeability, please see “Intestinal permeability and leaky gut syndrome testing” below). Research suggests that abnormal intestinal permeability precedes the onset of the two common IBD disorders, ulcerative colitis (UC) and Crohn’s disease (CD) (Schmitz et al., 1999; Yacyshyn & Meddings, 1995). Studies have also shown increased intestinal permeability in other diseases including Type 1 diabetes (Carratù et al., 1999) and that up to 50 % of Type 1 diabetics have high levels of zonulin (Sapone et al., 2006).
Physiological and Biochemical Imbalances and Associated Health Conditions

The balance and interactions between the gut microbiome and GALT can be disrupted by a variety of influences. Two important initiating factors are intestinal viruses and antibiotic exposure, which can increase the risk of developing Crohn’s disease (CD) (Ungaro et al. 2014). Evidence suggests that 25-30% of patients with IBS develop the condition after an enteral infection (Neal, Barker, & Spiller, 2002). Imbalanced intestinal microbiota exerts a significant effect on the host immune function both in the GI tract and elsewhere in the body (Yeoh, Burton, Suppiah, Reid, & Stebbings, 2013). These effects are further influenced by genetic predisposition or susceptibility to a range of disorders including GI diseases, allergies, inflammation, and dermatological disorders. In addition, elevated stress levels and a poor diet high in sugars, allergenic foods, and/or processed foods may impact one’s ability to stave off infection (Yeoh et al., 2013).

Gut dysbiosis, microbial imbalances and subsequent GI disorders appear to have their roots at birth and in early development when the sterile infant gut begins to be colonized by bacteria. The composition of the infant microbiome may have lasting effects on human metabolism and immune function (Biasucci et al., 2010). The infant’s initial exposures to microorganisms occur in the vaginal canal and through contact with its mother. Infants born vaginally have higher numbers of *Bifidobacterium* and *Bacteroides* compared with infants born via cesarean section (Biasucci et al., 2010). With delivery by a C section, the skin microbiota of the hospital staff may be a primary contributor to initial colonization. A second important factor in inoculation is whether a baby is breastfed or formula fed. Breastfeeding confers important components to build a healthy microbiome such as unique human milk oligosaccharides and maternal antibodies. Infant exposure to these constituents of breast milk may impact childhood risk of immune, digestive and metabolic conditions such as allergy, infection and diarrhea, and chronic digestive and inflammatory conditions later in life (Azad et al., 2013). Additionally, early introduction of solid foods and common allergens creates potential for food intolerance reactions. Such reactions can manifest as conditions such as GERD, ear infections, asthma, or skin rashes (Tsabouri, Priftis, Chaliasos, & Siamopoulos, 2014).

In adolescents and adults, a combination of additional factors emerges that determine the susceptibility to GI symptoms or disorders. A health history from birth can elucidate potential allergies, food intolerances, immune-related symptoms or disorders, antibiotic exposure, family history, poor diet, and stress. These factors all impact risk of developing GI disorders and may contribute to their onset and/or progression. Overt or subclinical nutritional deficiencies should be considered depending on the extent of compromised digestion/absorption and the length of time that GI symptoms and disruption have been present (Maudgal, Ang, Patel, Bland, & Maxwell, 1985). This is perhaps best illustrated in the elderly. Chronic lifelong GI symptoms often result in worsening nutritional status over time, thereby further exacerbating GI disorders such as IBD (Ha & Katz, 2014). Nutritional deficiencies may also compound other health issues, such as a compromised nervous system, and contribute to depression, memory loss, fatigue and other symptoms or disorders (Martone et al., 2013; Gillette-Guyonet, Secher & Vellas, 2013). Finally, ongoing and uncontrolled GI symptoms may also increase risks for esophageal and colon cancer (Moayyedi & Talley, 2006; Nguyen et al., 2014; Bernstein et al., 2001; M’Koma, 2013).
Interplay of Important Factors:
Diet, Stress, the Microbiome, Intestinal Permeability/Leaky Gut, Obesity, and Inflammation

Diet and stress have significant and direct influences on the gut microbiome, and all three of these factors exert effects on intestinal permeability, obesity and inflammation (Konturek, Brzozowski, & Konturek, 2011; Lopez-Legarea, Fuller, Zulet, Martinez, & Caterson, 2014; Cox, West, & Cripps, 2015; Teixeira, Collado, Ferreira, Bressan, & Maria do Carmo, 2012). Since these factors are inextricably linked, they should be treated simultaneously for optimal results.

Stress (physical or emotional) is an overlying factor that can adversely affect gut motility, GI secretions, mucosal blood flow and repair, bowel microbiota, and visceral perception (Konturek et al. 2011). Most GI patients not only report the presence of significant stresses, but they are also aware that stresses significantly worsen their symptoms (Lackner, Gudleski, DiMuro, Keefer, & Brenner, 2013). Research also suggests that there is bidirectional signaling between the brain and the gut, so that stress will affect not only gut microbiota and other factors, but the gut microbiome may affect behavior and related brain systems (Mayer, Knight, Mazmanian, Cryan, & Tillisch, 2014).

There is emerging evidence that increased intestinal permeability may be a key factor linking diet and dysbiosis to obesity and inflammation (Teixeira et al., 2012, Cox et al., 2015). Potential harmful factors include endotoxemia, food antigen absorption, nutritional deficiency, and direct effects from dietary components such as sugars and certain fatty acids (Allin, Nielsen, & Pedersen, 2015). On the other hand, immunomodulatory nutrients such as amino acids (eg. glutamine), fatty acids (eg. omega 3 fatty acids and conjugated linoleic acid) and probiotics/prebiotics may restore normal intestinal barrier function (Andrade et al., 2015).

The gut microbiota is dynamic and responsive to a variety of environmental factors including diet and biological changes related to aging. Emerging and compelling data suggests that gut microbiota can have profound effects on human health. For example, coupled with low-grade inflammation and excessive energy intake, microbial balance appears to have a significant impact on obesity risk (Luoto, Collado, Salminen, & Isolauri, 2013). Specifically, Firmicutes and Bacteroidetes are the two predominant phyla of bacteria in the gut. The ratio of one to the other impacts inflammation in the body (Verdam et al., 2013). In fact, it has been demonstrated that an imbalanced gut with more Firmicutes than Bacteroidetes is correlated with higher rates of obesity and inflammation, likely as a result of increasing energy harvest and storage (Jumptertz et al., 2011; Perlmutter & Loberg, 2015). Additionally, a 2015 study revealed that Firmicutes bacteria alter human gene expression, increasing risk of inflammatory diseases, obesity, cardiovascular disease and diabetes (Holscher et al., 2015). These types of studies provide evidence that the human microbiome plays an active and significant role in the pathogenesis of chronic inflammatory conditions throughout the life cycle.

Emerging Science
Recent science has demonstrated that the gut microbiome and its interactions with gut and systemic immune system, have far ranging effects on GI health, auto-immune disorders,
allergies, metabolism, and overall health and well-being (Kostic et al., 2015; Nieuwdorp, Gilijamse, Pai, & Kaplan, 2014; Tsabouri et al., 2014). Advances in DNA sequencing have created new opportunities for researchers to explore the role of the human genome in health and disease. The National Human Genome Research Institute’s Centers for Common Disease Genomics (CCDG) is pioneering research to explore the impact of the genome on common cardiovascular, metabolic and neuropsychiatric diseases. Future research may investigate the genome’s role in other disorders including inflammatory and autoimmune conditions (NIH, 2016). In addition, the Human Microbiome Project will create the Inflammatory Bowel Disease Multi’Omics Database (IBDMDB) in an effort to better understand how the gut microbial ecosystem changes over the course of IBD and improve diagnosis and therapy for the disease (Integrative Human Microbiome Project, 2014). Ongoing research in metagenomic sequencing is, therefore, likely to have a significant impact on the assessment and treatment of chronic GI disorders such as IBD as well as respiratory conditions, auto-immune diseases, atopic diseases, cancer and metabolic diseases such as obesity and Type 2 diabetes (NIH, 2016; Integrative Human Microbiome Project, 2014). Initial research is also suggesting bi-directional influences in the gut – brain connection, suggesting that the gut microbiome has an influence in depression, anxiety and possibly other neuropsychological conditions (Mayer et al., 2014; Pärtty, Kalliomäki, Wacklin, Salminen, & Isolauri, 2015).

There is an emerging understanding that many chronic diseases are associated with altered bowel microbiota balance, whether increased presence of potentially pathogenic bacteria or inadequate amounts or diversity of healthy bacteria. For example, a recent landmark study prospectively followed infants at high risk for developing Type 1 diabetes. These researchers from Harvard and MIT found that those infants who developed diabetes had a decrease in microbial diversity and an increase in potentially pathogenic bacteria prior to the diagnosis of Type 1 diabetes (Kostic et al., 2015). Although additional research is necessary to further understand potential mechanisms involved and other contributing factors, this is one of the most compelling studies to date connecting the emerging science of bowel microbiota, immune function, intestinal permeability, genetics, diet and other factors to the development of auto-immune disease.

Disruption of Gut-Immune Cross Talk from Modern Lifestyle
With our increasingly fast-paced and high stress lifestyle, it can often be challenging to eat healthfully, exercise, and manage the stresses of modern society. The resulting negative health effects may be further amplified by decreasing microbial diversity from soil and food. Industrial food production and exposure to antibiotics and pesticides, the clinical use of antibiotics and other medications, increasing exposure to environmental toxins, and chronic stress may all impact human microbial diversity (Reganold et al., 2010; Konturek et al., 2011). Additionally, a recent study of industrial food additives discusses the possibility that food additives may increase intestinal permeability (Lerner & Matthias, 2015), which could further complicate concerns related to diet as larger food and non-food molecules are allowed to pass through the tight junctions. Specific factors of concern include glucose, salt, emulsifiers (Chassaing et al., 2015), organic solvents, gluten, and nanoparticles. Together, these factors may contribute to increased levels of immune-related disorders, increasing auto-immune and inflammatory diseases, and increasing levels of other chronic disorders such as fibromyalgia (Fasano, 2012; Visser, Rozing, Sapone, Lammers, & Fasano, 2009).
While the complexity and varied nature of these contributing factors pose a challenge to patients and practitioners, a comprehensive and integrative approach to assessment and management can be beneficial. A key goal in nutrition therapy is to help patients engage in health promoting activities that address their specific GI symptoms and disorders.

II. Core Assessment

Introduction
The initial evaluation of GI disorders begins with an accurate clinical assessment that includes:

- Collecting a comprehensive health and dietary history
- Performing a GI-focused physical exam
- Identifying signs and symptoms the patient is experiencing
- Considering applicable results of any prior testing and diagnoses that have been made by another physician or healthcare provider
- Formulating a diagnosis

GI-Focused Health History
A general, GI focused health history should inquire about personal, genetic, familial, medical, dietary, psychosocial and lifestyle factors that may contribute to the patient’s presentation. The history should include inquiry into the following:

- **Genetic susceptibility**: Family members of a person suffering from IBS are two to three times more likely to experience symptoms themselves (Saito, 2011). Twin studies have also suggested a genetic component to IBS risk (Bengtson, Rønning, Vatn, & Harris, 2006) and a genetic link has also been observed in IBD (Dos Santos et al., 2014). Given the heredity of select GI disorders, the clinician should therefore inquire about family history of:
  - GI disorders such as GERD, SIBO, IBS, IBD, celiac disease and others
  - Dietary or environmental allergies (Yeoh et al., 2013)
  - Auto-immune disorders such as RA, SLE or other immune and auto-immune disorders (Perlmutter & Loberg, 2015)
  - Dermatologic disorders such as atopic dermatitis (Walker, Powel & Talley, 2014), pruritis (DeWitt, Bishop, Buescher, & Stone, 2006), urticaria (Lepczyńska, Chen, & Dzika, 2015), angioedema and other primary immunodeficiencies (Boisson, Quartier, & Casanova, 2015)
  - Genitourinary complaints including enuresis, prostatitis (Murphy et al., 2015)
  - Neuropsychological disorders such as mood disorders, ADHD, headaches/migraines, autism, seizures (Perlmutter & Loberg, 2015)
  - Respiratory/otolaryngological conditions including asthma, recurrent aphthous ulcers, chronic rhinitis, and/or chronic serous otitis (chronic or recurrent ear infections) (Tsabouri et al., 2014)
  - Energy disorders such as chronic fatigue syndrome and fibromyalgia (Lakhan & Kirchgessner, 2010; Perlmutter & Loberg, 2015).
History of infections and antibiotic use:
A history of chronic or recurrent yeast infections or fungal infections may be associated with increased risk of developing autoimmunity, IBS and SIBO (Lipski, 2012). Fungal infections such as Candida, Aspergillus and Cryptococcus may impact digestive and systemic health. These fungi produce toxins that contribute to leaky gut and upon entering the bloodstream, can impact immunity, hormone balance and cognition (Lipski, 2012). Candida colonization has been seen in the intestines of IBD patients and long-term antibiotic use can significantly alter the microbiome, allowing fungi such as Candida albicans to flourish (Underhill & Iliev, 2014). Long-term or frequent antibiotic use can have lasting impacts on the microbial landscape in the GI (Underhill & Iliev, 2014). Therefore, history of recurrent infections or frequent use of antibiotics for recurrent ear infections, sinus infections, acne, prostatitis, urinary tract infections and/or other circumstances should be elucidated.

Dietary History
A dietary history can be accomplished using a 4 – 7 day food record, food frequency questionnaire, or a 24-hour dietary recall. Because each instrument has its own strengths and limitations, no single best dietary assessment tool exists (Thompson & Byers, 1994). Instruments should be chosen with the goal of getting an accurate representation of the patient’s eating behaviors and identifying high-risk behaviors that can influence patient management. The best approach for dietary assessment should be individualized based on the patient’s age, writing ability, presence of a primary caregiver/surrogate, and purpose of the assessment. Clinicians should consider collecting information on various factors that may influence future priorities when counseling patients on behavioral change:
- Type and quantity of food consumed and avoided
- Preparation methods used
- Timing of meals and snacks
- Location of meals (e.g. at restaurant, in car, in front of TV, at dinner table, etc.)
- Social setting
- Mindfulness practices employed
- Knowledge and beliefs regarding food and eating

The clinician should be specifically looking for foods related to allergies, intolerances and specific foods or dietary factors impacting symptoms. For example, there is limited evidence that suggests specific foods may provoke symptoms of GERD, although the association is not conclusive (Nandurkar et al., 2004). Implicated foods that may provoke GERD include onions, chocolate, coffee, alcohol, peppermint, fatty meals/ fried foods, and acidic foods such as citrus fruits and tomatoes. IBS symptoms may be triggered by certain carbohydrates, specifically fermentable oligosaccharides, disaccharides, monosaccharides, and polyols (FODMAPs) such as fruits, sugars, artificial sweeteners, wheat and other foods (Barrett & Gibson, 2007). Withdrawal of these foods from the diet may relieve symptoms in IBS and possibly in IBD (Barrett & Gibson, 2007). (See FODMAP diet below).

The clinician should also inquire about any dietary approaches the patient may have tried to reduce symptoms. Again, specific attention is given to allergenic foods, sugars (including fruits/fructose) and common GI stimulants or irritants. Other factors to evaluate include:
disordered eating patterns, sugar or carbohydrate cravings, comfort or stress eating, and any other issues that patients may report or feel is important.

Commonly used dietary assessment tools are briefly described below:

**Food frequency questionnaires (FFQs):** Although there is no standard FFQ, validation studies have shown that the FFQ is useful in assessing food intake in adults (Haftenberger et al., 2010). These screening tools ask patients to report typical intake of a specific food or food group over a given period of time. For example, “How many servings of vegetables did you consume during the past month?” An estimate of usual intake can be made by compiling the findings from a series of questions. This approach gives the clinician a general picture of the patient’s nutrient intake, but neglects to inquire about significant details. Because it can be self-administered by the patient it may save time. However, the reliability of FFQs is questionable, since longer food frequency questionnaires have been found to overestimate intake and shorter lists tend to underestimate intake (Krebs-Smith, Heimendinger, Subar, Patterson, & Pivonka, 1994).

**Food diary:** Like its name suggests, patients keep a log of all food and drink consumed each day. The patient records intake in real time, a distinct advantage of this method, as patients are less likely to omit items due to forgetfulness. However, studies have found that dietary records are subject to error; specifically patients tend to underreport intake, especially obese patients (Lichtman et al., 1992). Outside factors can affect patient compliance including frequent participation by the patient, literacy, and language barriers.

**24-hour dietary recall**
- This method asks the patient to report intake of all food and drink over the preceding 24-hours
- Probing questions are asked to clarify intake. For example, if a patient stated they consumed “a coffee,” the interviewer should ask whether anything was added (e.g. cream and/or sugar) and in what quantity
- Questions about cooking methods and timing of meals may also need to be asked
- The 24-hour dietary recall can generally be completed within 20 minutes (Thompson & Byers, 1994) and may offer insight into the patient’s intake patterns
- However, it is also subject to error since it relies on the patient’s memory of past intake and the completeness of information collected may depend on the experience of the interviewer

**Dietary screening of patients should also include the following questions:**
1. Number of meals/snacks per day
2. Time of day meals/snacks consumed
3. Location and duration of time of meals and snacks
4. Amount and type of beverages consumed
5. Special dietary practices (vegan, vegetarian, etc.)
6. Foods avoided due to allergy, preference, or religion
7. Whether meals are planned in advance
8. Frequency of meals outside the home, cooking own meals
9. Whether eating alone or with others
10. Limitations with food purchasing or preparation (cost, lack of cooking skills, etc.)
    Difficulties with eating (loss of taste, chewing problems, problems swallowing, etc.)
11. Relationship to food (reward, punishment, sustenance)
    Use of dietary supplements and/or meal replacements

Psychosocial and Lifestyle Factors
Key psychosocial factors should be assessed including stress, mental health, physical
fitness/exercise, weight/BMI and waist circumferences, and other related factors.

Assessment of stress: Physical and psychological quality of life in GI patients with GERD,
IBS and IBD may be impacted by stress, which can both trigger symptoms and result from
a patient’s experience these conditions. There are several ways to quantify stress through
questionnaires or surveys of stressful events. Measures of psychological symptoms such
as anxiety and depression and biological measures (eg heart rate variability - HRV) can be
assessed and monitored. The perceived stress scale (Cohen, Kamarck, & Mermelstein,
1983) is a simple survey that assesses a patient’s perception of stress. Additional
assessment tools such as the Irritable Bowel Disease surveys and questionnaires (Crohn’s
and Colitis Foundation of America, n.d.) and quality of life assessments can be used in
conjunction with symptom tracking to determine changes over time.

Assessment for depression and anxiety: Anxiety and depression have been implicated
as comorbidities in IBS, IBD and GERD. A 2016 study found a significant association
between symptoms of depression or anxiety with clinical recurrence of IBD (Mikocka-
Walus, Pittet, Rossel, von Känel, & Swiss IBD Cohort Study Group, 2016). Inflammatory
cytokines and physical symptoms of IBD may lead to elevated anxiety, as can steroid
treatment and other psychological effects of the condition (Mikocka-Walus et al., 2016).
Adding insult to injury, anxiety related to functional bowel disorders can further augment GI
symptoms. As previously discussed, many patients with IBS also experience symptoms of
anxiety and/or depression. In addition, a 2015 study found that both anxiety and depression
increased reflux symptoms and negatively impacted quality of life in patients with GERD
(Yang, Jiang, Hou, & Song, 2015a). As such, quality of life, mental health and
neurotransmitter function questionnaires can be helpful in determining factors that impact
GI function. Any significant mental health findings should be referred to a mental health
practitioner.

Assessment of trauma, abuse or neglect: A history of trauma, abuse or neglect is
associated with psychological disturbance and may also amplify or trigger GI symptoms in
patients with GERD (Mizyed, Fass, & Fass, 2009) IBD (Walker, Gelfand, Gelfand, Creed, &
Katon, 1996) and functional gastrointestinal disorders like IBS (Drossman, Talley,
Heitkemper and colleagues reported that women with IBS who had a history of abuse or
neglect were more likely to experience disturbed sleep, somatic symptoms, and
psychological distress as well as heartburn and nausea (2011). In addition, the use of
psychotropic drugs, commonly used in the treatment of psychological disorders, may
promote reflux symptoms by reducing lower esophageal sphincter (LES) pressure, salivary
secretion of bicarbonate and prolonging gastric emptying (Mizyed et al., 2009). Inquiry into
a patient’s history of past or current trauma, abuse or neglect and referral to a qualified
mental health professional may improve clinical outcomes (Drossman et al., 1995).

**Smoking:** Smoking may decrease the lower esophageal sphincter (LES) pressure, compromising GI integrity and increasing risk of esophageal (and other) cancers. GERD patients using psychotropic medications are more likely to smoke than non-GERD patients using the same medications (Mizyed et al., 2009). Smoking is also independently associated with more frequent occurrences of CD (Lakatos et al., 2009) and with poorer outcomes (Nunes et al., 2012; Johnson, Cosnes, & Mansfield, 2005). Smoking cessation may reduce the risk of a CD relapse by up to 65% (Johnson et al., 2005). Additionally, smokers are more likely to develop CD than nonsmokers (Johnson et al., 2005). As a result, maintenance therapy, surgery and biologic drugs are used more frequently among the smoking population of patients with CD (Johnson et al., 2005; Nunes et al., 2012).

Interestingly, while smokers with CD have poorer outcomes and more severe cases of the condition, smoking appears to protect against the development of, or lessen the severity of, ulcerative colitis (Johnson et al., 2005). However, other complications of smoking along with increased mortality risk outweigh IBD symptoms and cessation is still advised. Health professionals can use the “four A’s” to encourage smoking cessation with patients (Johnson et al., 2005):
1) Ask about current smoking habit
2) Advise them to stop
3) Assist by way of available methods/therapies
4) Arrange follow-up
In addition, referrals to specialists, counseling and smoking cessation clinics can further improve outcomes (Johnson et al., 2005).

**Medications and Nutritional Supplements**

The practitioner should collect a current list of medications and nutritional supplements. As previously described, a major focus should be on use of antibiotics, lifetime history of antibiotic exposure and the impact of these medications on the gut microbiota. Many pharmaceuticals are associated with GI side effects, including non-steroidal anti-inflammatory medications (NSAIDs) by prescription and over the counter (Gabriel, Jaakkimainen & Bombardier, 2001). In addition, antipsychotics and SSRI antidepressant medications are correlated with gastrointestinal disturbances such as constipation (Lindsey, 2009) Anti-inflammatory steroids are associated with an increase in upper intestinal damage and bleeding, in particular when these steroids are used concomitantly with high-dose NSAIDS (Hernández-Díaz & Rodríguez, 2001). Hypochlorhydria (low stomach acid) and hypergastrinemia (elevated blood levels of the hormone gastrin) may result from long-term proton pump inhibitor (PPI) therapy (Metz, 2008). Hypochlorhydria may increase susceptibility to bacterial or parasitic infection if these pathogens are not destroyed by stomach acid. If and when PPI use ceases, patients are at increased risk of rebound hypersecretion of stomach acid and the recurrence of heartburn or bleeding from ulcers (Metz, 2008).

Nutritional supplements, although often beneficial, may in some cases contribute to GI symptoms and should be examined. For example, magnesium gluconate may be the best tolerated form of magnesium (Coudray et al., 2005), whereas the oxide and citrate forms,
commonly used for their laxative properties in colonoscopy prep, may be more likely to promote diarrhea and GI pain symptoms (Yamasaki et al., 2014; Kim et al., 2016). An excessive number of supplements in general might be too much for the GI tract to tolerate, therefore, types and timing of supplements should be assessed. Herbal supplements should also be closely analyzed in light of the patient’s health history to determine if misuse of herbal preparations may be contributing to GI symptoms.

**Physical Activity**

Research supports the benefits of exercise in a variety of GI disorders as well as for stress-related symptoms and conditions (Bilski, Brzozowski, Mazur-Bialy, Sliwowski, & Brzozowski, 2014; Johannesson, Ringström, Abrahamsson, & Sadik, 2015; Strickland & Smith, 2014). Clinicians should be mindful that vigorous exercise may induce GERD symptoms in athletes (Festi et al., 2009). However, it is important to note that these findings are not seen with normal levels and intensity of physical activity, which has been shown to offer a protective effect against the symptoms of GERD (Nilsson, Johnsen, Ye, Hveem, & Lagergren, 2004). As mentioned, patients with gastrointestinal dysfunction may experience changes in quality of life. Assessment of a client’s ability or willingness to engage in physical activity may provide insight into the extent of symptoms and their impact of QOL. Physical activity is discussed in more detail below.

Type, frequency and duration of physical fitness and should also be assessed, and is usually obtained through self-report of aerobic exercise, weight training, group fitness classes, or other activities. The clinician should ask:

- On average, how many days a week do you perform moderate intensity physical activity or exercise, where your heart is beating faster and your breathing is harder than normal (such as a brisk walk)?
- On average, how many total minutes of physical activity or exercise do you perform on those days?

- Assessing sedentary time is just as important as assessing activity, and is a primary intervention in both children and adults. To counsel patients about becoming less sedentary, the physical activity assessment should also include inquiry about other factors that may impact ability and or motivation to participate in physical activity, including:
  - Environmental limitations (access to safe and convenient places to play/exercise)
  - Motivation and attitudes towards activity
  - Physical or mental disabilities
  - Enjoyable activities (i.e. ask an adult what they enjoyed as a teen or child)

**The GI-Focused Physical Examination**

The physical examination should include measurement of anthropometric data including BMI, waist circumference and body composition. Being overweight (BMI of 25.0–29.9 kg/m²) or obese (BMI ≥ 30 kg/m²) are associated with abnormal peristalsis (Koppman et al., 2007) as well as inflammation (Cox et al., 2015), so it is important to assess and address weight status. More recent evidence suggests that weight may be associated with imbalanced bowel microbiota and can have metabolic influences (Cox et al., 2015;
Serious nutritional deficiencies may result as a consequence of gastrointestinal dysfunction, and nutrient status should be assessed as part of the GI-focused physical exam. Damage to the mucosal lining of the intestine or resection of the small intestine can result in malabsorption (Nelms, Sucher, Lacey, & Roth, 2010). Muscle wasting, edema, pallor, skin rashes and loss of subcutaneous fat may indicate malnutrition/malabsorption (Valentini et al., 2008). A thorough analysis of the patient’s eyes, mouth, hair, skin and nails can preliminarily identify potential nutritional deficiencies and indicate need for further testing. (See “Assessing Nutritional Deficiency” practitioner handout).

Additionally, use of drugs to treat IBD such as corticosteroids and sulfasalazine may increase nutritional needs for protein, calcium, phosphorus, zinc, vitamin B6, folate and vitamin D. Magnesium deficiency may be indicated with chronic constipation (Mg deficiency common in IBD) while poor hydration, potassium and electrolyte deficiency may result from diarrhea. A skin turgor test may be useful in assessing hydration status related to diarrhea. Bowel habits should be discussed with the patient to determine potential for malabsorption of fat-soluble nutrients as well.

Medical Assessment and Laboratory Testing
Medical assessment and laboratory testing is dependent on a number of factors and should be recommended as needed, on an individual basis. Key determinants are the type and severity of symptoms and the diagnosis (if known), as well as the duration of symptoms, and overall symptom and disease profile. The patient’s personal needs, preferences, and goals should also be considered as should the costs involved. Conventional medical testing of GI symptoms is also dependent upon the specific symptoms present and/or the suspected diagnosis. Some of these tests are:

**Upper Endoscopy**: An endoscope is used to examine the lining of the upper GI tract to identify the cause of symptoms such as heartburn, pain, nausea/vomiting as well as confirm the cause of abnormal lab results. GERD, celiac disease and other upper GI diseases can be diagnosed using this procedure.

**Colonoscopy**: A colonoscopy is used to examine the rectum and colon to look for inflammation, ulcers, polyps and cancer. This procedure is employed to identify the cause(s) of changes in bowel habits, abdominal pain, bleeding and weight loss and as a screening test for colon cancer. Patients with a personal history of IBD or family history of colon cancer may require earlier screening.

**Assessment for Celiac disease**: Celiac disease is a condition characterized by a complete intolerance to gluten. It may be necessary to evaluate gluten’s role in digestive issues that are present. Various biomarkers can be assessed including gliadin antibodies, and endomysial and transglutamine antibodies. An intestinal biopsy may also be recommended. Symptoms of IBS and celiac disease often overlap, and conditions may be misdiagnosed or concurrent (Zwolińska-Wcisło, Galicka-Latała, Rozpondek, Rudnicka-
Therefore, careful testing is recommended to ensure proper care and appropriate intervention strategies.

**Assessment of individual nutrient imbalance:** Due to the high risk of malabsorption, nutritional assessment is particularly important in IBD (Galland, 2007), however, nutrient status should also be assessed for those with other gastrointestinal conditions and symptoms. Patients with chronic gastrointestinal malfunction are at even greater risk of deficiency, particularly if they have co-morbid disorders, are elderly and/or have a poor diet (Ha & Katz, 2014). Nutrients that are most commonly deficient (clinically or subclinically) and may require testing include vitamin A, vitamin C, 25-hydroxy vitamin D, vitamin B12, folate, magnesium, calcium, zinc, iron and selenium (Lipski, 2012).

**Specialized Laboratory Testing**

Specific integrative medical testing is often used to assess GI disorders. While these tests may prove to be helpful, clinicians should educate patients and remain mindful that the research on select specialty testing remains limited at this time. More studies are required to clarify the validity and reliability of such specialized laboratory testing.

The following are a list of potentially helpful lab tests:

- **Comprehensive digestive stool analysis (CDSA):** Provides an analysis of levels of healthy bacteria, potentially pathogenic bacteria, amount and/or types of yeast/fungi and possibly other micro-organisms (eg. parasites). The CDSA also includes additional helpful information including markers of macronutrient digestion, absorption, pancreatic function and inflammation in addition to measuring bacterial metabolites such as short chain fatty acids (SCFAs). The CDSA is a non-invasive home stool kit, and is useful in differentiating inflammatory conditions like IBS from more serious conditions such as IBD, colon cancer and diverticulitis.

- **Intestinal permeability and leaky gut syndrome testing:** This test directly measures non-metabolized sugar output in the urine. Mannitol is a small sugar molecule, readily absorbed in a healthy intestine. Lactulose, on the other hand, is a much larger molecule that should not be so easily absorbed. Test results showing high urine concentrations of both mannitol and lactulose indicate increased intestinal permeability, while low levels of both indicate general malabsorption. Testing for leaky gut does not reveal the etiology of the condition, but it may be useful in ruling out other conditions and for addressing absorption of food antigens, bacterial antigens and other potentially adverse or toxic compounds (Lipski, 2012).

- **Nutritional assessment or organic acid testing (OAT):** Organic acids present in the urine provide insight into metabolic function, digestion and the action of microorganisms in the GI. Organic acid testing may be helpful in assessing methylation, energy production, oxidative damage, fatty acid metabolism, carbohydrate metabolism and inflammation. This test can be considered a general screening for patients with a long standing history of digestive symptoms and IBD, and/or a more complex or systemic
presentation (Lipski, 2012). Evaluation of nutritional status and/or organic acid testing for metabolites could be useful.

**Food Intolerance or allergy:** Food intolerance and allergy testing may provide helpful baseline indicators of potentially allergenic or intolerant foods, and can be IgE or IgG mediated tests. IgG testing reveals delayed sensitivity reactions (approximately 95% of food allergies) and IgE mediated responses are acute (the other 5%) (Lipski, 2012). An elimination or rotational diet will still need to be used to confirm the contribution of specific foods and/or dietary influences (Please see the “Elimination Diet” handout).

**Breath testing:** The lactulose breath test (LBT) has been most commonly used to assess the presence of SIBO in recent years. The human GI tract does not utilize ingested lactulose; instead, bacteria metabolize lactulose to produce hydrogen and methane gas (Ghoshal & Srivastava, 2014). LBTs often result in false positives, however, as hydrogen production in patients with SIBO may be similar to production in those with fast intestinal transit time (Ghoshal & Srivastava, 2014; Rana & Malik, 2014). Rana and Malik suggest that LBT is a better test of orocecal transit time, rather than as a diagnostic test for SIBO and recommend the glucose breath test (GBT) as a more appropriate assessment of SIBO (2014).

As in SIBO, carbohydrates such as glucose may be inappropriately metabolized by bacteria in IBS patients. As a result, hydrogen can be detected in exhaled air and breath tests can be useful in determining FODMAPs for patients with IBS symptoms (Ghoshal & Srivastava, 2014). Specifically, breath tests can determine whether or not fructose, lactose and/or sorbitol are being incompletely metabolized by intestinal bacteria.

### III. Core Intervention, Education and Management

**Introduction**

Each factor mentioned above can be viewed as a step in a staircase, such that there is a threshold over which symptoms occur and a disorder becomes apparent. Improvements in diet, gut microbiota, exercise, and/or stress may result in the ability to go beneath the threshold to allow for healing. Encouraging dietary change, targeted nutritional supplementation, increasing stretching and exercise, and application of relaxation techniques are essential, while monitoring changes in symptoms, quality of life, and objective measures of disease status.

The treatment and management of GI disorders may be most effective through a partnership between the patient/ and the practitioner(s). While the practitioner works to develop a treatment strategy and monitor the patient’s response to care, patient education and self-care is paramount for improving outcomes. It is important for the patient to understand his or her condition, the contributing factors and the approaches that are helpful for mitigating symptoms. One study of self-management training in University of California patients showed that a personalized self-management strategy significantly reduced physician visits and hospitalizations (Robinson, Thompson, Wilkin, Roberts, & Northwest Gastrointestinal Research Group, 2001). Similarly in IBS, a patient-centered approach with
effective practitioner-patient communication has been found to improve outcomes, patient satisfaction, and healthcare utilization (Di Palma & Herrera, 2012).

Dietary Factors

General Macronutrient Considerations
There is currently no consensus regarding dietary guidelines for IBS and IBD (Iacovou, Tan, Muir & Gibson, 2015; Ananthakrishnan et al., 2012; Richman & Rhodes, 2013), although it is commonly accepted that diet has a significant and central role in both these conditions (Eswaran, Tack, & Chey, 2011; Dixon, Kabi, Nickerson, & McDonald, 2015). This largely results from our limited but increasing understanding of the interplay among the key factors of diet, gut microbiota, immune function, inflammation, intestinal permeability, and stress. It is therefore essential to assess and address a broad range of influences to produce an individualized and effective dietary plan.

A general guideline to follow when caring for people with GI disorders is to encourage consumption of healthy and tolerated proteins, fats, and carbohydrates. An extreme but effective example of this is the use of short-term enteral formula diets for CD, which promote remission in active CD (Aldhous, Meister, & Meister, 2001; Giaffer, Cann, & Holdsworth, 1991). Approximately 30% of CD patients maintain remission after completing an enteral feeding protocol (Giaffer et al., 1991). Additionally, enteral formula diets promote remission in up to 96% of eosinophilic esophagitis patients (Wechsler, Schwartz, Amsden, & Kagalwalla, 2014). In most cases, however, dietary guidelines are addressed using natural and whole foods. For example, the elimination diet or low FODMAP diet discussed below both provide excellent foundational diets for those suffering GI symptoms.

Diet interventions should be individualized not only for efficacy but also for potential religious, spiritual, or general health reasons. For example, a well-planned vegan or vegetarian diet can be healthy in general, but may not be well tolerated by some patients with GI disorders because of the higher carbohydrate and fiber content of vegetarian foods. An individualized approach should be taken with beans/legumes, grains, and fruits (Suskind, Wahbeh, Gregory, Vendettuoli, & Christie, 2014; Goldstein, Braverman, & Stankiewicz, 2000).

General Micronutrient Considerations: Nutritional status and nutritional deficiency/insufficiency is an important consideration in IBD (Galland, 2007), and may be important in GERD and IBS, depending upon the severity of disease or symptoms and the duration of illness. The consequence of nutritional deficiencies and/or insufficiencies is a worsening of symptoms, and the possibility that they may be causing secondary health symptoms such as fatigue, depression and other symptoms or problems. In GERD and IBS, this can be a concern when the symptoms have been severe or present for a long time, when dietary intake has been inadequate or poor diet and/or when there are age-related vulnerabilities. These vulnerabilities in elderly patients may include a range of other symptoms/diagnoses and/or medication effects that may be compounding the circumstances.

As previously discussed, various micronutrient deficiencies can result from gastrointestinal malabsorption, including vitamin A, vitamin C, 25-hydroxy vitamin D, vitamin B12, folate,
magnesium, calcium, zinc, iron and selenium (Lipski, 2012). Anemia is one of the most common comorbidities in IBD with frequency around 21-24% in most populations (Antunes et al., 2015). Antioxidant needs may also increase in inflammatory GI conditions. A gut-healing protocol in conjunction with an appropriate balanced diet and multi-vitamin/multi-mineral supplementation is recommended to optimize nutrition.

**Food Intolerance and Food Allergy:** Identifying specific foods and beverages that may be contributing to symptoms is an essential part of managing GI disorders. As many practitioners know, an elimination diet is an effective tool for identifying food intolerances and some research supports its effectiveness (Slomin, Grovit, & Bulone 2009; Weschler et al., 2014).

A recent review article raised questions about the validity and reliability of various food allergy tests, and suggested several actions for the testing companies and the industry as a whole to adhere to universal and scientifically validated standards (Vojdani, Pollard, & Campbell, 2014). The argument in support of these cell-mediated or antibody tests is that they provide a more simplified approach and/or motivation that may be needed for dietary compliance. Without scientifically validated standards, however, a food elimination trial will still need to be evaluated to test the tolerance of potentially offending foods (Ballmer-Weber, 2014).

Note: Other non-allergenic foods may contribute to inflammation, GI symptoms and poor disease management and should be monitored. These include carrageenan (Borthakur, Bhattacharyya, Dudeja, & Tobacman, 2007) high fat and fried food, caffeine, alcohol, spicy foods, acidic foods, carbonated beverages and many others.

There are several dietary approaches that can be considered to address digestive disorders. Regardless of the dietary strategy employed, clinicians should be mindful that an overall holistic or integrative approach includes targeted nutritional supplements and other lifestyle factors including movement, exercise, and stress management. Lifestyle interventions are often inextricably linked to dietary management, as they may support the improvement of mediating factors such as bowel microbiota (Konturek et al., 2011; Hsieh et al., 2015; Floch, 2005, Bibiloni et al., 2005) and IP (Petriz et al., 2014), which could lessen the reactivity or intolerance to foods. Recommendations should be individualized with consideration for patient preference and likelihood of compliance. (Please see the attached handouts for select resources and protocols associated with the following dietary strategies).

**Dietary Strategies:**

**Elimination Diet** – This dietary strategy requires the elimination of all highly allergenic foods or commonly intolerant foods. Eliminated foods often include dairy, sugar, alcohol, caffeine, corn, peanuts, soy, wheat, other gluten grains (rye, barley), eggs, citrus, yeast, and all fermented foods. A traditional elimination diet removes all of the above foods concurrently for a period of several weeks before the reintroduction phase, when each food is individually tested for a response. The elimination approach can also be applied as a rotation elimination, or in phases. Phase one involves restriction of dairy, wheat, sugar,
alcohol and caffeine, and all of the other restrictions are added in phase two. Each of these options requires rigorous implementation by patients and close monitoring by practitioners. Although the research support for elimination diets is lacking, investigations of eosinophilic esophagitis have some of the best studies showing effectiveness of an elimination diet in both children and adults (Wechsler et al., 2014). (Please see the “Elimination Diet” handout for an example of a protocol for this approach).

**Specific Carbohydrate Diet (SCD)** – This dietary approach is outlined in Elaine Gotschall’s book, *Breaking the Vicious Cycle*, and may reduce symptoms and support GI healing (Gotschall, 1994; Kakodkar, Farooqui, Mikolaitis, & Mutlu, 2015). It is based on specific carbohydrate restrictions of disaccharides, polysaccharides and starches. The Specific Carbohydrate Diet cuts out all lactose, grains, and many legumes, allowing carbohydrates from fruits, honey, homemade yogurt, nuts, and certain nonstarchy vegetables. The goal of the SCD is to starve certain strains of bacteria that produce inflammatory byproducts. Some research supports it benefits, particularly in CD (Suskind et al., 2014; Lorenz-Meyer et al., 1996; Kakodkar et al., 2015).

**Low FODMAP Diet** – The Fermentable Oligo-Di-Monosaccharides And Polyols (FODMAP) diet is based on the theory that these sugars, which are found in many carbohydrates, have an osmotic effect and draw excess water into the GI tract. FODMAPs are often not digested or absorbed well, and are fermented by intestinal bacteria (particularly if eaten in excess). Emerging research suggests significant benefit in 68-76 % of IBS patients, especially within the first seven days of adherence to this diet (Iacovou et al., 2015; Mansueto, Seidita, D’Alcamo, & Carroccio, 2015). The low FODMAP diet may be particularly beneficial in ameliorating symptoms of diarrhea, bloating, abdominal pain, and flatulence in IBS patients due to the poor absorption, osmotic activity, and rapid fermentation of FODMAPS (Chumpitazi et al., 2015; Halmos, Power, Shepherd, Gibson, & Muir, 2014; Barrett, 2013). Chumpitazi and colleagues reported that hydrogen breath test results were improved in IBS patient populations during adherence to a low FODMAP diet, suggesting diet-related alterations to GI motility and/or bacterial colonies in the small intestine with reduced consumption of FODMAPs (2015). Low FODMAP dietary lists are changing and expanding. High FODMAP foods are listed below for reference (Barrett, 2013):

- Apples, apricots, cherries, blackberries, mango, nectarines, peaches, pears, persimmon, plums, watermelon, artichokes, asparagus, cauliflower, garlic, mushrooms, onion, shallots, snow peas, spring onion, legumes, pistachios, cashews, wheat, rye, barley, condensed milk, evaporated milk, cottage cheese, ricotta cheese, ice cream, custard, milk, yogurt, honey, and sweeteners containing isomalt, mannitol, sorbitol, or xylitol.

**Low Carbohydrate Diet** – This approach is similar to the SCD in that many or most carbohydrates are limited or restricted. Malabsorption of carbohydrates such as lactose and fructose is common in the IBD population and ingestion of these sugars often exacerbates symptoms. Dietary restriction of these sugars may be helpful in reducing symptoms and flare ups (Goldstein et al., 2000). Low fiber diets are often recommended interchangeably with low residue diets as part of IBD therapy, however, there are few studies supporting the removal of fiber during an IBD flare (Shah & Limketkai, 2015). In fact, diets high in soluble fiber, which tend to be fermentable and viscous fibers, have been shown to reduce the risk
of various conditions including heart disease, diabetes, obesity, diverticular disease, and constipation (Shah & Limketkai, 2015; Slavin, 2013).

Various therapeutic foods can be utilized individually or in combination to promote gut health in addition to the diet programs discussed above. Therapeutic foods include bone broths, fermented foods, fiber-containing foods, prebiotic foods, cooked and pureed foods and therapeutic herbs. See "Therapeutic Foods" handout for details regarding the efficacy and use of each of these foods.

**Lifestyle Factors**

**Stress**

Stress is one of the most important lifestyle factors that affects GI symptoms and disorders, and is often cited by patients as an important factor that will make symptoms worse (Lee et al., 2015; Grzesiak et al., 2013). Research supports this association although there are also negative study findings (Whitehead & Crowell, 1991) suggesting that causes and contributing factors in GI disorders are multi-factorial and that stress may be less important in individual cases. Research has shown that stress has specific and adverse influences on gastrointestinal physiology and function such as gut motility, GI secretions, intestinal permeability, mucosal blood flow and repair, bowel microbiota and visceral perception (Konturek et al., 2011). Stress also promotes inflammation, which may contribute to systemic effects such as insulin resistance, oxidative stress and susceptibility to other disorders such as CVD and depression (Perlmutter & Loberg, 2015). In addition, stress can decrease secretory IgA which can increase adhesion of pathogenic bacteria to mucosal tissue and lead to greater intestinal permeability (Campos-Rodríguez et al., 2014). This supports the broad and major influence that stress has in GI function and health, such that stress management and other interventions that can counterbalance these effects are essential.

Stress also is an underlying factor for comfort eating and food addiction that compounds GI symptoms and disorders. Although there is little or no research that specifically connects these two factors in GERD, IBS, SIBO and IBD, it does lead to overeating and often includes sugars, wheat, dairy and other less healthy, allergenic and/or processed foods. Specific eating patterns that should be monitored in addition to overeating include eating too close to bedtime, mindful eating (not doing anything else, awareness of thoughts and feelings) and other considerations on an individual basis.

**Exercise**

Exercise or physical activity is important for people with significant stomach and intestinal symptoms or disorders, although the approaches need to be individualized since high intensity exercise may worsen symptoms (Nathan, Norton, Czuber-Dochan, & Forbes, 2013; Zuhl et al., 2012) and research has mostly been inconsistent or weak (Bilski et al., 2014). As described above, there is considerable research connecting stress to IBS, GERD and IBD (Konturek et al., 2011; Drossman et al., 1995; Mizyed et al., 2009) and some good research describes the benefits of exercise for anxiety and depression (Zschucke, Gaudlitz, & Ströhle, 2013; Mago & Mahajan, 2010), so it would be logical to assume positive effects in GI disorders. Exercise that decreases weight in GERD patients can affect GI motility and
improve symptoms (Djärv et al., 2012), and adipose tissue and skeletal muscle cytokines can have anti and pro-inflammatory effects, that can influence IBD (Bilski et al., 2014).

One study found that increasing physical activity improved IBS symptoms and psychological symptoms (Johannesson et al., 2015). Another investigation of inspiratory muscle training in GERD, showed decreased heartburn and regurgitation scores (E Souza et al., 2013). Interestingly, animal studies have found that exercise can affect diversity and type of microbiota (Petriz et al., 2014) and protect enteric neurons from age-related neurodegeneration (Martinez et al., 2008).

- **Mind-Body Approaches and Complementary/Alternative Medicine Therapies**

  Stress management modalities including biofeedback, meditation, mindfulness, yoga, tai chi and chi gong, may be helpful in stress reduction. Some clinical evidence also supports the value of therapies such as acupuncture, massage and hypnotherapy in improving IBS symptoms and quality of life, and can be incorporated part of an overall treatment plan (Chedid et al., 2014; Grundmann & Yoon, 2014).

  Various mindfulness-based stress reducing techniques have been implicated as adjunctive therapies for patients with IBS and IBD in particular (Aucoin, Lalonde-Parsi, & Cooley, 2014; Evans et al., 2014; Berrill, Sadlier, Hood, & Green, 2014; Zernicke et al., 2013). Among these, mindfulness-based stress reduction, multi-convergent therapy (a combination of mindfulness mediation and behavioral therapy) and iyengar yoga show promise in reducing symptoms such as chronic pain, sleep quality, fatigue, mood, and somatization disorders (Evans et al., 2014; Berrill et al., 2014). Cognitive Behavioral Therapy (CBT) and hypnosis have also been shown to be beneficial for IBS (Palsson, Turner, Johnson, Burnett, & Whitehead, 2002; Drossman et al., 2003) and a general relaxation training program was found to be helpful for GERD (McDonald-Haile, Bradley, Bailey, Schan, & Richter, 1994). Research in this area is ongoing, however, it appears that mindfulness-based stress reducing techniques may have lasting effects with ongoing amelioration of symptoms and improved quality of life (Aucoin et al., 2014). Referral to a psychologist or other licensed therapist can be helpful as part of a treatment program.

- **Smoking Cessation**

  Smoking cessation is an indispensable part of management of all GI disorders. Not only does smoking decrease the lower esophageal sphincter (LES) pressure contributing to GERD, it also compromises GI integrity, and increases risk of esophageal (and other) cancers. As previously discussed, smokers with CD have poorer outcomes and more severe cases of the condition; however, smoking cessation is associated with improved outcomes in ulcerative colitis (Johnson et al., 2005). Despite this, smoking cessation is still advised due to the high risk of mortality and complications. Patients should be provided with smoking cessation therapy options and referrals to specialists, counseling or smoking cessation clinics as appropriate (Johnson et al., 2005).

**Nutritional Supplements**

Nutritional supplementation can be an important part of an overall dietary and lifestyle management program of digestive symptoms and disorders. The supplements can benefit GI health both though symptom management, restoration of gut microbiome, inflammation
reduction, and support of nutritional status. In general, most patients with GI disorders would therefore benefit from supplementation with:

1. **Probiotics:** Promote the colonization of healthy bacteria and mitigate dysbiosis, improve intestinal wall integrity, stimulate immunity, normalize motility, block pathogen-to-pathogen communication and prevent pathogen adherence to the binding sites (Bull & Plummer, 2015). Dosage and strains should be based on the client’s condition and tolerance.

2. **Digestive enzymes:** Ensure that nutrients are adequately digested for optimal absorption, leaving as little residue in the GI tract as possible. Digestive enzymes, particularly pancreatic enzymes, may be beneficial in the treatment of a wide variety of malabsorptive conditions (Roxas, 2008). Dosage recommendations for malabsorptive conditions ranges from 25,000-40,000 units of porcine lipase per meal or 18,750-30,000 units of fungal lipase per meal (Roxas, 2008).

3. **Multivitamin and mineral:** Due to the prevalence of malabsorption and food avoidance among those with chronic gastrointestinal conditions, a multivitamin/multimineral supplement can provide adequate nutrients during therapy (Goldstein et al., 2000; Galland, 2007; Lipski, 2012). Multivitamin/multimineral supplements should be chosen based on a thorough health history and nutritional assessment (Ward, 2014).

Other supplements can be recommended or prioritized as needed based on the specific symptoms or diagnosis.

The clinician should be mindful of the timing and duration of supplementation. These details are described below. Another consideration is the quantity and form of supplementation since digestion and absorption of nutrients should be addressed on an individual basis, and the inclusion of too many supplements has the potential of being too difficult for the GI tract to tolerate.

In addition to the three foundational supplements listed above, the following are a list of supplements that may be considered for GERD, SIBO, IBS, and IBD:

**Supplements in Support of GERD**
The standard therapy for GERD is the use of proton pump inhibitor (PPI) medication. Patients on PPIs can experience varying responses, from total amelioration of symptoms to no change in symptoms (Subramanian & Triadoafilopoulos, 2015). The following nutritional supplements may be beneficial:

- **Licorice root extract (Deglycyrrhizinated licorice - DGL):** Licorice root is a demulcent which forms a soothing film over mucous membranes. Some research suggests benefits of DGL in reducing inflammation and promoting healing of the esophageal tissues (Yarnell & Abascal, 2010). The glycyrrhizin is removed so that longer-term use does not raise blood pressure.
• **Melatonin:** Some melatonin is produced in the gastrointestinal mucosa, and has been shown to influence GI secretion, motility, digestion and nutrient digestion (Brzozowska, Strzalka, Drozdowicz, Konturek, & Brzozowski, 2014). In addition, melatonin acts as an antioxidant that helps to maintain GI integrity, protect the esophagus and stomach, heal ulcers and protect against GERD in humans (Brzozowska et al., 2014). Melatonin may also promote better sleep by impacting circadian rhythms and it has been implicated as adjunctive therapy for fertility (Fernando & Rombauts, 2014) and T2DM (Zephy & Ahmad, 2015) due to its ability to scavenge free radicals.

**Supplements in Support of SIBO**

The current standard treatment for SIBO is a course of oral antibiotics, most commonly Rifaximin, which is estimated to be about 46% effective in correcting SIBO (Chedid et al., 2014). Rifaximin has been FDA approved for use in hepatic encephalopathy, but not for SIBO. This is an expensive antibiotic, and may have adverse effects on the gut microbiome. The following herbal therapies alone or in combination may be just as effective in the treatment of SIBO (Chedid et al., 2014):

• **Oil of oregano:** Oil of oregano contains phytochemicals such as thymol and carvacrol, well known for their antibacterial properties and ability to inhibit growth of intestinal microbes. Research has shown that this oil also induces apoptosis of human colon cancer cells (Chedid et al., 2014).

• **Berberine:** A component of various plants including Chinese goldthread, barberry and Oregon grape, berberine-containing plants have been used in traditional medicine systems for diarrhea. In addition to its antimicrobial and analgesic properties, this compound decreases intestinal motility and gastric secretions (Chen, Yu, Li, Fichna, & Storr, 2014). It appears to inhibit gram-negative bacteria and reduce microbial adhesion to the intestinal mucosa, limiting damage to the mucosal lining (Chen et al., 2014). Berberine has also been shown to down-regulate inflammatory cytokine action, including tumor necrosis factor -alpha (TNF-α) and interleukin 8 (IL-8) among others (Chen et al., 2014).

• **Thyme:** Rich in volatile oils, thyme has potent antimicrobial actions against specific strains of bacteria including *Helobacter pylori, Escherichia coli, Klebsiella pneumoniae, Salmonella enteritidis* and the fungi *Candida albicans* (Chedid et al., 2014; Balick, 2014).

• **Wormwood:** Also has potent antimicrobial and anti-inflammatory effects and has been used traditionally to treat gastric irritation (Balick, 2014). Wormwood has also been shown to induce remission in Crohn’s disease (Chedid et al., 2014).

Note that lemon balm, horsetail and red thyme essential oil may also be useful for their anti-anxiety, anti-microbial and anti-diarrheal effects (Chedid et al., 2014).
Supplements in Support of IBS

Classic treatment of IBS involves pharmacotherapy such as antidiarrheal medications or laxatives (depending on the IBS type), antidepressants such as tricyclic antidepressants (TCAs) and selective serotonin reuptake inhibitors (SSRIs) to decrease pain, antispasmodics that relax smooth muscle tissue and bulking agents (Wall, Bryant, Bottenberg, Maki, & Miesner, 2014). It is more appropriate to treat with the range of natural approaches that address underlying causes first, and consider medications as a last resort. Various alternative therapies can be employed in the treatment of IBS:

- **Probiotics:** Research shows an increased risk of developing IBS concurrent with dysbiosis, suggesting that supplementation with probiotics may be helpful for reducing IBS symptoms in all IBS types (Whelan, 2011). While it remains unclear if one strain or a combination of probiotics is superior, the benefits for IBS are compelling. As described previously, many species in the *Lactobacillus* and *Bifidobacterium* genera are beneficial bacteria with documented effects (Wall et al., 2014). In particular, the strain *Bifidobacterium infantis* 35624 (O'Mahoney et al., 2005), and *Lactobacillus plantarum* 299v (Ducrotté, Sawant, & Jayanthi, 2012) appear to be safe and effective for the treatment of IBS by reducing symptoms of abdominal pain, bloating, and intestinal inflammation (Whorwell et al., 2006; Brenner & Chey, 2008).

- **Prebiotics:** Prebiotics are carbohydrates that resist digestion and become fermented by beneficial microflora. Oligosaccharides such as oligofructose, as well as inulin, lactulose and resistant starch are considered prebiotics and have been shown to simulate beneficial *Bifidobacterium* proliferation (Slavin, 2013). Prebiotic effects can be derived from foods such as banana, whole grain wheat, whole grain corn, psyllium, leeks, asparagus, chicory, Jerusalem artichokes, garlic, onions, oats, and soybeans (Slavin, 2013).

- **Peppermint oil:** This is a botanical with anti-spasmotic effects that has several studies and a meta-analysis supporting its use (Ford et al., 2008; Kligler & Chaudhary, 2007; Wall et al., 2014). Clinical trials have reported significant reductions in abdominal pain and severity after 4 weeks compared to placebo. Benefits did not last after the peppermint oil was discontinued (Brandt et al., 2009). A combination of peppermint oil and caraway oil (90mg and 50mg respectively), has been shown to reduce motility in the gastrointestinal tract by delaying gastric emptying and relaxing the gallbladder (Goerg & Spilker, 2003). This may provide relief for those with motility disorders such as IBS and non-ulcerative dyspepsia.

- **Ginger:** Another anti-spasmotic herb, although less research has been done to support its use in IBS. Researchers have found that the active constituent gingerol may enhance gastrointestinal motility and reduce abdominal pain (Ghayur & Gilani, 2005). Additionally, ginger has been traditionally used to curb nausea and shows benefits in motion sickness, morning sickness and inflammatory conditions (Pizzorno & Murray, 2012) and in soothing post-operative nausea (Spanier, Howden & Jones, 2003).
• **Herbal prokinetics:** A prokinetic herbal preparation combining chamomile, bitter candytuft, angelica root, caraway fruits, milk thistle, lemon balm leaves, greater celandine, licorice root, and peppermint leaves have been reported in a double-blind, randomized, placebo-controlled, multi-center trial to improve abdominal pain and QOL in IBS (Madisch, Holtmann, Plein, & Hotz, 2004). Studies report that such herbal combinations can impact the entire symptom complex of IBS, due to effects on various parts of the GI, unlike more targeted herbal therapies that may only impact one symptom at a time (Ottillinger, Storr, Malfertheiner, & Allescher, 2013).

• **Vitamin D:** Deficiency was found to be prevalent among IBS patients and supplementation may play a therapeutic role in management of the condition (Khayyat & Attar, 2015).

• **Supplements in Support of IBD**

  • IBD is considered an incurable condition, and current treatment strategies aim at reducing inflammation and symptoms in IBD patients with surgery and/or medication. Common drug therapy involves combinations of anti-inflammatory drugs like sulfasalazine, corticosteroids, immune system suppressors and antibiotics in conjunction with over-the-counter pain relievers and nutritional supplements such as:

  • **Probiotics:** Patients with ulcerative colitis that were administered the probiotic VSL#3 had a reduction in their UC Disease Activity Index Score (UCDAI) (Bibilioni et al., 2005; Floch, 2005). Some individual strains have been shown to be beneficial as well, such as the probiotic strain *E. coli* Nissle 1917, which induced remission in patients with CD more quickly than an untreated control group (Malchow, 1997). In UC this same strain has been shown to be as effective as the pharmaceutical Mesalazine in supporting disease remission (Kruis et al., 2004).

  • **Saccharomyces boulardii:** Some research exists supporting the use of *saccharomyces boulardii* for reducing inflammation and diarrhea in IBD and for decreasing the risk for *C. difficile* infection (Guslandi, Giollo, & Testoni, 2003; Plein & Hotz, 1993; Guslandi, Mezzi, Sorghi, & Testoni, 2000; Garcia et al., 2007; McFarland, 2010).

  • **Fish oil:** Due to the prevalence of malabsorption, those with IBD are at risk of fatty acid deficiency (Socha et al., 2005). The anti-inflammatory effects of polyunsaturated fatty acids (PUFA) in fish oil may be useful in managing IBD conditions in the short term (Lee, 2008), however research is mixed on the efficacy of fish oil for maintaining remission in UC and CD (Lev-Tzion, Griffiths, Leder & Turner, 2014). A 1993 study found increased n3 and decreased n6 plasma PUFAs in patients with inactive IBD, suggesting an abnormality in PUFA metabolism in this population (Esteve-Comas et al., 1993).

  • **Fish protein hydrolysates (FPHs):** FPHs provide bioavailable peptides with antioxidant, immunomodulatory and antimicrobial properties, and have shown promise in repairing the intestinal lining (Nobile et al., 2016). FPHs have been shown to repair gastric injury in a variety of models, in particular due to the concentrations
Fitzgerald (2005) examined the efficacy of fermented FPHs in epithelial injury and repair in vitro and in vivo; a 59% reduction in gastric injury was seen in vivo at higher concentrations of FPH administration. FPHs also potentiate the secretion of IgA antibodies (Martínez-Augustin, Rivero-Gutiérrez, Mascaraque, & Sánchez de Medina). A deficiency of sIgA has been associated with IBD-like inflammation in humans (Martínez-Augustin et al., 2014), suggesting a potential for FPHs to contribute to disease treatment by modifying intestinal barrier function and inflammation in inflammatory bowel conditions, and in cases of damage related to NSAID drug use (Marchbank, Limdi, Mahmood, Elia, & Playford, 2008).

- **Folic acid**: Malabsorption and use of sulfasalazine drugs may result in folate deficiency in IBD populations (Burr, Hall, & Subramanian, 2016). Folic acid supplementation has been shown to decrease the risk of colon cancer and may have a local mucosal effect on cell replication (Burr et al., 2016).

- **Iron**: Intestinal blood loss, reduced iron absorption, iron retention within cells and poor iron utilization all contribute to the prevalence of iron deficiency anemia in IBD populations (Antunes et al., 2015) Oral or intravenous iron supplementation may be helpful in ameliorating symptoms and improving quality of life in anemic IBD subgroups (Gisbert et al., 2009).

- **Boswellia** (*Boswellia serrata*): This Ayurvedic herb contains boswellic acids with anti-inflammatory properties that may be effective in the treatment of IBD (Triantafyllidi, Xanthos, Papalois, & Triantafillidis, 2015). A small study comparing use of boswellia (900 mg) to use of sulfasalazine (3 g) in UC patients found that disease remission was twice as likely with use of boswellia compared to sulfasalazine therapy over the course of six weeks (Gupta et al., 2001).

- **Aloe vera**: The anti-inflammatory effects of aloe leaf seem to be effective in reducing disease activity in a portion of UC patients (Triantafyllidi et al., 2015).

- **Vitamin D**: Vitamin D deficiency is highly prevalent in IBD, increasing risk of low bone mineral density and fractures (Reich, Fedorak, Madsen, & Kroeker, 2014). Supplementation has been shown to reduce risk of CD relapse and improve IBD outcomes, likely as a result of the anti-inflammatory and immunomodulating effects of vitamin D in the gut (Reich et al., 2014).

- **Specialized Pro-Resolving Mediators (SPMs)**: Animal studies show that SPMs such as the lipoxin, resolvin, protectin and maresin families of lipid mediators help to facilitate the clearance of microbes and inflammatory components, resolving acute inflammation (Serhan, 2014). An in situ study of the lipoxin receptor FPR2 in colonic mucosal biopsies from patients with CD, found that FPR2 gene expression was increased by approximately six times in active CD, suggesting that lipoxin signaling is unregulated in inflammatory conditions (Prescott & McKay, 2011). Lipoxins enhance the clearance of invading microbes by macrophages and decrease production of inflammatory cytokines. Prescott and McKay conclude that lipoxin-
driven macrophage activity may play an important role in healing tissue in areas such as the gut, by resolving inflammation and allowing for eradication of bacteria that have penetrated the tissue (2011).

Medications: Drug-Nutrient Interactions and Adverse Effects

There are a number of important drug nutrient interactions that require consideration when evaluating and treating GI symptoms and disorders. In addition, there are a number of medications that can have a range of adverse effects on digestion and absorption. The classical and core medication issues involve the use of antibiotics (affecting normal gut microbiota), non-steroidal anti-inflammatory drugs (NSAIDs) that have GI toxicity and tissue damaging effects, (Harirforoosh, Asghar, & Jamali, 2014) and antacids or GERD medications (both OTCs and prescribed). While these medications are important and beneficial when appropriately recommended or prescribed, their overuse may contribute to health problems as well as the concern is that underlying causes of GI symptoms or disorders are not being addressed.

Examples of adverse effects and drug-nutrient interactions include:

- **Acid suppression medications (Antacids, PPIs):** Long term use can impair vitamin B12 status, decrease mineral absorption and nutritional status, and increase the risk of food allergy or intolerance (Pali-Schöll, & Jensen-Jarolim, 2011). Evidence suggests these medications can decrease microbial diversity (Seto, Jeraldo, Orenstein, Chia, & DiBaise, 2014) and PPI use has been positively associated with GERD, dyspepsia, IBS, and bloating (Choung, Locke, Schleck, Zinsmeister, & Talley, 2013).

- **NSAIDs:** Use of non-steroidal anti-inflammatory medications can increase upper GI bleeding, peptic ulcers (Yang et al., 2015b) and intestinal permeability causing sensitivity to bacterial and food antigens, thereby worsening symptoms in IBS and IBD (Jenkins et al., 1991; Ananthakrishnan et al., 2012). Additionally, these drugs can cause lower GI complications such as bleeding, perforation, obstruction, inflammation and ulceration as well as colitis (Lehmann, & Beglinger, 2005). NSAID use may also increase the risk of GERD by decreasing tone of the lower esophageal sphincter (Ruszniewski, Soufflet & Barthelemy, 2008). NSAIDS inhibit prostaglandin synthesis, causing ulceration throughout the GI (Hawkey, 2001). Traditional NSAIDS block both cyclooxygenase-1 and -2 (COX-1 and COX-2) enzymes, suppressing the gastroprotective mechanisms of COX-1 and increasing risk for intestinal damage. Inhibition of these enzymes likely contributes to both the efficacy and toxicity of these drugs (Yang et al., 2015b).

- **Antipsychotics and Antidepressants:** As discussed, antipsychotics and SSRI antidepressant medications are correlated with gastrointestinal disturbances such as constipation (Lindsey, 2009). Antidepressant medications have also been significantly correlated with bloating and may contribute to small intestine bacterial overgrowth (Choung et al., 2013). Use
of mental health drugs can alter appetite, and weight gain or weight loss may result (Bobroff, Lentz & Turner, 1999). Consequently, nutrient status should be carefully monitored.

- **Anti-inflammatory steroids**: Steroid medications are associated with an increase in upper intestinal damage and bleeding, in particular when these steroids are used concomitantly with high-dose NSAIDS (Hernández-Díaz & Rodríguez, 2001).

### Managing Common Nutritional Deficiencies

- The primary and ongoing concern that occurs secondary to many GI disorders is nutritional deficiency and insufficiency. As nutrient absorption declines or if intake is inadequate, deteriorating nutritional status occurs. A classic example would be susceptibility to osteopenia/osteoporosis with longstanding IBD from reduced vitamin D levels and inadequate calcium and magnesium intake or absorption, along with other key nutrients. Signs and symptoms of common nutrient deficiencies should therefore be identified and treated, as needed (See “Assessing Nutrient Deficiency” Handout).

### The Role of the Microbiome

The influence of the gut microbiome on human health is a very exciting area of research within nutrition and medicine that may have a significant impact on the assessment and management of GI disorders. The changing gut microbiome can be impacted by antibiotics, poor diet, genetics and other lifestyle factors, contribute to a range of symptoms and increase susceptibility to a variety of disorders and/or comorbidities including auto-immune diseases, allergies, obesity and diabetes, age-related diseases/premature aging, and chronic and complicated systemic imbalances (Jäger & Kuchroo, 2010; Rakoff-Nahoum et al., 2004; Hall et al., 2008; Kato et al., 2014; O’Toole & Jeffery, 2015). These conditions may also be compounded by adverse effects of environmental toxin exposures on gut microbiota balance (Wan, Wu, He, Tang, & Wang, 2015).

**Diet and the microbiome**: There is a growing body of literature describing which dietary factors and foods promote specific and healthy bacterial species in the GI tract. Diet has been shown to impact the landscape of the gut microbiome, particularly relating to consumption of fiber, other prebiotics and non-animal protein compared to diets high in animal protein, sugar and starches. A greater proportion of Firmicutes and *Prevotella* that metabolize dietary plant polysaccharides are associated with the former, more agrarian diet, while *Bacteroides* and bile-tolerant bacteria are associated with an industrialized diet (De Filippo et al., 2010; Albenberg & Wu, 2014; Wu et al., 2011; David et al., 2014). Vegetarian diets that are higher in carbohydrates and various types of fiber, also promote better microbiome profiles high in fecal short-chain fatty acids (SCFAs) such as butyrate by colonic bacteria. Butyrate can be used by the colon to promote tissue growth and inhibit inflammation and carcinogenesis (Hamer et al., 2008). It also has the potential to alter gene expression in the brain, and a high-fiber diet may be a significant factor in the prevention of neurological decline (Bourassa, Alim, Bultman, & Ratan, 2016). The Mediterranean diet, a prototypical healthy diet, also increases, *Prevotella* and *Enterococcus* (Lopez-Legarrea,
Fuller, Zulet, Martinez, & Caterson, 2014). As more research is done in this area, there is growing concern that modern diets are impacting chronic illness such as obesity and IBD by altering the genetic composition and metabolic activity of the human microbiome (David et al., 2014).

Another important impact of diet on the microbiome relates to foods exposed to antibiotics, pesticides and other treatments. Organic food have a greater diversity of microorganisms (Reganold et al., 2010), while foods exposed to toxins have been shown to disturb energy metabolism, alter protein and DNA synthesis and cause oxidative stress in animal models (Wan et al., 2015). More research is required to elucidate the precise dietary influences on microbiota, as well as their influences on immune, metabolic, and anti-inflammatory effects.

It is likely that the ongoing research into the microbiome will provide evidence to suggest that the presence or lack of certain microbial or bacterial species impact the pathogenesis or consequences of specific disorders. This means that there will be more precise information about which genus, species or strain might be potentially pathogenic, preventive, protective, or therapeutic for a variety of conditions. This is the aim of significant research projects such as the Human Microbiome Project.

**Impact of lifestyle factors on microbiome:** The primary lifestyle factors that can impact bowel microbiota are stress and exercise, although smoking does also have an impact as well. Research suggests that stress can decrease the presence of species of *Lactobacillus* that are known to be beneficial (Konturek et al., 2011). Other research suggests that gut microbiota diversity and healthy bacterial populations increase with exercise, further evidence of the impact that exercise has on well-being (Cerdá et al., 2016).

**Fecal Microbial Transplant (FMT):** There are compelling examples of the impact of microbial balance on disease through current fecal microbial transplant research. FMT involves the inoculation of a sick individual with stool from a healthy individual. It is used therapeutically in *C. difficile* infections and there is preliminary research on the efficacy of FMT therapy in IBD, obesity, metabolic syndrome and functional gastrointestinal disorders such as IBS (Rossen et al., 2015; Konturek et al., 2011; Gupta, Allen-Vercoe & Petrof, 2015). Ongoing research on stool transplant for obesity and Type 2 diabetes mellitus is showing promising results as well (Halmos & Suba, 2016). While it would be much easier to just provide general probiotic nutritional supplementation to all, future research will help answer the fundamental question of what is the ideal or optimal healthy bowel microbiota for a given population.

**Intervention and Treatment Stages**

**Stage I: Establishing the diagnosis and identifying the etiology**

Since patients suffering from gastrointestinal conditions often present with no clear diagnosis and experience various symptoms, the nutritional assessment described herein is a critical element of the process. The identification of underlying causes and contributing factors is the first step in a customized treatment approach.
Stage II: Developing the Management Plan and Expected Outcomes
Once assessment information is collected and causes and contributing factors identified, it is important to provide a comprehensive treatment program. This program can be modified based on ongoing assessment, changes in symptoms and/or testing. It is essential to make sure that the patient or client is engaged in implementing the program and prepared to adhere to the treatment plan. A comprehensive treatment plan involves assessment and implementation of a healthy foundational diet, use of targeted supplements to optimize nutrient status and healing as well as exercise and stress management techniques. A general guideline to clinical management of GI disorders can be found in the “Treatment Strategies” handout.

Ongoing Refinement of Program – The Science and Art of Healing
Refinement and enhancement of the initial treatment plan may be indicated based on results. In addition to nutritional refinement, the inclusion of other modalities such as acupuncture, chiropractic, massage, and/or mind-body approaches should be considered.

Behavioral Change Considerations
Because diet, exercise, and stress management are such key elements in an effective approach to managing digestive health symptoms and disorders, these lifestyle behaviors warrant a more thorough description. Therefore, documentation of dietary intake using a one-week food record or other means would be important as well as reporting of any symptoms that occurred during that time. Similarly, logging exercise regimens and other activities such as relaxation technique practices are essential to understanding how well a lifestyle framework has been established and whether or not it is being effectively adhered to. Asking the patient about their experience with each of these areas is also important to get feedback on what they think was most helpful, how easy or challenging each of the adjustments or changes were, and any other related issues, positive or negative, will be helpful to address.

It is increasingly difficult to manage these lifestyle factors in the current high-paced and stressful lives that we all seem to live. In many cases, there can also be traumas or stresses that are embedded in families, relationships, and other psychological or emotional problems from childhood related to self-esteem, conflict, and other circumstances that need to be dealt with. In such cases, co-management and/or referral to a licensed psychologist or other mental health therapist may be indicated. From a practical standpoint it is important to appreciate that each of these areas requires attention. The degree to which they are addressed and the specific approaches that are taken may best be led by the patient with the assistance or coaching from the practitioner. In many of the most chronic and complicated cases the involvement of a counselor, psychologist and/or spiritual advisor may be necessary so that this area is effectively addressed.
IV. Core Monitoring and Evaluation

Introduction

While the foundation of evaluating progress with digestive disorders is done both through symptom monitoring and objective measures, assessing changes in symptoms involves co-management by practitioners and patients. At the same time, practitioners should evaluate how well patients have established a nutrition and lifestyle program that produces the desired symptom resolution and disease management results. Self-management is an essential step so that there is a good understanding of food intolerances, supplement efficacy, and how much exercise and relaxation is necessary to most effectively manage symptoms. It also may be helpful to develop therapeutic and maintenance phases of a program to give patients the most flexibility, as well as to be able to control or manage symptoms when they are worse or if they feel that a relapse is beginning. This should be done cautiously however, since patients may have difficulty with maintaining an effective level of adherence to their program that does not cause a worsening of symptoms.

Ongoing Lab Assessment

Objective results are particularly important for GERD and IBD where endoscopy and colonoscopies can assess progress and disease status. From an integrative medicine standpoint, there are a range of other tests that can be helpful for monitoring progress on bowel microbiota, intestinal permeability, and other measures. There may be timing or cost issues and there is some debate regarding the usefulness of testing that has led practitioners and patients to focus on symptom responses or outcomes that will often improve empirically. Laboratory assessments may be most justified in chronic and more complicated issues.

Monitoring Behavioral Change

Monitoring behavioral change is a key factor in improving and managing digestive symptoms and disorders. Lasting lifestyle change can be difficult, and long-term success rates for dietary and exercise changes are generally very poor. There are however, some ways that success rate might be better for GI disorders than obesity, for example. Diet, supplementation, exercise, and stress management all have potentially beneficial effects and work together to help patients control their symptoms, which may provide motivation for ongoing adherence to a program. Patient-centered and individualized care is also helpful to ensure that practitioners work effectively to support each of the key areas of health management.

Health coaching and/or coaching techniques can improve outcomes of treatment as well. This includes the use of motivational interviewing, positive psychology, promoting self-efficacy and other similar approaches. When combined together, these techniques offer a strong behavioral change program for promoting lasting lifestyle change. The Transtheoretical Model of Behavior Change (Prochaska & DiClemente, 1983) can be used by the clinician to identify the stage of change of each patient. The initial intervention can then be tailored to help the patient move toward and remain in the maintenance stage.

The five stages of change are as follows:

1. Precontemplation
2. Contemplation
3. Preparation
4. Action
5. Maintenance
1. **Precontemplation**: Patients are unaware of a need for change or in denial of the need. Clinician should help patients identify the benefits of change.

2. **Contemplation**: when a patient recognizes a need to change but has not acted upon it. The clinician should help the patient resolve their ambivalence.

3. **Preparation**: The patient recognizes a need to change and has a willingness to change. The clinician should help the patient navigate perceived barriers and develop a plan of action.

4. **Action**: The patient has begun implementing the desired change. The clinician should provide support and guidance.

5. **Maintenance**: The patient has incorporated the desired change into their daily routine. The clinician should provide ongoing support and help prevent relapse.

Rarely do patients progress through these five stages in a linear sequential manner. Often patients transition backwards, from action back to contemplation or even from maintenance to precontemplation. It is important for the clinician to reassure patients that this is normal and to continue to assist the patient in moving back into the action and maintenance stages.

To determine a patient’s readiness to change, the clinician can begin by asking: *On a scale of 0 to 10 how important do you think it is to start a weight loss program now?* If the score is low, follow up with: *What would have to change in your life to bring that up one point or more?*

To determine a patient’s sense of self-efficacy or confidence in the ability to implement the behavioral change, ask the patient: *On a scale of 0 to 10 how confident are you that you can be successful in a program.* If the score is low, follow up with: *What do you need / what can I do to help to bring that confidence score up to match the importance score?*

Help develop the patients’ confidence by tapping into their strengths as identified from past success, which may or may not be related to weight loss. Ask the patient: *Tell me about something you did in the past where you set a goal and were successful?* Followed by: *To what do you attribute your success in achieving that goal? What behavior, resource, or, support helped you to be successful?* The same resources and strategies that helped the patient succeed in the past with other challenges in life (for example, having the support of a friend) may be helpful to them now as they embark on a lifestyle change. Clinicians should use the responses to these questions to help inform ways to personalize the management plan to cater to needs and strengths of each unique patient.

People often gravitate toward approaches that are most familiar and perceived ability to succeed is an important factor in patient motivation. While this is natural and helpful for moving forward, care is required to be sure that essential components of the program are not avoided or inadequately addressed. For example, stress or trauma can be an overriding issue and may need to be addressed in several ways including meditation, meditative-type exercises such as yoga, tai chi, and/or through counseling or other psychology-based or spirituality-based modalities.
Condition Specific Considerations

Many circumstances and factors should be addressed to produce successful outcomes. It is therefore important to maintain a context of individualized and effective treatment approaches. Some patients may respond quickly and dramatically, while others take a step or two forward and then have a minor or major setback that requires the reevaluation of the treatment plan. If setbacks occur, the treatment process may need to continue more slowly for any number of reasons and other practitioners or modalities may provide additional support in healing. A medical practitioner or allied healthcare provider’s role in treatment will be to work collaboratively and engage in the integrative medical model to ensure successful outcomes.

GERD: GERD can often be effectively managed using the strategies outlined in this module. Medications should be used prudently as they are primarily intended for short-term use and they may also lead to impaired digestion and absorption of nutrients. Specific strategies include smoking cessation (if applicable), identifying key dietary triggers, losing weight if overweight or obese, and effectively managing stressors.

IBS: Symptom control and disease management of IBS is also often achievable when the overall program elements described in this module are implemented. It should be noted that people with IBS have a 10 times greater risk of developing IBD (Rodríguez, Ruigómez, Wallander, Johansson, & Olbe, 2000) and a high proportion of IBS patients also have SIBO (Ghoshal & Srivastava, 2014). Medications are a last resort and are often not indicated because they do not address the underlying causes or contributing factors. Fruits and simple carbohydrate malabsorption may be a problem that some practitioners do not appreciate since they are generally healthy and certainly better than processed sugars. There are also nutritional status concerns with longer-term symptoms or dysfunction.

SIBO: Symptoms of SIBO often overlap with IBS symptoms, and since bacterial overgrowth is a prevalent comorbidity in IBS, treatment strategies used to address one may impact the other. Herbal therapy has been shown to be a very effective method of treatment for those with SIBO who do not meet the Rome III criteria for IBS (Chedid et al., 2014).

IBD: Of the four disorders, IBD is the most complex and difficult to manage. The primary goals with IBD are to maintain nutritional status and minimize intestinal permeability and inflammation. An integrative medical model of care is most important here to make sure that all of the key areas that promote optimal health and well-being are utilized. A team of practitioners may be necessary to fully support the patient or client. Comprehensive GI medical testing and assessment helps to monitor disease status and an integrative program can be used to develop and refine an individualized and comprehensive approach. Finally self-management is critical to the success of IBD management, and clients should be encouraged to fully participate and partner in managing their disease. This is particularly essential when patient feel that a relapse may be occurring.

An integrative medical approach as the foundation of treatment can improve outcomes, as various body systems may be impacted by IBD. In addition to maintaining nutrient status and healing the gut, stress management is an essential part of managing this condition. A range of other modalities may be employed such as
acupuncture, massage, and mind-body techniques to address the psychological aspects of disease management.

Summary and Conclusions

This digestive health module presents a framework to assist the practitioner in the management of digestive symptoms and disorders that are commonly seen in clinical practice. More tools and programs are available than ever before to assess and treat digestive health issues. Perhaps the most exciting and beneficial is information related to the microbiome which offers advancements in support of not only GI disorders, but also for preventive and therapeutic approaches for a range of other conditions such as auto-immune diseases and metabolic disorders including obesity and diabetes.

A few final points to remember are that:
(a) Digestive health is a key measure of overall health and well-being;
(b) Digestive health illustrates the importance of individualized medicine in order to achieve optimal health outcomes; and
(c) As with many of the most chronic or complicated patients, having the right combination of practitioners working together in an inter-professional or integrative collaboration will be most effective.

These characteristics of health and healthcare remind us of that medicine is both a science and an art. When both aspects of medicine are persistently and openly applied to clinical practice, the best results are achieved and patient satisfaction is highest. It is therefore up to our integrative medical community to effectively care for patients and clients with GI symptoms and disorders. Ongoing research will continue to support evidenced-based interventions, and integrative practitioners can work to educate the public and healthcare practitioner community about methods for comprehensive, individualized, and effective care.
Handouts (Appendix A)

1. Elimination Diet
2. Assessing Nutritional Deficiencies
3. Supplementation
4. Resources

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### About the Board for Certification of Nutrition Specialists

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The BCNS is committed to the concept that nutrition is both a profession and a powerful tool, and has encouraged a growing number of health professionals to obtain the necessary education and experience to utilize nutrition in practice. Thus, in addition to clinical nutritionists, the CNS credential may be obtained by advance-degreed health professionals who demonstrate the requisite knowledge and skills in clinical nutrition to become nutrition specialists.

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