

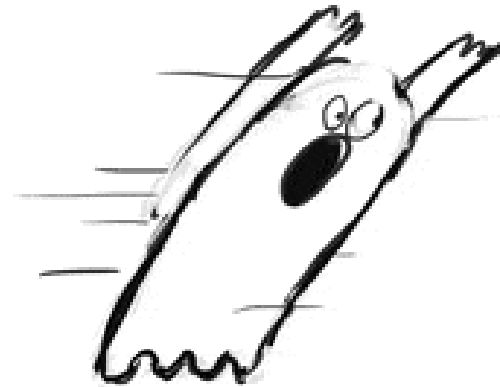
Acute Gastroenteritis in Children

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Why diarrhea?!

- Although global mortality due to diarrheal diseases has declined substantially (39%) during the past 2 decades, it remains **unacceptably high!**
- In addition to the risk of **mortality**, high rates of diarrhea can be associated with long-term **adverse** outcomes. Diarrheal illnesses, especially episodes among young children that are recurrent, prolonged, or persistent, can be associated with **malnutrition, stunting, micronutrient deficiencies**, and significant deficits in psychomotor and cognitive **development**.



Definition

- **Gastroenteritis**: inflammation of the gastrointestinal tract, most commonly the result of **infections** with bacterial, viral, or parasitic pathogens
- Many of these infections are **foodborne** illnesses.
- **Manifestations**: diarrhea and vomiting, which can also be associated with systemic features such as abdominal pain and fever
- **Dysentery**: frequent small stools containing visible blood, often accompanied by fever, tenesmus, and abdominal pain
- Distinguished from **bloody diarrhea**: larger volume bloody stools with less systemic illness.
- **Prolonged** (lasting 7-13 days)
- **Persistent diarrhea** (lasting 14 days or longer) are important because of their impact on growth and nutrition.



Pathogens



Pathogens

- **Rotavirus** is the most common cause of AGE among children throughout the world.
- The major bacterial pathogens that cause AGE are nontyphoidal *Salmonella* (NTS), *Shigella*, *Campylobacter*, and *Yersinia*.
- **EPIDEMIOLOGY IN LOW- AND MIDDLE-INCOME COUNTRIES:** most episodes of moderate-to-severe diarrhea were attributed to 4 pathogens:
 - **Rotavirus**
 - *Cryptosporidium*
 - *Shigella*
 - **ETEC**
- to less extent, **adenovirus**



Risk Factor

- Age:
 - Rotavirus and NTS: **infancy**
 - Endemic shigellosis peaks in **1-4 yr**
 - Campylobacter and Cryptosporidium: bimodal: greatest in **infants and young children**/ a secondary peak in **adolescents and young adults**
 - Pandemic V. cholerae and S. dysenteriae type 1: **all age groups**
- Immunocompromised or malnourished: NTS, *Shigella*, *Campylobacter*, *Yersinia*, and *Cryptosporidium* are more frequent and more severe
- Immunodeficiency
- Measles
- Malnutrition: increases mortality, particularly when associated with micronutrient deficiency. Vitamin A deficiency accounts for 157,000 deaths from diarrhea, measles, and malaria. Zinc deficiency is estimated to cause 116,000 deaths from diarrhea and pneumonia.
- Lack of exclusive or predominant breastfeeding



Clinical Manifestations

- Diarrhea: passage of **3** or more abnormally loose or liquid stools per day. Frequent passage of formed stools is **not** diarrhea!
- **Old** classification: mild, moderate and severe dehydration.
- difficult to distinguish between mild and moderate dehydration!
- **Therefore most guidelines now combine mild and moderate dehydration and simply use none, some, and severe dehydration.**
- Signs that best predict dehydration: prolonged capillary refill time >2 sec, abnormal skin turgor, hyperpnea (deep, rapid breathing suggesting acidosis), dry mucous membranes, absent tears, and general appearance (including activity level and thirst)
- Tachycardia, altered level of consciousness, and cold extremities with or without hypotension suggest **severe** dehydration

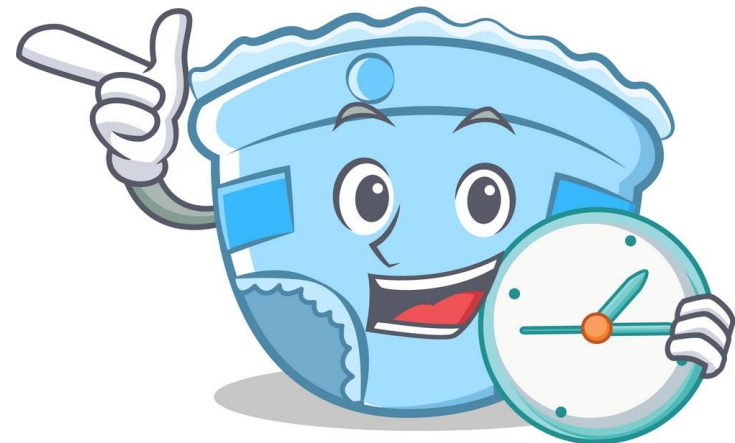


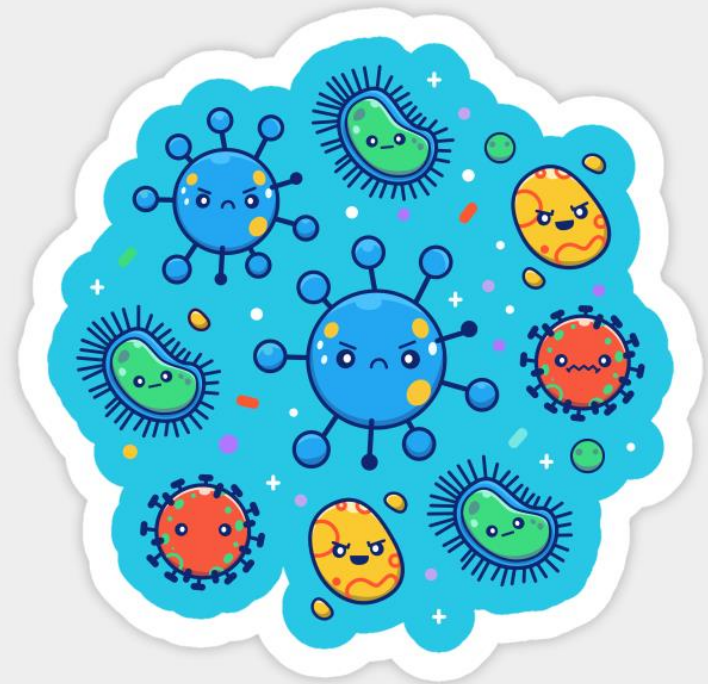
Table 366.12 Clinical Signs Associated With Dehydration

| SYMPTOM | MINIMAL OR NO DEHYDRATION | SOME DEHYDRATION | SEVERE DEHYDRATION |
|-------------------|---------------------------------------|---|--|
| Mental status | Well; alert | Normal, fatigued or restless, irritable | Apathetic, lethargic, unconscious |
| Thirst | Drinks normally; might refuse liquids | Thirsty; eager to drink | Drinks poorly; unable to drink |
| Heart rate | Normal | Normal to increased | Tachycardia, with bradycardia in most severe cases |
| Quality of pulses | Normal | Normal to decreased | Weak, thready, or impalpable |
| Breathing | Normal | Normal; fast | Deep |
| Eyes | Normal | Slightly sunken | Deeply sunken |
| Tears | Present | Decreased | Absent |
| Mouth and tongue | Moist | Dry | Parched |
| Skinfold | Instant recoil | Recoil in <2 sec | Recoil in >2 sec |
| Capillary refill | Normal | Prolonged | Prolonged; minimal |
| Extremities | Warm | Cool | Cold; mottled; cyanotic |
| Urine output | Normal to decreased | Decreased | Minimal |



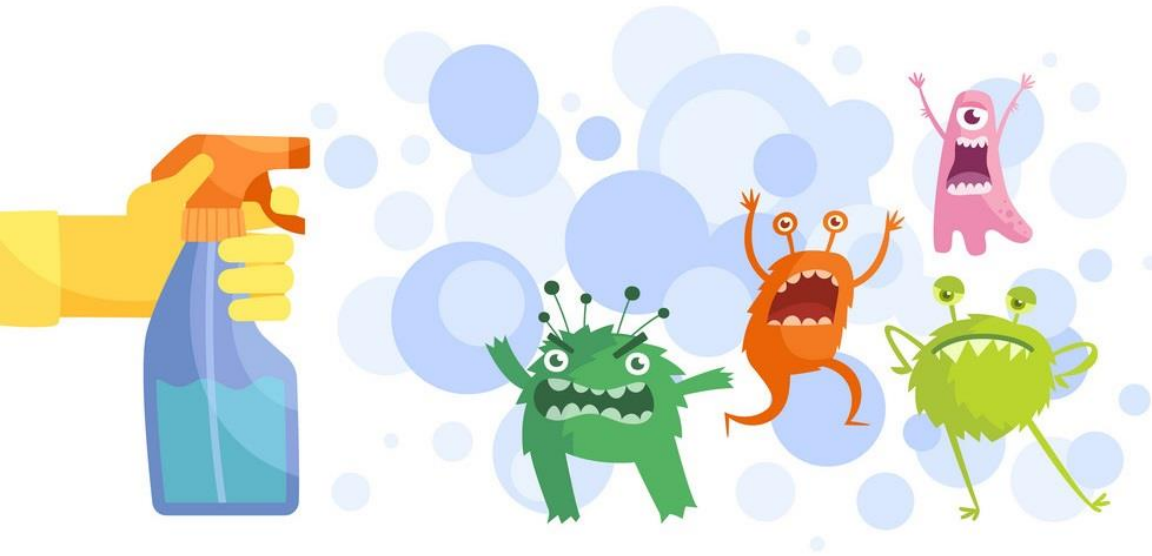
Viral Diarrhea

- Usually begin with **vomiting** followed by frequent passage of **watery** nonbloody stools, associated with fever in about half the cases.
- The diarrhea **lacks fecal leukocytes**, but stools from 20% of cases contain mucus.
- Recovery with complete resolution of symptoms generally occurs within 7 days.
- Although disaccharide malabsorption(**LD**) is found in 10–20% of episodes, it is rarely clinically significant.



Bacterial Diarrhea

- Fever $>40^{\circ}\text{C}$
- Overt fecal blood
- Abdominal pain
- no vomiting before diarrhea onset
- high stool frequency (>10 per day)



The classical bacterial agents, NTS, *Shigella*, *Campylobacter*, and *Yersinia*, present with 1 of 5 **syndromes**:

1. **Acute diarrhea**, the most common, may be accompanied by fever and vomiting
2. **Bloody diarrhea or frank dysentery**, classically caused by *Shigella*.
3. Invasive, nonfocal disease (**enteric fever**), febrile illness associated with bacteremia without localized infection. Diarrhea may be minimal or absent. Although classically the result of *S. Typhi* or *Paratyphi A and B* (affect preschool and school-age children in endemic countries), enteric fever can result from systemic spread of the classical bacterial enteropathogens (affect infants, particularly <3 mo, the immunocompromised, and children with malnutrition. Additional risk factors: hemolytic anemia and intravascular lesions for NTS, and iron overload, cirrhosis, and chelation therapy for *Yersinia* sepsis)



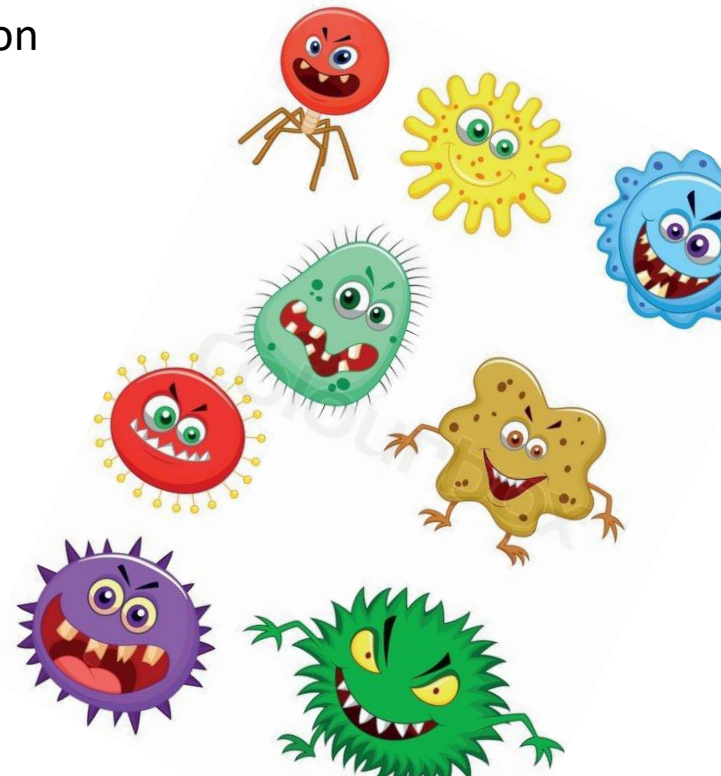
The classical bacterial agents, NTS, *Shigella*, *Campylobacter*, and *Yersinia*, present with 1 of 5 **syndromes**: (Cont.)

4. **Extraintestinal** invasive infections: mesenteric adenitis, appendicitis, and rarely cholecystitis, mesenteric venous thrombosis, pancreatitis, hepatic, or splenic abscess. Bacteremic spread may result in pneumonia, osteomyelitis, meningitis (3 conditions seen most commonly with NTS), abscesses, cellulitis, septic arthritis, and endocarditis. *Shigella* can cause noninvasive contiguous infections such as vaginitis and urinary tract infections.
5. **Vertical** transmission of *Shigella*, NTS, and *Campylobacter* can produce perinatal infection resulting in a spectrum of illness from isolated diarrhea or hematochezia to fulminant neonatal sepsis. One species of *Campylobacter*, *C. fetus*, is particularly virulent in pregnant women and can result in chorioamnionitis, abortion, and neonatal sepsis and meningitis.



Protozoal Diarrhea

- **prolonged**, sometimes for 2 wk or more, but usually self-limited
- episodes of sometimes-**explosive** diarrhea with nausea, abdominal cramps, and abdominal bloating.
- stools are usually watery but can be **greasy** and **foul** smelling due to concomitant malabsorption of fats
- Occasionally diarrhea may alternate with constipation



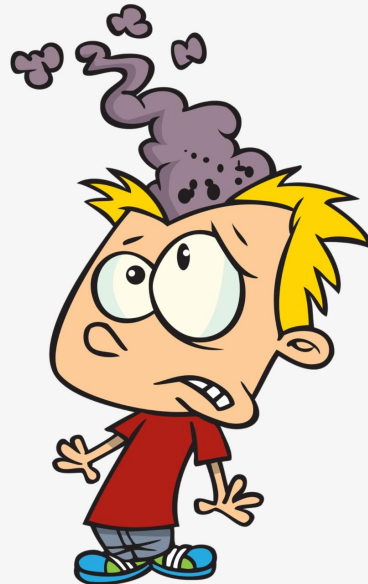
Complications

- dehydration
- electrolyte, or acid-base derangements
- Poor growth and nutrition
- secondary infections
- micronutrient deficiencies (iron, zinc, vitamin A)
- Intussusception
- Bacteremia
- Toxic megacolon
- intestinal perforation
- rectal prolapse



Complications, cont.

- HUS: Risk factors: age 6 mo to 4 yr, bloody diarrhea, fever, elevated leukocyte count, treatment with antibiotics and antimotility agents
- Pseudoappendicitis: CT-scan or sonogram may be helpful to distinguish true appendicitis
- Adults: reactive arthritis following infection with the classical bacterial enteropathogens and Guillain-Barré syndrome following *Campylobacter* infection
- *Entamoeba*: severe ulcerating colitis, colonic dilation, and perforation, liver abscesses



Differential Diagnosis

- anal fissures
- intermittent intussusception
- juvenile polyps
- Meckel diverticulum
- Necrotizing enterocolitis
- Inflammatory bowel disease
- congenital secretory diarrheas
- endocrine disorders (hyperthyroidism)
- Neoplasms
- food intolerance
- medications (particularly antibiotics)
- Cystic fibrosis
- celiac disease
- milk protein intolerance
- congenital or acquired disaccharidase deficiency
- Appendicitis
- pelvic inflammatory disease
- pyloric stenosis
- intestinal obstruction,
- Pancreatitis
- cholecystitis



Evaluation

- hydration status and electrolyte balance, evidence of sepsis or invasive bacterial infection
- **History and physical examination:** duration of diarrhea and a description of stools (frequency, amount, presence of blood or mucus), fever (duration, magnitude), vomiting (onset, amount and frequency), and the amount and type of solid and liquid oral intake, urine output, whether eyes appear sunken, whether the child is active, whether the child drinks vigorously, and the date and value of the most recent weight measurement, general appearance (activity, response to stimulation) and respiratory patterns, skin turgor, capillary refill time, mucous membrane moisture level, presence of tears, and extremity temperature



Laboratory diagnosis

- Most cases of AGE do **not** require diagnostic laboratory testing.
- Stool specimens: mucus, blood, neutrophils or fecal lactoferrin, **culture** (**restricted** to patients with clinical features predictive of bacterial AGE, have moderate or severe disease, are immunocompromised, in outbreaks with suspected hemolytic-uremic syndrome, or have a highly suggestive epidemiologic history)
- Standard stool **culture** methods performed in clinical microbiology laboratories recover *Shigella* and *Salmonella* species. If *Campylobacter*, *Yersinia*, or *Vibrio* species are suspected, the laboratory **should be notified** unless media are routinely used for their detection.
- All **bloody** stools should also be inoculated into media specific for detection of *E. coli* 0157:H7 or directly tested for the presence of Shiga-like toxin (or both).



Laboratory diagnosis, cont.

- *C. difficile* infection: older than 2 yr who have recently received antibiotics or have other risk factors
- Protozoa: recently traveled to an endemic area, contact with untreated water, symptoms (direct microscopy for cysts and trophozoites: 3 specimens from separate days)
- Electrolytes: severe dehydration, when intravenous fluids are administered, history of frequent watery stools, yet the skin pinch feels doughy without delayed recoil(hypernatremia), inappropriate rehydration fluids have been administered at home
- HUS: CBC, PBS, platelets, serum electrolytes, renal function tests
- shigellosis can demonstrate bandemia or even a leukemoid reaction
- Blood culture: **if** concern for systemic bacterial infection
- Persists: endoscopic evaluation, biopsy (IBD), sweat test (CF)



Treatment

- rehydration and maintenance ORS
- replacement of continued losses in diarrheal stools and vomitus after rehydration
- continued breastfeeding
- refeeding with an age-appropriate, unrestricted diet as soon as dehydration is corrected
- Zinc supplementation is recommended for children in developing countries



Table 366.13 Fluid and Nutritional Management of Diarrhea

| DEGREE OF DEHYDRATION* | REHYDRATION THERAPY | REPLACEMENT OF LOSSES DURING MAINTENANCE [†] |
|------------------------|--|---|
| Some dehydration | Infants [‡] and children: ORS, 50-100 mL/kg over 3-4 hr. Continue breast feeding. After 4 hr, give food every 3-4 hr for children who normally receive solid foods. | Infants and children: <10 kg body weight: 50-100 mL ORS for each diarrheal stool or vomiting episode, up to ~500 mL/day >10 kg body weight: 100-200 mL ORS for each diarrheal stool or vomiting episode; up to ~1 L/day Replace losses as above as long as diarrhea or vomiting continues |
| Severe dehydration | Malnourished infants may benefit from smaller-volume, frequent boluses of 10 mL/kg body weight due to reduced capacity to increase cardiac output with larger volume resuscitation. Infants (<12 months) and children (12 mo to 5 yr) without malnutrition: Give 20-30 mL/kg boluses of intravenous isotonic crystalloid solution (e.g., normal saline solution) over 30-60 min. Repeat boluses as necessary to restore adequate perfusion. Then give 70 mL/kg over 2.5-5 hr. (Note the slower infusion times are for infants.) Reassess the infant or child frequently and adjust infusion rate if needed. Switch to ORS, breast milk, and feed as described for some dehydration, when the child can drink, perfusion is adequate, and mental status is normal. Adjust electrolytes and administer dextrose based on chemistry values. | Infants and children: <10 kg body weight: 50-100 mL ORS for each diarrheal stool or vomiting episode, up to ~500 mL/day >10 kg body weight: 100-200 mL ORS for each diarrheal stool or vomiting episode; up to ~1 L/day Adolescents and adults: Ad libitum, up to ~2 L/day Replace losses as above as long as diarrhea or vomiting continue. If unable to drink, administer either through a nasogastric tube or give 5% dextrose 0.25 normal saline solution with 20 mEq/L potassium chloride intravenously. |



Hydration

Limitations to ORS (**IV preferred**):

- Shock
- decreased level of consciousness
- Ileus
- intussusception
- carbohydrate intolerance (rare)
- severe emesis
- High stool output (>10 mL/kg/hr)



Diet Selection

- Foods with complex carbohydrates (rice, wheat, potatoes, bread, and cereals), fresh fruits, lean meats, yogurt, and vegetables should be reintroduced while ORS is given.
- Fatty foods or foods high in simple sugars (juices, carbonated sodas) should be **avoided**.
- If the normal diet includes infant formula, it should **not be diluted**, or changed to a lactose-free preparation **unless** lactose malabsorption is evident.
- *Withdrawal of milk and replacement with specialized lactose-free formulations are unnecessary.*



Diet Selection, Cont.

- Alternative strategies for reducing the lactose load while feeding malnourished children who have prolonged diarrhea include addition of milk to cereals and replacement of milk with fermented milk products such as yogurt.
- Addition of green banana or pectin to the diet has also been shown to be effective in the treatment of persistent diarrhea.



Zinc supplementation

Zinc supplementation in children with diarrhea in **developing** countries leads to :

- reduced duration and severity of diarrhea
- prevent from recurring
- reduce all-cause mortality by 46% and hospital admission by 23%
- Leads to increased use of ORS and reduction in the inappropriate use of antimicrobials

- All children **older than 6 mo** of age with acute diarrhea in at-risk areas should receive oral zinc (**20 mg/day**) in some form for 10-14 days during and continued after diarrhea.



Additional Therapies

- Probiotic
- Ondansetron (oral mucosal absorption preparation): 4 mg for children 4-11 yr old and 8 mg for children older than 11 yr [generally 0.2 mg/kg]
- Antimotility agents (loperamide) are **contraindicated** in children with dysentery and probably have **no role** in the management of acute watery diarrhea in otherwise healthy children.



Antibiotic Therapy

- Antibiotics are used primarily to treat **severe** infections, prevent **complications** in high-risk hosts, or to **limit** the spread of infection.
- Shigella: ceftriaxone, azithromycin, ciprofloxacin / co-trimoxazole, cefixime
- NTS: the same, BUT only **if** age<3mo, achlorhydria, hemolytic anemia, UC, immunocompromised, malignancies, blood disorders
- Yersinia: if bacteriemia or invasive: Third-generation cephalosporins, ciprofloxacin, carbapenems, co-trimoxazole; if age>8 y: doxycycline, Gentamicin
- Campylobacter: if bacteriemia, immunosuppression, dysentery, severe: Macrolides



Antibiotic Therapy, (cont.)

- Treatment of *C. difficile*: Removal of the offending antibiotic, if possible; Antibiotic therapy directed against *C. difficile* should be instituted if the symptoms are **severe** or **persistent**; Testing for *C. difficile* is **discouraged** for children with diarrhea who are **<2 yr** unless there is strong evidence to implicate *C. difficile* as the etiologic agent; **Oral** vancomycin and metronidazole for 7-14 days (first line agents); The first relapse should be treated with **another course** of antibiotics based on severity of illness; For recurrent disease, **tapering and/or pulsed regimen of oral vancomycin over a 4- to 6-wk** period has been proposed; Fecal transplant; *Fidaxomicin*



Antibiotic Therapy, (cont.)

- Entamoeba: cyst: iodoquinol, paromomycin/ colitis, liver abscess: metronidazole, tinidazole, nitazoxanide
- Giardia: if persistent: metronidazole, tinidazole, nitazoxanide



Prevention

- Promotion of Exclusive Breastfeeding and Vitamin A
- Rotavirus Immunization
- Improved Water and Sanitary Facilities and Promotion of Personal and Domestic Hygiene



Traveler's Diarrhea

- It is the most common (28%) travel-associated health problem in children
- watery diarrhea or dysentery

Treatment:

- Loperamide reduces the number of stools in older children with watery diarrhea and improves outcomes when used in combination with antibiotics in traveler's diarrhea. However, **loperamide should not be used in febrile or toxic patients with dysentery, in those with bloody diarrhea, and in children younger than 6 yr.**



Traveler's Diarrhea, (cont.)

- Antibiotics are **not** recommended for **mild** diarrhea that is tolerable, is not distressing, and does not interfere with planned activities. When empiric therapy is required abroad, **azithromycin** is suggested for young children. **Fluoroquinolones** are recommended for older children and adults and as second line therapy for younger children. Short-duration (**3 days**) therapy is effective.



Prevention

- ORS and age-appropriate antibiotics should be included in a routine health packet.
- Travelers should drink bottled or canned beverages or boiled water.
- They should avoid ice, salads, and fruit they did not peel themselves.
- Food should be eaten hot, if possible. Raw or poorly cooked seafood is a risk, as is eating in a restaurant rather than a private home.
- Swimming pools and other recreational water sites can also be contaminated.
- Chemoprophylaxis is not routinely recommended for previously healthy children or adults. Nonetheless, travelers should bring azithromycin (younger than 16 yr of age) or ciprofloxacin (older than 16 yr of age) and begin antimicrobial therapy if diarrhea develops.



That's it!

