FODMAP Journey:
What, Why & How of Diet Plan

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Disclosures

- Nothing to disclose
Objectives

- Describe what FODMAP carbohydrate consists of
- Recognize patient populations that are appropriate for the FODMAP diet
- Identify necessary dietary restrictions when following the FODMAP Diet
FODMAP

- Fermentable
- Oligosaccharides
- Disaccharides
- Monosaccharides
- AND
- Polyols
IBS affects 10-15% US population
Unknown numbers as only 10-46% seek medical attention
8-25% school-aged children with recurrent abdominal pain
Population

- Kids with functional abdominal pain or chronic abdominal pain report lower quality of life than healthy controls
  - Increased incidence of school absenteeism
  - Decreased energy
  - Less likely to be physically active
  - Less likely to be involved in school activities
  - Increased feelings of loneliness & sadness

Youssef et al. Pediatrics 2014
Patients with IBS report more adverse reactions to food

- 84% IBS patients reported food intolerances

Carlson et al

- Perceived role of specific foods on GI symptoms in children
- Identified median of 11 foods exacerbating GI symptoms
- Spicy foods, cow’s milk, pizza most common
- Kids developed own coping strategies
  - “You kind of feel left out because you want to be able to eat the same things they do, but you don’t want to be that person at the party throwing up because of that”
- Parents perceived change in QOL but not the kids themselves

Who is our target?

- Patients diagnosed with functional gastrointestinal diseases (FGIDs) including irritable bowel syndrome, abdominal migraine & childhood functional abdominal pain

- Diagnosis by exclusion:
  - Celiac
  - IBD
  - Food allergies
  - EoE
  - Cancer
  - Gastritis
Where to Begin?!
History of FODMAP

- Dr. Sue Shepherd pieced together puzzle starting in 1999
- Through PhD work, realized FODMAPs were triggers for IBS
- Dr. Shepherd & Dr. Peter Gibson began Low FODMAP Diet research
  - 2005-2007
  - Took off in 2009
- [http://www.med.monash.edu/cecs/gastro/fodmap/](http://www.med.monash.edu/cecs/gastro/fodmap/)
FODMAP TRENDS

www.google.com/trends
FODMAP Characteristics

- Short-chain carbohydrates
  - Poorly absorbed
  - High osmotic activity
  - Rapidly fermented
Mechanisms that may influence symptoms of FGIDs:

- Fermentation of short chain carbohydrates
- Nonimmune food sensitivity
- Alterations in gut motility
- Luminal fluid shifts
- Highly osmotic dietary substances
- Gut hormone changes
- Gut microbiome

FODMAP – WHY?

- Underlying physiological phenomenon luminal distention
- Lumen distention:
  - Solid, liquid, or gas
- Lumen distention:
  - Bloating
  - Abdominal distention
  - Possible motility changes

Gibson & Shepherd. J Gastroenterol Hepatol 2010
FODMAP – WHY?

- CHO left in small bowel – draws water into the lumen which causes distention, bloating, pain
- Increased osmotic load delivered into distal small intestine & colon
- (GAS) Rapid fermenting by colonic bacteria ⇒ gas, cramping, diarrhea
FODMAP Mechanism of Action

- **Osmotically Active**
  - Mannitol increases small bowel water content 10x versus glucose in healthy volunteers
  - Dietary FODMAP content correlates with ileostomy output
    - Higher output with higher FODMAP content; increase 22%
  - Enteral formulas with lower FODMAP content cause less enteral nutrition-associated diarrhea

Marciani et al. Gastroenterology 2010; 138:469-77
Barrett et al. Gastroenterology 2009
Halmos. J Gastroenterol Hepatol 2013
FODMAP Mechanism of Action

- Highly Fermentable (Produce Gas)

Ong DK et al. J Gastroenterol Hepatol 2010; 25:1366-1373
Mechanism Summary (Fermentable)

- Low-FODMAP alleviates symptoms by reducing undigested carbohydrates that make it to colon & feeds colon bacteria
- Less fermentation results in decreased abdominal pain & bloating, decreased flatulence

Wilson & Hill. Australian Family Physician 2014
Barrett & Gibson. Ther Adv Gastroenterol 2012
Carbohydrates Ahead!
Oligosaccharides

- Fructans
  - Linear structure
  - Wheat major source
  - Small bowel lacks ability to break bonds
  - Not absorbed at all

- Galactans
  - Linear structure with galactose
  - Small bowel lacks ability hydrolyze
  - Not absorbed at all
Oligosaccharides

<table>
<thead>
<tr>
<th>FRUCTAN CULPRETS</th>
<th>GALACTAN CULPRETS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Wheat products</td>
<td>Lentils</td>
</tr>
<tr>
<td>Rye</td>
<td>Legumes</td>
</tr>
<tr>
<td>Onions</td>
<td>Chickpeas</td>
</tr>
<tr>
<td>Garlic</td>
<td>Broccoli</td>
</tr>
<tr>
<td>Artichokes</td>
<td>Beans</td>
</tr>
<tr>
<td>Inulin*</td>
<td>Brussels Sprouts</td>
</tr>
<tr>
<td>FOS* – added as prebiotic</td>
<td>Soy-based products</td>
</tr>
</tbody>
</table>
Disaccharides

- Naturally occurring in mammal milk
- Requires enzyme lactase to break down $\Rightarrow$ glucose & galactose
- Malabsorption can actually be tested:
  - Hydrogen breath test
  - Lactose tolerance test
  - Small bowel biopsies with w/ enzyme activity
Disaccharides

CULPRETS

- Milk
- Yogurt
- Pudding
- Custard
- Cottage cheese
- Ice cream
Monosaccharides

- Fructose aka “Fruit sugar”
- 1:1 ratio with glucose
  - Facilitated diffusion
- Absorption capacity varies from person to person
- Limited transport across jejunum
- Malabsorption
  - Test
    - Determine if hereditary fructose intolerance (HFI)
Monosaccharides

- Average daily intake amongst Americans = 55 gm$^1$
  - Adolescents = 73 gm/day$^1$
- Most healthy adults absorb 15 gm$^2$
- 40% of adults started having symptoms with 25 gm$^3$

Monosaccharides

What About Kids?!

- Gomara et al.
  - 33% had positive HBT
  - Symptoms increased as load of fructose increased
  - Significant improvement abdominal pain & belching with 2 months on low-fructose diet

- Escobar et al.
  - Largest study with 222 patients
  - 54.5% positive HBT
  - Max dose 25 gm
  - 76.9% patients reported improved symptoms on low-fructose diet
Monosaccharides

CULPRETS

- Agave
- Apple*
- Honey
- High fructose corn syrup (HFCS)

- Mangos
- Pears*
- Sugar snap peas
- Watermelon*

*Also contain polyols
Polyols

- Sugar alcohols
- No associated active transport system
- Passive diffusion
  - Pore of epithelium
  - Molecule size
    - Molecule size makes diffusion in small bowel difficult, creating laxative effect
- Mucosal disease
Polyols

- Found in some fruits & vegetables
  - Small amounts may be tolerated
  - Mushrooms & cauliflower
- Added as humectants in food processing
- Added as sweeteners; sugar-free gums, mints
Polyols

**CULPRETS**

- Stone Fruits
  - Apricots
  - Nectarines
  - Cherries
- Sugar alcohol sweeteners
  - Mannitol
  - Sorbitol
  - Xylitol
Low FODMAP Diet
Low FODMAP Diet

- A few rules to remember:
  - FODMAPs in the diet do not cause functional GI disorders but is an opportunity to minimize symptoms.
  - This diet restricts FODMAP globally not individually.
    - Reduce intake of ALL poorly absorbed short chain carbohydrates.

Gibson & Shepherd. J Gastroenterol Hepatol. 2010
Low FODMAP Diet - Implementation

- Full dietary recall
  - Assess frequency & volume of FODMAP intake
- Symptom history & record
- Adjust diet based on intake
  - Example: a patient is eating a large amount of beans (cultural diet); consider reducing intake prior to overwhelming family and completely eliminating from diet
- Target most problematic FODMAP containing foods
  - Partial restriction
Low FODMAP Diet - Implementation

- Most problematic per Barrett et al.
  - Oligosaccharides
    - Fructans - wheat, rye, onions, garlic, artichokes
    - Galactans - legumes
  - Disaccharides
    - Lactose - milk
  - Monosaccharides
    - Fructose - honey, apples, pears, watermelon, mango, & HFCS
  - Polyols
    - Sorbitol - apples, pears, stone fruit, SF mints/gum
    - Mannitol - mushrooms

Barrett & Gibson Therap Adv Gastroenterol 2012
Low FODMAP Diet - Implementation

- Strict trial of Low FODMAP x6-8 weeks
  - Kids
    - Chumpitazi et al found improvement of symptoms & lower HBT in just 2 days
- If symptoms continue, consider reduction of caffeine, alcohol, high-fat foods

Chumpitazi et al Gastroenterology 2014.
Low FODMAP - Reintroduction

- Rechallenging/Reintroduction
  - Allows for individualization of diet
  - Avoids over-restriction
- Keeping track of symptoms while reintroducing is a vital part of the process

Warman 2013
Low FODMAP Diet - Reintroduction

- 1 FODMAP per week
- Eat the food x2 that week
- If symptoms occur, remove food from diet
  - Once symptom free
    - Decrease serving size in half & challenge again
    - Try another food from within the same FODMAP group
Low FODMAP Diet - Reintroduction

- Polyols
- Lactose
- Fructose
- Fructans
- Galactans
Low FODMAP Diet - Reintroduction

**UNIVERSITY OF ARIZONA PROTOCOL:**

<table>
<thead>
<tr>
<th>Carbohydrate</th>
<th>Amount</th>
</tr>
</thead>
<tbody>
<tr>
<td>Polyols:</td>
<td></td>
</tr>
<tr>
<td>Sorbitol</td>
<td>2-4 dried apricots</td>
</tr>
<tr>
<td>Mannitol</td>
<td>½ cup mushrooms</td>
</tr>
<tr>
<td>Lactose</td>
<td>½ - 1 cup milk</td>
</tr>
<tr>
<td>Fructose</td>
<td>½ mango or 1-2 tsp honey</td>
</tr>
<tr>
<td>Fructans</td>
<td>2 slices of wheat bread, 1 garlic clove</td>
</tr>
<tr>
<td></td>
<td>or 1 cup pasta</td>
</tr>
<tr>
<td>Galactans</td>
<td>½ cup lentils or chickpeas</td>
</tr>
</tbody>
</table>
High FODMAP food

Per serving

<table>
<thead>
<tr>
<th>Carbohydrate</th>
<th>Max Amount</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lactose</td>
<td>&lt;4 grams</td>
</tr>
<tr>
<td>Mannitol/Sorbitol (Polyols)</td>
<td>&lt;0.3 grams</td>
</tr>
<tr>
<td>Fructans</td>
<td>&lt;0.3 grams</td>
</tr>
<tr>
<td>Galactooligosaccharides Fructans</td>
<td>&lt;0.3 grams</td>
</tr>
<tr>
<td>Fructose</td>
<td>&gt;0.2 grams excess of glucose</td>
</tr>
</tbody>
</table>

Mullin et al. JPEN 2014
## Low FODMAP Diet

<table>
<thead>
<tr>
<th></th>
<th>Fructose</th>
<th>Lactose</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>High FODMAP</strong></td>
<td>Watermelon, canned fruit, peaches, mango, pears, apples, watermelon, dried fruit, coconut milk*</td>
<td>Milk (cow, goat, sheep), yogurt, ice cream, evaporated milk, powdered milk, soft &amp; fresh cheeses (i.e. mascarpone, ricotta, cottage)</td>
</tr>
<tr>
<td></td>
<td>Asparagus, artichokes, sugar snap peas</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Honey, agave, high-fructose corn syrup</td>
<td></td>
</tr>
<tr>
<td><strong>Substitute FODMAP</strong></td>
<td>Ripe fruits: Bananas, grapefruit, honeydew, citrus fruits, strawberries, blueberries, kiwi, raspberries</td>
<td>Lactose free milk products, unsweetened almond*/rice milk, hard cheeses (i.e. pamesan, cheddar, mozzarella, Swiss), Lactose free yogurt, butter, gelato, sorbet</td>
</tr>
<tr>
<td></td>
<td>Male syrup, golden syrup</td>
<td></td>
</tr>
</tbody>
</table>

- Limit 1 serving FODMAP friendly fruit per meal
- Consume ripe fruits
- *Inconclusive

Charts adapted from:
- Scarlata. 2010
- Gibson & Shepherd. 2009
- Mullin et al. 2014
# Low FODMAP Diet

<table>
<thead>
<tr>
<th>Fructans</th>
<th>Oligosaccharides</th>
<th>Polyols</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>High FODMAP</strong></td>
<td>Watermelon</td>
<td>Lentils, chickpeas, legumes (beans such as: kidney, soy, baked beans) Broccoli</td>
</tr>
<tr>
<td>Brussels sprouts, artichokes, leek, onion, beetroot, cabbage, garlic, okra, shallots, snow peas</td>
<td></td>
<td>Cauliflower, snow peas, mushrooms</td>
</tr>
<tr>
<td>Grains such as wheat &amp; rye Inulin &amp; FOS</td>
<td></td>
<td>Sorbitol, mannitol, xylitol, maltitol</td>
</tr>
<tr>
<td><strong>Substitute FODMAP</strong></td>
<td>Carrots, celery, bok choy, bamboo shoots, eggplant, com, green beans, lettuce, chives, parsnip, pumpkin, tomato, red/yellow/orange bell pepper, potatoes, spinach, butter lettuce, bean sprouts</td>
<td>Bananas, blueberries, grapefruit, kiwi, citrus fruits, raspberries, grapes</td>
</tr>
<tr>
<td>Garlic infused oil</td>
<td></td>
<td>Sugar, glucose, aspartame, sweetener w/o ‘ol’</td>
</tr>
<tr>
<td>Gluten-free breads, cereals, rice, rice &amp; com pasta, rice cakes, plain potato chips, tortilla chips</td>
<td></td>
<td></td>
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</table>
Low FODMAP Diet

- Remember this is a **LOW** FODMAP diet not a **NO** FODMAP diet
- No food is all GOOD or all BAD
- Diet changes should be made in the context of WHOLE diet
- Dietitian delivered diet in order to reach full potential of minimizing symptoms & meeting nutritional needs
## Low FODMAP Diet

<table>
<thead>
<tr>
<th>Proteins</th>
<th>Grains</th>
<th>Dairy</th>
<th>Fruit</th>
<th>Vegetables</th>
</tr>
</thead>
<tbody>
<tr>
<td>Beef, chicken, fish, egg, pork, tofu</td>
<td>Rice, oats, quinoa, polenta, corn, rice cakes, rice crackers, oatmeal (plain), plain potato chips, tortilla chips, millet, buckwheat</td>
<td>Lactose free dairy products, unsweetened rice/algmond milk*, 1 oz hard cheese (cheddar, Swiss, feta, mozzarella) 1 Tbsp cream cheese</td>
<td>Banana, blueberries, cantaloupe, grapefruit, grapes, honeydew, citrus fruits, raspberries, rhubarb, strawberries, kumquat, tangelo</td>
<td>Zucchini, squash, tomato, tump, spinach, potato, parsnip, olives, lettuce, eggplant, cucumber, carrots, chives, carrots, celery, Brussels sprouts, bok choy, green beans, bamboo shoots, sprouts</td>
</tr>
<tr>
<td>Almonds, flax, peanuts, pecans, pumpkin seeds, sunflower seeds, walnuts, nut butters (natural)</td>
<td>Gluten Free pasta, breads &amp; flours</td>
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</tr>
</tbody>
</table>

Note: Portion size is important and some of the vegetables require limited intake as they are moderate in FODMAP concentration.
FODMAP Friendly Snacks

- Vegetables
- Rice cakes
- Red meat
- Eggs
- Hard cheeses
- Popcorn

- Yogurt
- Nuts/Seeds (1-2 Tbsp)
- Tortilla Chips
- Gluten free pretzels/crackers
- Natural nut butters
- Plain kefir
FODMAP Friendly Beverages

- Water! Water! Water!
- Sodas w/ cane sugar
- Alternative milks
- Lactose free milk
- 125 mL fruit or vegetable juice (1 serving)
Barriers/Limitations

- Strict eliminations can result in:
  - Weight loss
  - Food aversions
  - Failure to Thrive
  - Increased risk of nutrient deficiencies
  - Increased risk of eating disorders
Barriers/limitations

- Complaints of constipation during elimination phase
- Restriction of prebiotic foods
- Role of small bowel bacteria overgrowth
- May be difficult for vegetarian patient
- Cut-off levels of FODMAP content
- FODMAP content of US-friendly foods
There's an App for That!

- Multiple FODMAP Apps available
- Monash University
  - Most popular
  - More expensive
- Low FODMAP Diet for IBS
Additional Resources

- www.sueshepherdworks.com.au
- http://www.med.monash.edu/cecs/gastro/fodmap/
- http://blog.katescarlata.com/fodmaps-basics/
- http://stanfordhealthcare.org
- www.health.arizona.edu
FODMAP carbohydrates are poorly absorbed, osmotically active, and rapidly fermented (produce gas).

Data continues to emerge regarding FODMAP and outcomes in children.

A registered dietitian should be an integral part of FODMAP Diet education so as not to impede growth potential and ensure nutritional adequacy.
References

- Barrett & Gibson. Fermentable oligosaccharides, disaccharides, monosaccharides and polyols (FODMAPs) and non allergic food intolerance: FODMAPs or food chemicals? Ther Adv Gastroenterol. 2012;5:261-268.
References

QUESTIONS?