FROM THE ACLM

PRESIDENT'S DESK

Dexter Shurney, MD, MBA, MPH

The Gut Microbiome: Unleashing the Doctor Within

Wisdom From the Past

Hippocrates said,

Everyone has a doctor in him or her; we just have to help it in its work. The natural healing force within each of us is the greatest force in getting well. Our food should be our medicine. Our medicine should be our food.

As we continue to embark on the transformation of health care, it will be increasingly important to educate and empower our patients about their body's amazing ability to heal itself. While this is not always an easy task, new research continues to provide us, as lifestyle medicine practitioners, with new ways to deliver our message. Perhaps no research is quite as exciting for lifestyle medicine as that of the human gut microbiome and its incredible and undeniable impact on human health.

Not surprisingly, it was Hippocrates who also coined the phrase, "All diseases begin in the gut." While 2000 years of time and research has demonstrated that not *all* diseases originate in the gut, an increasing number of conditions are linked to the complex ecosystem of microbes that reside in the gut. The most promising part? We have the unique ability to manipulate this ecosystem, and health outcomes, through practical

methods, many of which just so happen to be the pillars of lifestyle medicine.

The Human Microbiome

The human gastrointestinal (GI) tract is the complex plumbing system within; it is our first line of defense and our largest interface between the outside world. It is the microbial ecosystem, referred to as the gut microbiome, that is partially responsible for maintaining human health

which further stimulates the absorption of salts and water. The microbiome ensures protection from pathogenic colonization by competing for attachment sites and nutrients as well as through its ability to produce and secrete antimicrobials. In addition, healthy gut microbiota are essential for the development and homeostasis of the immune system. Structurally, certain bacteria in the microbiome have been shown to strengthen the

It is the microbial ecosystem, referred to as the gut microbiome, that is partially responsible for maintaining human health and is also associated with various diseases.

and is also associated with various diseases.

Trillions of microorganisms survive in our intestines that have protective, structural, and metabolic roles. Metabolically, the gut microbiota functions to produce vitamins and synthesize amino acids. It is also involved in bile acid biotransformation and the fermentation of nondigestible substrates into short-chain fatty acids,

mucus layer of the intestinal wall, which works as an obstacle to the uptake of proinflammatory molecules and antigens. Other bacteria are involved with strengthening the tight junctions of intestinal cell wall, which is partially responsible for keeping pathogens from entering the bloodstream.¹

Dysbiosis is a term used to refer to a microbiota community associated with a

diseased state that can be differentiated from the microbiota community associated with a healthy control state. Many factors can alter the ecosystem of the GI tract including antibiotics, psychological and physical stress, radiation, altered peristalsis, and dietary changes.² The exact relationship between dysbiosis and various disease pathogenesis is somewhat uncertain mainly due to the lack of definitive research in this area. It does appear clear that there is a bidirectional relationship between human gut dysbiosis and disease, especially diseases of inflammation. Not only does dysbiosis of the gut microbiome lead to certain diseases, certain diseases also alter the gut microbiome. Recent findings have illustrated a role of microbiota dysbiosis in cardiovascular disease, irritable bowel disease, *Clostridium difficile* infection, and inflammatory bowel disease,¹ as well as rheumatoid arthritis,³ colorectal cancer,⁴ obesity,⁵ and diabetes.⁶

Manipulating the Gut Microbiome

The gut microbiome is established at birth and is influenced by a variety of factors including birth method, infant feeding method, age, genetics, environmental exposures, hygiene, immune status, zip code, diet, and medication use; it is constantly evolving and unique to each person. A healthy microbiome is largely achieved by increasing the amount of “good” bacteria in the gut, which can be accomplished in a variety of ways.

Perhaps the most well-known and widely used method of altering the gut microbiome as a treatment option includes the protocol of using fecal microbiota transplantation (FMT) to treat *Clostridium difficile* infection (CDI). Cure rates of >90% are being consistently reported from multiple centers.⁷ CDI develops as a result of critical changes to the gut microbiota and is effectively treated by microbiota-based therapy. FMT CDI therapy is theorized to work by replacing or strengthening the protective

microbiome of natural colonic flora that has been disrupted by antibiotics and/or other environmental or iatrogenic factors.⁸

Arguably the most cost-effective and undervalued method of improving the gut microbiome is through manipulating the diet of the host. Diet is a particularly important factor in determining the microbiota composition of the gut⁹ and has been shown to rapidly respond to dietary changes.¹⁰

Prebiotics

Prebiotics are nondigestible food ingredients that beneficially affect the host by selectively stimulating the growth and/or activity of one or a limited number of bacteria in the colon, and thus improves host health.¹¹ These are essentially foods that feed and nourish the good bacteria in the gut. In general, eating high-fiber plant-based foods is a good foundation for a prebiotic-rich diet. Some foods that have been shown to be particularly helpful in improving the gut microbiome include asparagus, artichokes, onions, garlic, leeks, oatmeal, bananas, chicory root, honey, and beans.¹²

In addition to feeding a healthy gut flora, both soluble and insoluble dietary fiber in plant-based foods are important parameters in influencing the risk of chronic disease. Properties of dietary fiber, such as fermentability and viscosity, are thought to be important driving factors. Other compounds in foods containing dietary fiber, such as flavonoids, may also modulate the gut microbiota.¹³ Higher intakes of dietary fiber reduce the risk of developing several chronic diseases such as cardiovascular disease, type 2 diabetes, and some cancers, and have been associated with lower body weights. In addition, population studies indicate that groups who consume more dietary fiber have less chronic disease.¹³

Probiotics

Probiotics are live, active microorganisms ingested to alter the GI flora for health benefits. In the gut,

probiotics compete with harmful bacteria for adhesion sites to either rid the body of pathogens or increase the host's immune system. Benefits of probiotics were first recognized when people started eating fermented foods. Examples of probiotic-rich foods include sauerkraut, fermented vegetables, miso, tempeh, kimchi, kefir, green olives, wine, natto, sourdough bread, pickles, no-sugar added yogurt, and kombucha.¹⁴

The potential benefits of probiotics are widespread, but to date there is no standardized application for practice. The umbrella of probiotics includes hundreds of species of bacteria with even more strains, each performing a specific function or having a benefit when applied alone and/or in combination with another strain. The most commonly researched probiotic genera include *Lactobacillus*, *Bifidobacterium*, and *Streptococcus* along with yeast varieties which include *Saccharomyces boulardii*.¹⁴ Strains of *Lactobacillus* have demonstrated to improve health in a variety of ways including, but not limited to, help certain vaginal conditions, treat diarrhea, boost immunity, improve anxiety and depression, reduce infection risk, improve psychological health, improve symptoms of autism, decrease allergy symptoms in children, reduce inflammation, prevent dental caries, and neurological health. *Bifidobacterium* has shown to reduce inflammation through the stimulation of immune cells, improve eczema in infants, improve anxiety/depression, and reduce inflammation. *Saccharomyces boulardii*, found in the yeast used to make kombucha, has been used for almost 30 years to treat several GI conditions including CDI and diarrhea.

Implications of the Western Lifestyle

There is no argument that Western eating patterns are responsible for most chronic disease in the United States. Overall, Americans are getting too much

saturated fat, refined sugar, trans fats, refined grains, and cholesterol due to high intakes of sugary sweetened beverages and desserts, processed and unprocessed animal foods, and ultra-processed grain-based foods. On top of that, most are not getting adequate amounts of vitamins, minerals, fluid, or dietary fiber. As of 2015, the mean intake of dietary fiber in the United States was 17 g/day, with only 5% of the population meeting the adequate intake.¹⁵ The recommendation for dietary fiber is 25 g for adult women and 38 g for adult men. In lifestyle medicine circles, the guidance is often higher with minimum recommends of 40 g and 50 g for adult women and adult men, respectively.

The lack of plant-based, high-fiber, and prebiotic/probiotic foods in the Western diet has resulted in a decrease of healthy gut bacteria, a diminished mucus layer, and increased gaps in the junctions of cells that line the gut. This dysbiosis allows pathogenic “bad” bacteria to enter the bloodstream and populate, which increases systemic inflammation, risk for infection, and risk for chronic diseases.

In addition to Western diet, stress shows both direct and indirect effects on the functions of the GI tract, in particular on the mucus physiology and the composition of microbiota.¹⁶ Exercise, which we know to have a variety of benefits to the host in preventing chronic disease, has also been shown to improve the gut microbiome in animal and human studies.^{17,18} Another emerging lifestyle factor that also seems to be associated with gut microbiome is sleep, whether this impact is direct or indirect, causal or associative is still unclear at this time.

Although we have just begun to scrape the surface when it comes to comprehending the depths of information about the trillions of bacteria that live in the gut and how this ecosystem affects human health, we can acknowledge that for many of the same reasons that our Western lifestyles lead to the top preventable chronic diseases, they also lead to gut dysbiosis. Whether gut dysbiosis is the chicken or the egg

when it comes to chronic diseases is still unclear. One thing remains true, however, and it is that the principles of lifestyle medicine remain the gold standard of treatment for both.

Perhaps our careers in Western medicine have taught us that the difficulty in getting our patients from acceptance and education of lifestyle medicine to application is the lack of systems in place to make prevention models practical, lucrative, and ongoing. While we still have a lot to learn about how to transform health care, we can use what we know about the gut microbiome as yet another vehicle through which to educate our audiences. If we are all armed with an array of teaching tools and practical lifestyle applications, we can better empower our patients, colleagues, communities, and countries to unleash their inner healing powers and the doctor within.

Declaration of Conflicting Interests

The author(s) declared no potential conflicts of interest with respect to the research, authorship, and/or publication of this article.

Funding

The author(s) received no financial support for the research, authorship, and/or publication of this article.

Ethical Approval

This research protocol was approved by the Ohio University Institutional Research Board.

Informed Consent

Not applicable, because this article does not contain any studies with human or animal subjects.

Trial Registration

Not applicable, because this article does not contain any clinical trials. **AJLM**

References

1. Prakash S, Rodes L, Coussa-Charley M, Tomaro-Duchesneau C. Gut microbiota:

next frontier in understanding human health and development of biotherapeutics. *Biologics*. 2011;5:71-86.

2. Faith JJ, Guruge JL, Charbonneau M, et al. The long-term stability of the human gut microbiota. *Science*. 2013;341:1237-439.
3. Scher JU, Szczesnak A, Longman RS, et al. Expansion of intestinal *Prevotella copri* correlates with enhanced susceptibility to arthritis. *Elife*. 2013;2:e01202.
4. Kostic AD, Chun E, Robertson L, et al. *Fusobacterium nucleatum* potentiates intestinal tumorigenesis and modulates the tumor-immune microenvironment. *Cell Host Microbe*. 2013;14:207-215.
5. Le Chatelier E, Nielsen T, Qin J, et al. Richness of human gut microbiome correlates with metabolic markers. *Nature*. 2013;500:541-546.
6. Karlsson FH, Tremaroli V, Nookaew I, et al. Gut metagenome in European women with normal, impaired and diabetic glucose control. *Nature*. 2013;498:99-103.
7. Khanna S, Vazquez-Baeza Y, González A, et al. Changes in microbial ecology after fecal microbiota transplantation for recurrent *C difficile* infection affected by underlying inflammatory bowel disease. *Microbiome*. 2017;5:55. doi:10.1186/s40168-017-0269-3
8. Grehan MJ, Borody TJ, Leis SM, Campbell J, Mitchell H, Wettstein A. Durable alteration of the colonic microbiota by the administration of donor fecal flora. *J Clin Gastroenterol*. 2010;44:551-561.
9. Cani PD. Human gut microbiome: hopes, threats and promises. *Gut*. 2018;67:1716-1725.
10. David LA, Maurice CF, Carmody RN, et al. Diet rapidly and reproducibly alters the human gut microbiome. *Nature*. 2014;505:559-563.
11. Vinolo MA, Rodrigues HG, Nachbar RT, Curi R. Regulation of inflammation by short chain fatty acids. *Nutrients*. 2011;3:858-876.
12. Guarner F, Khan AG, Garisch J, et al; World Gastroenterology Organization. World Gastroenterology Organisation global guidelines: probiotics and prebiotics October 2011. *J Clin Gastroenterol*. 2012;46:468-481.
13. Tzounis X, Rodriguez-Mateos A, Vulevic J, Gibson GR, Kwik-Uribe C, Spencer JP. Prebiotic evaluation of cocoa-derived flavanols in healthy humans by using a randomized, controlled, double-blind, crossover intervention study. *Am J Clin Nutr*. 2011;93:62-72.

14. Ellis E. The potential of probiotics: exploring the promising world of probiotics, one species at a time. *Food and Nutrition*. <https://foodandnutrition.org/from-the-magazine/the-potential-of-probiotics/>. Published April 12, 2018. Accessed January 16, 2019.
15. Dahl WJ, Stewart ML. Position of the Academy of Nutrition and Dietetics: health implications of dietary fiber. *J Acad Nutr Diet*. 2015;11:1861-1870.
16. He J, Guo H, Zheng W, Yao W. Effects of stress on the mucus-microbial interactions in the gut. *Current Protein Pept Sci*. 2019;20:155-163.
17. Kang SS, Jeraldo PR, Kurti A, et al. Diet and exercise orthogonally alter the gut microbiome and reveal independent associations with anxiety and cognition. *Mol Neurodegener*. 2014;9:36.
18. Clarke SF, Murphy EF, O'Sullivan O, et al. Exercise and associated dietary extremes impact on gut microbial diversity. *Gut*. 2014;63:1913-1920.