Acute and chronic diarrhoea in childhood

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Diarrhoea, vomiting and dehydration in childhood

Talk Overview
- What is the definition of diarrhoea
- What are the mechanisms of diarrhoea
- What are the causes of vomiting and diarrhoea
- Acute versus chronic diarrhoea
- Discussion of common diarrhoeal conditions (acute and chronic)
- Management of dehydration and acute diarrhoea

Diarrhoeal disease in childhood
- 2 million deaths annually worldwide
- 15% of all child deaths
  - 6% of child deaths in Europe
  - 18% of all child deaths in SE Asia
- >90% of all deaths occur in developing nations

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
Gastrointestinal absorption

Causes of acute diarrhoea and vomiting
- Gastrointestinal infections
- Food poisoning
- Mechanical
  - obstruction, intussusception
- Appendicitis
- Haemolytic Uraemic Syndrome
- Other infection
  - UTI, sepsis
- Food allergy (cow’s milk intolerance, Coeliac)

Remember medications can cause diarrhoea
Causes of acute vomiting
- All the above
- Pyloric stenosis
- Appendicitis
- Raised intracranial pressure
- Meningitis
- Metabolic disease

Infectious diarrhoea
- Viral
  - Rotavirus, adenovirus, small round viruses
- Bacterial
  - Campylobacter jejuni
  - Shigella, Salmonella, S aureus, Clostridium perfringens, E coli
- Parasitic
  - Giardia, Cryptosporidia

History of travel and exposure to unsecured water supply is important to obtain

Mechanisms of acute infectious diarrhoea
- Villus damage
  - viruses
- Enterotoxin production
  - V cholerae, ETEC, Salmonella, C jejuni, S aureus, Cl perfringens, Cl difficile, Y enterocolitica
- Adherence
  - EPEC, G lamblia, Y enterocolitica
- Cytotoxin production
  - STEC, S dysenteriae, C jejuni, Cl difficile
- Invasion
  - BEC, C jejuni, Cryptosporidium, Y enterocolitica

Rotavirus
- Wheel-like
- Double-stranded RNA
- ~80nm diameter
Rotavirus - epidemiology
- Most common cause of diarrhoeal illness in children
- 600,000 deaths/year worldwide
- Mortality <0.5% - dehydration
- Autumn and winter months
- All children exposed by age 5

Rotavirus - Pathophysiology
Damage to tips of villus cells, leading to:
- Loss of absorptive capacity
  - Water and electrolyte transport linked to glucose and amino acid cotransporters on luminal surface of enterocyte
- Loss of digestive capacity
  - Disaccharidases on cell surface

Rotavirus - Clinical features
- Most prominent in 6-24 months age group
- Incubation 2-3 days
- May be coryzal prodrome
- Fever
- Vomiting and Diarrhoea
- Diagnosis confirmed by stool immunofluorescence

Other viral gastroenteritis
- Adenovirus
  - Not seasonal, more prolonged diarrhoea
- Small round viruses
  - Astrovirus
    - Milder than rotavirus
  - Calicivirus
    - Localised outbreaks in older children. Short incubation period and duration of symptoms

Other infectious cause?
- Unlikely to be viral gastroenteritis if:
  - Bloody stool
  - Severe systemic illness
  - Severe abdominal pain
  - Prominent / billious / projectile vomiting
  - Prolonged history (> 2 weeks)

Causes of bloody diarrhoea
- Infectious colitis (eg salmonella) (any age)
- Allergic colitis and gastroenteritis (< 6 mth old) (eg food protein induced enterocolitis)
- Inflammatory bowel disease (> 2yo) (Crohn’s disease, ulcerative colitis)
- Meckel’s diverticulum
Chronicity of presentation is important

Acute presentation (1-5 days)
usually viral and self-liming
Subacute presentation (1-2 weeks)
think giardia and bacterial gastro
Chronic presentation (weeks-months)
consider food allergy (including Coeliac disease), lactose intolerance

Management of dehydration

Management of diarrhoea and vomiting

Assess whether acute or chronic

- If acute: assess whether surgical or infectious - if acute then management of hydration and metabolites is key
- If chronic: assess whether failure to thrive or not – if chronic then management of weight and micronutrients is key

Dehydration

- Clinical signs
  - Recent weight loss
  - Skin turgor
  - Peripheral perfusion
  - Dry mucous membranes
  - Sunken eyes
  - Sunken fontanelle
  - Acidotic breathing
  - Acidosis
  - Tachycardia and hypotension

Dehydration

Mild (<4%) Moderate (4-6%) Severe (>6%)

<table>
<thead>
<tr>
<th>Appearance</th>
<th>Alert</th>
<th>Restless, irritable</th>
<th>Lethargic</th>
</tr>
</thead>
<tbody>
<tr>
<td>Skin turgor</td>
<td>Normal</td>
<td>Slow (1-2s)</td>
<td>Very slow (&gt;2s)</td>
</tr>
<tr>
<td>Perfusion</td>
<td>Normal</td>
<td>Cool</td>
<td>Cold</td>
</tr>
<tr>
<td>M membranes</td>
<td>Moist</td>
<td>Dry</td>
<td>Dry</td>
</tr>
<tr>
<td>Eyes</td>
<td>Normal</td>
<td>Sunken</td>
<td>Sunken</td>
</tr>
<tr>
<td>Breathing</td>
<td>Normal</td>
<td>Normal</td>
<td>Deep acidotic</td>
</tr>
<tr>
<td>Blood pressure</td>
<td>Normal</td>
<td>Normal</td>
<td>Hypotension</td>
</tr>
<tr>
<td>Heart rate</td>
<td>Normal</td>
<td>Normal</td>
<td>Rapid, feeble</td>
</tr>
</tbody>
</table>

Treatment of dehydration

- Treat shock
- Oral rehydration in mild or moderately dehydrated
  - Oral rehydration solution via mouth or NG tube
  - Continue to feed in addition
Oral Rehydration Solutions

- Salt and sugar solutions utilise glucose-linked cotransporter in small intestine

![Diagram of glucose transport](Image)

Oral Rehydration Therapy

- Mild / no dehydration:
  - Increase frequency of usual fluids
  - Frequent, small volume drinks
  - Avoid hypertonic solutions (fruit juice, fizzy drinks)
  - Avoid low-calorie drinks

Oral Rehydration Therapy

- Moderate dehydration:
  - Nasogastric
  - Calculate fluid deficit and fluid requirement
  - Replace deficit over 6 hours
  - Give daily maintenance (full 24 hour requirement) over next 18 hours
  - Allow for ongoing losses (diarrhoea)
  - Continue to offer food and usual drinks

Rehydration Therapy

- Severe dehydration
  - Intravenous access
  - Intravenous fluid resuscitation
    - 20ml/Kg 0.9% NaCl
    - Repeat to restore circulation
  - Rehydration - oral/intravenous
    - ORS or 0.45% NaCl, 5% Dextrose, 20mmol/L KCl
    - Deficit over 6 hours
    - Maintenance amount over next 18 hours

Rehydration Therapy (continued)

- Severe dehydration
  - Check electrolytes and acid-base in
    - Severely dehydrated children
    - Children with altered conscious state
    - The very young
    - Those with other abnormalities
**Rehydration therapy**

- **Calculation example**
  - 10 Kg infant, moderately dehydrated
  - Deficit over 6 hours
    - 5% of body weight = 0.5Kg
    - = 500ml
    - 500ml in 6 hours = 84ml/hr
  - 24 hour maintenance over 18 hours
    - 100ml/Kg = 1000ml
    - 1000ml in 18 hours = 55ml/hr

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**Other treatments**

- Antibiotic treatment is rarely necessary
  - Shigella
  - Yersinia
  - Giardia
  - C. difficile
  - (Campylobacter)
  - (Salmonella)
- Antiemetics not useful
- Antidiarrhoeals not useful

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**Family and contact hygiene is important**

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**Metabolic derangement**

- Metabolic acidosis
  - ketosis, bicarbonate loss, inadequate tissue perfusion
- Hypernatraemia (Na >150mmol/l)
  - Excessive water loss, Na administration
- Hyponatraemia (Na < 130mmol/l)
  - Excessive water administration, Na loss

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**Criteria for admission**

- Shock
- Moderate or severe dehydration
- Complicated
  - Hyper/hyponatraemia, short gut syndrome, immunocompromised host
- Very young
- Social concerns
Reasons to think again
- Bilious, bloodstained or projectile vomiting
- Abdominal distension, tenderness
- High fever
- Persistent tachycardia or hypotension

Overview of treatment for acute diarrhoeal disease
- Resuscitation
- Diagnosis
- Assessment of hydration
- Start rehydration
- Admit to hospital?
- Continue feeds
- Reassess

Overview
- Physiology of GI absorption
- Definition of chronic diarrhoea
- Categories of causes
- Algorithm for diagnosis
- Specific diseases
- Practical tips
AMPLIFICATION OF SURFACE AREA OF HUMAN SMALL INTESTINE

<table>
<thead>
<tr>
<th></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>Plicae</td>
<td>×3</td>
<td>10,000</td>
</tr>
<tr>
<td>Villi</td>
<td>×10</td>
<td>100,000</td>
</tr>
<tr>
<td>Microvilli</td>
<td>×20</td>
<td>2,000,000*</td>
</tr>
</tbody>
</table>

* Doubles Tennis Court = 1,750,000 cm²

Gastrointestinal absorption

Fat digestion and absorption
Mechanism of abetalipoproteinaemia

Protein digestion and absorption

What is diarrhoea?
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- What is normal?
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  - 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>No. / 24 hr</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>0.5-5</td>
<td>0.3-6</td>
</tr>
<tr>
<td>Mean wt</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>0.5-40</td>
<td>2.98</td>
<td>4-180</td>
</tr>
<tr>
<td>Stool water</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 (less common now) are the commonest causes
ETIOLOGY OF DIARRHEA: ↑ COLONIC LOAD

**EXAMPLE:**

<table>
<thead>
<tr>
<th>Flow</th>
<th>Normal</th>
<th>↑ tp &lt; Tm</th>
<th>↑ tp &gt; Tm</th>
</tr>
</thead>
<tbody>
<tr>
<td>Absorption</td>
<td>Normal</td>
<td>↑ to Tm</td>
<td>↑ to Tm</td>
</tr>
<tr>
<td>Ileocecal Flow</td>
<td>2500 ml</td>
<td>4500 ml</td>
<td>6500 ml</td>
</tr>
<tr>
<td>Colonics</td>
<td>Absorption</td>
<td>150 ml</td>
<td>450 ml</td>
</tr>
<tr>
<td>Fecal H₂O</td>
<td>No</td>
<td>No</td>
<td>Yes</td>
</tr>
<tr>
<td>Diarrhea</td>
<td>No</td>
<td>No</td>
<td>Yes</td>
</tr>
</tbody>
</table>

**INGESTED FAT**

**STEATORRHEA**

**CHRONIC DIARRHEA**

**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**
    - Abnormal stool, rarely rectal blood

IS THERE FAT MALABSORPTION?

- **YES** Digestive or Absorptive
  - Fat stools
  - Fatty acid crystals

**CHRONIC DIARRHEA**

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  - Fatty acid crystals
Fat globules implies impaired digestion

Impaired intraluminal digestion I

**Affecting all nutrients**
- Cystic fibrosis

- Shwachman syndrome (pancreatic hypoplasia, neutropenia and metaphyseal chondrodysplasia)
  - Johanson-Blizzard syndrome
  - Pearson syndrome
  - Cystinosis

Impaired intraluminal digestion II

**Affecting fat absorption**
- Biliary atresia
- Impaired enterohpatic circulation
  - (e.g., ileal resection or Crohn’s disease)
- Blind loop
  - Isolated lipase or colipase defect
  - Impaired bile acid synthesis

Impaired intraluminal digestion III

**Affecting proteins**
- Congenital trypsinogen defect
- Congenital enterokinase defect

Fatty acid crystals implies impaired absorption – capable of partial hydrolysis

Chronic Diarrhoea

1. Is there retention with overflow?
2. Is there failure to thrive?
   - Yes: Always investigate
   - No: Continue your care

3. Is stool volume increased?
   - Yes: checklist
   - No: checklist

4. Is there fat malabsorption?

   - Yes: checklist
   - No: checklist
Differentiating between Osmotic and Secretory Diarrhoea

- **Osmotic**
  - Na < 70mEq/litre
  - Osmolality > (Na+K)x2
  - pH < 5
  - Reducing substances
  - Volume < 200ml/day
  - Ceases when oral intake is stopped

- **Secretory**
  - Na > 70mEq/litre
  - Osmolality = (Na+K)x2
  - pH > 6
  - No reducing substances
  - Volume > 200ml/day

Differential Diagnosis of Secretory Diarrhoea

- Infection with toxigenic organisms (e.g., Cholera, E. Coli, Salmonella)
- Surreptitious drug administration e.g., laxatives
- Bile acid malabsorption
- Congenital electrolyte transport defect
- Hormone-secreting tumours e.g., VIPoma, Gastrinoma, Carcinoid, Pheochromocytoma
- Mastocytosis

Differential Diagnosis of Osmotic Diarrhoea

- Osmotic Laxatives
- CHO malabsorption e.g., Glu-Gal transport defect, lactase and isomaltase-sucrase deficiency
- Overfeeding (<6mth)
- GI infections
- Coeliac disease
- CMP/Soy allergy
- Inflammatory diseases
- Auto-immune enteropathy
- Bacterial overgrowth
- Abetaliproteinaemia
- Lymphangiectasia

SUGAR MALABSORPTION

- Average diet 350 g CHO
- Assume 5% gets to colon
- 18 g monosaccharides = 95mOsm
  - drags 300 ml water

LACTOSE MALABSORPTION

- LACTOSE $\xrightarrow{\text{lactase}}$ GLUCOSE + GALACTOSE

* USING GLUCOSE BY-PASSES NEED FOR LACTASE
* NO NEED TO CHANGE PROTEIN OR FAT
Lactose intolerance
- Primary (congenital) – rare
- Secondary (acquired)
  - Temporary – post-infectious damage to villous (e.g., rotavirus or giardia)
  - Permanent – 97% of Africans and Asians

Coeliac Disease
- A disease of the proximal SI characterised by an abnormal small intestinal mucosa and associated with a permanent intolerance to gluten
- Not seen in Asian and infrequent in the Black population
- Incidence 1 in 300 in Ireland and 1 in 500 in Australia (seroprev 1%)
- DQ2,7 can be used for family screening

Pathogenesis
- Gluten induced T cell mediated immune response within the lamina propria following a yet to be defined sensitization process
- Humoral immunity appears to play a limited role in the pathogenesis of this disorder
- Wheat, rye, barley (unlikely oats)
**ESPGHAN CRITERIA 1969, 1974**

- ABNORMAL MUCOSA ON GLUTEN
- HISTOLOGICAL RESPONSE TO GLUTEN-FREE DIET
- HISTOLOGICAL RELAPSE ON GLUTEN CHALLENGE

**ESPGHAN CRITERIA 1990**

- ABNORMAL MUCOSA ON GLUTEN
- FULL CLINICAL REMISSION ON DIET

Exceptions where diagnostic doubt:
- < 2 years of age at presentation
- asymptomatic: family members
- diabetes
- short stature

**Clinical Presentation**

- Chronic diarrhoea, FTT 9-18 months of age and before 9 months presents with mainly vomiting
- Constipation in 10%
- Short stature, anaemia, personality problems
Atypical Presentation

Neurological: Seizures in 5% of adults, cerebellar ataxia, dementia, peripheral neuropathy, myopathy, cerebral calcification and folate deficiency

Dermatitis Herpetiformis:
chronic pruritic papulovesicular rash over extensor surfaces and Ig A deposits in the skin with mild biopsy findings

Elevated transaminase levels

Clinical Associations

• Immune: Ig A deficiency, IDDM, Thyroiditis, CAH, Ig A nephropathy, fibrosing alveolitis, CMP enteropathy

• Other: Down syndrome, CF, Alpha-1-antitrypsin deficiency,

Screening tests

• Antigliadin Abs: IgA(specific) and IgG(sensitive) with false positive results in GI infections, IBD and other allergic disorders

• Anti-endomysial (IgA based) quoted as having a sensitivity and specificity approaching 97%

• Anti-tissue transglutaminase sensitivity and specificity of 98%, again IgA based assay

Diagnosis

• Abnormal SI mucosa

• Clinical response to gluten-free diet

• 3 biopsies rarely required unless there is doubt surrounding the Dx, less then 2 yrs at time of diagnosis, no previous biopsy and teenagers who plan to start a normal diet

Long-term complications

• Osteoporosis

• Malignant GI disease: Birmingham study demonstrated an increased risk of lymphoma, GI cancer and other malignancy

• Gluten free and not reduced gluten containing diet protected against the development of these malignancies

Lactose intolerance

• Primary (congenital) – rare

• Secondary (acquired)
  • Temporary – post-infectious damage to villous (eg rotavirus or giardia)
  • Permanent – 97% of Africans and Asians
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**Clinical Presentation**

- Chronic diarrhoea, FTT 9-18 months of age
- Constipation in 10%
- Short stature, anaemia, irritability, dental hypoplasia

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**Cows milk protein allergy**

- 2% of children <2yo
- Usually occurs with within days to weeks of starting cow's milk (eg formula)
- Can occur in breast fed babies
- Symptoms of diarrhoea, vomiting, irritability, eczema
- Usually settles with extensively hydrolysed formula (eg Peptijunior, Alfare)
- 10-20% also intolerant of soy formula

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**Bacterial Overgrowth**

- Colonic flora proliferate in the SI in areas of stasis and leads to a clinical syndrome characterized by anaemia and steatorrhea
- Factors predisposing to the development of bacterial overgrowth include anatomical abnormalities, motility disorders, excess bacterial load (e.g., achlorhydria, fistula and loss ileocaecal valve) and abnormal host defence
Clinical Features

- **Classic:** fat malabsorption and anaemia
- **Systemic:** Arteritis, vesicopustular rash, Raynaud’s, nephritis, hepatitis
- **Other:** Weight loss, short stature, abdominal pain, PLE, osteomalacia, night blindness and ataxia

Diagnostic tests

- **Radiology**
- **Laboratory:** 72-hr faecal fat and Sudan stain for fat
- **Non-Invasive:** Breath tests
- **Invasive:** Duodenal aspiration and culture

The practical reality of chronic diarrhoea

A good history is invaluable!

**Type** — fluidity, number, size, colour and smell

- Liquid stools in congenital chloride diarrhoea
- Noisy with flatus in cases of sugar malabsorption
- Loose and bulky in Coeliac disease
- Pasty, yellowish and cheesy smell in exocrine pancreatic insufficiency
- Acidic smell due to fermentation
- Offensive smell in Coeliac disease
- Undigested food, foul smelling, alt with normal stools in well nourished toddler in Toddler’s diarrhoea

History

**Timing**

- Neonatal (congenital causes)
- Introduction or elimination of cow’s milk proteins, wheat, lactose or sucrose
Causes of neonatal diarrhoea

- Congenital lactase deficiency
- Congenital glucose-galactose deficiency
- Congenital chloride diarrhoea
- Congenital bile-acid malabsorption
- Congenital defective jejunal Na/H exchange
- Congenital enterokinase deficiency
- Congenital microvillus atrophy
- Intestinal pseudo-obstruction
- Hirschsprung's disease

History

Associated symptoms

- Anorexia (intestinal malabsorption)
- Increased appetite (CF)
- Thirst (severe and fluid diarrhoea)
- Abdominal pain, bloating (fermentation)
- Weakness (Coeliac disease)

What you can learn from one faecal specimen!

MICROSCOPY

- wbc, rbc, mucus
- colitis
- cysts
- giardia
- fatty acid crystals
- mucosal damage
- fat globules
- pancreatitis

BIOCHEMISTRY

- Reducing substances
- Tryptic activity
- low = pancreatic insufficiency
- Stool electrolytes
- Na > 70 = active secretion

Other investigations

- FBE – IBD, increased eosinophils in cow/soy milk intolerance or parasites
- LFTs- assess liver disease, U/Es
- TSH to rule out hyperthyroidism
- Breath test – sugar malabsorption
- Ba meal and follow through – IBD or anatomical problems

Endoscopy and biopsy

To exclude:

- Coeliac disease
- Giardia
- Abetaproteinemia (fat fill enterocytes)
- Lymphangiectasia (villi distorted by ectatic lymphatics)
- Sensitisation to food proteins (cow, soy, wheat)
- Inflammatory bowel disease