ACUTE GASTROENTERITIS IN CHILDREN

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ACUTE GASTROENTERITIS

Definition

ACUTE GASTROENTERITIS

It is an infection of the gastrointestinal tract caused by bacteria, viruses and parasites.

It covers infections that cause diarrhea.

Diarrhea is loose, watery stools three or more times a day (≥3 defecations/day).

It usually takes less than a week.

It is not expected to last more than two weeks.

ACUTE GASTROENTERITIS

ACUTE GASTROENTERITIS

Etiology

Bacteria (~%15)	*Viruses (~%75)*	*Parasites (~%5)*
Aeromonas spp.	Astroviruses	*Balantidium coli*
Bacillus cereus	Caliciviruses	*Blastocystis hominis*
Campylobacter jejuni	Enteric adenovirüs	*Cryptosporidium parvum*
Clostridium perfringens	Herpes simplex viruses	*Cyclospora cayetanensis*
Clostridium difficile	Norovirus	*Encaphalitozoon intestinalis*
Escherichia coli	Rotavirus	*Entamoeba histolytica*
Plesiomonas shigelloides	Cytomegalovirus	*Enterocytozoon bieneusi*
Salmonella spp.		*Giardia lamblia*
Shigella spp.		*Isospora belli*
Staphylococcus aureus		*Strongyloides stercoralis*
Vibrio cholerae		*Trichuris trichiura*
Vibrio parahaemolyticus		
Yersinia enterocolitica		

ACUTE GASTROENTERITIS
Transmission

ACUTE GASTROENTERITIS

Fecal-oral route

Contaminated water and food

ACUTE GASTROENTERITIS

Microorganisms that can be transmitted from person to person with a small amount of inoculum.

- ***Shigella***
- ***Escherichia coli***
- ***Norovirus***
- ***Rotavirus***
- ***Giardia lamblia***
- ***Cryptosporidium parvum***
- ***Entamoeba histolytica***

ACUTE GASTROENTERITIS
Epidemiology

EPIDEMIOLOGY

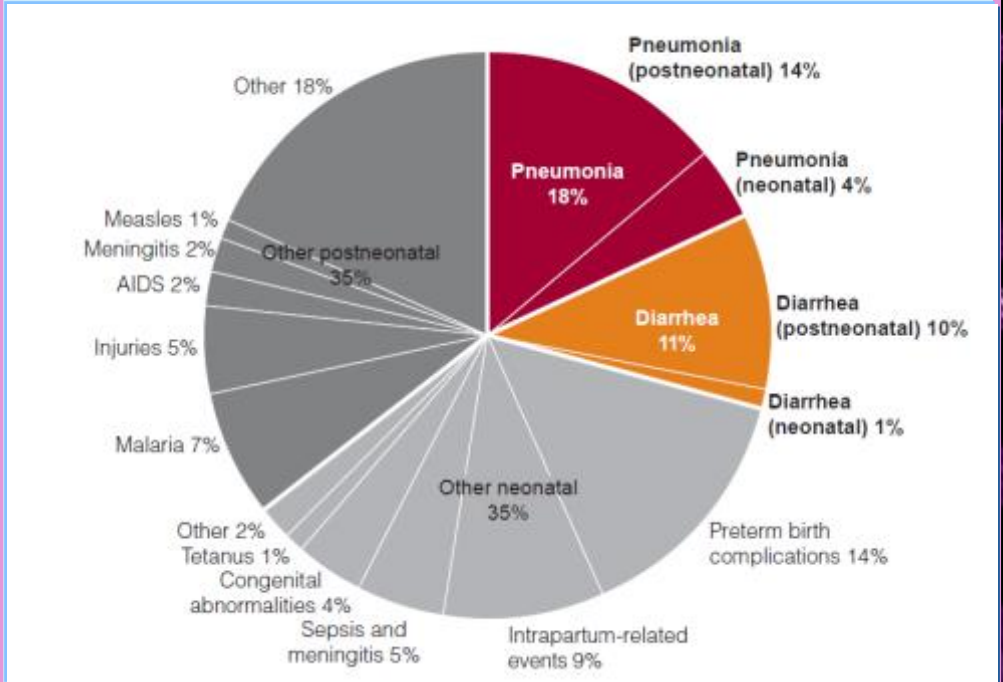
It is an important cause of morbidity and mortality under the age of 5 in underdeveloped countries.

In underdeveloped countries, 3-6 attacks occur per year.

It causes about 1.5-2 million deaths per year.

It is the second most common cause of child death.

EPIDEMIOLOGY



ACUTE GASTROENTERITIS
Signs and Symptoms

ACUTE GASTROENTERITIS

Diarrhea

Vomiting

Fever

Abdominal pain

Signs of dehydration

ACUTE GASTROENTERITIS

ACUTE GASTROENTERITIS
Complications

COMPLICATIONS	CAUSATIVE AGENT
Reactive arthritis	*Salmonella, Shigella, Yersinia, Campylobacter, Cryptosporidium, Clostridium difficile*
Guillain-Barré syndrome	*Campylobacter*
Glomerulonephritis	*Shigella, Campylobacter, Yersinia*
IgA nephropathy	*Campylobacter*
Erythema nodosum	*Yersinia, Campylobacter, Salmonella*
Hemolytic anemia	*Campylobacter, Yersinia*
Hemolytic uremic syndrome	*S. dysenteriae 1, E. coli*

ACUTE GASTROENTERITIS
Laboratory Findings

ACUTE GASTROENTERITIS

Macroscopic examination of stool

Microscopic examination of stool

Stool culture and PCR

Antigen detection tests

ACUTE GASTROENTERITIS

Complete blood count

Serum electrolytes (Na and K)

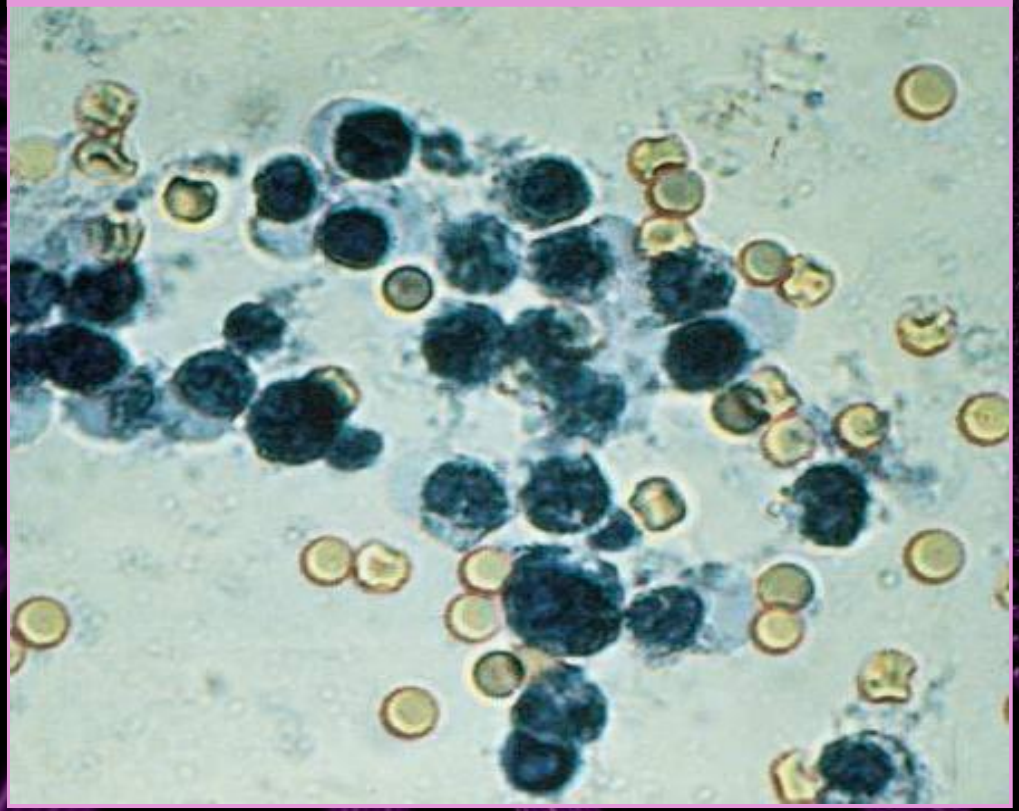
Kidney function tests (Urea and Cre)

Serum glucose level

Aterial blood gases

ACUTE GASTROENTERITIS
Laboratory Findings

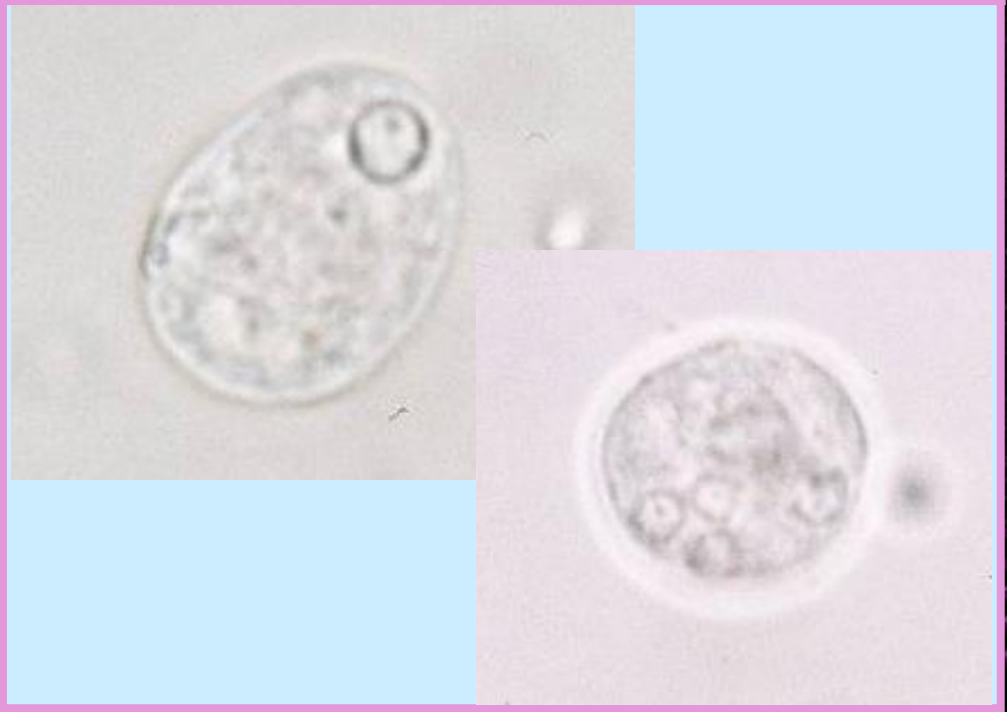
STOOL MICROSCOPY



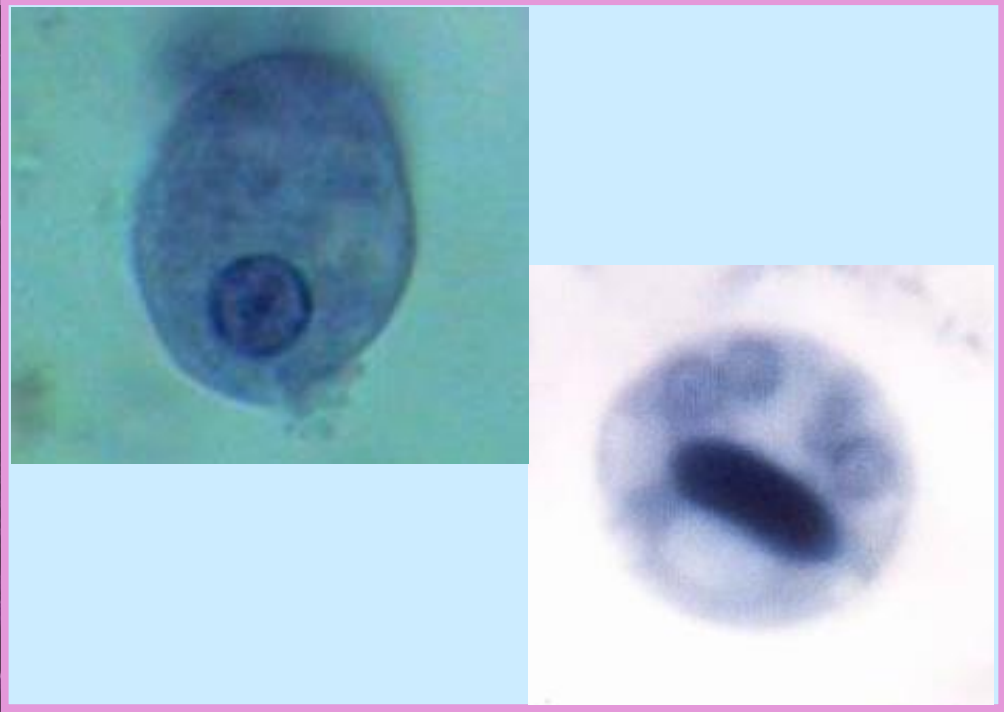
STOOL MICROSCOPY

ACUTE GASTROENTERITIS
Laboratory Findings

ENTAMOEBA HISTOLYTICA



ENTAMOEBA HISTOLYTICA



ACUTE GASTROENTERITIS
Laboratory Findings

ENTAMOEBA HISTOLYTICA

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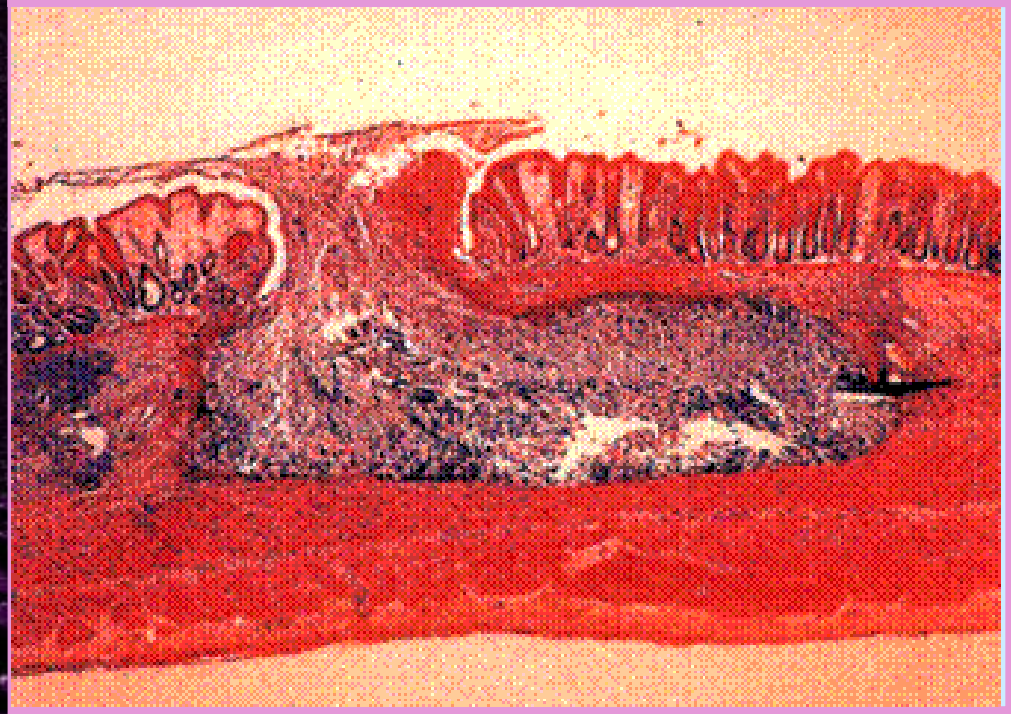

ACUTE GASTROENTERITIS
Laboratory Findings

GIARDIA INTESTINALIS

GIARDIA INTESTINALIS

ACUTE GASTROENTERITIS
Differential Diagnosis

ANATOMICAL DEFECTS
Malrotation
Intestinal duplication
Hirschsprung's disease
Fecal impaction
Short bowel syndrome
Microvilli atrophy
Strictures

MALABSORBTION
Disaccharidase deficiency
Glucose-galactose malabsorption
Pancreatic insufficiency
Cystic fibrosis
Shwachman syndrome
Intraluminal bile salt deficiency
Cholestasis
Hartnup's disease
Abetalipoproteinemia
Celiac disease

ENDOCRINE DISEASES
Thyrotoxicosis
Addison's disease
Adrenogenital syndrome

FOOD POISONING
Heavy metal
Scombroid
Ciguatera
Mushroom

NEOPLASIS
Neuroblastoma
Ganglioneuroma
Pheochromocytoma
Carcinoid
Zollinger-Ellison syndrome
VIP syndrome

OTHERS
Non-GI infections
Milk allergy
Crohn's Disease
Ulcerative colitis
Familial dysautonomia
Immunodeficiency
Protein-losing enteropathy
Acrodermatitis enteropathica
Laxative use
Motility disorders
Pellagra

ACUTE GASTROENTERITIS

Treatment

1. Fluid and electrolyte therapy
2. Maintaining nutrition
3. Symptomatic and supportive treatments
4. Agent-specific treatment with antimicrobial drugs

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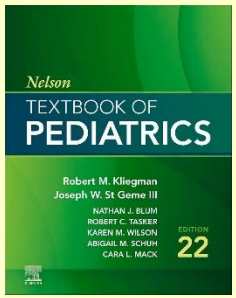
DEHYDRATION CLASSIFICATION (IV)

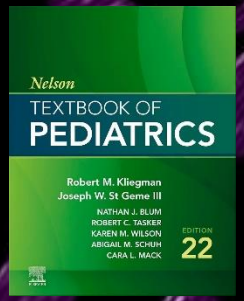
MILD DEHYDRATION	MODERATE DEHYDRATION	SEVERE DEHYDRATION
WEIGHT LOSS **Infant: <5%** **Older child and adult: <3%**	**5-10%** **3-6%**	**> 10%** **> 6%**
CLINICAL FINDINGS **Normal physical findings** **Normal or increased pulse** **Decreased urine output** **Thirsty** 	**Tachycardia** **Little or no urine output** **Irritable/lethargic** **Sunken eyes and fontanel** **Decreased tears** **Dry mucous membranes** **Mild delay in elasticity (skin turgor)** **Delayed capillary refill (>1.5 sec)** **Cool and pale**	**Peripheral pulses either rapid and weak or absent** **Decreased blood pressure** **No urine output** **Very sunken eyes and fontanel** **No tears** **Parched mucous membranes** **Delayed elasticity (poor skin turgor)** **Very delayed capillary refill (>3 sec)** **Cold and mottled limp** **Depressed consciousness**

DEHYDRATION CLASSIFICATION

Mild dehydration (<5% in an infant; <3% in an older child or adult): Normal or increased pulse; decreased urine output; thirsty; normal physical findings

Moderate dehydration (5–10% in an infant; 3–6% in an older child or adult): Tachycardia; little or no urine output; irritable/lethargic; sunken eyes and fontanel; decreased tears; dry mucous membranes; mild delay in elasticity (skin turgor); delayed capillary refill (>1.5 sec); cool and pale

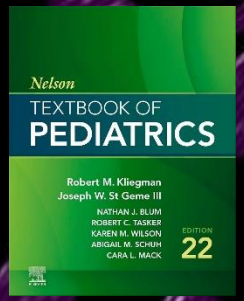
Severe dehydration (>10% in an infant; >6% in an older child or adult): Peripheral pulses either rapid and weak or absent; decreased blood pressure; no urine output; very sunken eyes and fontanel; no tears; parched mucous membranes; delayed elasticity (poor skin turgor); very delayed capillary refill (>3 sec); cold and mottled; limp, depressed consciousness



DEHYDRATION CLASSIFICATION

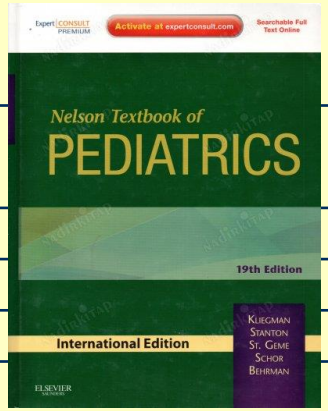
1. Restore intravascular volume
   Isotonic fluid (NS or LR): 20 mL/kg over 20 min
   Repeat as needed
2. Calculate 24 hr fluid needs: maintenance + deficit volume
3. Subtract isotonic fluid already administered from 24 hr fluid needs
4. Administer remaining volume over 24 hr using 5% dextrose NS + 20 mEq/L KCl
5. Replace ongoing losses as they occur

LR, Ringer lactate; NS, normal saline.



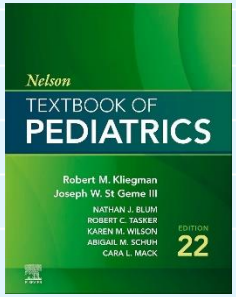
DEHYDRATION CLASSIFICATION (ORAL)

	MINIMAL OR NO DEHYDRATION	MILD TO MODERATE DEHYDRATION	SEVERE DEHYDRATION
Loss of Body Weight	(<%3)	(%3-9)	(>%9)
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	More decreased



DEHYDRATION CLASSIFICATION

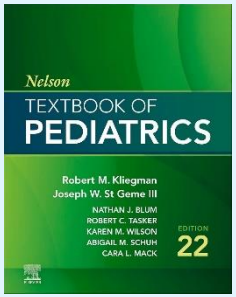
SYMPTOM	MINIMAL OR NO DEHYDRATION	SOME DEHYDRATION	SEVERE DEHYDRATION
Mental status[C,G4,W]	Well; alert	Normal, fatigued or restless, irritable	Apathetic, lethargic, limp, unconscious/comatose
Thirst[W]	Drinks normally; might refuse liquids	Thirsty; eager to drink	Drinks poorly; unable to drink
Heart rate[G10]	Normal	Normal to increased	Tachycardia, with bradycardia in most severe cases
Quality of pulses[G10]	Normal	Normal to decreased	Weak, thready, or impalpable
Breathing [G10]	Normal	Normal; fast	Deep, fast
Eyes[C,G10,W]	Normal	Slightly sunken	Deeply sunken
Tears[C,G4]	Present	Decreased	Absent
Mouth and tongue/mucous membranes[C,G4]	Moist	Dry, "sticky" or "tacky"	Parched
Skinfold[G10,W]	Instant recoil	Recoil in <2 sec (slow)	Recoil in >2 sec (very slow)
Capillary refill[G4]	Normal	Prolonged	Prolonged; minimal
Extremities	Warm	Cool	Cold; mottled; cyanotic
Urine output[G10]	Normal to decreased	Decreased	Minimal



[C]Denotes inclusion in Clinical Dehydration Scale (CDS); CDS scores each category from 0 to 2 with an overall score of 0 = no dehydration (<3%), 1-4 = some dehydration (<6%).
[G4]Denotes inclusion in 4-point and 10-point Gorelick scales: ≥2 Clinical Signs ≥5% ΔBW; ≥3 Clinical Signs ≥10% ΔBW.
[G10]Denotes items included in 10-point Gorelick scale but not in the 4-point Gorelick scale: ≥3 Clinical Signs ≥5% ΔBW; ≥7 Clinical Signs ≥10% ΔBW. Gorelick Scale uses "no or minimal dehydration" and "moderate to severe dehydration."
[W]Denotes inclusion in the World Health Organization (WHO) scale.
BW, Body weight.

DEHYDRATION CLASSIFICATION

DEGREE OF DEHYDRATION	REHYDRATION THERAPY	REPLACEMENT OF LOSSES
Some dehydration	Infants and children: ORS, 75 mL/kg over 3-4 hr. Continue breastfeeding. After 4 hr, give food every 3-4 hr for children who normally receive solid foods.	*Infants and children:* <2 yr old: 50-100 mL ORS for each diarrheal stool or vomiting episode, up to ~500 mL/day ≥2 yr old: 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 5-10 mL/kg body weight due to reduced capacity to increase cardiac output with larger volume resuscitation. Infants (<12 mo) and children (12 mo to 5 yr) without malnutrition: Give 20-30 mL/kg boluses of IV isotonic crystalloid solution (e.g., Ringer lactate or 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.) If IV hydration is not possible, administer ORS 20 mL/kg/hr × 6 hours via nasogastric tube. Reassess the infant or child frequently and adjust infusion rate if needed. Give ORS as soon as the child can drink. Allow to feed (breast milk or solid food) as described for some dehydration. Adjust electrolytes and administer dextrose based on chemistry values.	*Infants and children:* <10 kg body weight (children <2 yr): 50-100 mL ORS for each diarrheal stool or vomiting episode >10 kg body weight (children ≥2 yr): 100-200 mL ORS for each diarrheal stool or vomiting episode *Adolescents and adults:* Ad libitum Replace losses as above as long as diarrhea or vomiting continue If unable to drink, either administer ORS through a nasogastric tube or give dextrose-containing IV fluids as appropriate based on chemistry values



Note: Low-osmolarity ORS can be given to all age-groups, with any cause of diarrhea. It is safe in the presence of hypernatremia, as well as hyponatremia (except when edema is present). Some commercially available formulations that can be used as ORS include Pedialyte Liters (Abbott Nutrition), CeraLyte (Cera Products), and Enfalac Lytren (Mead Johnson). Popular beverages that should not be used for rehydration include apple juice, Gatorade, and commercial soft drinks.

ORS, Oral rehydration solution; IV, intravenous.

ACUTE GASTROENTERITIS

Treatment

1. Fluid and electrolyte therapy
2. Maintaining nutrition
3. Symptomatic and supportive treatments
4. Agent-specific treatment with antimicrobial drugs

ACUTE GASTROENTERITIS
Treatment: Nutrition

Breastfed babies	**During rehydration and maintenance continue breastfeeding.**
Formula feeding	**Resume normal formula after rehydration.**
Non-Breastfed Non-Formula feeding	**After the rehydration, give the liquid and solid foods that the child normally takes. Avoid foods rich in fatty and simple sugars.**

ACUTE GASTROENTERITIS

Treatment: Nutrition

APPROPRIATE	INAPPROPRIATE
Water Rice Potatoes Soups (potato, carrot, rice) Yogurt Ayran Fruits and vegetables Bread Cracker Milk Lean meat (Chicken)	Cola and similar drinks Soft drinks Beverages

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ACUTE GASTROENTERITIS
Treatment: Anti-diarrheal Drugs

- **Drugs that shorten the severity and duration of diarrhea**
  - **Anti-motility drugs:** Loperamide, Diphenoxylate+atropine
  - **Anti-secretory drugs:** Bismuth subsalicylate, Racecadotril
  - **Adsorbent drugs:** Kaolin-pectin, Attapulgite, Smectite

Shigellosis	**Prolongation of disease duration**
***C. difficile* colitis**	**Development of toxic megacolon**
Shiga toxin producing *E. coli*	**HUS development**
Drug side effects	**Development of encephalopathy**
Drug interaction	**Impairment of the absorption of other drugs**

- **Cost**

These drugs are not recommended in children.

ACUTE GASTROENTERITIS
Treatment: Anti-emetic Drugs

- **Drugs that prevent or reduce vomiting**
  - **Serotonin receptor antagonists**
    - **Ondansetron**
  - **Phenothiazines**
    - **Promethazine, metoclopramide, prochlorperazine**
  - **Antihistamines**
    - **Dimenhydrinate**
  - **Dopamine receptor antagonists**
    - **Domperidone**
  - **Glucocorticoids**
    - **Dexamethasone**

These drugs are not routinely recommended in children.

ACUTE GASTROENTERITIS

Treatment: Probiotics and Prebiotics

- **Probiotics: Live microorganisms that have the potential to benefit the host by altering the host's intestinal flora.**
  - *Saccharomyces boulardii*
  - *Lactobacillus rhamnosus GG*
  - *Lactobacillus acidophilus*
  - *Streptococcus thermophilus*
- **Prebiotics are substrates used selectively by beneficial host microorganisms.**
  - *Fructooligosaccharides*
  - *Inulin*
- **The mechanism of action is controversial**
  - Binding sites from intestinal epithelial cells, competition for nutrients
  - Secretion of bacteriocins
  - Stimulation of the immune system...

Viral gastroenteritis	**Shortens the duration of illness**
Antibiotics related diarrhea	**Generally useful**
Tourist diarrhea	**Conflicting results have been reported**
Dysenteriae	**No benefits**

These agents are not routinely recommended in children.

ACUTE GASTROENTERITIS

Treatment: Zinc

Zinc deficiency is associated with T cell dysfunction, amd lymphoid atrophy.

Zinc deficiency; Intestinal disaccharidase activity is reduced

Zinc deficiency; Intestinal secretory activity increases

Zinc deficiency; Longer and more severe diarrhea

Zinc deficiency; Higher chance of chronic diarrhea

With its treatment, the duration of diarrhea is reduced by 25%, and the number of defecations by 33%.

In malnourished children and in regions where zinc deficiency is common, 20 mg/day (10-14 days) should be given.

Not routinely recommended in children whose zinc deficiency is not considered.

ACUTE GASTROENTERITIS

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ACUTE GASTROENTERITIS

Treatment: Antibiotics

- Empirical antibiotic therapy is not usually required.
- Administration of antibiotics in EHEC gastroenteritis may increase the risk of HUS.
- Infants with severe malnutrition and diarrhea should be given antibiotics.
- Toxic patients with suspected bacteremia should be given antibiotics.
- Empirical antibiotic therapy should be started according to regional resistance patterns.

ACUTE GASTROENTERITIS
Treatments: Antibiotics

ORGANISM	DRUGS OF CHOİCE	DOSAGE AND DURATION OF TREATMENT
Shigella	Ciprofloxacin, Ampicillin, Ceftriaxone, or TMP-SMX	Ceftriaxone IV, IM 50–100 mg/kg/day qd, bid × 7 day
	Most species have become resistant to antibiotics	Ciprofloxacin PO 20–30 mg/kg/day bid × 7–10 day
		TMP 10 mg/kg/day and SMX 50 mg/kg/day bid × 5 day
		Ampicilin PO, IV 50–100 mg/kg/day qid × 7 day
EPEC, ETEC, EIEC	TMP-SMX or Ciprofloxacin	10 mg/kg/day TMP ve 50 mg/kg/day SMX bid × 5 day
		Ciprofloxacin PO 20–30 mg/kg/day qid for 5–10 day
Salmonella	Infections in the normal host with non-typhoidal species do not require treatment	*See Shigella* therapy
	Indication for treatment: infants <3 months, malignancy, chronic GI disease, severe colitis, hemoglobinopathies, HIV infection and other immunodeficiencies	
	Most species have become resistant to antibiotics	
Aeromonas/Plesiomonas	TMP-SMX	10 mg/kg/day TMP ve 50 mg/kg/day SMX bid 5 day
	Ciprofloxacin	Ciprofloxacin PO 20–30 mg/kg/day bid 7–10 day
Yersinia spp.	Antibiotics are not usually needed for diarrhea	
	Deferoxamine therapy should be discontinued during severe infection or bacteremia.In sepsis, doxycycline, aminoglycoside, TMP-SMX, or fluoroquinolone are used in combination.	
Campylobacter jejuni	Erythromycin or Azithromycin	Erythromycin PO, 50 mg/kg/day tid 5 day
		Azithromycin PO, 5–10 mg/kg/day qid 5 day
Clostridium difficile	Metronidazole (first choice)	PO 30 mg/kg/day tid 5 day
	Vancomycin (second choice)	PO 40 mg/kg/day qid 7 day

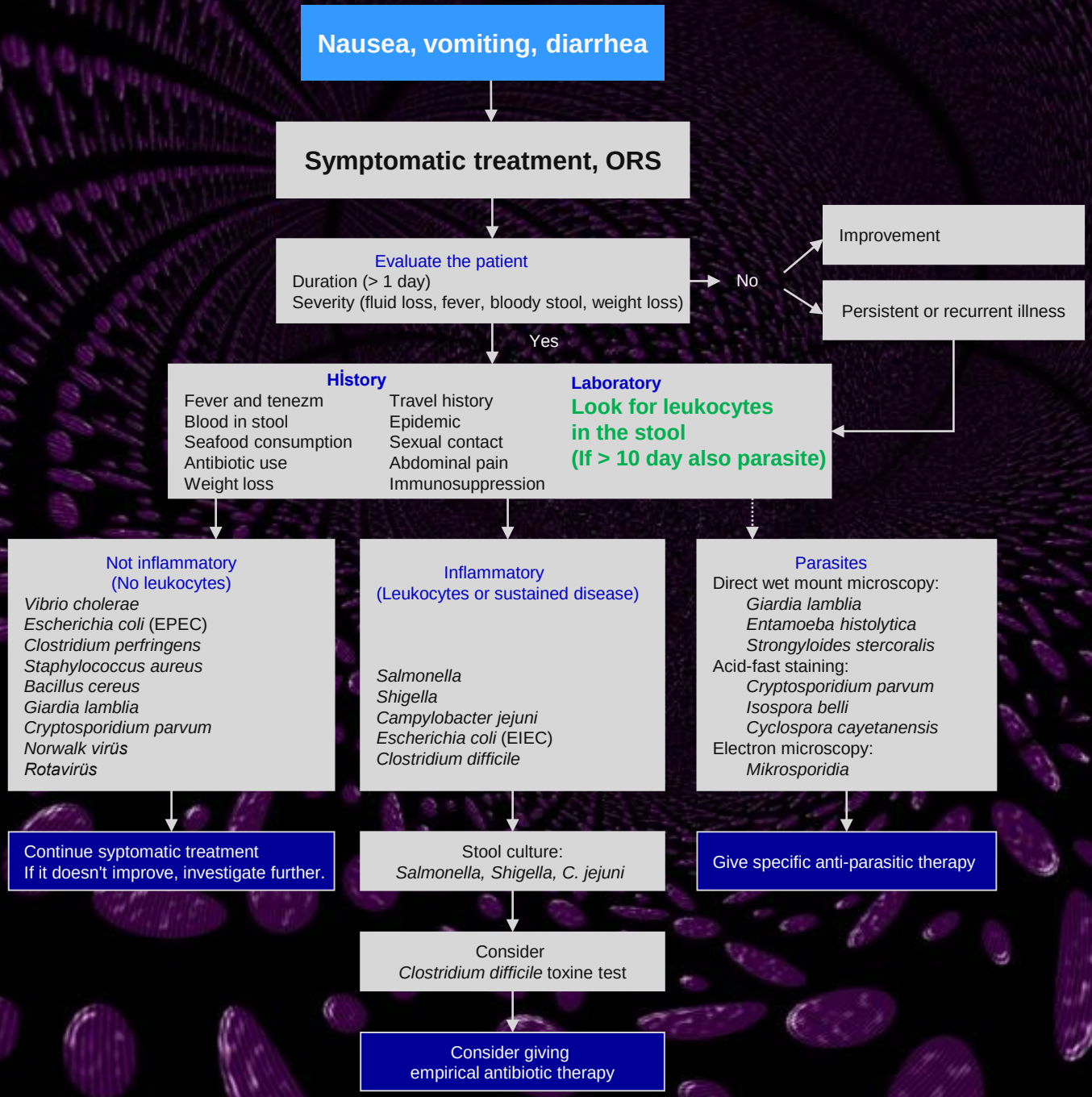
ACUTE GASTROENTERITIS

Risk Factors for Salmonella Bacteremia

- Newborns
- Infants <3 months
- Infants <12 months with temperatures >39°C
- Immunodeficiency
- Malignancy; especially leukemia and lymphoma
- Immunosuppressive and corticosteroid therapy
- Hemolytic anemia; sickle cell anemia, malaria, bartonellosis
- Collagen vascular disease
- Inflammatory bowel disease
- Gastrectomy or gastroenterostomy
- Achlorhydria or antacid drug therapy
- Bowel motility disorder
- Shistosomiasis
- Malnutrition

ACUTE GASTROENTERITIS
Treatment: Antiparasitic Drugs

PARASITE	ANTIMICROBIAL DRUG
Balantidium coli	*Tetracycline, metronidazole or iodoquinol*
Blastocystis hominis	*Metronidazole or iodoquinol*
Cryptosporidium parvum	*Paramomycin or azithromycin*
Cyclospora cayetanensis	*TMP-SMZ*
Encaphalitozoon intestinalis	*Albendazole*
Entamoeba histolytica	*Metronidazole and/or iodoquinol*
Enterocytozoon bieneusi	*Albendazole*
Giardia lamblia	*Metronidazole, albendazole, furazolidone or paramomycin*
Isospora belli	*TMP-SMZ*
Strongyloides stercoralis	*Ivermectin or thiabendazole*
Trichuris trichiura	*Mebendazole or albendazole*



ACUTE GASTROENTERITIS

Prevention

PREVENTION

Compliance with hygiene rules

PREVENTION

ACUTE GASTROENTERITIS
Prevention

PREVENTION

Breastfeeding

PREVENTION

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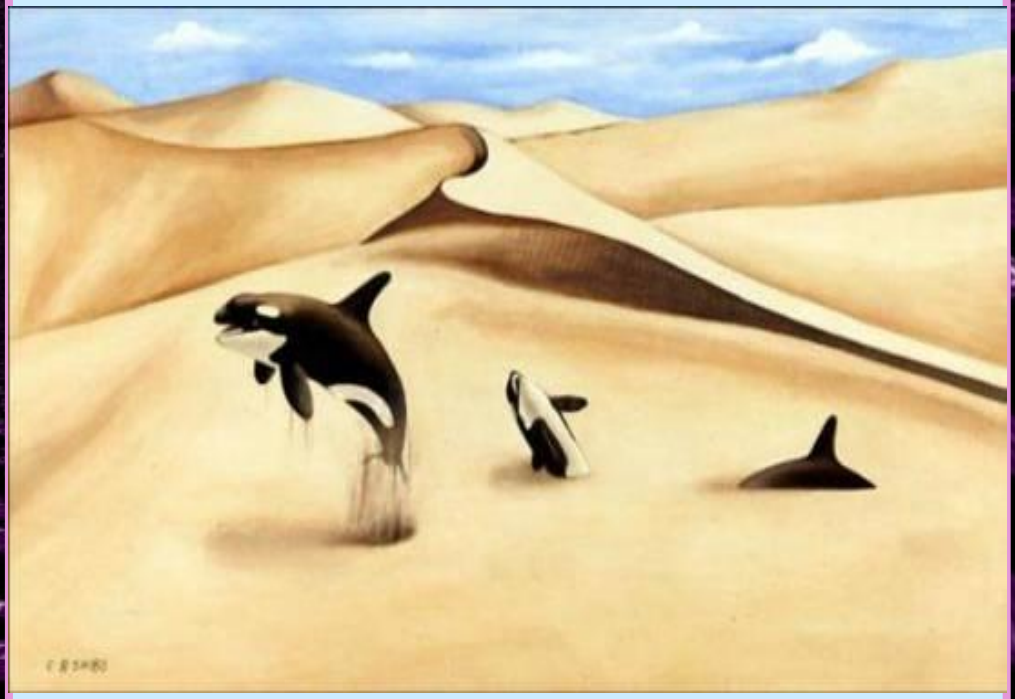
Prevention

PREVENTION

Using clean water and food

PREVENTION



ACUTE GASTROENTERITIS

Prevention

PREVENTION

Vaccination

PREVENTION