



Chapter 173 – Infectious diarrheal disease and dehydration

Episode overview:

Core questions:

- 1) What are three pathophysiologic types of diarrhea? Give an example of a cause for each
- 2) List 6 common causes of childhood infectious diarrhea in developed countries
- 3) List 5 important differential diagnoses of diarrhea in children
- 4) List 5 important differential diagnoses of vomiting in children
- 5) When should you initiate a medical evaluation of children with acute diarrhea?
- 6) Describe the typical presentation of
 - a. Rotavirus
 - b. Norovirus
 - c. Salmonella
 - d. Shigella
 - e. Yersinia
 - f. E. Coli
 - g. C. Difficile
- 7) List routine and high risk treatment recommendations for common bacteria causing acute infectious diarrhea in children
 - a. Salmonella non-typhi
 - b. Salmonella typhi
 - c. Shigella
 - d. Campylobacter jejuni
 - e. Yersinia enterocolitica
 - f. C. Difficile
 - g. Vibrio cholerae
 - h. Vibrio parahaemolyticus
 - i. E. Coli
- 8) List the presenting features and treatments for three common protozoa causing infectious diarrhea in children
- 9) Define and describe your diagnosis and management approach to dehydration that is
 - a. Mild
 - b. Moderate
 - c. Severe
 - d. Associated with Hypo/Hyponatremia

Wisecracks:

1. Name 5 causes of bloody diarrhea
2. Other than vomiting and diarrhea from infectious gastroenteritis, list 6 causes of volume depletion
3. Name the components of the Gorelick scale
4. What's the 4-2-1 rule?



Key concepts:

Identification of Pathogen

- Stool studies are not indicated in most uncomplicated cases of acute gastroenteritis (AGE). Exceptions are those cases in which specific treatment, specific prophylaxis, or health precautions are required, or in which the patient has systemic involvement, underlying medical complications, or the illness involves dysenteric features (blood, mucous, severe tenesmus).
- Antibiotics are not required for most cases of uncomplicated acute bacterial enteritis. Antibiotics are recommended routinely for *Campylobacter*, *C. difficile*, *Giardia intestinalis*, and *E. Histolytica*. Antibiotics can be considered for *Cryptosporidium*, traveler's diarrhea, and *Shigella* (because antibiotics have been shown to decrease diarrhea and eradicate organisms in the stool).
- Patients with Shiga toxin-producing *E. coli* (STEC) **should not** empirically receive antibiotics, because they may increase the risk of hemolytic-uremic syndrome (HUS).
- Testing for fecal leukocytes is a useful initial test because it may support a diagnosis of invasive disease. This test should be considered in children with diarrhea who are febrile or have mucus or blood in the stool. If the test result is positive, stool culture is indicated to further guide management.

Oral Rehydration

- Most patients with mild to moderate dehydration can be treated with oral rehydration therapy (ORT). Resumption of feeding with age-appropriate diets should begin as soon as vomiting subsides.

Note: Routine fasting with infectious diarrhea is not recommended!

Dehydration Assessment

- The degree of volume depletion is estimated from the history and physical examination findings.

[The desired volume of oral rehydration solution is calculated as 30 to 50 mL/kg for mild dehydration and 60 to 80 mL/kg for moderate dehydration; 25% of the volume of oral rehydration solution is to be replaced every hour (100% over 4 hours). Continue to replace ongoing losses with 10 mL/kg for each diarrheal stool and 2 mL/kg for each vomiting episode. Severe Dehydration] -shownotes

- In severe dehydration, 20 mL/kg of 0.9% saline (or other appropriate isotonic crystalloid solution) given intravenously at a rapid rate should reverse signs of shock within 5 to 15 minutes. Repeated boluses of 20 mL/kg are indicated until clinical improvement occurs, but volume requirements greater than 60 mL/kg without signs of improvement suggest other conditions, such as septic shock, hemorrhage, capillary leak with third-space fluid sequestration, and heart failure.

Rosen's In Perspective

Diarrhea = Second leading cause of death in children <5 yrs worldwide!

Acute diarrhea is defined as the abrupt onset of abnormally high fluid content in the stool with increased volume or frequency.



As supported by the World Health Organization (WHO), “acute” diarrhea has a sudden onset and lasts no longer than 14 days; “chronic” or “persistent” diarrhea lasts longer than 14 days.

- *Dysentery, diarrhea associated with blood and mucus in the stool, implies a compromised bowel wall.*
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[1] What are three pathophysiologic types of diarrhea? Give an example of a cause for each.

Infectious agents cause diarrhea by adherence, mucosal invasion, enterotoxin production, and cytotoxin production.

Under normal circumstances, the absorptive processes for water and electrolytes predominate over secretion, resulting in net water absorption.

Diarrhea occurs when this balance is disrupted, either as a result of increased secretion from the gastrointestinal tract, decreased absorption of fluids, or from inflammation.

1. Secretory diarrhea

- Usually caused by a bacteria that produces a toxin; increased intestinal secretion of water into the gut lumen or an inhibition of absorption. Examples include...**
 - Vibrio cholerae*
 - Salmonella*
 - Shigella*
 - E. Coli*
 - C. diff.*
- The pooping doesn't stop with fasting!**

2. Osmotic diarrhea

- Water and electrolytes move into the gut lumen:**
 - Laxatives, Toddler's diarrhea (juice only diets)*
- Pooping stops with fasting**

3. Inflammatory diarrhea

- Caused by enteroINVASIVE organisms:**
 - Destruction of villous cells or dysfunction of cellular transporters, leading to loss of fluids and electrolytes, as well as mucus, proteins, and blood in the intestinal lumen. Caused by inflammation-induced neutrophil destruction of the bowel wall.*
 - *Typical acute viral gastroenteritis produces injury to the small bowel epithelium with **consequent disruption of microvilli**, decreasing the absorptive area, and preventing normal fluid, electrolyte, and nutrient absorption. The illness is compounded if the colon is unable to compensate for the large fluid volume.*
 - Examples:*
 - *Viral: Rotavirus, adenovirus, Norovirus*



- *Bacterial: Salmonella, shigella, campylobacter*

4. Dysmotility

[2] List 6 Common Causes of Childhood Infectious Diarrhea in Developed Countries

See table 172.1 in Rosen's 9th edition, for the common causes of childhood infectious diarrhea in developed countries.

Viruses (70-80%): RAN

- Rotavirus
- Norovirus & sapovirus
- Astrovirus
- Adenovirus

Bacteria (10-20%): 2V's, 3 C's, 3 S's spells YES

- Vibrio cholera
- Vibrio parahaemolyticus
- Campylobacter jejuni
- Clostridium perfringens
- Clostridium difficile
- Salmonella species
- Shigella species
- Staphylococcus aureus
- Yersinia enterocolitica
- Escherichia coli; ETEC

Protozoa (<10%): ENTs Cry like Giants

- Entamoeba histolytica
- Cryptosporidium
- Giardia intestinalis

[3] List 5 important differential diagnoses of diarrhea in children

Head-to-toe physical examination of the patient should focus on signs of dehydration that may indicate another cause for the diarrhea:

- *(e.g., otitis media, pyelonephritis, appendicitis, diabetic ketoacidosis),*

or signs that indicate the disease may have become extra-intestinal or systemic:

- *Bone pain (osteomyelitis)*
- *Altered mental status (meningitis)*
- *Petechiae (hemolytic-uremic syndrome [HUS])*

Refer to Table 172.8 in Rosen's 9th edition for the common causes of diarrhea in children.



5 important causes of diarrhea in children include:

- 1) Malabsorption (e.g. milk intolerance, excessive fruit juice)
- 2) Inflammatory bowel disease
- 3) Congenital adrenal hyperplasia
- 4) Urinary tract infection
- 5) Infection

Plus other emergencies (e.g. pseudomembranous colitis, toxic megacolon)

Risks factors for death from diarrhea include:

- Age younger than 1 year;
- Birth weight less than 2500 g;
- Malnourishment;
- African American, Hispanic American, or American Indian ethnicity;
- Immunocompromise;
- Illness during winter months.

[4] List 5 important differential diagnoses of vomiting in children

Refer to Table 172.7 in Rosen's 9th edition for the common causes of vomiting in children.

Important categories of differential diagnoses include:

- Central Nervous System
- Gastrointestinal
- Drug
- Endocrine
- Renal
- Cardiac
- Infection

[5] When should you initiate a medical evaluation of children with acute diarrhea?

Otherwise well children with acute, non-bloody diarrhea and no exposures to increase the risk of bacterial enteritis are usually managed without any ancillary studies. - Uptodate.

Things change if:

- The child is very ill appearing
- Significantly dehydrated (risk of severe secretory diarrhea)
- Fever and blood or mucus in the stool but without toxic appearance:
 - Stool culture for *Salmonella*, *Shigella*, *Campylobacter spp*, *Yersinia*, and Shiga toxin-producing *Escherichia coli* (STEC)
 - *C. difficile* toxin (only for patients older than 2 years of age with compatible clinical features, antibiotic exposure or other risk factors or predisposing conditions) - Uptodate



- **Recent immigration, travel to an underdeveloped country, backcountry camping, exposure to poultry or other farm animals, or consumption of processed meat: stool for ova and parasites.**
- **Immunocompromised (HIV)**

Stool cultures should also be considered in patients with systemic involvement or underlying chronic medical conditions, if the illness involves dysenteric features, or if it lasts longer than 2 weeks. Many hospital laboratories do not include testing for E. coli O157:H7 or Y. enterocolitica in their routine stool culture; thus the emergency clinician must order these tests separately.

Refer to Box 172.3 in Rosen's 9th edition for indications for medical evaluation of children with acute diarrhea

- Young (e.g., <6 months old or weight <8 kg)
- History of premature birth, chronic medical conditions or concurrent illness
- Fever to at least 38 degrees for infants, <3 months or at least 39 degrees for children 3-36 months old
- Visible blood or mucus in stool
- **High output**, including frequent and substantial volumes of diarrhea
- Persistent vomiting
- Caregiver's report of signs consistent with dehydration (e.g., sunken eyes or decreased tears, dry mucous membranes or decreased urine output)
- Change in mental status (e.g., irritability, apathy or lethargy)
- Suboptimal response to oral rehydration therapy (ORT) already administered or inability of the caregiver to administer ORT

Don't forget to consider other things in the Ddx such as:

- **Appendicitis**
- **Intussusception**
- **HUS**

[6] Describe the typical presentation of:

a. Rotavirus

- Rotavirus is the leading cause of diarrhea worldwide among children younger than 5 years old.**
- Abdominal pain, N/V, low grade fever, large volume watery diarrhea.**
- Winter - spring, lasts 4-8 days, Fecal-oral or respiratory secretions.**
- Neurologic symptoms, most commonly seizures, occur in 2% to 3% of children with rotavirus infection. The chronically ill or malnourished child often fails to repair damaged intestinal epithelium post rotavirus infection, leading to a vicious cycle of malnutrition and progressive epithelial injury.*
- An effective vaccine exists to prevent this infection

b. Norovirus

- Becoming the most common viral cause of acute GE.
- < 5 yrs, any season, fecal-oral transmission,**
- Abrupt onset abdominal pain, N/V, watery diarrhea**
- Lasts 2-3 days**



- v. *Norovirus accounts for approximately 12% of severe gastroenteritis among children younger than 5 years old. As the number of rotavirus cases decreases, norovirus is becoming the most common cause of infectious diarrhea in children.*
- c. **Salmonella**
 - i. **Typhi = travelers = treatment = typhoid fever**
 1. **Travelers, contaminated food/water, chronic carriers exist.**
 2. **Marked abdominal Pain, N/V, high fever. MILD diarrhea.**
 - a. Systemic symptoms: headache, malaise, anorexia,
 3. **Requires treatment with antibiotics**
 - ii. **Non-typhi = non-travelers, no treatment (except children)**
 1. **< 4 yrs. Short incubation period - 12-36 hrs, ill x 1 week**
 2. **Animals, contaminated water,**
 3. **Abdominal pain, N/V/D, fever, dysentery,**
 4. Can develop systemic manifestations and bacteremia
- d. **Shigella**
 - i. **<5 years old, ill x 2-3 days**
 - ii. **Abdominal pain, N/V/D, tenesmus, systemic symptoms**
 1. *Hallucinations, confusion and seizures. Reactive arthritis (Reiter's syndrome) can occur weeks after the infection. Rare complications of Shigella infection include bacteremia, HUS, toxic megacolon, pseudo-membranous colitis, and encephalopathy (Ekiri syndrome).*
 2. Fecal oral transmission
 3. There may be a role for antibiotics
- e. **Campylobacter**
 - i. Abdominal pain, N/V/D
 - ii. Illness lasts 2-3 days with treatment, and 2-3 weeks without treatment
 - iii. Fecal oral transmission
 - iv. Can mimic intussusception, and occur after febrile seizures.
- f. **Yersinia**
 - i. **6 yrs old, sick for few days.**
 - ii. **High fevers, abdominal pain, N/V/D. Dysentery.**
 - iii. **Watch for pseudoappendicitis syndrome (mesenteric adenitis)**
- g. **E. Coli. - AHITP**
 - i. **STEC (aka. EHEC or enterohemorrhagic E. Coli) - shiga toxin producing E. Coli.**
 1. **All ages, lasts 7 days, fecal-oral (humans/animals)**
 - a. **Abdominal pain, n/v, bloody or non-bloody diarrhea**
 2. **Shiga toxin production → HUS (test poop for 0157)**
 3. *E. coli O157:H7 is the prototype and most virulent of the EHEC. Outbreaks have been linked to ground beef, petting zoos, contaminated apple cider, raw fruits and vegetables, and ingestion of water in recreational areas.*
 4. *HUS, the triad of microangiopathic hemolytic anemia, thrombocytopenia, and renal insufficiency, is a serious complication of EHEC infection and occurs in up to 15% of children with E. coli O157:H7.*
 5. *The overall incidence of HUS caused by a diarrheal pathogen (usually STEC) is estimated to be 2.1 cases per 100,000 persons per year, with a peak incidence in children younger than 5 years old (6.1 cases per 100,000 per year). HUS typically develops as diarrhea that is resolving,*



usually 7 days but up to 3 weeks after the onset of the illness. Patients often present with pallor, weakness, irritability, and oliguria or anuria. Patients with HUS can develop neurologic complications, such as seizures, coma, and cerebral vessel thrombosis. Approximately 50% of patients who have HUS will require dialysis, and 3% to 5% die.

6. Most recently, in 2012, a study showed an increased risk of developing HUS if a child with STEC is treated with antibiotics (36% versus 12%, $P = 0.001$). This risk was seen across all antibiotic classes. Therefore, we recommend that empirical antibiotics should not be administered because of the potential risk of HUS—except in cases when a child is extremely ill or in septic shock.

- ii. **EPEC - enteropathogenic**
 - 1. Mild diarrhea, from resource-limited areas, little abdominal pain and vomiting.
 - 2. Not toxin-mediated, risk for chronic disease
 - iii. **ETEC - enterotoxigenic**
 - 1. Abdominal pain, watery diarrhea, mild vomiting. Enterotoxin produced.
 - 2. Resource-limited areas and travelers
 - iv. **EIEC - enteroinvasive**
 - 1. All ages. Abdominal pain, and diarrhea - watery with or without dysentery.
 - v. **EAEC - enteroaggregative**
 - 1. Risk for becoming prolonged diarrhea, abdominal pain and watery/bloody diarrhea.
- h. **C. Difficile**
- i. > 24 months. Duration variable.
 - ii. Abdominal pain, low grade fevers, watery diarrhea
 - iii. Can be present in asymptomatic carriers!

[7] List routine and high risk treatment recommendations for common bugs causing acute infectious diarrhea in children

Antibiotics are routinely recommended for Salmonella **TYPHI (typhoid fever), Campylobacter, C. difficile, Giardia intestinalis, and E. histolytica** and can be considered in **Cryptosporidium, Shigella, Salmonella non-typhi, .**

GECCC
(all protozoa; some bacteria)

Common themes:

- If super sick/shocky = IV ceftriaxone
- Azithromycin is a generally safe guess if the person can tolerate PO
- Antibiotics: may not help everyone, but decreases the duration of shedding in stool
- Resistance and recurrent disease is common, which don't always require a change of antibiotics (they may just need a repeat course of the same antibiotics)
- The only no-no treatment is for EHEC O157



Premature babies (younger than 1 year old), neonates, young infants, and patients with immunosuppression, chronic diseases, and articular or valve prostheses are at increased risk for developing complications (bacteremia, sepsis, invasive disease, extraintestinal disease) from pathogens causing acute diarrhea.

i. Salmonella non-typhi

- i. Consider drawing blood cultures if unwell (can become bacteremic)
- ii. No; treatment prolongs excretion; does not shorten disease
- iii. **Reasons to treat:**
Infants <3 months old, prolonged illness, chronic GI disease, neoplasms, hemoglobinopathies, HIV, immunosuppression, localized invasive disease (osteomyelitis, abscess, meningitis) or bacteremia
Treatment with PO septrax or amoxicillin; IV with ampicillin or ceftriaxone.

j. Salmonella typhi (typhoid fever)

- i. Travel to south central Asia.
- ii. **All patients should be treated!**
 - 1. Those who are well with uncomplicated disease = azithromycin
 - 2. Anyone with delirium, enteric fever, shock needs:
 - a. **Start with IV medications; change to oral when susceptibility is known. Ceftriaxone 100 mg/kg every day or divided every 12 hours or Cefotaxime 200 mg/kg divided every 4 to 6 hours (maximum 12 g/day) or Ciprofloxacin 20 mg/kg divided every 12 hours**

k. Shigella

- i. **No routine treatment; usually self-limited but treatment decreases diarrhea and eradicates organism from stool**

<p><i>Shigella species</i></p>	<p>No; usually self-limited but treatment decreases diarrhea and eradicates organism from stool</p>	<p>Severe disease, bacteremia, dysentery, immunosuppression Less ill and able to tolerate PO</p>	<p>IV: Ceftriaxone 50–100 mg/kg for 5 days or *Ciprofloxacin (>17 years old or ceftriaxone contraindicated) 20 mg/kg divided every 12 hours or Azithromycin 10 mg/kg for 3 days Oral: Azithromycin 12 mg/kg for first day, then 6 mg/kg for days 2 to 5 or *Ciprofloxacin 20 mg/kg divided every 12 hours for 5 days</p>	<p>Oral route preferred when possible and disease is not serious TMP-SMX and ampicillin only if isolated strain is susceptible because of high resistance Amoxicillin less effective because of rapid absorption from GI tract</p>
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l. Campylobacter jejuni

<p><i>Campylobacter jejuni</i></p>	<p>Yes</p>	<p>Usually recommended for all infections; most children will resolve on own</p>	<p>Oral: Azithromycin 10 mg/kg for 3 days or Erythromycin 40 mg/kg divided every 6 hours for 5 days</p>	<p>Shorten duration of illness and excretion of organisms and prevent relapse if given early Resistance to fluoroquinolones is frequent</p>
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m. Yersinia enterocolitica



<i>Yersinia enterocolitica</i>	No	Septicemia or extra intestinal sites of infection; immunocompromised host	Oral: TMX-SMX 10 mg/kg divided every 12 hours or Oral or IV *Fluoroquinolone: Ciprofloxacin 20 mg/kg divided every 12 hours or IV: Ceftriaxone 50 to 100 mg/kg divided every day or every 12 hours or Cefotaxime 150 to 200 mg/kg divided every 4 to 6 hours (maximum 12 g)	Usually resistant to penicillin and first generation cephalosporins Antibiotics do decrease the duration of fecal excretion but do not decrease length of diarrhea Extraintestinal disease treat for 4 weeks
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n. C. diff.

<i>C. difficile</i>	Yes	Symptomatic patients Severe disease, underlying intestinal tract disease, and those who don't respond to oral metronidazole use vancomycin	Stop antimicrobial therapy Oral or IV: Metronidazole 30 mg/kg divided every 6 hours for at least 10 days (maximum dose 2 g/day) or Oral: Vancomycin 40 mg/kg divided every 6 hours for at least 10 days (maximum dose 2 g/day)	25% relapse after treatment; infection usually responds to second course IV vancomycin is not effective Do not give antimotility agents
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o. Vibrio cholera

<i>Vibrio cholera</i>	No	Patients with moderate to severe disease	Oral: Doxycycline 4–6 mg/kg or Azithromycin 20 mg/kg single dose or Tetracycline 25 to 50 mg/kg divided every 6 hours (maximum dose 3 g) for 3 days	Susceptibility testing recommended Treatment decreases duration of diarrhea and eradicates bacteria from stool
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p. Vibrio parahaemolyticus

<i>V. parahaemolyticus</i>	No	Severe diarrhea, septicaemia Patients <8 years old	Third-generation cephalosporin and doxycycline* (patients ≥8 years old) TMX-SMX and aminoglycoside	
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q. E. coli

i. NO abx treatment for cases of EHEC / STEC (o.157) unless in septic shock.

<i>E. coli</i>	No for STEC infection	Severe watery diarrhea in a traveler to RLA	Azithromycin or fluoroquinolone*	Treating patients with STEC may increase risk for HUS
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A few other non-antibiotic options:

- 1. Antidiarrheal compounds that impair gastrointestinal motility, such as loperamide (Imodium), diphenoxylate, and atropine (Lomotil), can prolong and exacerbate disease, and thus have no role in the treatment of acute infectious diarrhea in young children. The agents may also cause lethargy, paralytic ileus, toxic megacolon, CNS depression, coma, and even death.**

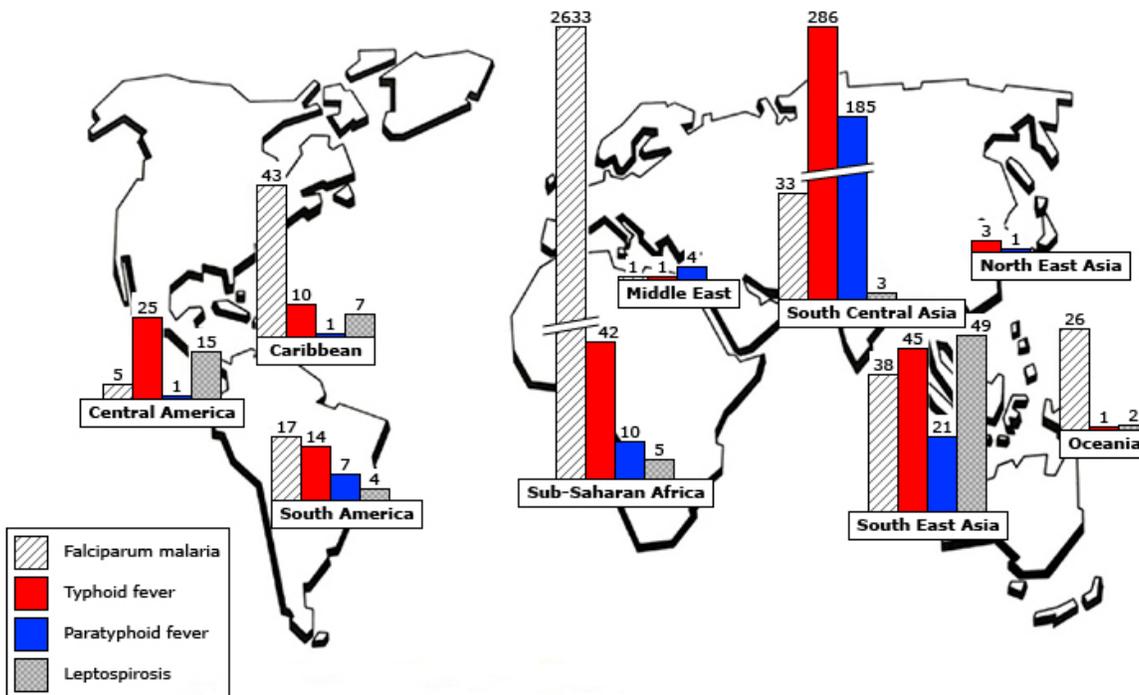


- Probiotics have been studied extensively over the past several years for the treatment of acute infectious diarrhea. In large clinical trials, *Lactobacillus reuteri*, *Lactobacillus rhamnosus*, and *Saccharomyces boulardii* reduced mean duration and frequency of watery diarrhea and number of watery stools per day, and improved stool consistency.

The European Society of Gastroenterology, Hepatology, and Nutrition, the National Institute for Health and Clinical Excellence, and the AAP all agree that when used alongside rehydration therapy, **probiotics appear to be safe and have clear beneficial effects in shortening the duration of and reducing stool frequency in acute infectious diarrhea.** More research is needed to determine appropriate doses for different strains of probiotics.

- The WHO recommends zinc supplementation (10 to 20 mg/day for 10 to 14 days) for all children younger than 5 years old with AGE, although few data exist to support this recommendation for children in developed countries.

Infections in returning travelers by region of exposure, 1996 to 2011



This map indicates the number of cases of selected acute and potentially life-threatening diseases region reported among 82,825 travelers from resource-rich countries to various tropical regions between 1996 to 2011. Data are from the GeoSentinel surveillance network.

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[8] List the presenting features and treatments for three common Protozoa causing infectious diarrhea in children



Protozoal illnesses are rare, < 1% of cases of acute infectious diarrhea

- **Cryptosporidium**
- **Giardia intestinalis**
- **Entamoeba histolytica**

Metronidazole Stops Crying Giants from Entering houses

● **Cryptosporidium**

- All ages, N/V, abdominal pain, non-bloody frequent watery diarrhea. Fatigue, anorexia, weight loss (severe disease in the immunocompromised)
- *Because shedding can be intermittent, at least three stool specimens collected on separate days should be examined before considering test results to be negative. Treatment is usually supportive. However, the FDA has approved a 3-day course of nitazoxanide oral suspension for the treatment of immunocompetent children older than 1 year old.*
- TREATMENT:
 - Not routinely needed.
 - Treat high risk groups:
 - Children > 1 yr & HIV + > 12 yrs with Nitazoxanide.

● **Giardia intestinalis (Beaver fever)**

- ++abdominal pain, N/V, **foul smelling diarrhea, flatulence, watery diarrhea**, abdominal distension, anorexia, anemia, FTT
- Asymptomatic infection is possible, humans are the main reservoir. Cysts spread via animal feces.
- Can cause recurrent disease;
- TREATMENT:
 - Routine treatment necessary; symptoms may recur - so repeat the same treatment.
 - Most require treatment
 - Oral: Metronidazole 15 mg/kg/day divided every 8 hours for 5 to 10 days (maximum 250 mg every 8 hours)
 - Children >1 year old: Nitazoxanide:
 - Children ≥3 years old: Tinidazole 50 mg/kg single dose (maximum 2 g/dose)

● **Entamoeba histolytica**

- Immigrants or visits to high risk areas
 - Chronic excretion possible
- Abdominal pain, N/V, **colitis → dysentery**
- Gradual onset -- progressive symptoms, with TENESMUS and weight loss.
- TREATMENT:
 - Routine treatment recommended!
 - Asymptomatic excretors:
 - Iodoquinol
 - Paromomycin
 - Mild-severe intestinal/extraintestinal disease:
 - Metronidazole



- Tinidazole
- Paromomycin

*Symptoms can become chronic and may mimic inflammatory bowel disease. Complications include fulminant colitis, toxic megacolon, and ulceration of the colon and perianal area, rarely with perforation. Complications are more common in patients treated inappropriately with corticosteroids or antimotility drugs. Ultrasonography, computed tomography, and magnetic resonance imaging can identify liver abscesses and other extraintestinal sites of infection. Follow-up stool examination is recommended after completion of therapy, because complete eradication of intestinal infection is difficult. Asymptomatic household members with stools positive for *E. histolytica* should also be treated.*

[9] Define and describe your diagnosis and management approach to dehydration that is...

- Mild
- Moderate
- Severe
- Associated with Hypo/Hypernatremia

Refer to Table 172.9 in Rosen's 9th edition for the clinical assessment of the degree of dehydration.

Think about it like you're going to walk into a room to assess a child:

- You glance at the triage complaint first - (usually no obvious clue)
- Then you look at the vitals:
 - Make sure you check the peds-appropriate ranges!
 - Tachy or hypotensive = Mod → SEVERE! (they will be in the resus room!)
 - Hyperpnea (late sign, assuming the RR was counted for a minute)
- Next you glance through the door - is the child alert and interactive or altered (Mod-severe)
 - How are their eyeballs?
 - Are they making TEARS?
- Lastly, touch them:
 - Fontanelle?
 - Cap refill
 - Centrally
 - Peripherally
 - Skin turgor:
 - The skin **over the trunk should be examined for tenting** (suggesting hyponatremia) or a doughy texture (suggesting hypernatremia).

For moderate to severe dehydration:

A serum electrolyte panel and BUN, serum creatinine, and blood glucose level are most likely to be clinically useful. Sodium concentration is important in identifying isonatremic, hyponatremic, and hypernatremic states for appropriate choice of therapy. A low serum bicarbonate level may indicate loss of bicarbonate in the stool or may reflect poor tissue perfusion. Urine studies are rarely helpful.



Children with dysentery, characterized by fever, bloody stools, and abdominal cramping, should have BUN and serum creatinine concentrations measured and stool culture specimens sent and examined for E. coli O157:H7 to identify potential cases of HUS.

Management:

Refer to Box 172.4 in Rosen's 9th edition for the principles of appropriate treatment of children with diarrhea and dehydration

- **Oral rehydration solutions should be used for rehydration**
- **Oral rehydration should be performed as rapidly as possible**
- **Unrestricted diet is recommended as soon as dehydration is corrected**
- **For breast-fed infants, nursing should be continued**
- **For formula-fed infants, diluted formula is not recommended, special formula is not necessary**
- **Additional oral rehydration solution should be administered for ongoing diarrheal losses**

Ondansetron, a selective 5-hydroxytryptamine type 3 receptor antagonist, acts at chemoreceptors in the peripheral and CNS to alleviate nausea. Ondansetron has been shown in numerous well-designed studies in children to reduce episodes of vomiting in the ED, improve oral intake in the ED, reduce the need for IV fluid rehydration, and reduce admissions.

a. Mild

- i. Oral rehydration therapy (ORT) is a safe and effective treatment of infants and children with mild to moderate dehydration.**
- ii. Just because they keep vomiting, doesn't mean they need an IV.
- iii. Losses can be replaced at 10 mL/kg for each stool and 2 mL/kg for each emesis.
Diet should not be restricted.*****

b. Moderate

- i. Oral rehydration therapy (ORT) is a safe and effective treatment of infants and children with mild to moderate dehydration.**
- ii. Just because they keep vomiting, doesn't mean they need an IV.
- iii. Losses can be replaced at 10 mL/kg for each stool and 2 mL/kg for each emesis.
Diet should not be restricted.*****

******Children with severe dehydration, shock, lethargy, acute abdomen, suspected intestinal obstruction, sodium derangement, or significant underlying illness should be identified by means of a thorough history, physical examination and laboratory tests and be excluded from ORT.******

c. Severe

- i. Need to consider the differential for why they are so volume depleted!**
- ii. Administration of 20 mL/kg of 0.9% saline (or other appropriate isotonic crystalloid solution) intravenously at a rapid rate should result in reversal of signs of shock within 5 to 15 minutes. In critical situations, intraosseous routes should be used if venous access is not immediately available.**
- iii. Glucose can be administered per the "rule of 50," whereby the percent dextrose multiplied by the number of mL per kilogram equals. For neonates, a 10% dextrose solution should be given at approximately 5 mL/kg. Children 1 month old to approximately 8 years old or 25 kg should be given 2 mL/kg of 25% dextrose.**



- d. **Associated with Hypo/Hyponatremia = these kids are more sick appearing than the eunatremic child.**
- i. **Hyponatremia**
 1. Hx of: vomiting/diarrhea with free water replacement; or SIADH
 2. Need LABS to make the dx; get urine lytes as well.
 3. ***In the child with seizures or altered mental status, correction of hyponatremia should not be delayed. In these patients, 3 to 5 mL/kg of 3 percent saline is the suggested initial therapy.***
 - ii. **Hyponatremia**
 1. Hx of: concentrated formula/soup or febrile illness leading to hyperventilation
 2. Need labs to make the dx!

Overly rapid correction of serum sodium levels (>0.5 to 1 mEq/hr or >12 to 24 mEq/day) can lead to central pontine myelinolysis in hyponatremia and cerebral edema in hypernatremia. Neurologic status and serum sodium concentration should be closely monitored and the amount of sodium content of repletion fluid adjusted to maintain a slow correction.

Wisecracks:

1) Name 5 causes of bloody diarrhea.

I wish this was a short list, but really the number of causes is huge; here are a few:

- **Infectious**
 - STEC
 - EAEC
 - Shigella
 - Campylobacter
 - Yersinia
 - Salmonella non-typhi
- **Inflammatory**
 - IBD
- **Neoplastic**
 - malignancy
- **Vascula**
 - HSP
- **Structural**
 - Meckel's diverticulum

2) Other than vomiting and diarrhea from infectious gastroenteritis, list 6 causes of volume depletion.

Refer to Table 172.11 in Rosen's 9th edition for the differential diagnosis of volume depletion

Renal:



- Diuretics, renal tubular acidosis, renal failure, urinary tract obstruction, diabetes insipidus, diabetes mellitus, hypothyroidism, adrenal insufficiency, renal trauma, salt-wasting nephritis

Extrarenal:

- Third spacing (pancreatitis, peritonitis, sepsis), skin loss (burns, cystic fibrosis), lung loss, CHF, liver failure, hemorrhage

3) Name the components of the Gorelick scale

In 2015, a meta-analysis found both the CDS and Gorelick scale improve diagnostic accuracy over unstructured physician assessment. However, with only approximately 80% accuracy, neither can definitively rule in or out dehydration in infants and children.

There is the ten point or the four point (underlined) Gorelick scale...

Refer to Table 172.10 in Rosen's 9th edition for the Clinical Dehydration Scale including the Gorelick scale.

Gorelick scale:

	No or minimal dehydration	Moderate-severe dehydration
<u>General appearance</u>	Alert	Restless, lethargic, unconscious
<u>Capillary refill</u>	Normal	Prolonged or minimal
<u>Tears</u>	Present	Absent
<u>Mucous membranes</u>	Moist	Dry, very dry
Eyes	Normal	Sunken, deeply sunken
Breathing	Normal	Deep, rapid
Quality of pulses	Normal	Thready, weak or impalpable
Skin elasticity	Instant recoil	Slow recoil, recoil >2 seconds
Heart rate	Normal	Tachycardia
Urine output	Normal	Reduced

4) What's the 4-2-1 rule?

Refer to Table 172.12 in Rosen's 9th edition for maintenance fluid and electrolytes.

Fluids:

- 4 mL/kg/hr for first 10 kg body weight
- 2 mL/kg/hr for second 10 kg body weight
- 1 mL/kg/hr for each additional kg body weight

Shout outs:

<https://emergencymedicinecases.com/episode-19-part-2-pediatric-gastroenteritis-acute-constipation-bowel-obstruction/>