Nutrition and the Immune system: Are we missing something?

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Outline

• Review of Gut/Immune system interaction
  – How do foods we eat affect the immune system?
  – Gut Brain Axis
• Nutrition in MS:
  – Is there a “Best” Diet
• What can we do now and why?
  – Fats, fiber, sodium, sugar, processed foods
  – Food records
  – Wellness Model (food as medicine, exercise, stress management)

Part 1

• Review of Gut/Immune system interaction
  – Review of the Digestive System
  – Review of the Immune system
  – How do foods we eat affect the immune system?
  – Gut Brain Axis
The Digestive System

Absorption of Nutrients


Immune System

• Innate and Adaptive
• Leukocytes
• Innate system = Phagocytes (Any cells that ingest)
  • Neutrophils – kills microbes then dies (pus)
  • Macrophages – Eats a lot (can also “present”)
  • Natural Killer cells – Can kill human cells
  • Dendritic Cells – Eats pathogen and carries to spleen or lymph nodes (passes intelligence)
  – Adaptive/Acquired system= Lymphocytes (have antigen receptors)
    • T-Cells – Mature in the Thymus, Cell mediated immunity
    • B-Cells – Mature in the Bone marrow, humoral mediate immunity

Immune system

• Peripheral lymphoid system
  – Peripheral lymph nodes and spleen
  – React to antigens that have entered tissues or spread to the blood
• Mucosal Associated Lymphoid Tissue (MALT)
  – Includes all mucus membranes (lungs, eyes, nose mouth, uterus, vagina, AND gut)
  – Gut Associated Lymphoid Tissue (GALT)
Gut Associated Lymphoid Tissue

• "The crucial position of the gastrointestinal system is testified by the huge amount of immune cells that reside within it. Indeed, gut-associated lymphoid tissue (GALT) is the prominent part of mucosal-associated lymphoid tissue (MALT) and represents almost 70% of the entire immune system; moreover, about 80% of plasma cells [mainly immunoglobulin A (IgA)-bearing cells] reside in GALT." (Vighi, G et al. 2008)

GI Tract and Immune System

• In medical terms the digestive system is “outside” the body.
• Bacteria in the GI tract outnumbers the total cells in our bodies by at least 10:1
• Normally a “Symbiosis” exists between the bacteria and the host
• “In the intestinal tract, the immune system must have tolerance to the normal intestinal flora yet respond to pathogenic microorganisms...”(Kudsk KA, Pierre JF, 2014)
Mucosal Immunity

- Cells in the Lamina Propria of lung and intestine
- Innate Immune system
  - Slows growth and/or lyses bacteria (Paneth cells)
    - Phospholipase A2 (sPLA2)
    - Lysozyme
    - Reg IIIγ
  - Mucous layer that covers intestinal epithelia surface
    (Goblet Cells)
- Adaptive Immune system – prevents attachment of bacteria to the luminal wall by producing immunoglobulin A (sIgA)
  - Preventing attachment = decreased bacterial invasion and epithelial stress

Adaptive Mucosal Immunity

- Naïve T and B cells are attracted to adhesion molecules produced/expressed by the Peyer’s Patch (lymph nodes of the intestines)
  - Peyer’s Patch includes:
    - M-Cells (microfold cells)
    - Dendritic cells
    - Macrophages

- The T and B cells are sensitized to the antigens → mesenteric lymph nodes → thoracic duct → bloodstream → lumen

- B Cells mature into IgA with the regulation of the T-cells cytokines (Th1 inhibitory OR Th2 stimulating)
Innate Mucosal Immunity

• Impacts the growth and composition of gut microbes
  – Paneth Cells (secrete antimicrobial peptides and proteins into the lumen)
    • Maintain a sterile environment
    • Reduction in Paneth Cells = increased inflammation
  – Goblet Cells (secretion of mucin glycoproteins)
    • Protect epithelium
    • Repairs damaged epithelium
    • Produces mucous
      – allows smooth passage of food during peristalsis
      – Maintain gut homeostasis (nutrient source to endogenous bacteria)

Complexity of the Mucosal Immune system
Managing the Micro Flora

• Dealing with a pathogen is a rare thing for our digestive immune system.
  – Most of its energy is spent managing our microflora
  – Several researchers proposed that our digestive immune system evolved not because of pathogens but to allow us to live in harmony with our microflora.

Inflammation

• If pathogens or even healthy bacteria make it to our blood our peripheral system mounts a STRONG inflammatory response (fever, chills, aches etc.)
  – Fortunately this rarely happens
• Our mucosal immune system in contrast is exposed to bacteria constantly
  – A strong inflammatory response every time would not be beneficial
  – Instead the gut becomes anergic (blocks inflammation) with help of T regulatory cells and a unique APC cell
Chronic Inflammation

What if things go wrong?

- When bacteria/pathogens become too great the mucosal immune system must take action
  - Antigen Presenting Cells (APC) lose their anergy.\(^{20, 21}\)
  - Inflammatory immune cells from the blood are recruited to the gut.
  - Anti inflammatory Treg cells give way to Th17 cells.
  - Th17 cells are highly effective at killing bacteria, but they can also be very damaging to our own bodies.
  - The Gut remains healthy as long as the infection ramps up and then back down when the threat is taken care of.
  - If the inflammation does not go down the inflammatory cells begin to take control – leaving the host in a constant inflammatory state
The Gut Brain Connection

• Chief among these is the concept of the brain–gut axis, a term which describes the complex bidirectional communication system that exists between the central nervous system (CNS) and the gastrointestinal tract (GIT) which is vital for maintaining homeostasis (Cryan and O’Mahony, 2011).
• Key Players:
  – CNS
  – Neuroendocrine system
  – Neuroimmune systems
  – Sympathetic and Parasympathetic arms of the autonomic nervous system (ANS)
  – Enteric nervous system (ENS)
  – Intestinal microbiota
Brain/Gut connection

To fully understand the gut-brain connection you need to be an endocrinologist, immunologist, pathologist and neurologist... anyone?!!!?? 😊

The gut and brain communicate in bi directional pathways via the:

1. **Nervous system**
   - Some of the Microbiome can release neurotransmitter
   - Signaling to vagal nerve

2. **Endocrine system**
   - The body responds to stress (mental or physical) via the hypothalamic-pituitary-adrenal axis
   - The beneficial gut bacteria help turn on/off the cortisol and adrenaline response
   - Each strain of bacteria have different effects (hunter and gather’s had much more mass/variety of gut bacteria than modern westernized humans)

3. **Immune System**
   - Far more complex than the endocrine system
   - Stress response does not distinguish between mental and physical distress
   - Under stress we release inflammatory cytokines with signal the immune system
   - Simply put the immune system deals with stress as if it were an infection
   - Gut plays a key role in regulating the immune system (previously explained in detail)

Mucosal Cell Brain Connection
Evidence thus far

- Rats raised germ-free have different production of key brain neuron fertilizers (including BDNF) that help with neuro regeneration, neuroplasticity, and repair than do rats that are colonized with gut bacteria (Dinan T, Cryan J; 2012).
  - BDNF being low is implicated in clinical depression, chronic anxiety syndromes, and other psychiatric disease.
- Stress can affect the microbiome (Wang Y; 2014)
  - Mice exposed to early parental loss have an immediate reduction in the amount of lactobacilli in the feces.
  - Some of these microbiota changes are long term, including decreasing some “friendly” bacteria and increasing the relative abundance of pathogenic bacteria such as Clostridium.

Evidence Continued

Pathways in gut-brain communication: evidence for distinct gut-to-brain and brain-to-gut syndromes. (Keightley PC, Koloski NA, Talley NJ; 2015)

RESULTS:

- Population surveys show a strong correlation between anxiety, depression, and functional GI disorders:
  - 5 and 12 year f/u- psychological distress can predict later onset of a functional GI disorder and vice versa.
- Brain to gut pathways include the autonomic nervous system, hypothalamic-pituitary-adrenal axis including corticotrophin (ACTH – increased release of cortisol) releasing factor directly acting on the gut
- Gut to brain pathways include:
  - Ascending pain pathways
  - Cytokines release including TNF in response to bacterial translocation and inflammation
  - 5-hydroxytryptamine (Serotoin – feeling of wellbeing) secretion by entero-endocrine cells
  - Psychoactive chemicals of bacterial origin which may enter the blood stream, such as gamma-aminobutyric acid (GABA – excitatory neuro transmitter)
Results continued

- The ability to control rodent temperament and HPA responsiveness with early modification of gastrointestinal flora, and the effects of early stress on the barrier function of the gastrointestinal tract and flora, suggests an ability of both systems to prime each other in early life for later problems.
- This hypothesis seems to be supported by a possible protective effect of a probiotic strain of bacteria in a model of early rat psychological trauma.

CONCLUSION:
- The next wave of research may involve preventative microbiological gut based treatments for primary psychological presentations.
Evidence

Hot topics in gut microbiota (Doré, J et al; 2013)

• Reduced contact of people with natural environmental biodiversity may adversely affect the human commensal microbiota and its immuno modulatory capacity. (Hansk I, Hertzon L, Fyhrquist N, et al 2012)
• Beneficial organisms (‘old friends’) are depleted from the modern urban environment and lifestyle. (Rook GA 2012, Blaser MJ, Falkow S 2009)
• There is evidence that diminished exposure to microbial biodiversity in early life leads to defective immuno regulation, exaggerated cytokine response to social stressors and susceptibility to depression. (Diaz Heijtz et al. 2011; Bailey MT et. Al 2011)
• An inflammation-associated form of depression identified in rich countries appears to be unusual in developing countries (McDade TW 2012, Rook GAW 2013)

• A role of intestinal microbiota on the development of stress, emotion and pain modulation systems has been identified involving neuroplastic changes in emotion regulation regions and signaling systems (Diaz Heijtz R 2011)
• Healthy women demonstrated that a four-week intake of a fermented milk product with probiotic affected activity of brain regions that control central processing of emotion and sensation (Tillisch K, Labus J, Kilpatrick L et al. 2013)
• In humans, a putative link between altered serotonin biology along the gut-brain axis and autistic spectrum disorder (ASD) is proposed. Evidence for altered gut microbiota in ASD is accumulating and includes: higher levels of Bacteriodetes and lower levels of Firmicutes, and an increase in lactobacilli and reduction in bifidobacteria (Prasad HC et al 2009; Finegold SM, et al 2010)
Commensal microbiota is fundamental for the development of inflammatory pain.  
(Amaral FA, Sach D, Costa V et al; 2008)

**Background:**
- The ability of an individual to sense pain is fundamental for its capacity to adapt to its environment and to avoid damage.
- The sensation of pain can be enhanced by acute or chronic inflammation.
- This study investigated whether inflammatory pain, as measured by hyper nociceptive responses, was modified in the absence of the microbiota.
- Also evaluated mechanical nociceptive responses induced by a range of inflammatory stimuli in germ-free and conventional mice.

**Results:**
- Inflammatory hyper nociception was reduced in germ-free mice. Reduction of hyper nociception induced by carrageenan was associated with reduced tissue inflammation and could be reversed by reposition of the microbiota or systemic administration of lipopolysaccharide.
- Significantly, decreased hyper nociception in germ-free mice was accompanied by enhanced IL-10 (down regulates immune stimulation) expression upon stimulation and could be reversed by treatment with an anti-IL-10 antibody.

**Conclusion:** Contact with commensal microbiota is necessary to develop inflammatory hyper nociception. These findings implicate an important role of the interaction between the commensal microbiota and the host in favoring adaptation to environmental stresses, including those that cause pain.
Pathways involved in bidirectional communication between the gut microbiota and the brain. Multiple external direct and indirect pathways exist through which the gut microbiota can modulate the gut-brain axis. They include endocrine (hormonal), immune (cytokines) and neural (nervous and enteric nervous system) pathways. The brain regulates these mechanisms to influence the composition of the gut microbiota, for example, under conditions of stress. The hypothalamic-pituitary-adrenal axis regulates cortisol secretion, and cortisol can affect neurones (including cytokine secretion) both locally in the gut and systemically. Cortisol can also alter gut permeability and barrier function, and change gut microbiota composition. Conversely, the gut microbiota and probiotic agents can alter the levels of circulating cytokines, and this can have a marked effect on brain function. Both the vagus nerve and modulation of enteric nervous system levels are strongly implicated in linking the influence of the gut microbiota to the brain. In addition, short-chain fatty acids are respiratory bacterial metabolites of dietary fibres that can also modulate brain functions.

This diagram depicts a human brain, the gut-brain axis as a physiological mechanism that maintains health in humans. At Alacrite we recommend that you supply your horse by normalising the gut-brain axis that before it falls into a state of dysbiosis.
Part 2

• Nutrition in MS
  – Why do we think food and MS may be related?
  – Is there a “Best” Diet?

Role of "Western diet" in inflammatory autoimmune diseases.
(Manzel A, et al; 2014)

• Developed societies, although having successfully reduced the burden of infectious disease, constitute an environment where metabolic, cardiovascular, and autoimmune diseases thrive.
• Nutritional patterns collectively termed the "Western diet", including, high-fat and cholesterol, high-protein, high-sugar, and excess salt intake, as well as frequent consumption of processed and 'fast foods', promote obesity, metabolic syndrome, and cardiovascular disease.
• These factors have also gained high interest as possible promoters of autoimmune diseases. Underlying metabolic and immunologic mechanisms are currently being intensively explored.
Multiple Sclerosis

PREVALENCE BY COUNTRY (2013)

People per 100,000 with MS
- >100
- 60.91-100
- 26.01-40
- 5.01-20
- 0-5
- Data not provided

Caloric Intake

[World map with color coding indicating caloric intake]
Meat consumption

Poor nutrition in persons with MS

• Fatigue
  – Too tired to cook or eat (skip meals)
  – Decreased activity/calorie expenditure

• Depression
  – Increased high fat foods/sweets
  – Increased appetite to to antidepressants
  – Eating for comfort or loss of appetite

• Mobility/limitations
  – Difficulty chewing/swallowing
  – Difficulty getting to the store and/or preparing meals
Swank MS Diet

- Saturated fat should not exceed 15 grams per day.
- Unsaturated fat (oils) should be kept to 20-50 grams per day.
- No red meat for the first year.
- After the first year, 3 oz. of red meat is allowed once per week.
- Dairy products must contain 1% or less butterfat unless otherwise noted.
- No processed foods containing saturated fat.
- Cod liver oil (1 tsp. or equivalent capsules) and a multivitamin and mineral supplement are recommended daily.
Wahls Diet

Created by Dr. Terry Wahls who was diagnosed with Multiple Sclerosis in the year 2000, by 2003 she was w/c bound

- In 2007, she developed a diet that was designed to feed her mitochondria. After one year on the diet, she no longer needed the wheelchair and was able to bike 18 miles
- Wahls Diet has 3 levels, to help people transition to healthier eating.
  - **Level 1 – The Wahls Diet**: no gluten, no eggs, no dairy (with the exception of ghee), no refined oils, limited sugar and no processed foods.
  - **Level 2 – The Wahls Paleo Diet**: Level 1 PLUS: (1) Reduce consumption of non-gluten grains, white potatoes, and legumes to only twice per week and remove soy altogether (with the exception of fermented soy). (2) Increase meat consumption to a minimum of 9 ounces daily. (3) Increase your healing foods to include organ meats, seaweed, fermented foods, soaked nuts/seeds, and more raw foods.

LEVEL 3 – Wahls Paleo Plus

- This is the diet Terry personally follows
  - Ketogenic diet (high fat, low-carb and moderate protein)
    - Unlike conventional ketogenic diets, it is specifically designed to include 6 cups of vegetables daily for nutrient density
    - Still maintaining ketosis through the chemistry of eating **5 tablespoons of coconut oil per day**.
    - Requires 100% compliance, eliminating all grains, legumes, soy and white potatoes, and limiting starchy vegetables to two servings per week and fruit to 1 cup of berries daily. Protein is reduced according to size and gender, with the emphasis of shifting the body to burning fat for energy. It also adds an element of intermittent fasting.
Paleo Diet

- The Paleo Diet was first introduced in the 1970’s by Dr. Walter L. Voegtlin
  - Based on the belief that evolution is a slow process, and our bodies haven’t evolved to handle the modern diet.
  - In fact, our bodies haven’t evolved past the hunter-gatherer stage,
  - Autoimmune protocol to specifically help ease the symptoms of autoimmune disorders
    - Limits nuts, seeds, beans, grains, sweeteners, dried fruits, dairy, processed foods, alcohol, chocolate, eggs, gums, nightshades (including all peppers/spices), vegetable oils, herbs from seeds, tapioca
    - 6-8 weeks then re-introduce only 1 food every 5 days
    - Avoid FODMAPS

Differences between Whal’s and Paleo?

- Dairy is removed from the Wahls Protocol permanently, and eggs are removed for 3 months and then reintroduced to test for tolerance
- Nuts, seeds and nightshades are freely allowed and only removed later if you don’t heal with the regular template.
- The AIP removes all of these foods for the elimination period, and allows all of them to be tested for tolerance during the reintroduction period
Gut and Psychology Syndrome Diet (GAPS)

Created by Dr. Natasha Campbell-McBride
- She credits the Specific Carbohydrate Diet (created in the 1950's by Dr. Sidney Haas)
- Foundation is that a damaged digestive tract cannot break down specific types of carbohydrates (grains, starches and refined sugars) and this leads to an overabundance of harmful bacteria which further irritate the digestive tract, causing further difficulty digesting food, resulting in a vicious cycle. By eliminating these carbohydrates from the diet, the digestive tract can heal, and with it, associated digestive disease.
- Campbell-McBride had a child who was autistic.
  - Variation is an emphasis on nutrient-dense foods and the addition of a detox program.
  - Believes she cured her son The GAPS Diet is divided into two parts: The Introduction Diet and the Full Diet

FODMAP

- Carbohydrates vary in form from long-chain carbohydrates (e.g. starch) to simple sugars (e.g. glucose) that are well-digested and absorbed to produce energy.
- Fiber and resistant starch are long-chain carbohydrates resistant to digestion and are important for stool formation and normal bowel function.
- The Australian group has produced strong evidence that a group of short-chain carbohydrates, named FODMAPs (Fermentable Oligo-saccharides, Di-saccharides, Mono-saccharides And Polyols) are problematic for those with IBS.
- These short-chain carbohydrates are poorly absorbed in the small intestine and rapidly fermented by bacteria in the gut. The production of gas by these bacteria is a major contributor to symptoms.
### Comparison of 3 “Healing Diets”

**Wahls, GAPS, Paleo**

<table>
<thead>
<tr>
<th>Avoid refined sugars and limit natural sugars</th>
</tr>
</thead>
<tbody>
<tr>
<td>Avoid all packaged and processed foods (mostly because of the additives they contain)</td>
</tr>
<tr>
<td><strong>Grain Free</strong> (no wheat, rice, oats, amaranth, quinoa, millet, barley, buckwheat, rye, spelt or corn)</td>
</tr>
<tr>
<td><strong>Dairy</strong> is a common food intolerance</td>
</tr>
<tr>
<td>• Wahls eliminates it</td>
</tr>
<tr>
<td>• GAPS reintroduces after a period of elimination</td>
</tr>
<tr>
<td>• Paleo – eliminate or use raw</td>
</tr>
<tr>
<td><strong>Eliminate or limit legumes (dried bean family)</strong></td>
</tr>
<tr>
<td>• Wahls – slowly transitions away</td>
</tr>
<tr>
<td>• Paleo – eliminates</td>
</tr>
<tr>
<td>• GAPS – only allows lentils, split peas and white navy beans</td>
</tr>
<tr>
<td><strong>Soy Free</strong></td>
</tr>
<tr>
<td><strong>Starch importance of fats!</strong> (important building blocks for hormone and metabolism – brain is 2/3rds fat!)</td>
</tr>
<tr>
<td><strong>Starch - Root veggies have varying starch contents (potatoes high, beets low)</strong></td>
</tr>
<tr>
<td>• GAPS - only allows those with the lowest starch content: beets, carrots and winter squash, believing that starch feeds harmful bacteria in the body.</td>
</tr>
<tr>
<td>• Wahls - prioritizing non-starchy vegetables.</td>
</tr>
<tr>
<td>• Paleo – Varies – some restrict all together, others feel you starve both harmful and beneficial bacteria</td>
</tr>
</tbody>
</table>
### Comparison of 3 “Healing Diets”
Wahls, GAPS, Paleo

<table>
<thead>
<tr>
<th>Non Starchy vegetables</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Wahls – 9 cups a day! (3 cups leafy greens, 3 cups sulfur rich, 3 cups colorful)</td>
</tr>
<tr>
<td>• Paleo – Infinite amount of non-starchy vegetables (however people usually get caught up in meat eating!)</td>
</tr>
<tr>
<td>• GAPS – Focuses on fiber filled vegetables (introduction diet fiber is removed to help heal the digestive tract, then on full diet non starchy veggies are allowed)</td>
</tr>
</tbody>
</table>

| Nutrient Rich foods are emphasized                                         |
|• Bone broths, organ meats, egg yolks and naturally fermented foods         |

| Organic vegetables and grass-fed meats is stressed (reduce pesticides and antibiotics/hormones) |

| Detoxification                                                                 |
|• GAPS and Wahls have detox components                                        |
|• Detox baths, saunas, removing home toxins                                    |

| Vitamin D is a must                                                           |
|• Incorporate getting sunlight 15-30 minutes daily                             |

| Lifestyle changes are encouraged                                               |
|• Time outdoors, natural exercise, socialization, quality sleep, fresh air, meditation |

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**JERF Diets 😊**

- **JUST EAT REAL FOOD**
- **NOT DIETS – TLC, DASH, Mediterranean – Healthy Dietary patterns**
- Consume a dietary pattern that emphasizes intake of vegetables, fruits, and whole grains; includes low-fat dairy products, poultry, fish, legumes, non tropical vegetable oils and nuts, and limit intake of sodium, sweets, sugar-sweetened beverages and red meats.
Comparison of the “Best US Diets”

1. DASH Diet - Endorsed by the U.S. Department of Health and Human Services, DASH is meant to prevent high blood pressure. It's heavy on produce and low in saturated fat and salt.
2. TLC Diet - The National Institutes of Health developed this plan. It's high in fiber and calcium and low in saturated fat.
3. Mediterranean Diet - This eating plan includes lots of whole grains, fresh fruits and vegetables, salmon, and "heart-healthy" fats such as olive oil. Red wine in moderation is encouraged.

Therapeutic Lifestyle Change Diet

- **TLC diet** does not primarily target weight-loss; instead, it is for maintaining an ideal body weight and determining the ideal daily calorie intake.
  - Intake of saturated fat should be kept below 7 percent of the total calorie intake
  - Daily cholesterol intake should be kept below 200 milligrams
  - Sodium intake must be limited to 2400 mg per day
  - 25-35% of daily total calories should come from fat intake
  - Calorie intake should be kept to a level needed for maintaining healthy weight
  - Physical activity must be maintained regularly along with the diet, i.e. at least 30 minutes of exercise each day.
Mediterranean Diet

DASH DIET

- The DASH diet eating plan is a diet rich in fruits, vegetables, low fat or nonfat dairy. It also includes mostly whole grains; lean meats, fish and poultry; nuts and beans.
- It is high fiber and low to moderate in fat.
- It is a healthy way of eating, designed to be flexible enough to meet the lifestyle and food preferences.
- Americanized version of the Mediterranean diet, and to be easier to follow, since it has more specific guidelines.
- Designed to lower blood pressure, and was not specifically a weight loss plan.
- Discourages refined and processed foods, which are mostly empty calories.
- You can see sample menus for the original plan, the weight loss plan, and vegetarian plan.

DASH diet

<table>
<thead>
<tr>
<th>Type of Food</th>
<th># of servings 2,000 calories</th>
<th># of servings 1600-3100 calories</th>
</tr>
</thead>
<tbody>
<tr>
<td>Grains and grain products</td>
<td>7-8</td>
<td>6-12</td>
</tr>
<tr>
<td>Fruits</td>
<td>4-5</td>
<td>4-6</td>
</tr>
<tr>
<td>Vegetables</td>
<td>4-5</td>
<td>4-6</td>
</tr>
<tr>
<td>Low Fat or non fat dairy foods</td>
<td>2-3</td>
<td>2-4</td>
</tr>
<tr>
<td>Lean Meats, Fish, Poultry</td>
<td>2 or less</td>
<td>1.5-2.5</td>
</tr>
<tr>
<td>Nuts, Seeds, Legumes</td>
<td>4-5</td>
<td>3-6</td>
</tr>
<tr>
<td>Fats and Sweets</td>
<td>Limited</td>
<td>2-4</td>
</tr>
</tbody>
</table>

Part 3

• What we can be doing now and why?
  – Fats, fiber, sodium, sugar, processed foods
  – Food records
  – Wellness Model (food as medicine, exercise, stress management)
Recommendations?

1. Avoid Processed Foods (if you do that, you can probably skip the rest 😊)
2. Fats in Moderation
   - Trans fats vs. Cis fats
   - Saturated vs. Unsaturated
   - Omega 3/Omega 6 ratio
3. Decrease Sugar
4. Decrease Sodium
5. Increase Fiber

Processed Foods

- The definition can vary slightly, but it usually refers to foods that are packaged in boxes, cans or bags.
- Processed extensively to be edible and are not found as is in nature.
- Processed foods often contain additives, artificial flavorings and other chemical ingredients.
- Processed foods often contain some type of chemically processed vegetable oil (corn, cottonseed, soybean, canola, safflower) = TRANS FATS
  - Olive oil, avocado oil and nut oil, which can be simply obtained with a cold-press are a better choice
- Low-Fat Products contain chemical ingredients to simulate the flavor and texture of fat
- Refined sugars, high-fructose corn syrup, and sugar substitutes (sugar free), such as aspartame, sorbitol and sucralose, are also processed ingredients
Trans Fats

• While some natural trans fats occur in meat and dairy products, the majority of trans fats come from processed foods (i.e., hydrogenated oils).

• Arrangement of atoms
  – Cis Fats = The chains of carbon atoms are on the same side of the double bond, resulting in a kink.
  – Trans Fats = Hydrogen atoms are on the opposite side of the double bonds of the carbon chain, making the fat molecule straight. (Easy to pack, higher melting point, usually solid at room temperature, last longer)

Cis-Fat – Molecular Structure
Trans Fat – Molecular Structure

Saturated vs. Unsaturated

- **Saturated**
  - Solid at room temperature
  - Common sources of saturated fat include red meat, whole milk and other whole-milk dairy foods, cheese, coconut oil
  - The word "saturated" here refers to the number of hydrogen atoms surrounding each carbon atom. The chain of carbon atoms holds as many hydrogen atoms as possible
  - A diet rich in saturated fats can drive up total cholesterol, and tip the balance toward more harmful LDL cholesterol
  - Most nutrition experts recommend limiting saturated fat to under 10% of calories a day

- **Unsaturated fats**
  - come mainly from vegetables, nuts, seeds, and fish.
  - liquid at room temperature, not solid.
  - There are two broad categories: monounsaturated and polyunsaturated fats
Unsaturated Fats... there is more 😊

- Monounsaturated Fats
  - have a single carbon-to-carbon double bond. The result is that it has two fewer hydrogen atoms than a saturated fat and a bend at the double bond. This structure keeps monounsaturated fats liquid at room temperature.
  - Mediterranean region - low rate of heart disease despite a high-fat diet. The main fat is not the saturated animal fat but olive oil, which contains mainly monounsaturated fat.

- Polyunsaturated fats are *essential* fats
  - used to build cell membranes and the covering of nerves.
  - Needed for blood clotting, muscle movement, and inflammation.
  - A polyunsaturated fat has two or more double bonds in its carbon chain.
    - Two main types of polyunsaturated fats: omega-3 fatty acids and omega-6 fatty acids
    - The numbers refer to the distance between the beginning of the carbon chain and the first double bond. Both types offer health benefits.

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### Omega 3 vs Omega 6

<table>
<thead>
<tr>
<th>Omega-3</th>
<th>Omega-6</th>
</tr>
</thead>
<tbody>
<tr>
<td>&quot;Good&quot; Eicosanoids</td>
<td>&quot;Bad&quot; Eicosanoids</td>
</tr>
<tr>
<td>Prevents blood clots caused by platelet aggregation</td>
<td>Promotes blood clots caused by platelet aggregation</td>
</tr>
<tr>
<td>Causes the dilation (opening) of blood vessels</td>
<td>Causes constriction (closing) of blood vessels</td>
</tr>
<tr>
<td>Reduces pain</td>
<td>Increases pain</td>
</tr>
<tr>
<td>Decreases cell division</td>
<td>Increases cell division</td>
</tr>
<tr>
<td>Enhances the immune system</td>
<td>Depresses the immune system</td>
</tr>
<tr>
<td>Improves brain function</td>
<td>Depresses brain function</td>
</tr>
</tbody>
</table>
The importance of the ratio of omega-6/omega-3 essential fatty acids.
(Simopoulos AP; 2002)

- Several sources of information suggest that human beings evolved on a diet with a ratio of omega-6 to omega-3 essential fatty acids (EFA) of approximately 1
  - **Western diets the ratio is 15/1-16.7/1.**
- Excessive amounts of omega-6 polyunsaturated fatty acids (PUFA) and a very high omega-6/omega-3 ratio, as is found in today's Western diets, promote the pathogenesis of many diseases, including cardiovascular disease, cancer, and inflammatory and autoimmune diseases

Omega 3/6 ratio’s

- In the secondary prevention of cardiovascular disease, a ratio of 4/1 was associated with a 70% decrease in total mortality.
- A ratio of 2.5/1 reduced rectal cell proliferation in patients with colorectal cancer,
- Lower omega-6/omega-3 ratio in women with breast cancer was associated with decreased risk.
- Ratio of 2-3/1 suppressed inflammation in patients with RA,
- Ratio of 5/1 had a beneficial effect on patients with asthma
- These studies indicate that the optimal ratio may vary with the disease under consideration.
- The therapeutic dose of omega-3 fatty acids will depend on the degree of severity of disease resulting from the genetic predisposition.
Evolutionary aspects of diet, the omega-6/omega-3 ratio and genetic variation: nutritional implications for chronic diseases. (Simopoulos AP; 2007)

- Increased dietary intake of linoleic acid (LA) leads to:
  - Oxidation of low-density lipoprotein (LDL)
  - Platelet aggregation
  - Interference of the incorporation of EFA in cell membrane phospholipids
- Both omega-6 and omega-3 fatty acids influence gene expression.
  - Omega-3 fatty acids have anti-inflammatory effects, suppress interleukin 1beta (IL-1beta), tumor necrosis factor-alpha (TNFalpha) and interleukin-6 (IL-6)
- Dietary arachidonic acid (AA) and LA increase the risk for cardiovascular disease in those with the variants, whereas dietary intake of eicosapentaenoic acid (EPA) and docosahexaenoic acid (DHA) decrease the risk.
America’s Sugar Problem

• 1822: Americans consume 45 grams of sugar every five days, or the amount of sugar in a can of coke.
• 2012: Americans consume 756 grams of sugar every five days, or 130 POUNDS of sugar a year.
• Sweet receptors evolved in ancestral environments poor in sugars and are thus not adapted to high concentrations of sweets.
• Extreme stimulation of these receptors by sugar-rich diets generate a supranormal reward signal in the brain, with the potential to override self-control mechanisms and thus to lead to addiction. (Lenoir, M et al; 2007)

Role of sugars in human neutrophilic phagocytosis
(Sanchez, A et al; 1973)

• Venous blood was drawn from the arm after an overnight fast and at 0.5, 1, 2, 3, or 5 hr postprandial.
• The phagocytic index (mean number of bacteria viewed within each neutrophil) was determined by microscopic examination.
• Oral 100-g portions of carbohydrate from glucose, fructose, sucrose, honey, or orange juice all significantly decreased the capacity of neutrophils to engulf bacteria as measured by the slide technique.
• The decrease in phagocytic index was rapid following the ingestion of simple carbohydrates.
• The decreased phagocytic index was not significantly associated with the number of neutrophils. These data suggest that the function and not the number of phagocytes was altered by ingestion of sugars.
• This implicates glucose and other simple carbohydrates in the control of phagocytosis and shows that the effects last for at least 5 hr.
Sugars 😞

- Raises insulin levels → releases growth hormones → Depresses immune system
- Insulin also promotes the storage of fat
- Complex carbohydrates tend to be absorbed more slowly, lessening the impact on blood-sugar levels
- Glucose and Vitamin C have similar chemical structures
  - Compete for one another to enter cells
  - More glucose than Vitamin C – Glucose gets in
  - Vitamin C needed to enhance phagocyte activity (eating bacteria)
- Refined dietary sugars lack minerals and vitamins
  - Utilization of the body’s micro-nutrient stores needed to metabolize
  - Depleting these nutrients impedes cholesterol and fatty acid metabolism = higher blood serum triglycerides and cholesterol

Is Fruit OK?

- Fruit contains fructose (a naturally occurring sugar)
  - ALSO contains fiber, vitamins and minerals.
  - It does effect your blood sugar but not in the same way as refined sugar
- Fruit juices – more of a problem
  - The juice is squeezed, giving you all of the juice but very little of the fiber or nutrients
Sugar Alternatives

- **Honey** – A study comparing honey to various types of compounds resulted in good results:
  - "Overall, honey improved blood lipids, lowered inflammatory markers, and had minimal effect on blood glucose levels." Along with that, honey resulted in a lower blood glucose spike in rats compared to other types of sugar. (Nazir et al.; 2014)
- **Agave Nectar**
  - Unfortunately, despite the fact that it comes from a cactus (which is natural!), very processed and similar to high fructose corn syrup.
- **Aspartame**: Some studies cite an increased link with aspartame and cancer
- **Sucralose**
  - Artificial sweetener
  - Non-caloric (Because the body can’t break it down)
  - 600 times as sweet as sucrose (table sugar)
- **Stevia**
  - Naturally occurring sweetener from the Sunflower family.
  - 300 times sweeter than table sugar
  - Allegedly has a lower effect on blood glucose levels
  - Has been used in Japan and South America with minimal adverse effects.
- **Saccharin**
  - Artificial sweetener
  - It was linked to increased risk of cancer within laboratory rats and labeled as dangerous by the US,
  - Label was removed in 2000 due to the fact that the results couldn’t be replicated in humans.

**Bottom Line**: EAT LESS SUGAR and if you do eat it, get it from fruit or naturally occurring sweeteners.

High Fructose Corn Syrup?

- Molecularly similar to other refined sugars but seems to affect the body differently.
- A recent study conducted by Princeton University concluded (Bocarsly, ME et al; 2010):
  - Rats with access to high-fructose corn syrup gained significantly more weight than those with access to table sugar, even when their overall caloric intake was the same.
  - Long-term consumption of high-fructose corn syrup also led to abnormal increases in body fat, especially in the abdomen, and a rise in circulating blood fats called triglycerides.
Sodium

  - 2 groups of patients with MS
  - 1st group n=70 with RRMS followed longitudinally for 2 years, Sodium intake was estimated from urine and serum samples
  - 2nd group n=52 replicated the 1st group
- The patients had an average daily salt intake of approximately 4 g per day
- Higher sodium intake was significantly associated with greater exacerbations.
  - Compared patients with < 2 g per day, those with an average daily intake of 2 to 4.8 g had a symptom exacerbation rate that was 2.75 times higher and among those with an average daily intake of 4.8 g or higher, the risk was 3.95 times higher.
- Patients with sodium intake above the national average showed a 3.4-fold increased chance of developing a new lesion on MRI and were found to have, on average, as many as 8 more T2 lesions.

Sodium continued

- Among the theories on the mechanisms that could explain the association is the possibility that sodium intake boosts the generation of TH17 cells, which are the subset of T cells that are primarily implicated in the autoimmune response in patients
- “Still another theory is that the modulation of gut flora caused by high sodium intake could have an effect because gut flora interacts with the immune system and could therefore affect MS disease activity.

Other explanations for the correlation?
- “Individuals with more relapses, for instance, may have received more steroids and therefore had increased salt intake and excretion due to the higher disease activity and not the other way around,” he said, “although we think this is unlikely because we separated sodium intake assessment from steroids intake.”
- In addition, patients with increased disease activity who may have hypothalamic lesions can develop inappropriate antidiuretic hormone secretion and therefore excrete higher amounts of sodium.
- “There is no evidence yet that MS patients who reduce salt intake show improvements in symptoms. This is the next step — to see if reducing salt intake actually makes a difference.”
Fiber

- **Soluble fiber**
  - Dissolves in water and becomes a gelatinous form
  - Slow digestion and increases absorption of vital nutrients from some foods
  - Helps lower blood cholesterol and glucose levels
- **Insoluble fiber**
  - stays in its fibrous form, helps food pass through the digestive system and adds bulk to the stool, which helps you to stay regular
  - Whole-wheat flour, wheat bran, nuts and many vegetables are good sources of insoluble fiber.

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Food Records

- One of the most valuable things we can do as healthcare providers is to educate patients to pay attention to what they eat:
  - Food Diaries (3 day)
  - Online free websites and apps
  - Food frequency scales
- Most say it is an eye opening experience to actually evaluate their eating habits
So remember:

**Happy peaceful eating**

Your state of mind as you eat, is the most **crucial ingredient** of your diet. - Pratima Raichur

The best six doctors anywhere and no one can deny it are:

- Sunshine
- Water
- Rest
- Air
- Exercise
- Diet
References

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