Chronic Diarrhoea

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Overview

- Physiology of GI absorption
- Definition of chronic diarrhoea
- Categories of causes
- Algorithm for diagnosis
- Specific diseases
- Practical tips
Review GI physiology in Ganong
Fig. 2.4 The villi and crypts of the small intestinal mucosa.
**AMPLIFICATION OF SURFACE AREA OF HUMAN SMALL INTESTINE**

<table>
<thead>
<tr>
<th>Structure</th>
<th>Amplification Factor</th>
<th>Surface Area (cm²)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cylinder</td>
<td>1</td>
<td>3,300</td>
</tr>
<tr>
<td>Folds</td>
<td>x3</td>
<td>10,000</td>
</tr>
<tr>
<td>Villi</td>
<td>x10</td>
<td>100,000</td>
</tr>
<tr>
<td>Microvilli</td>
<td>x20</td>
<td>2,000,000*</td>
</tr>
</tbody>
</table>

*Digestive Absorptive Cell*  

* Doubles Tennis Court = 1,750,000 cm²
Gastrointestinal absorption

Diagram showing the absorption of iron, folic acid, vitamins, fat, proteins, and the reserve area for absorption.
Fat digestion and absorption
**1 Gram Fat Drop**

- **Diameter**: 1.28 cm
- **Number**: 1
- **Surface Area**: 5 cm² (Postage Stamp)

**1 Gram Emulsion Droplets**

- **Diameter**: 0.6 µm
- **Number**: $8 \times 10^{12}$
- **Surface Area**: 10 m² (9' x 12' Rug)

**1 Gram Micelles**

- **Diameter**: 50 Å
- **Number**: $17 \times 10^{18}$
- **Surface Area**: 1300 m² (6 Tennis Courts)

**Emulsification** leads to **Lipolysis** with the help of **Bile Salts** leading to the formation of **Micelles**.
Mechanism of abetalipoproteinaemia

Fig 3. Pathways of lipid transport in the mucosa and step where inhibition of protein synthesis interferes with fat absorption.
Protein digestion and absorption
### Table 9-2. Intraluminal and mucosal digestion of carbohydrates

<table>
<thead>
<tr>
<th>Diet (percentage of carbohydrate intake)</th>
<th>Luminal enzymes</th>
<th>Oligosaccharides and disaccharides presented to mucosa</th>
<th>Mucosal enzymes</th>
<th>End products</th>
</tr>
</thead>
<tbody>
<tr>
<td>Starch (60%)</td>
<td></td>
<td>Maltose, maltotriose, and other oligosaccharides (α-1,4 linkage)</td>
<td>Glucoamylase (maltase)</td>
<td>Glucose</td>
</tr>
<tr>
<td></td>
<td>Salivary and pancreatic alpha-amylases</td>
<td>Alpha-dextrins (α-1,6 linkage)</td>
<td>Alpha-dextrinase (isomaltase)</td>
<td>Glucose</td>
</tr>
<tr>
<td>Amylopectin</td>
<td></td>
<td>Maltose, maltotriose, and other oligosaccharides</td>
<td>Glucoamylase (maltase)</td>
<td>Glucose</td>
</tr>
<tr>
<td>Amylose</td>
<td>Salivary and pancreatic alpha-amylases</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sucrose (30%)</td>
<td></td>
<td>Sucrose</td>
<td>Sucrase</td>
<td>Glucose and fructose</td>
</tr>
<tr>
<td>Lactose (10%)</td>
<td></td>
<td>Lactose</td>
<td>Lactase</td>
<td>Glucose and galactose</td>
</tr>
<tr>
<td>Trehalose</td>
<td></td>
<td>Trehalose</td>
<td>Trehalase</td>
<td>Glucose</td>
</tr>
</tbody>
</table>
What is diarrhoea?

- It is an increase in the frequency, volume and fluid content of stool.
- What is normal?

**Breast fed** babies can pass 1 stool q 10/7 or 10 stools/day,

**bottle fed** infants pass 2-3 pasty stools per day and

**older children** 1-2 formed stools /day or 1 stool q 2/7
### NORMAL STOOLS IN INFANTS

<table>
<thead>
<tr>
<th></th>
<th>1st week</th>
<th>8-28 days</th>
<th>1-12 mth</th>
<th>13-24 mth</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>No. / 24 hr</strong></td>
<td>4.0</td>
<td>2.2</td>
<td>1.8</td>
<td>1.7</td>
</tr>
<tr>
<td>Range</td>
<td>1-12</td>
<td>0-6</td>
<td>0-5</td>
<td>0-3</td>
</tr>
<tr>
<td><strong>Mean wt</strong></td>
<td>4.3</td>
<td>11</td>
<td>17</td>
<td>35</td>
</tr>
<tr>
<td>Range (g)</td>
<td>0.5-48</td>
<td>0.3-40</td>
<td>2-98</td>
<td>4-180</td>
</tr>
<tr>
<td><strong>Stool water</strong></td>
<td>73%</td>
<td>73%</td>
<td>75%</td>
<td>74%</td>
</tr>
</tbody>
</table>

Lemoh and Brooke, Arch Dis Childh 1979, 54:719
Definition of Chronic Diarrhoea

- History of diarrhoea >2/52
- Aetiology is based on physiological principles and include osmotic, secretory, inflammatory or GI dysmotility
- Can result in electrolyte and nutritional deficiencies
- Toddlers Diarrhoea and Overflow constipation are the commonest causes
Fluid Absorption in GI Tract

- 9000 ml enter (daily)
- Ileocecal flow: 2000 ml
- Fecal excretion: 100-200 ml
### Twenty-four Hour Fluid Load on GI Tract

<table>
<thead>
<tr>
<th>Source</th>
<th>Volume (ml)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dietary intake</td>
<td>2000</td>
</tr>
<tr>
<td>Saliva</td>
<td>1000</td>
</tr>
<tr>
<td>Gastric juice</td>
<td>2000</td>
</tr>
<tr>
<td>Bile</td>
<td>1000</td>
</tr>
<tr>
<td>Pancreatic juice</td>
<td>2000</td>
</tr>
<tr>
<td>Small intestine secretion</td>
<td>1000</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>9000</strong></td>
</tr>
</tbody>
</table>
Increased Luminal Osmolality

Normal
- 8000 ml
- small intestine
- colon
- normal stool

Abnormal
- 9000 ml
- small intestine
- colon
- diarrhoea

- 2000 ml
- 100-200 ml
- ++ ml
- 2000 ++ ml
MAJOR AREAS OF ABSORPTION OF NUTRIENTS AFTER A MEAL

Duodenum: Iron
Jejunum: Carbohydrates, Protein, Lipids, Sodium and Water
Ileum: Bile Acids

Cobalamin
### Daily Intestinal Fluid and Maximal Absorptive Capacity

(volume per 24 hours)

<table>
<thead>
<tr>
<th></th>
<th>Small Intestine</th>
<th>Colon</th>
</tr>
</thead>
<tbody>
<tr>
<td>Maximal Absorptive Capacity</td>
<td>~12 L</td>
<td>4-6 L</td>
</tr>
<tr>
<td>Normal Load</td>
<td>7-9 L</td>
<td>2-3 L</td>
</tr>
</tbody>
</table>
ETIOLOGY OF DIARRHEA: ↑ COLONIC LOAD

**EXAMPLE:**

- **Health**
  - Flow: Normal
  - Absorption: Normal
  - Ileocecal Flow: 2500 ml
  - Colonic Absorption: 2350 ml
  - Fecal H₂O: 150 ml
  - Diarrhea: No

- **Small Bowel Secretion**
  - Flow: ↑ to <\(T_M\)
  - Absorption: ↑ to \(T_M\)
  - Ileocecal Flow: 4500 ml
  - Colonic Absorption: 4350 ml
  - Fecal H₂O: 150 ml
  - Diarrhea: No

- **Key Parameters**
  - \(T_M\): Threshold for normal absorption
  - ↑: Increase in flow or absorption

**Legend:**
- Yellow: Normal values
- Green: Increased values
- Blue: Secretion values
INGESTED FAT

BLOCKED DIGESTION

STEATORRHEA

BLOCKED ABSORPTION
Chronic Diarrhoea

EXCLUDE RETENTION WITH OVERFLOW
Chronic Diarrhoea

EXCLUDE RETENTION WITH OVERFLOW

IS THERE FAILURE TO THRIVE?

YES    Always investigate
NO     Sometimes investigate
       Time is on your side
Chronic Diarrhoea

EXCLUDE RETENTION WITH OVERFLOW

IS THERE FAILURE TO THRIVE?

YES    Always investigate
NO     Sometimes investigate
       Time is on your side

IS STOOL VOLUME INCREASED?

YES

NO    WBC, RBC, mucus
      ie. Colitis
Bloody diarrhoea

- Infectious colitis
- Inflammatory bowel disease
- Eosinophillic gastroenteritis
- Cow milk protein colitis
Chronic Diarrhoea

EXCLUDE RETENTION WITH OVERFLOW

IS THERE FAILURE TO THRIVE?

YES Always investigate

NO Sometimes investigate
  Time is on your side

IS STOOL VOLUME INCREASED?

YES

NO WBC, RBC, mucus
  ie. Colitis

IS THERE FAT MALABSORPTION?

YES

Digestive or Absorptive?

Fat globules

Fatty acid crystals

DIGESTIVE

ABSORPTIVE
Fat globules implies impaired digestion
Impaired intraluminal digestion I

Affecting all nutrients

- CYSTIC FIBROSIS
  - Shwachman syndrome (panc hypoplasia, neutropenia and metaphysial chondrodysplasia)
  - Johanson-Blizzard syndrome
  - Pearson syndrome
  - Cystinosis
Impaired intraluminal digestion II

Affecting fat absorption

- Biliary atresia
- Impaired enterohepatic circ
  - (eg ileal resection or Crohn’s disease)
- Blind loop
  - Isolated lipase or colipase defy
  - Impaired bile acid synthesis
Impaired intraluminal digestion III

Affecting proteins

- Congenital trypsinogen defy
- Congenital enterokinase defy
Fatty acid crystals implies impaired absorption — capable of partial hydrolysis