STOOL GAZING: Appreciating All that Poop Can Reveal

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Disclosures

A. I have the following financial relationships with the manufacturers of commercial products and/or providers of commercial services:
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   – Perrigo - Paid Consultant
   – Medtronic - Paid Consultant
   – Norgine - Paid Consultant

B. I do not intend to discuss an unapproved/investigative use of a commercial product/device in my presentation
Tasseomancy

The art of tea leaf reading is known as Tasseomancy

1. ANCHOR
2. AXE
3. HEART
4. PALM TREES
5. TRIANGLES
6. LETTER “L”
Tasseomancy
Stool Analysis

• Can be used to learn a tremendous amount of information about a patient
• May provide critical diagnostic clues
• Can help determine disease type
  – Congenital/genetic
  – Infectious
  – Inflammatory
Objectives

• Review various disorders that can cause alterations in stool
• Identify stool tests to help diagnose enteric infections
  – Tests for malabsorption causing watery or fatty diarrhea
  – Cultures, ova and parasite testing
  – Antigen testing* (*i.e. H. pylori, Giardia, Cryptosporidia)
• Recognize fecal calprotectin as a non-specific marker of gut inflammation
Composition of Human Stool

- 75% water.
- 25% solid matter:
  - Undigested fiber and solidified components of digestive juices (30%)
  - Bacteria (30%)
  - Fat (10% to 20%)
  - Calcium, phosphate, other inorganic matter (10% to 20%)
  - Protein (2% to 3%)
Characterizing Stool

• Color
• Consistency
• Amount
• Shape
• Odor
• Presence of blood or mucus
Color

• Least exciting aspect of stool
• Affected by diet (what you eat)
  – Meat makes it darker
  – Milk makes it lighter
  – Red beets color stool red
  – Blackberries/blueberries make it dark green
Color

• Bile being excreted from the body typically colors stool yellow, green or brown
• Disruption of biliary flow due to liver disease
  – Cholestasis
  – Jaundice
  – Dark urine
  – White/clay colored stools
Biliary Atresia

• Most common cause of infant end-stage liver disease
• Timely diagnosis (within 30-45 days of life) has been associated with improved outcomes
  – Challenging due to more common physiologic indirect hyperbilirubinemia of the newborn
• COLOR of the stool can mean everything
• Evidence that giving parents stool color cards or apps can help identify acholic stools

Tseng, Pediatrics 2011
Stool color cards are currently distributed nationally in the following countries:
- Taiwan
- Switzerland
- British Columbia
- Brazil

**BC INFANT STOOL COLOUR CARD® SCREENING PROGRAM FOR BILIARY ATRESIA**

<table>
<thead>
<tr>
<th>Abnormal Stool Colours</th>
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<tbody>
<tr>
<td>#1</td>
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<tr>
<td>#2</td>
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<td>#6</td>
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</table>

<table>
<thead>
<tr>
<th>Normal Stool Colours</th>
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<tbody>
<tr>
<td>#7</td>
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<td>#8</td>
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<td>#9</td>
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</tbody>
</table>
After implementation of stool card intervention in Taiwan, median age at diagnosis decreased from 47-43 days of life.

Tseng, Pediatrics 2011
Consistency

• More interesting aspect of stool...
• Formed, semi-formed, no form
• Bristol Stool Chart
• Definitely a British *thang*
• Developed by Dr. Stephen Lewis and Dr. Ken Heaton at the University of Bristol
  – Published in the Scandinavian Journal of Gastroenterology in 1997
Bristol Stool Chart Gone Viral
<table>
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<tr>
<th>Type</th>
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<td>Lacking fibre</td>
</tr>
<tr>
<td>Type 6</td>
<td>Mushy consistency with ragged edges</td>
<td>Inflammation</td>
</tr>
<tr>
<td>Type 7</td>
<td>Liquid consistency with no solid pieces</td>
<td>Inflammation</td>
</tr>
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</table>
Types 6 and 7 vs. Reported “Diarrhea”

• Commonly reported problem
  – Affects 5% of the population at any given time

• Patients may vary greatly in their definitions
  – Loose stool consistency
  – Increased frequency
  – Urgency
  – Incontinence

• AGA guidelines stress the importance of noting “precisely what the patient means”

  Schiller CGH, 2016
Diarrhea in Children

• Focused HPI
  – Chronicity (< or > 2 weeks of symptoms (vs. AGA >4 weeks))
  – Timing of onset (Neonatal vs. toddler vs. older)
  – Characteristics (e.g. Blood, mucus vs. small volume incontinence, etc.)
  – Associated symptoms (e.g. weight loss, rash, abdominal distension)
  – Family history (helpful, but not exclusive)
Diarrhea in Children

• Resource-rich vs. resource-limited countries
• Due to a wide-variety of disorders
  – Developmental
  – Dietary
  – Malabsorptive diseases
  – Disordered immunity/inflammatory conditions
  – Enteric infections (Most common in resource-limited environments)
Classification of Diarrhea

Acute
- Infectious
- Ingestion

Chronic
- Watery
  - Osmotic
  - Secretary
- Inflammatory
  - Infectious
  - IBD
- Fatty
  - Malabsorption
Watery Diarrhea

• Can be secretory or osmotic...or a combination
• To distinguish using stool studies:
  – FECAL ELECTROLYTES
  – PH
  – REDUCING SUBSTANCES
  – CALCULATION OF THE OSMOTIC GAP
Etiologies of Watery Diarrhea

Osmotic
• Primary and secondary malabsorption

Secretory
• Certain enteric infections (e.g. cholera)
• Congenital diarrheas
• Neuroendocrine tumors
## Osmotic vs. Secretory Diarrhea

<table>
<thead>
<tr>
<th></th>
<th>Osmotic</th>
<th>Secretory</th>
</tr>
</thead>
<tbody>
<tr>
<td>Daily stool volume</td>
<td>&lt;1L</td>
<td>&gt;1L</td>
</tr>
<tr>
<td>Effect of fasting</td>
<td>Stops</td>
<td>Continues</td>
</tr>
<tr>
<td>Stool Na</td>
<td>30</td>
<td>100</td>
</tr>
<tr>
<td>Stool K</td>
<td>30</td>
<td>40</td>
</tr>
<tr>
<td>290 - 2(Na + K)</td>
<td>&gt;125 (&gt;50)</td>
<td>&lt;50</td>
</tr>
<tr>
<td>pH</td>
<td>Usually acidic</td>
<td>Usually neutral</td>
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Assessing for Enteric Infections through Stool

- **Bacterial**
  - **STOOL CULTURES** (Salmonella, Shigella, Campylobacter, Yersinia, E. Coli O157:H7)
  - **SPECIFIC ANTIGEN DETECTION** (i.e. Campylobacter)
  - **PCR** (i.e. C. diff)

- **Viral**
  - **SPECIFIC ANTIGEN DETECTION** (i.e. Rotavirus, CMV)

- **Parasitic**
  - **STOOL MICROSCOPY** (Protozoa, Helminths)
  - **SPECIFIC ANTIGEN DETECTION** (i.e. Giardia)
Assessing for Enteric Infections

• Most utility when investigating
  – Acute onset with blood and mucus
  – Chronic diarrhea for >2 weeks

• What organisms to look for should be guided by
  – Geographic exposure
  – Age of patient
  – Nature of clinical symptoms
Stool Microscopy (O&P)

- Bloody diarrhea
- Peripheral eosinophilia
- Evidence of bacteremia with enteric organism
- HIV infection or immunocompromised status
- Exposure to a region/vector known for parasitic infections
  - E.g. Travel to the tropics, developing countries, camping in North America with exposure to lake water, animal exposures
What might you find?

• Protozoa
  – Entamoeba histolytica
  – Giardia lamblia
  – Cryptosporidium
  – Cystoisospora
  – Cyclospora
  – Balantidium coli

• Nematodes
  – Ascaris
  – Trichuris
  – Hookworm
  – Enterobius
  – Capillaria

• Trematodes
  – Schistosomae

• Cestodes
  – Taenia solium
  – Hymenolepis nana
  – Diphyllo- bothrium
  – Hymenolepis diminuta
  – Dipyridium caninum
Common Nemotode Ova (EGGS!)

(A) Ascaris
(B) *Trichuris* (wet mount with iodine)
(C) hookworm (wet mount with iodine)
(D) *Enterobius* (pinworm)
(E) *Capillaria*
(F) *Strongyloides* rhabditiform larvae
What about common parasites?

(A) *Entamoeba histolytica* (trichrome stain)
(B) *Giardia lamblia* (wet mount)
(C) *Cryptosporidium* (acid-fast stain)
(D) *Cystoisospora* (wet mount with exposure to ultraviolet light)
(E) *Cyclospora* (wet mount)
(F) *Balantidium coli* (wet mount with iodine)
Which is most common in the USA?

(A) *Entamoeba histolytica* (trichrome stain)
(B) *Giardia lamblia* (wet mount)
(C) *Cryptosporidium* (acid-fast stain)
(D) *Cystoisospora* (wet mount with exposure to ultraviolet light)
(E) *Cyclospora* (wet mount)
(F) *Balantidium coli* (wet mount with iodine)
Classification of Diarrhea

- Acute
  - Infectious
  - Ingestion
  - Watery
    - Osmotic
    - Secretory
- Chronic
  - Inflammatory
    - Infectious
    - IBD
  - Fatty
    - Malabsorption
Diagnosis of Fatty Diarrhea

• Qualitative studies
  – **SPOT FECAL FAT**
  – **SUDAN III STAIN** (Prone to variable interpretations)
  – **ACID STEATOCRIT** (rarely available)

• Quantitative studies (Gold standard)
  – **72-HOUR FECAL FAT** (stool fat x 72 hours, with min 100g a day of fat consumption)
Etiologies of Fatty Diarrhea

• Malabsorption
  – Celiac disease
  – Short bowel syndrome
  – Post-resection diarrhea
  – Mesenteric ischemia

• Maldigestion
  – Pancreatic insufficiency
  – Cystic fibrosis
  – Bile acid deficiency
Other Stool Tests for Malabsorption

- **α-1 ANTIMRYPTPSIN**
  - Suggests protein malabsorption

- **REDUCING SUBSTANCES**
  - Suggests carbohydrate malabsorption (glucose, lactose, fructose)
  - Does not detect sucrose malabsorption
Classification of Diarrhea

Acute
- Infectious
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- Watery
  - Osmotic
  - Secretory

Chronic
- Inflammatory
  - Infectious
  - IBD

Fatty
- Malabsorption
Evidence of inflammation in the stool

- **GROSS OR OCCULT BLOOD**
- **MUCUS**
- **FECAL LEUKOCYTES**
- Inflammatory proteins
  - **CALPROTECTIN**
  - **LACTOFERRIN**
  - **POLYMORPHONUCLEAR NEUROTROPHIL ELASTASE (PMN-E)**
“New Kids on the Block” That Can Help with Diagnostic Decision Making

• **CALPROTECTIN**
  – Calcium and zinc binding protein that comprises ~60% of total cytosolic protein content of neutrophils

• **LACTOFERRIN**
  – Iron binding glycoprotein also in neutrophils

• **PMN-E**
  – Neutral proteinase stored in the granules of neutrophils to be released when activation occurs during inflammation
Figure 1. Receiver operator characteristic (ROC) curves to illustrate the trade-off between specificity and sensitivity for (A) lactoferrin (area under the curve $0.87 \pm 0.03, P < 0.0001$), (B) calprotectin (area under the curve $0.89 \pm 0.03, P < 0.0001$), (C) polymorphonuclear neutrophil-elastase (area under the curve $0.84 \pm 0.04, P < 0.0001$), and (D) CRP (area under the curve $0.75 \pm 0.04, P < 0.0001$).

Langhorst, AJG, 2008
Look for Fecal Calprotectin

• Available commercially since 2010
• Nonspecific marker of inflammation
  – Elevation indicates inflammation vs. infection
• Can be helpful in differentiating patients with abdominal pain and stool changes
  – Deciding whether or not YOU need to worry!!
• Can be used to monitor IBD and response to treatment
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Enteric infections Without Diarrhea

• #1 Enemy of the State is *Helicobacter pylori*
  – Affects up to 50% of the world population
  – Can cause abdominal pain, gastritis, bleeding
  – In kids, nausea, dyspepsia, PUD

• Serological tests fairly useless
  – Don’t differentiate between past/current infection
  – Low positive‐predictive value for active disease

• *H. pylori* stool antigen is test of choice
  – Should only be obtained if your intention is to treat if detected

Eusebi, Helicobacter, 2014
Final thoughts...

• Goal of the talk is to appreciate ALL that stool can reveal
• The word “ALL” begs quotation marks
• Really a very big topic
• Future is bright in terms of stool testing
What I didn’t talk about today...

- Biomarker and bioassay studies for cancer detection
  - i.e. FIT to replace screening colonoscopies
- Personalized analysis of microbiome
  - Probably the future of preventive medicine
  - Impact of microflora on health and health outcomes
Changes You May Wish to Make Now in Your Practice

• Consider stool a potentially valuable medium to divine diagnosis
  – At times MORE valuable than serum testing
    • Fecal calprotectin rather than CRP
    • H. pylori stool antigen rather than serology

• Avoid prolonged discussions about color
  – Except in neonates, where absence of color may be of critical importance

• Obtain precise definitions of diarrhea from patients
Stool Tests You May Wish to Order

- To differentiate osmotic from secretory diarrhea
  - FECAL ELECTROLYTES
  - PH
  - REDUCING SUBSTANCES

- To diagnose malabsorption
  - 72-HOUR Fecal Fat
  - α-1 ANTITRYPSIN
  - REDUCING SUBSTANCES

- To investigate infection vs. inflammation
  - CULTURES
  - ANTIGENS
  - PCR TESTS
  - MICROSCOPY
  - Fecal Leukocytes
  - OCCULT BLOOD
  - CALPROTECTIN
  - LACTOFERRIN
Thank You!
References

