

# Diarrhea (pediatrics)

Acute diarrheal diseases are among the most common diseases of childhood and are the most common cause of dehydration in infancy and in toddlers, which can lead to life-threatening conditions. However, diarrheal diseases usually have a mild, self-limiting course.

Acute diarrhea typically begins with the affected individuals being completely healthy. It may be accompanied by fever, which may indicate an inflammatory etiology or it could be due to dehydration. Children, especially infants, are much more prone to dehydration than adults due to the greater basal need for fluids and electrolytes per kilogram of weight, large body surface area for their size, and increased tendency to vomit.

The most common causative agents of diarrheal diseases in children are viruses (rotaviruses, caliciviruses, adenoviruses, astroviruses, noroviruses, and others). Other agents of acute diarrhea can include alimentary bacterial (e.g., salmonella and campylobacter), parasitic infections, medications, food allergies, vitamin deficiencies, heavy metal poisoning, and absorption disorders.<sup>[1]</sup>

Infectious diarrheal diseases are a serious problem, especially in developing countries, where 3-4 million children die from them each year. In developed countries, fatalities are much rarer.<sup>[2]</sup>

Acute diarrhea is defined as:

- A sudden change in the consistency and character of the stool with frequent emptying of sparse mushy to watery stools.
- A stool volume of more than 10 mL/kg/day<sup>[1]</sup>

In infants and toddlers, we define diarrhea as:

- **More frequent emptying of a larger volume of loose stools** <sup>[3]</sup>
- **Defecating more than 3 times a day** (we cannot automatically assume that this is a case of diarrhea)
- **Stool volume greater than 10 g/kg/day**
- Acute diarrhea usually does not last longer than a week<sup>[4]</sup>

## Diarrheal disorders by etiology

- **Viral gastroenteritis (viral diarrheal diseases)**
  - Rotavirus enteritis
  - Adenovirus enteritis
- **Bacterial gastroenteritis (bacterial diarrheal diseases)**
  - Campylobacter enteritis (*causative agent: Campylobacter jejuni*)
  - Salmonella enteritis (*causative agent: Salmonella enteritidis, S. typhimurium*)
  - Typhoid fever (*causative agent: Salmonella typhi*)
  - Paratyphoid fever (*causative agent: Salmonella paratyphi*)
  - Shigellosis (*causative agent: Shigella dysenteriae, flexneri, boydii, sonnei*)
  - Cholera (*causative agent: Vibrio cholerae*)
  - Infections caused by Escherichia coli
- **Gastrointestinal parasitosis**
  - **Protozoa:** Toxoplasmosis (*causative agent: Toxoplasma gondii*), Toxocarosis (*Toxocara canis / cati*), Giardiasis (*Giardia lamblia*), Amoebiasis (*Entamoeba histolytica*), Cryptosporidiosis (*Cryptosporidium parvum*)
  - **Nematodes:** Ascariasis (*caused by: Ascaris lumbricoides*), Trichuriasis (*Trichuris trichiura*), *Trichinella spiralis*, Enterobiosis (*Enterobius vermicularis*), *Strongyloides stercoralis*, *Ancylostoma duodenale*, *Necator americanus*, *Dracunculus*
  - **Cestodes:** Teniosis (*agents: Taenia solium, Taenia saginata*), *Diphyllobothrium latum*, (*Hymenolepis nana*), *Echinococcus granulosus*...
- **Enterotoxigenesis** - caused by enterotoxins
- **Drug-induced diarrhea**
  - Pseudomembranous enterocolitis

More detailed information can be found on the page *Differential diagnosis of diarrheal diseases*.

## Pathophysiology

- Changes in the intestinal mucosa (impaired absorption, digestion, secretion, and motility) lead to excessive loss of water and electrolytes, especially sodium and potassium, metabolic acidosis, and subsequent dehydration.
- Two main pathophysiological mechanisms: osmotic and secretory diarrhea.
- Viruses directly damage the intestinal villi and enterocyte brush border enzymes.
- Osmotic and secretory diarrhea are combined in the pathogenesis of rotavirus diarrhea. Osmotic diarrhea is caused by the destruction of villi (cell lysis) via the action of NSP4-induced glucose malabsorption (SGLT-1 inhibition) and inflammation (NK- $\kappa$ B, IL-8). Secretory diarrhea is caused by crypt cell proliferation

(compensatory secretory cell proliferation), NSP4 - enterotoxin (increased intracellular calcium, chloride secretion), vascular ischemia (microcirculatory disorders), and inflammation.

- Enteroinvasive bacteria (*Salmonella spp.*, *Shigella spp.*, *Campylobacter jejuni*, enteroinvasive *E. coli*) cause ulcerations and inflammatory infiltration of the intestinal mucosa.
- Some bacteria (enterotoxigenic *E. coli*, staphylococcal enterotoxin) stimulate active secretion of ions and water into the intestinal lumen by their toxins (cAMP, cGMP).
- Non-invasive bacteria and parasites adhere to the mucosa and cause inflammatory infiltration.<sup>[1]</sup>

## Pathophysiology of dehydration

- In the acute phase, the deficiency of body fluids first concerns only the extracellular space. With further progression, intracellular dehydration and tissue hypoxia occur.
- In about 70-80% of patients, water and sodium losses are proportional and **isotonic dehydration** occurs.
- About 10-15% of patients experience disproportionately large ion losses (mainly sodium) compared to water losses and **hypotonic dehydration** occurs. Hyponatremia can also develop or worsen if, during diarrhea, fluid losses are compensated with excessive fluid intake with little or no ion content.
- About 10-20% of patients have a disproportionate large water loss compared to electrolyte loss and **hypertonic dehydration** occurs. Improperly prepared dairy products are a common cause, causing a large renal load of electrolytes, and increased urine production. Another cause may be the incorrect treatment of an acute attack of diarrhea with home-prepared solutions with a high concentration of salts.
- Hypernatremia and dehydration may also be exacerbated by increased fluid loss due to the fever, high ambient temperature, hyperventilation, and associated decreased fluid availability.<sup>[1]</sup>

## Diarrheal diseases in infancy

### Etiology

- It is very diverse, so it is best to divide diarrheal diseases into **infectious and non-infectious** forms.
- In infants, the infectious form is more common.

### Clinical manifestation

- The symptomatology of diarrhea is determined by the severity of mucosal damage.
- Initially, infants refuse food 2-3 days before diarrhea occurs.
- Children stop gaining weight, vomit, are pale, lose interest in the environment, and have a fever.
- Diarrhea manifests suddenly: initially the stools are mushy, then they become watery.
- **Manifestations of dehydration:**
  - During the enteric phase, the turgor of the skin is reduced, the abdomen becomes meteoric, mild hepatosplenomegaly may be present, urine production is reduced.
  - The pulse gradually accelerates and with severe dehydration it slows.
  - The fontanelle depress and tears are missing when crying.
- The most severe form of infant enteritis is toxicosis.
  - It begins with vomiting of green vomit with an admixture of hematin and at the same time there are frequent watery stools.
  - Significant dehydration occurs - sunken fontanelle, reduced skin turgor, acrocyanosis, anuria
- The most important step before initiating therapy is the estimation of water and electrolyte loss, because acute lethality occurs only by hypovolemic shock, which requires adequate fluid and electrolyte replacement to treat.
  - The degree of dehydration can be determined by weight loss and laboratory examinations.

### Laboratory findings

- Acute diarrhea with weight loss below 5% of the original weight with good oral fluid intake can be treated only on an outpatient basis and no laboratory examinations are necessary.
- In the case of weight loss above 5%, epidemic diarrhea, and bloody stools, a thorough examination is indicated.
- Manifestations of hemoconcentration include **increase in Hb** and **hematocrit**.
- Laboratory examination involves the determination of sodium, potassium, and chloride osmolality and acid-base homeostasis.
- In severe toxic enteritis, metabolic acidosis (mainly due to loss of bicarbonate in the stool) ensues.
- Oliguria develops, often with proteinuria, urea and creatinine rise in the serum.
- Hypernatremic dehydration causes hyperglycemia (this is not treated with insulin, because there is a risk of cerebral edema).

### Diagnostics

- Anamnesis (nutritional change, epidemic occurrence, administration of ATB, and other drugs)
- **Stool evaluation:**
  - Secretory diarrhea (most often infectious) - watery, sparse, often with fever
  - Malabsorption of carbohydrates - foamy, sour smelling, pH below 6
  - Chronic eating disorders - bulky, greasy, putrid-smelling
  - Colon inflammation (indicates an infectious etiology- *Salmonella*, *Shigella*, *Yersinia*, *Campylobacter*) - mucus in stool, possibly bloody

- As soon as possible, a stool sample must be sent for microbiological examination (it must not be too thin and once stools are watery, we no longer have to cultivate pathogenic organisms).
- The presence of polymorphonuclear cells indicates a bacterial infection.
- In chronic disorders, there is a positive stool test for fats, carbohydrates, reducing substances, trypsin, and/or proteins.
- To exclude cystic fibrosis, we examine chloride concentration in sweat.
- Serology is not performed for acute diarrhea, but it is important in examining recurrent and chronic diarrhea.

## Treatment

Most cases of acute infectious gastroenteritis resolve spontaneously, so in the vast majority of cases, antibiotic therapy is not indicated. The key is to maintain adequate hydration of the child. With reduced hydration, rapid oral replacement of water and electrolyte losses is important. In more severe cases, correction of metabolic acidosis, and subsequent maintenance of hydration and early initiation of realimentation, which prevents further damage to the intestinal mucosa and thus the development of prolonged gastroenteritis, are necessary.<sup>[5]</sup>

### Rehydration

In the treatment of dehydration, oral (enteral) rehydration is preferred, which is as effective as intravenous rehydration, but has fewer side effects and shorter hospital stays.<sup>[5]</sup>

Oral rehydration solutions:

- Hypoosmolar, sodium content 60 mmol/L, composition according to ESPGHAN recommendations
- e.g., Kulíšek®, Kulíšek forte®, HIPPO ORS 200®, Vodníček Baby®, Vodníček Jahoda®, Enhydrol Banán®
- If the child is unable to drink the solution, it is given using a nasogastric tube.
- Fluid and ion loss is compensated in a short interval - 30-80 mL/kg (depends on how dehydrated the patient is) within 4 hours.<sup>[5]</sup>

Hydration maintenance:

- After correction of dehydration, the recommended daily volume of fluids is given frequently and in small doses in the form of usual drinks (breast milk, infant formulas, tea, mineral water,...).
- Hyperosmolar drinks such as juices or cola are not suitable.
- Oral hydration solutions compensate for the accompanying losses of fluids and ions (via diarrhea and vomiting) - 10 mL/kg up to a maximum volume of 100-150 mL.<sup>[5]</sup>

Recommended composition of glucose rehydration solution:

- 60 mmol/L Na, 20 mmol/L K, min. 25 mmol/L Cl, 10 mmol/L citrate, 74-111 mmol/L glucose
- Osmolality 200-250 mOsmol/L
- These solutions are prepared or can be produced according to the following recipe:

Rp.  
 Natrii chlorati 0,4375  
 Kalii chlorati 0,373  
 Natrii citrici dihydrati 0,735  
 Glucosi 5,0  
 M. f. pulv.  
 D. ad. sacc. pap.  
 D. S. dissolve the contents of the bag in 250 ml of boiled water

- Cooled (4-8 ° C) rehydration solution is administered in spoons (for 5-10 minutes, with 5-10 mL of solution every time, or continuously using a nasogastric tube)
- Mild conditions (with weight loss of up to 5%) can be treated on an outpatient basis (for 4 hours we give 50-100 mL/kg of the solution).
- Moderate and severe conditions require hospitalization.
- In the case of repeated vomiting or diarrhea, we add the amount lost (according to weight, or we count each watery stool as 50-100 mL).
- After 4 hours we check the hydration, if it has adjusted, we start with timely realimentation.
- In case of persistent diarrhea, we give 10 mL of solution per kg for each watery stool.
- It is fundamentally wrong to use juice or cola to rehydrate due to their high osmolality.<sup>[4]</sup>

### Realimentation

Early loading of the digestive tract reduces increased intestinal permeability, contributes to maintaining the integrity of the mucosa, prevents bacterial overgrowth, and the possibility of developing serious intestinal lesions, which can lead to atrophic mucosa.<sup>[5]</sup>

Breastfeeding is not interrupted - breast milk is given continuously even during the child's current dehydration. In non-breastfed infants, resuscitation begins after 4 hours of exclusive rehydration solution administration. Infants on formula, continue being fed their formula, which they were fed before the onset of acute gastroenteritis. Infant formulas are given in full concentration, not diluted. Lactose-free, soy, or hydrolysed milk formulas are not indicated. Toddlers and older children receive an age-appropriate diet - ideally, starchy foods (rice, potatoes, pasta,

pastries) are given first, then lean meat, carrot soups, apple and banana puree, etc... are given afterward. Drinks high in fructose, sucrose, or sorbitol and very sweet foods are not suitable. It is advisable to quickly transfer children to their normal diet, especially if they have not experienced vomiting.<sup>[5]</sup>

## Medications

Most acute gastroenteritis does not require medication. In the vast majority of cases, antibiotics are not indicated.<sup>[5]</sup>

Indications for antibiotics:

- Presumed or confirmed bacterial infection (especially *Salmonella enteritidis*)
  - In infants less than 3 months of age
  - In premature babies under 1 year of age
  - In immunodeficient or immunosuppressed children
  - In children with current serious illnesses or children experiencing malnutrition
  - With signs of sepsis
- Severe campylobacter enteritis
- Severe *Giardia lamblia* infection
- *Vibrio cholerae*, *Shigella dysenteriae*, *Salmonella typhi*, *Entamoeba histolytica* etc... infections<sup>[5]</sup>

Antibiotics:

- The drug of choice is cotrimoxazole - for salmonella, shigella, yersinia, ETEC, EIEC - for about 7 days.
  - For campylobacter infections we administer erythromycin and for clostridium difficile, vancomycin is used.
  - Giardia and entamoeba are treated with metronidazole<sup>[4]</sup>

Pharmacotherapy:

- Antiemetics (used for cases with severe vomiting): ondansetron
- Absorbants: smectite
- Drugs that reduce increased intestinal secretion in infectious acute gastroenteritis: racecadotril (does not affect intestinal motility).
- Probiotics: Lactobacillus GG and Saccharomyces boulardii strains (as recommended by ESPGHAN/ESPID).

Micronutrients, disinfectants, and motility suppressants are not indicated in developed countries.<sup>[5]</sup>

## Prevention

- Vaccination against rotavirus gastroenteritis

## Links

### Related articles

- Antidiarrheals

### References

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