

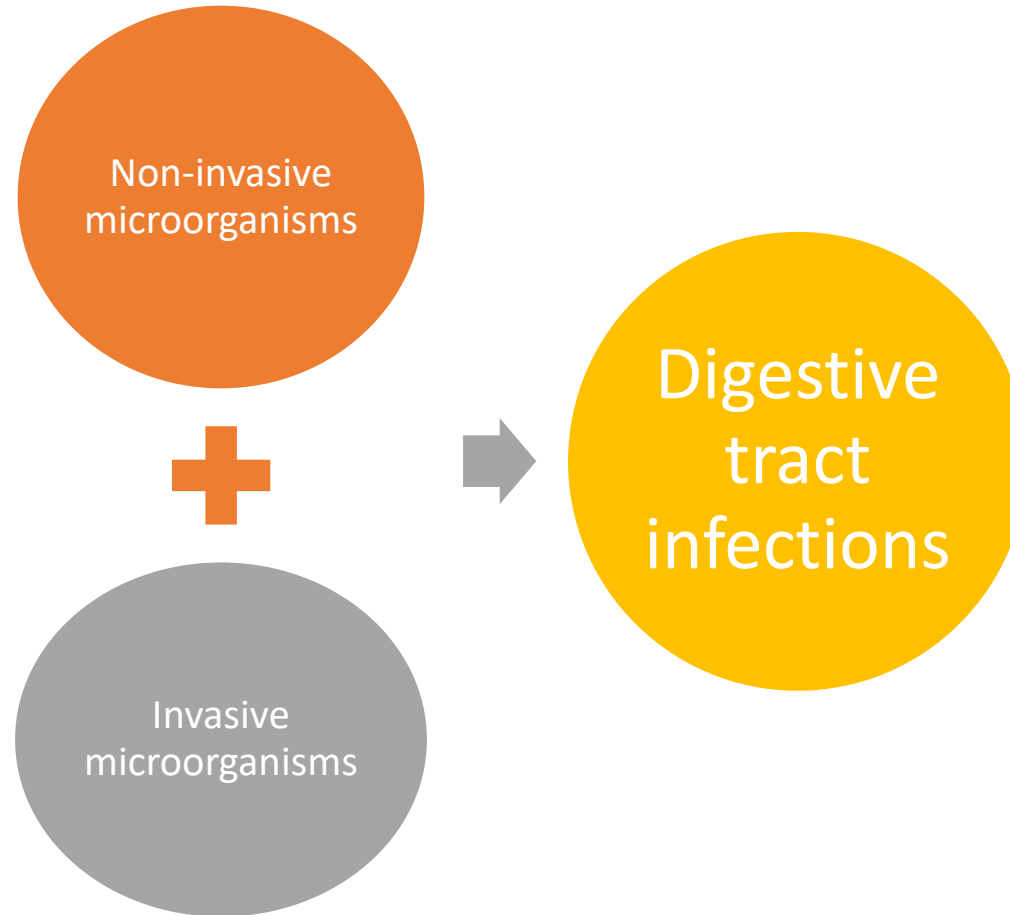
Digestive tract infections

Etiology	
Bacterial infections	Adenovirus
Shigella	Astrovirus
Non-typhus salmonella	Protozoal infections
Diarogenic Esherichia coli	Entamoeba histolytica
Campylobacter jejuni/coli	Cryptosporidium
Yersinia enterocolitica	Isospora belli
Clostridium difficile	Parasitic infections
Vibrio cholerae	Balantidium coli
Stapholococcus aureus-enterotoxigenic	Lamblia inestinalis
Clostridium perfringens	Trichinela spiralis,
Bacillus cereus	Strongiloides stercoralis
Viral infections	Ascaris lumbricoides
Rotaviruses	Fungal infections
Enteroviruses	Candida spp
Coleiavirus	

Differential diagnosis of diarrheal syndrome

- **Different bacterial, viral, parasitic infections of the intestinal mucosa**
- **Inflammatory foci near the intestine** (appendicitis, adnexitis, pyelonephritis)
- **Diarrhea as a general symptom during generalized infections**
- Other diseases of the digestive organs
- **Diarrhea due to chemical action (laxatives, drugs, poisons)**
- **Diarrhea in general metabolic disorders** (uremia, diabetes, hyperthyroidism, Addison's disease, pellagra, etc.)

Division of infections of the digestive tract according to the degree of invasiveness

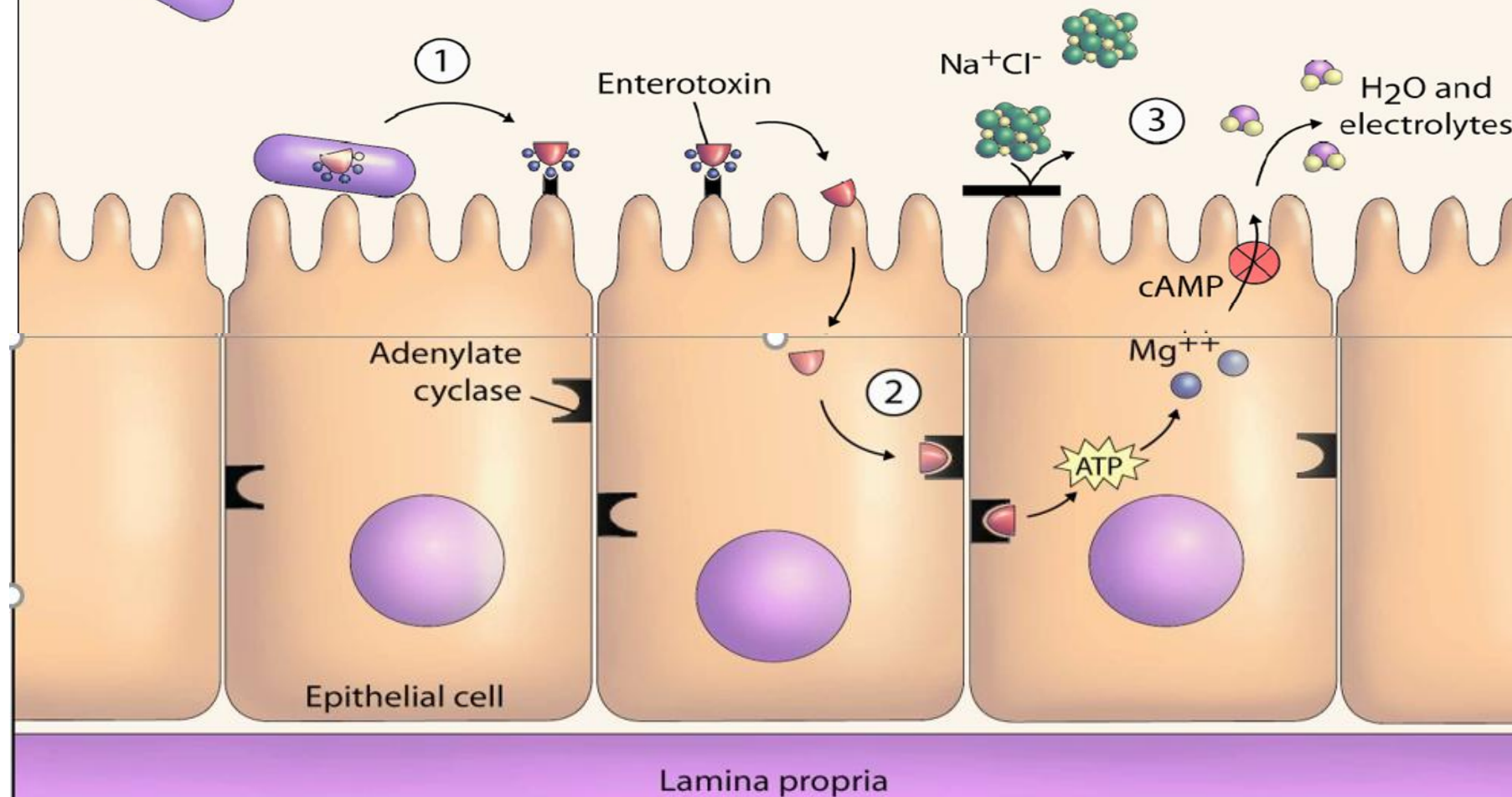


Pathogenesis of intestinal infections and intoxication

- **Non-invasive microorganisms**
- Overcoming immune defense mechanisms (primarily non-specific) Binding to specific receptors
- **No tendency to enter the epithelium**
- **No damage to epithelial cells** (or minimal damage-shortening of microvilli, without killing them)
- **Most often secrete enterotoxins**-disorder of electrolyte and water transport

- Pathogenesis of intestinal infections and intoxication-

Non-invasive microorganisms

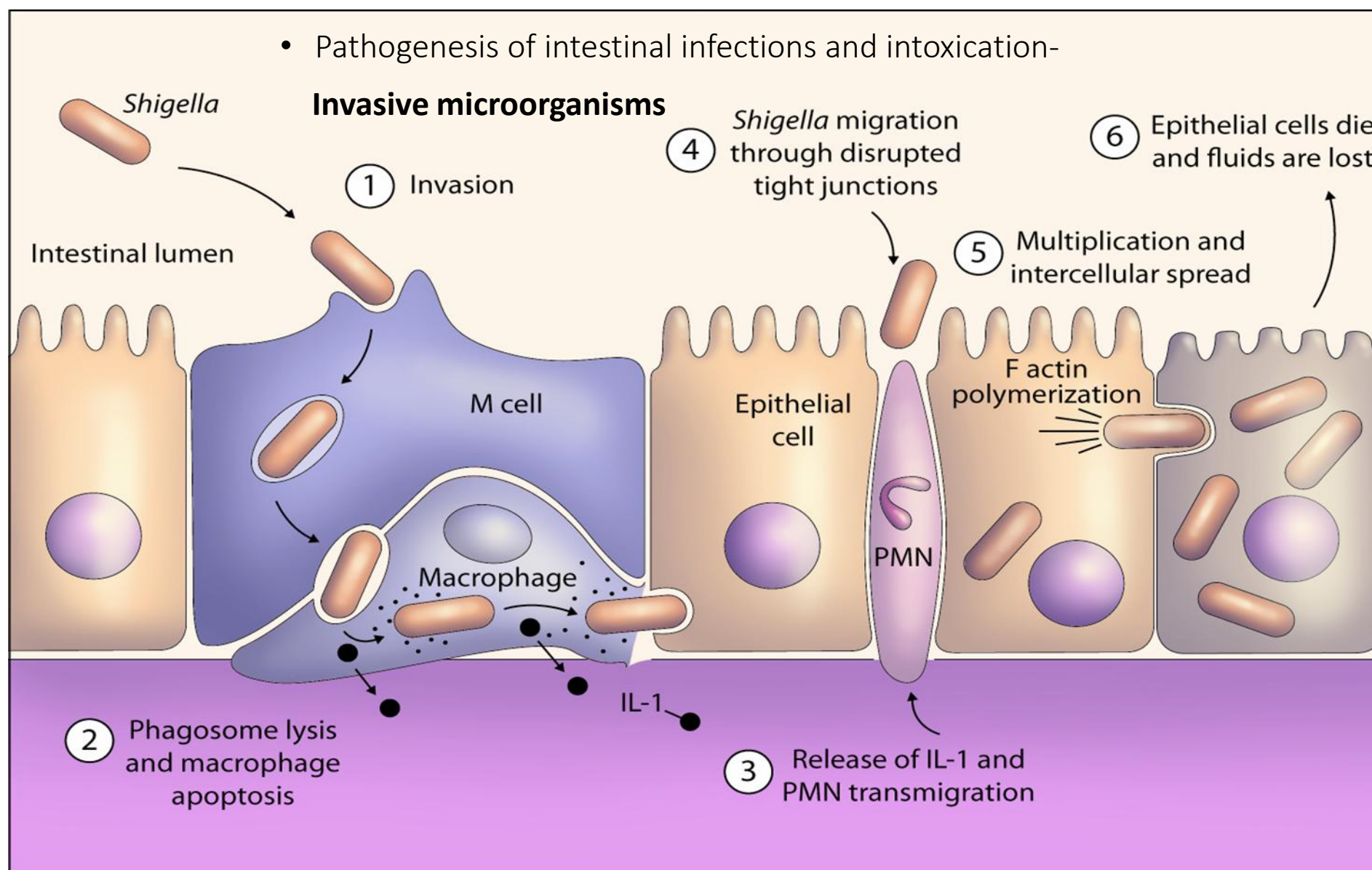


They multiply in the lumen of the intestine, on the epithelium, secrete enterotoxins that stimulate the secretion of adenyl-cyclase → permeability of the intestinal epithelium, secretion of water and electrolytes in the lumen → frequent, abundant watery stools

Invasive microorganisms

- **Binding to specific receptors**
- **Penetration into the epithelium**
- **Release of endo- and/or exotoxins**
- **Initiation of an inflammatory response**
- **Epithelial breakdown**
- Some pathogens penetrate the epithelium into the subepithelial space (further multiplication)
- Penetration into the **lymphatic system** and regional (mesenteric) lymph nodes
- Penetration into the **bloodstream** (bacteremia) with colonization of other organs (liver, brain, lungs, and endocardium)
- Sepsis

- Pathogenesis of intestinal infections and intoxication-



They penetrate the mucous cells and reproduce. When they break down, they release endotoxin (lipopolysaccharide with pyrogenic properties, PG), ... damage to the epithelium, necrosis and desquamation of cells (feces contain epithelium, Le, Er, mucus)

The influence of invasiveness of microorganisms on the clinical picture

INVASIVENESS OF MICROORGANISMS	INVASIVENESS OF MICROORGANISMS IMPACT ON THE CLINICAL PICTURE
Non-invasive microorganisms	<p>Short incubation period - usually a few hours</p> <p>The disease begins abruptly without warning or prodrome</p> <p>The temperature is usually not elevated</p> <p>The disease is short-lived, ends spontaneously (except cholera)</p>
Invasive microorganisms	<p>Incubation period - at least 24-48 hours</p> <p>The disease begins gradually</p> <p>The temperature is always present, over 38°</p> <p>The disease lasts longer and often requires treatment</p> <p>Tendency to complications</p>

Segmentation of lesions of the digestive tract

Segment of the digestive tract	Type of stool	Characteristics of stool
Proximal part of the small intestine	Enteric type 1	Very voluminous from beginning to end Watery consistency Mostly colorless Undigested food particles
Distal small intestine	Enteric type 2	Voluminous Pulpy consistency Green or brown in color
Large intestine (left half)	Colitic stool	Initially voluminous, later scanty First few stools feculent, later scanty, with increasing mucus content, blood in stool

The influence of invasiveness and segmentation of lesions on the clinical picture

Digestive tract segment	Invasiveness of microorganisms	Stool type	Types of pathogenic microorganisms
Stomach, duodenum, beginning of jejunum	Noninvasive	Enteric type 1	Staphylococcus aureus Bacillus cereus Vibrio cholerae
Ileum, especially terminal ileum	Invasive	Enteric type 2	Salmonellae Campylobacter jejuni Yersinia enterocolitica
Large intestine (especially the left half)	Invasive	Colitic	Shigellae Entamoeba histolytica Balantidium coli E. Enterohaemorrhage. Clostridium difficilae

General diagnosis of infections of the digestive system

- Clinical picture
- Epidemiological survey
- Physical findings
- Laboratory diagnostics –
 - ✓ Hematological analyses (CBC, hematocrit)
 - ✓ Biochemical analyses (CRP, urea, creatinine, AST, ALT, ionogram)

Establishing an etiological diagnosis of an intestinal infection

- **Bacteriological examination of stool (coproculture)**

- ✓ Suspected invasive infections (Salmonellae, Campilobacter jejuni, Yersinia enterocolitica..)
- ✓ Repeat (2-3 times)-sensitive in 70% (many bacterial intestinal infections, even up to 50%, remain etiologically undiagnosed)

- **Virological examination of stool**

- ✓ Electron microscopy
- ✓ Detection of viral antigen in stool

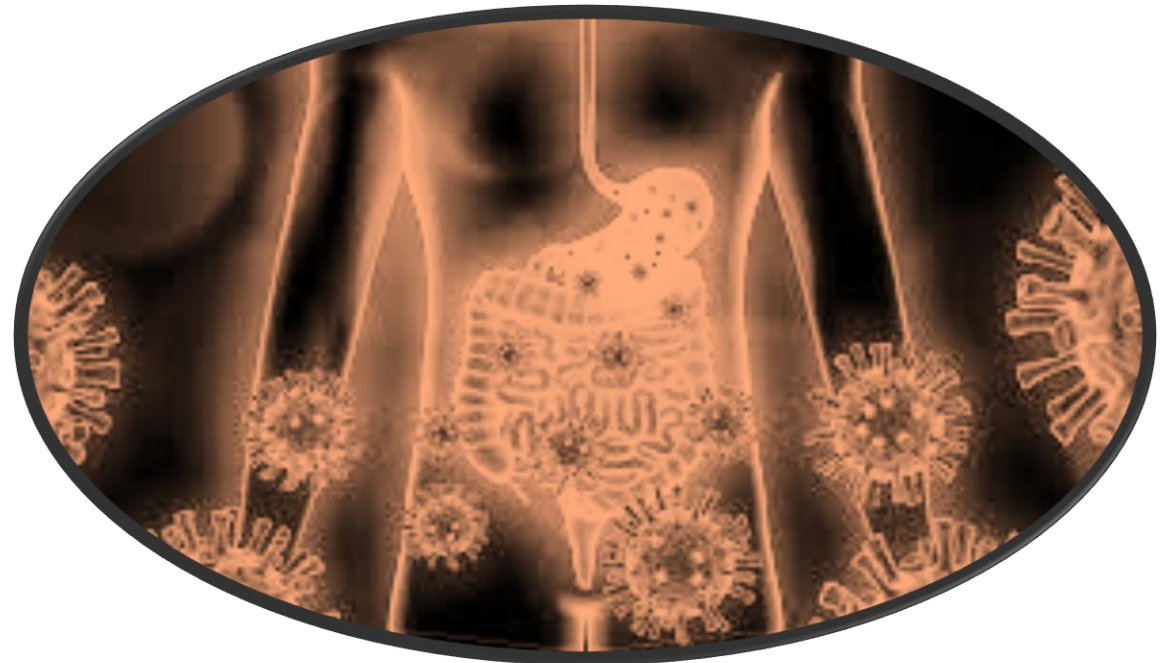
- **Parasitological examination of stool `**

- ✓ Triple examination of thick stool for protozoan cysts and helminth eggs
- ✓ Stool smear, staining and fixation-E.histolytica, Criptosporidium
- ✓ Serology-ELISA, yersiniosis, campylobacteriosis, clostridial infection (toxin A and B)

- **Stool PCR**

Therapy of intestinal infections and intoxication

- Hygiene and dietary regimen
- Rehydration (oral or parenteral)
- Probiotic supplements
- Antimicrobial therapy



Therapy of intestinal infections and intoxication

- Hygiene and dietary regimen
- Rehydration (oral or parenteral)

per os

or

parenteral

- ✓ Sweetened tea, salty lean soup, rice water with salt
- ✓ Oral rehydration products
- ✓ "Dacca" solution: NaCl+NaHCO₃+KCl 5:4:1

- ✓ Saline solution (0.9% NaCl)
- ✓ Glucosaline (0.9% NaCl+2.5% Glu)
- ✓ Ringer's solution 8.3% NaHCO₃

- . Drug therapy
- Antiemetics (there are no undigested food residues in the vomit - food intoxication)
- **Analgesics and antispasmodics should never be given!!!**
- -maybe it is a primarily surgical disease
- -maybe it is a surgical complication of a primarily infectious disease of the digestive organs
- -acute GIT infections do not cause such severe pain!
- **Antidiarrheals (loperamide) - never in infectious diarrhea!**

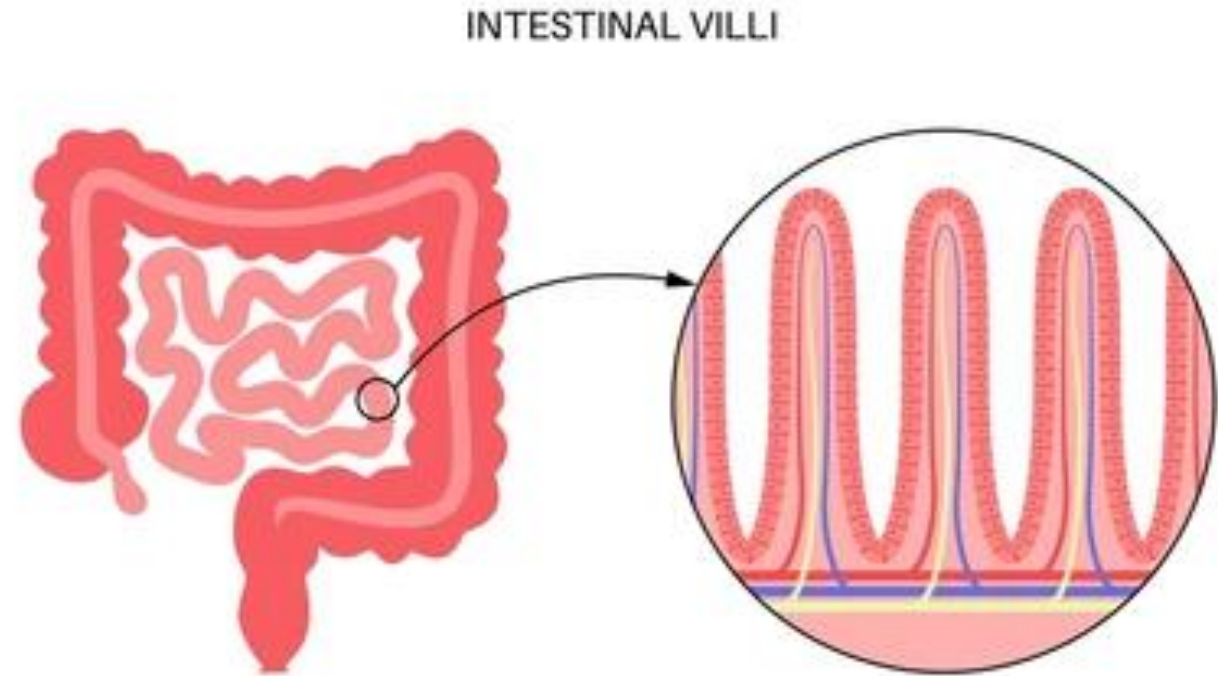
- **Antimicrobial therapy**
- Young children (under 3 months)
- **Elderly patients** (>65 years)

Immunocompromised individuals

Invasive infections

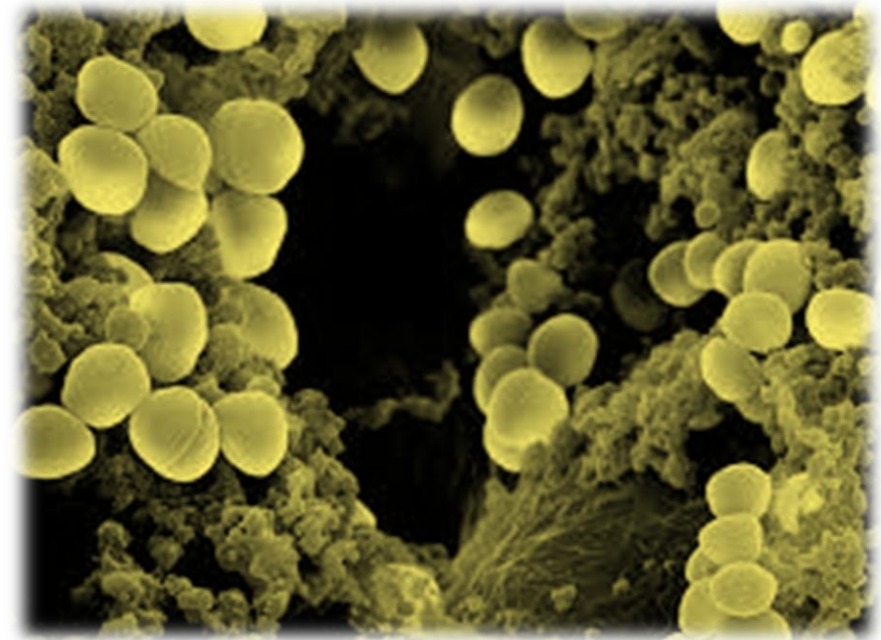
- Intestinal antiseptics
- Probiotics

Non-invasive digestive tract infectious



FOOD POISONING (Intoxicatio alimentaris)

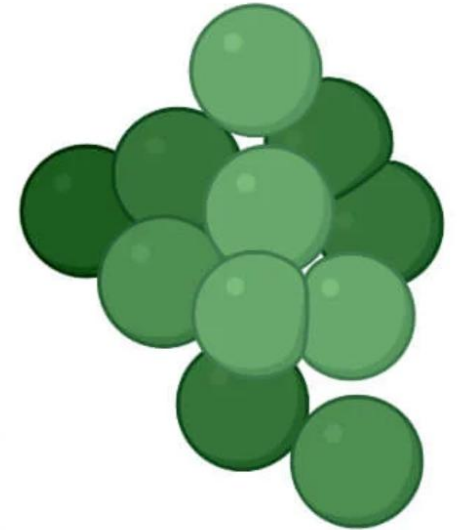
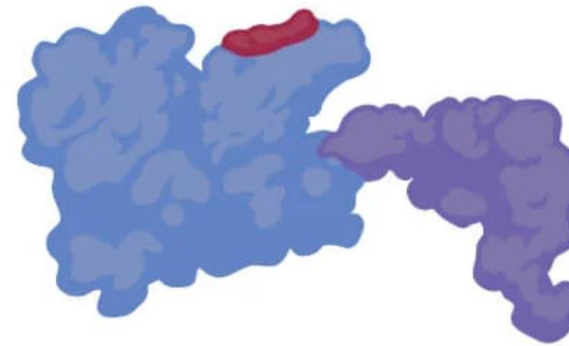
- *Staphylococcus aureus*
- *Bacillus cereus*
- *Clostridium perfringens*
- *Vibrio parahaemolyticus*



Staphylococcal toxin food poisoning

- One of the most frequent food poisonings
- Inoculation of toxin producing *S. aureus* into food by colonized food handlers
- Toxin is elaborated in foods like milk, cream, ice cream, mayonnaise, puddings, cooked ham, sausages, other processed meats,
- The toxin is heat-stable

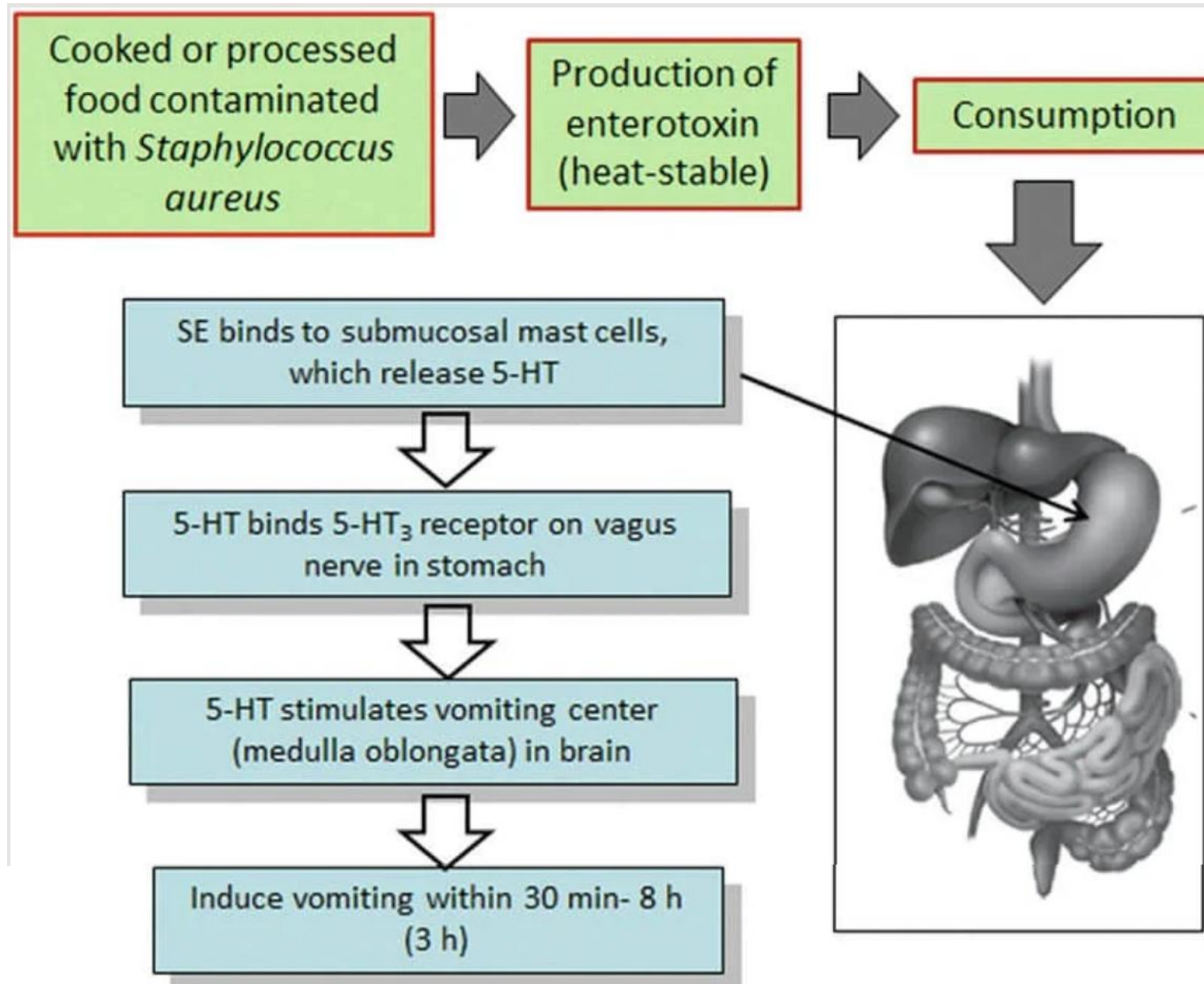
Staphylococcal food poisoning



Symptoms and complications of Staphylococcal food poisoning

- Enterotoxin infection occurs within 1-7 hours of ingestion and lasts no longer than 1 to 2 days. The severity of illness depends on the amount of toxin ingested present in the food and general health and age group of the victim
- Some of the common symptoms include:
 - Nausea
 - Vomiting
 - Diarrhea
 - Weakness
 - Sweating
 - Abdominal cramp
 - Fatigue
 - Chills
 - Myalgia
 - Headache
 - Fever

Toxin production during Staphylococcal food poisoning



Diagnosis

- Clinical picture
- Epidemiological survey
- Physical findings
- Laboratory findings (most often normal, signs of dehydration)
- Microbiological tests:
 - -Detection of enterotoxins in the remains of the incriminated food and vomit (rarely!)

Therapy

- Hygiene and dietary regimen
- Fluid and electrolyte replacement
- The use of antibiotics is not indicated!

Bacillus cereus food poisoning

- Large, motile, saprophytic bacillus

Pre-formed enterotoxins

- Heat stable toxin (ST)
- emetic form
- rice
- Heat labile (LT)
- diarrheal disease
- meats, dairy...



Bacillus Cereus

Reheated Rice Syndrome



Clinical features

- **EMETIC FORM**

- ST neurotox
- Incubation <6h
- Severe vomiting
- Lasts 8-10h



- **DIARRHEAL FORM**

- LT enterotoxin
- Incubation >6h
- Diarrhea
- Lasts 20-36h



Clostridium Perfringens food poisoning

- The same Clostridium that causes gas gangrene
- **Type A** is related to food poisoning
- (type B to necrotic enteritis)
- 2nd/3rd agent to cause food poisoning

Cytotoxin that binds

- to small bowel brush border
- alters the permeability
- resulting in cell death



Clostridium perfringens
Enterotoxins and Food poisoning

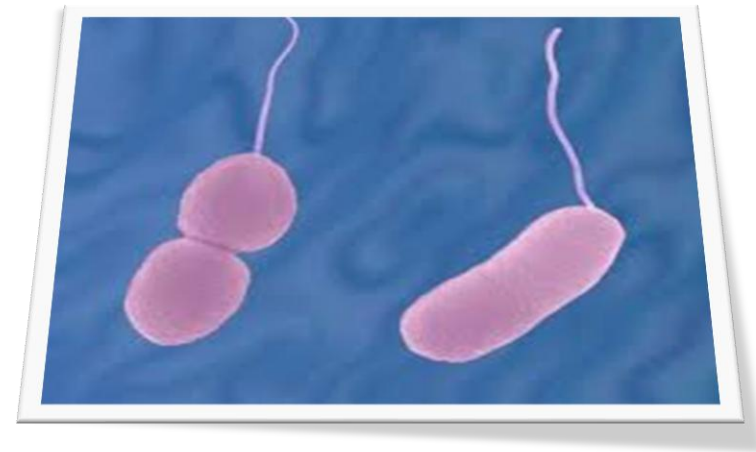
Clostridium perfringens food poisoning

- Related to reheating of the protein rich foods
 - Sporulation and germination, release of toxin
 - Food poisoning tends to occur in buffets and cafaterias its also called “cafeteria germ”
 - Also related to stews
-
- INCUB: 8-24h
 - Symptoms include severe watery diarrhea lasting for 12-24h
 - Fever and vomiting are uncommon
 - Keep hot foods hot!



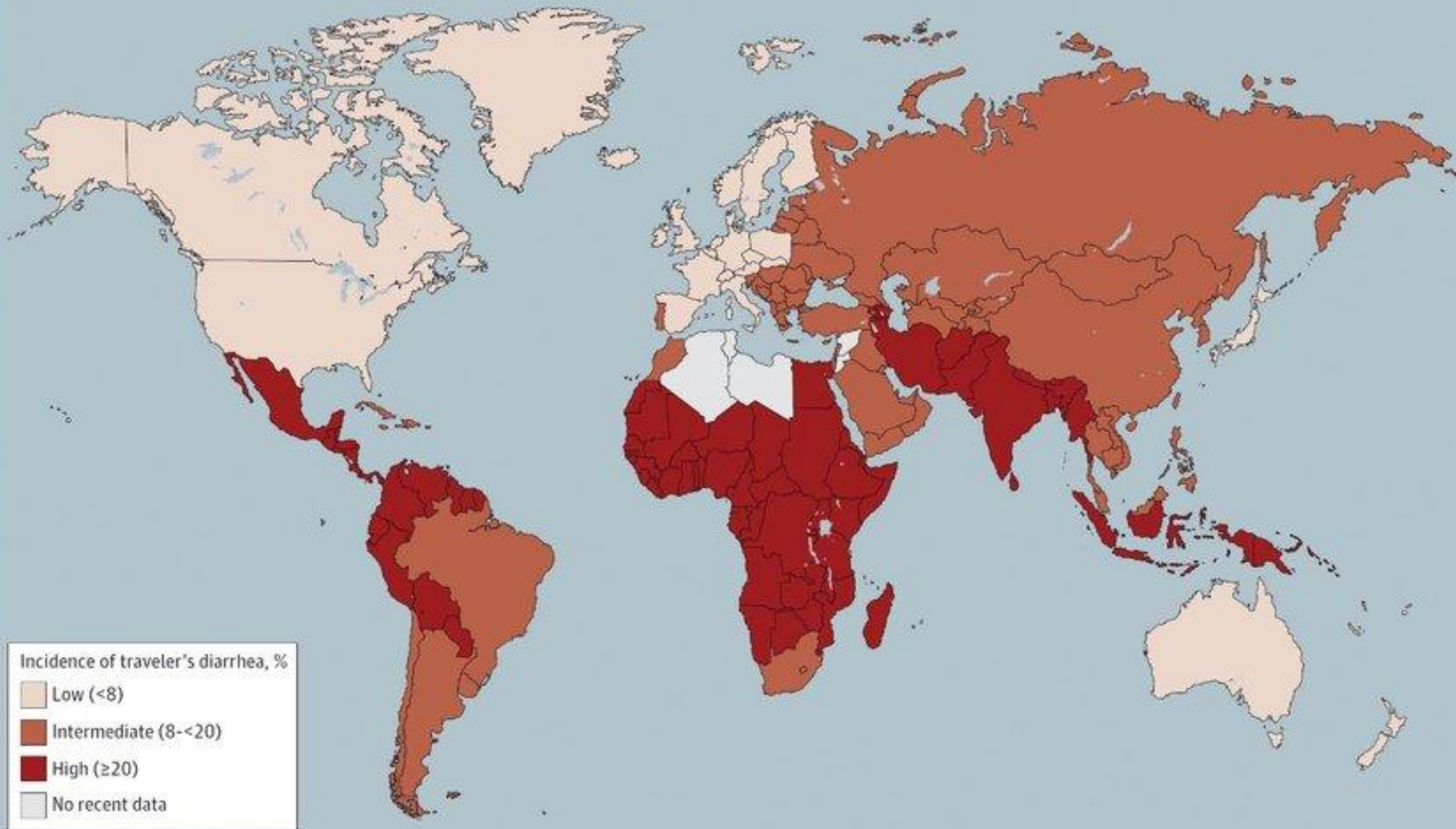
Vibrio parahaemolyticus food poisoning

- Prefers saline water
- Related to eating raw/undercooked seafood or swimming in the sea
- **INCUBATION 4h-4 days**
- **Clinical manifestations:**
 - 1. Watery diarrhea + abdominal cramping + nausea, vomiting, fever in ¼ of pts
 - OR
 - 2. Dystentery



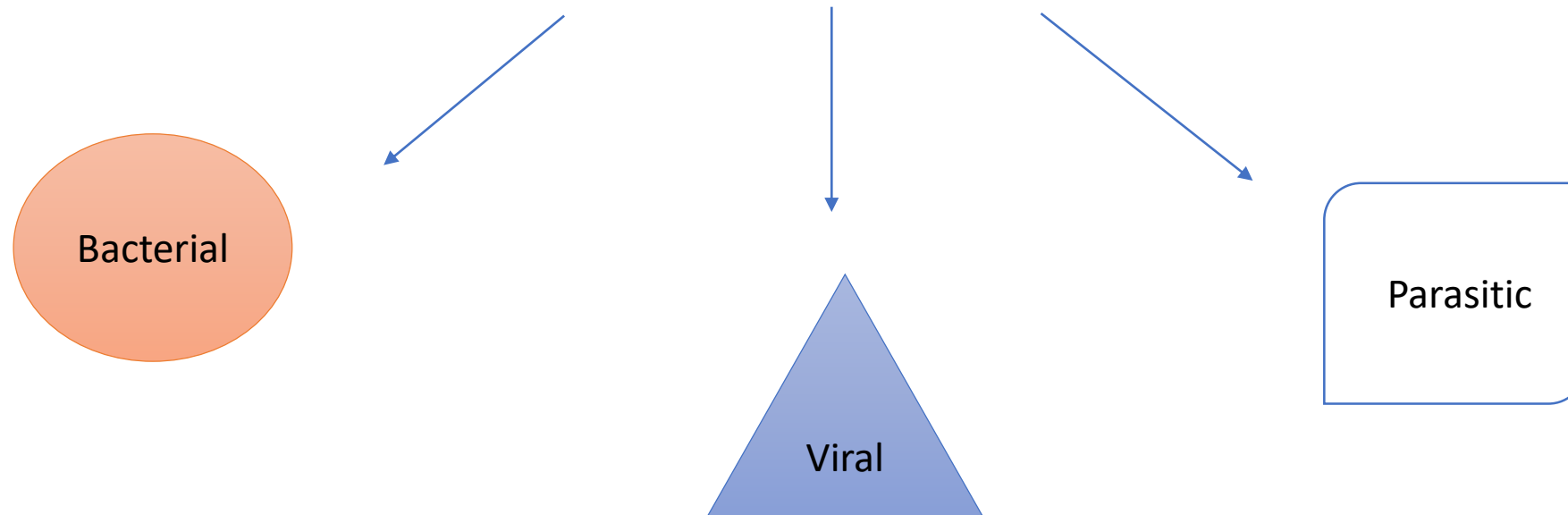
Travelers' Diarrhea

- Acute diarrhea associated with travel is referred to as travelers' diarrhea (TD)
- Although TD occurs more frequently in travelers to developing countries, this illness is actually prevalent worldwide
- The Latin America, Africa, the Middle East, and Asia are among countries considered high-risk destinations



Travelers' diarrhea (TD) is the most predictable travel-related illness. **Attack rates range from 30%–70% of travelers during a 2-week period, depending on the destination and season of travel**

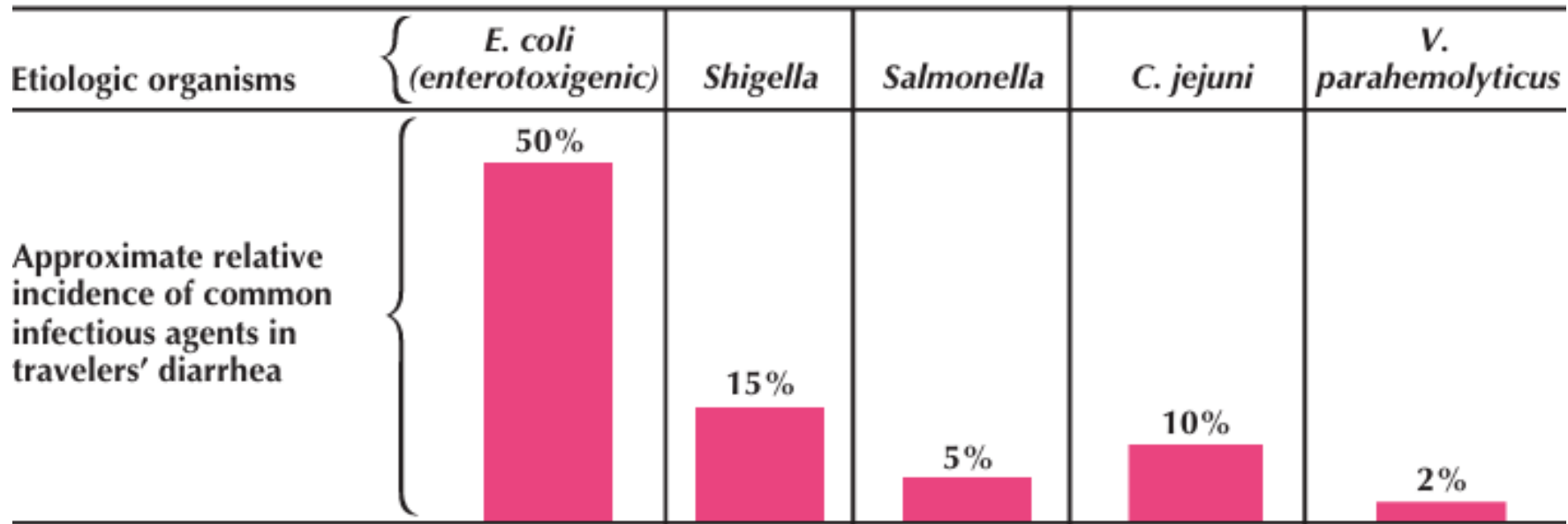
Etiological causes of traveler's diarrhea



- <https://wwwnc.cdc.gov/travel/yellowbook/2024/preparing/travelers-diarrhea>

Bacterial agents causing traveler's diarrhea

Bacteria make up about 80% of TD cases



Enterotoxigenic *Escherichia coli* and **enteroaggregative** *E. coli* are the most common bacterial causes of TD, accounting for 30% to 50% or more of cases

Viral agents causing traveler's diarrhea

- The most common viral causes, composing up to 10% of TD cases, are rotaviruses and noroviruses
- Rotaviruses are frequently found in the feces of asymptomatic travelers, indicating wide spread exposure to the virus
- Norovirus infections often occur as outbreaks, particularly on cruise ships and in other closed living group situations

• Parasitic agents causing traveler's diarrhea

- Intestinal protozoan parasites make up about 10% of TD cases
- Because of relatively longer incubation periods, symptoms may not develop until the traveler returns home
- Protozoa with shorter incubation periods include *Cryptosporidium*, with an incubation period of 3 to 8 days
- *Giardia lamblia* is the most common pathogenic protozoan infection in travelers
- It has an incubation period of 12 to 14 days, and travelers with TD during a 1- to 2-week trip are not likely to have *Giardia* as the cause unless it was preexisting

TREATMENT

- Oral Fluids and Diet Modification
- Probiotics
- Antimotility and Nonspecific Agents (The antisecretory agent bismuth subsalicylate (Pepto Bismol) taken as a liquid (1 ounce every 30 minutes until eight doses have been taken) works more slowly than antimotility agents)
- Antimicrobial Treatment

Acute diarrhea antibiotic treatment recommendations

ANTIBIOTIC ¹	DOSE	DURATION
Azithromycin ^{2,3}	1,000 mg	Single or divided dose ⁴
Azithromycin ^{2,3}	500 mg QD	3 days
Ciprofloxacin	750 mg	Single dose ⁴
Ciprofloxacin	500 mg BID	3 days
Levofloxacin	500 mg QD	1–3 days ⁴
Ofloxacin	400 mg BID	1–3 days ⁴
Rifamycin SV ⁵	388 mg BID	3 days
Rifaximin ⁵	200 mg TID	3 days

Cholera

- is an intestinal infection caused by *Vibrio cholerae*
- The hallmark of the disease is **profuse secretory diarrhea**.
- Cholera can be endemic, epidemic, or pandemic
- disease may be asymptomatic or mild, severe
- severe cholera can cause dehydration and death within hours of onset.
- Despite all the major advances in research, the condition still remains a challenge to the modern medical world.

Vibrio cholerae

- Comma shaped, motile, **aerobic**,
G- bacillus
- **flagellar H Ag**
- **somatic O Ag**
- Based on O Ag:
 - O1 serogroups
 - Classic biotype
 - **El Toro biotype**
 - NonO1 serogroups
 - *V cholerae* O139



Epidemiology

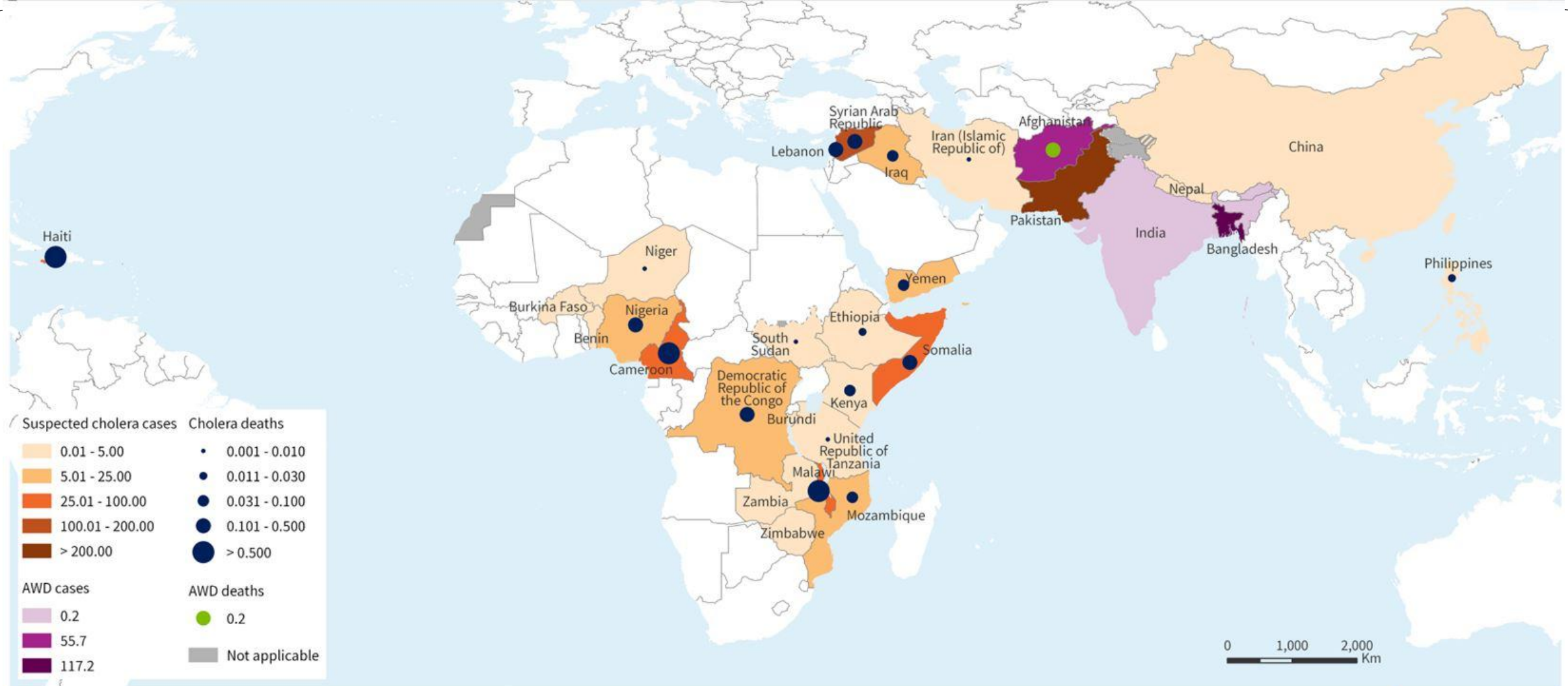
- Since 1817, 7 cholera pandemics have occurred.
- The pandemics originated from cholera's endemic reservoir in the Indian subcontinent.
- The first 6 were probably the result of *V cholerae* O1 of the classic biotype
- The seventh pandemic of cholera, and the first in the 20th century, began in 1961; by 1991, it had affected 5 continents.
- This seventh pandemic was the first recognized to be caused by the El Tor biotype of *V cholerae* O1.
- The pandemic continues today.

Epidemiology

- transmission by the fecal-oral route
- cholera is not a major threat in developed countries, but travelers, should be aware of the disease
- most cases occur in remote areas of developing countries where definitive diagnosis is not possible – underreporting is a major issue

Host factors contributing to transmission:

- Malnutrition
- Hypochlorhydria/achlorhydria
- Type O blood
- Age (adults are less frequently symptomatic)



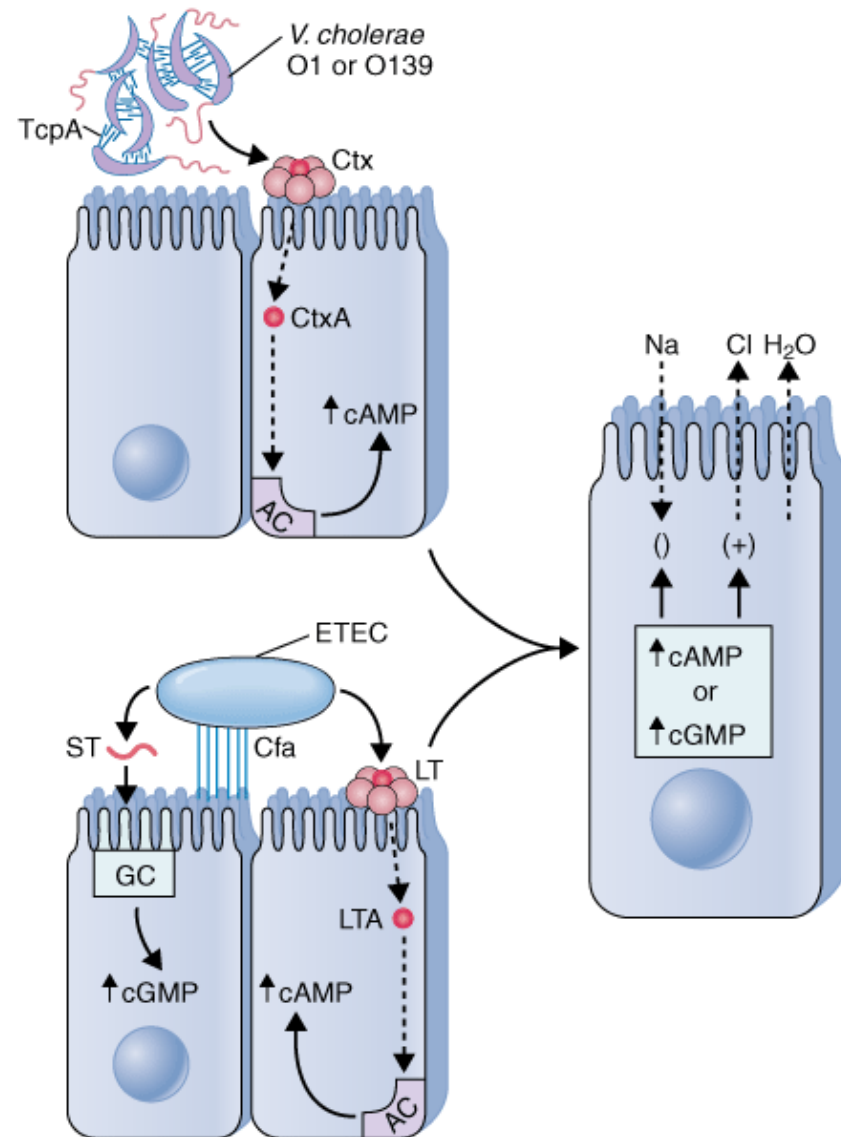
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Data Source: World Health Organization, United Nations Population Division (population prospect 2021)
Map Production: WHO Health Emergencies Programme
Map Date: 9 December 2022

In 2021, 23 countries reported cholera outbreaks, mainly in the WHO Regions of Africa and the Eastern Mediterranean. This trend has continued into 2022 with over 29 countries (Figure 1) reporting cholera cases or outbreaks. As of 30 November 2022, 16 of these have been reporting prolonged outbreaks.

Pathogenesis

- The activation of A1 leads to increase in cAMP
- cAMP blocks the absorption of sodium and chloride by the microvilli and promotes the secretion of chloride and water by the crypt cells
- The result is watery diarrhea with electrolyte concentrations **isotonic** to those of plasma.
- Fluid loss originates in the duodenum and upper jejunum
- The enterotoxin acts locally



Clinical manifestation

- INCUBATION 24-48h
- Sudden onset of watery painless diarrhea
- Often followed by vomiting and abdominal cramping
- The stool volume is more than in any other cause of diarrhea
- Cholera stool is **opaque** white liquid “rice water”
- **Dehydration can develop quickly!**
- Dehydration leads to acute tubular necrosis and renal failure
- In patients with severe disease, vascular collapse, shock, and death may ensue.

Diagnosis

- Clear based on clinical manifestation and fast profound dehydration
- If ID is needed direct microscopic examination of stool (including dark-field examination), Gram stain, culture, and serotype and biotype identification can be used
- Differential towards ETEC, viruses

Treatment

- **Rehydration** in 2 phases: rehydration and maintenance.

1. rehydration phase (in max 4 hours)

- IV rehydration at 50-100 mL/kg/h
- Lactated Ringer solution is preferred over isotonic sodium chloride solution because saline does not correct metabolic acidosis

2. maintenance phase (replacing ongoing losses)

- The oral route is preferred, and the use of oral rehydration solution (ORS) at a rate of 500-1000 mL/h

severe dehydration	IV Ringer lactate or saline	100 mL/kg in 3h period Start 30ml/kg in 30 min, then slow down Total amount for first 24 h: 200 L/kg
some dehydration	ORS (in first 4 h)	Children 1–2 y (8–10.9 kg): 600–800 mL Children 2–4 y (11–15.9 kg): 800–1200 mL Children 5–14 y (16–29.9 kg): 1200–2200 mL Patients >14 y (≥ 30 kg): 2200–4000 mL
no dehydration	ORS	Children < 2 y: 50–100 mL, Children 2–9 y: 100–200 mL Patients >9 y: up to 2000 mL/day

Treatment

- **Antibiotics**

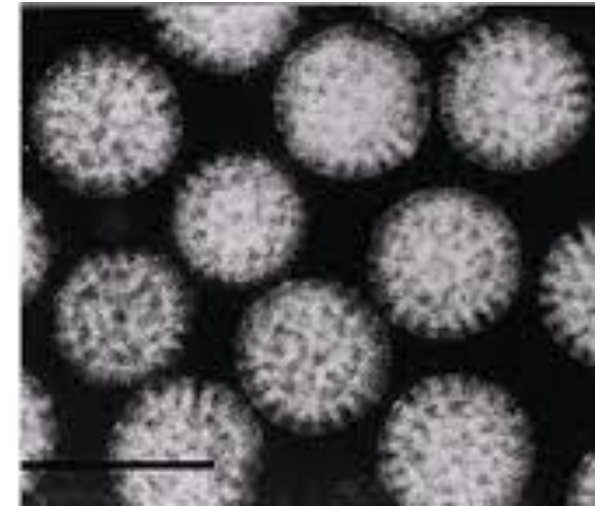
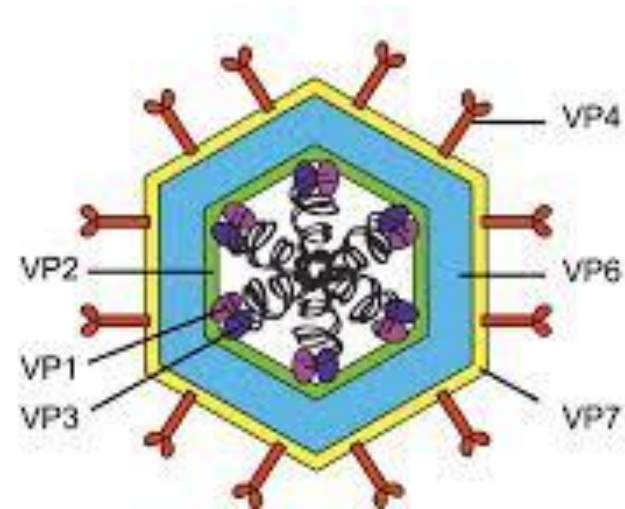
- Reduce volume of diarrhea and shorten the period of shedding
- After initial phase of rehydration
- 3-5d or a single dose
 - Doxycycline 7mg/kg QD single dose (max 300mg)
 - Doxycycline 2mg/kg BID day 1, then 2mg/kg QD on day 2 and 3
- Alternatives tetracycline, TMP-SMX, ciprofloxacin, ampicilin, erythromycin...

Rotavirus infections



Rotavirus infections

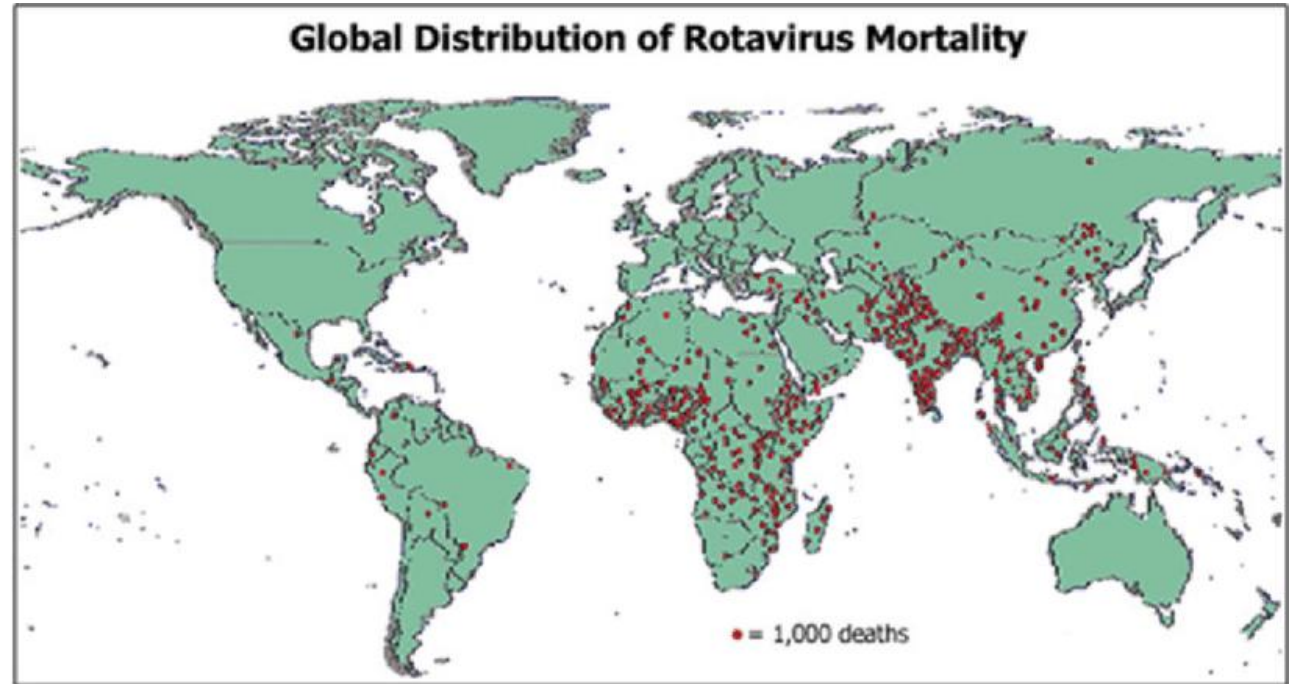
- Rotavirus infections are the most common cause of severe dehydrating gastroenteritis worldwide
- It is a disease of children, and children between the ages of 3 months and 3 years are most often affected
- Rotaviruses are segmented, nonenveloped, double-stranded ribonucleic acid (RNA) viruses that belong to the family Reoviridae
- There are eight distinct groups (A through H)
- Rotaviruses have a three-layer outer envelope, which consists of two proteins VP4 and VP7



Electron micrograph of rotavirus particles viewed by negative-staining

Geographic Distribution

- Rotavirus gastroenteritis is the most common cause of severe dehydrating diarrhea in infants and young children worldwide
- Rotavirus still causes approximately 200,000 child deaths each year, although this is a remarkable improvement over previous estimates



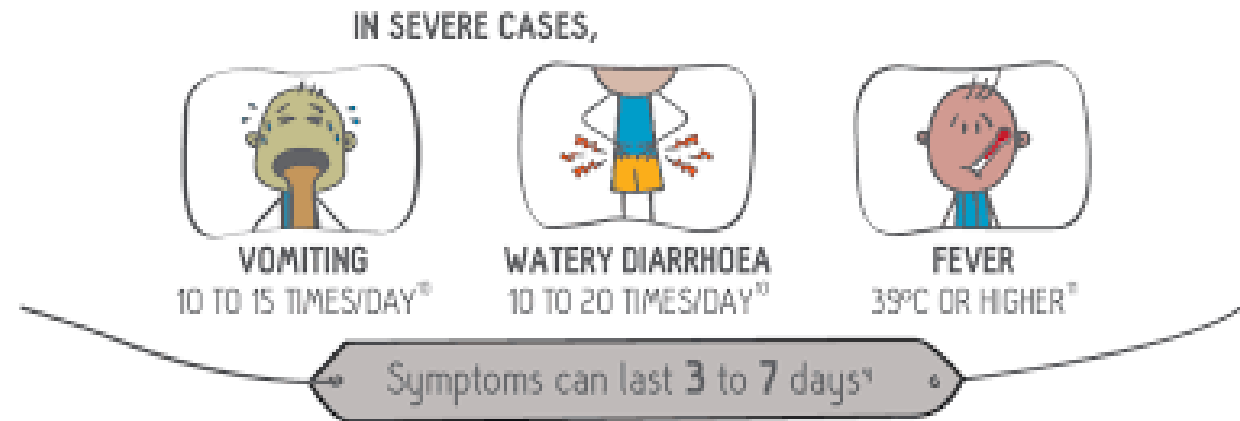
Distribution of rotavirus mortality worldwide (With kind permission, this picture is adapted from Parashar et al. 2003)

Risk Factors

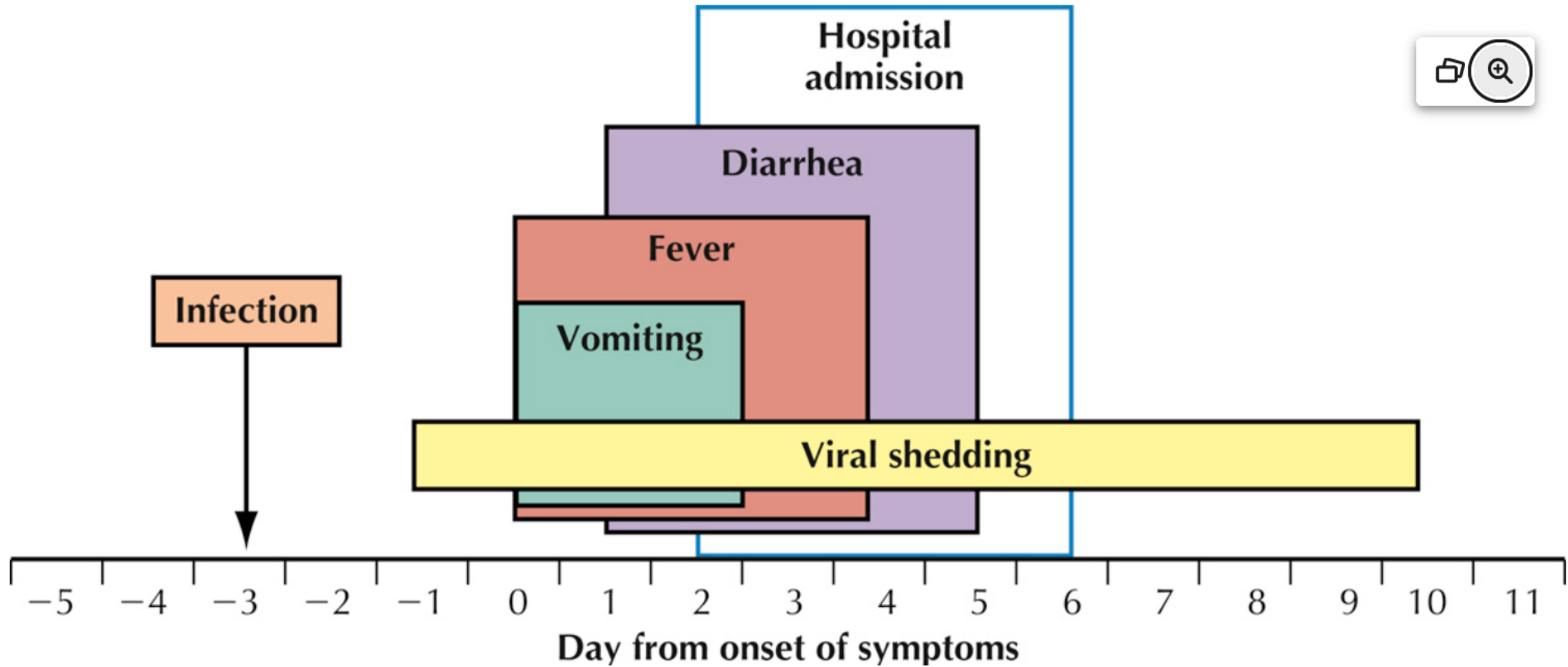
- Transmission of infection is primarily fecal-oral via person-to-person spread and contact with contaminated environmental surfaces where this virus can remain infectious for weeks to months
- Contamination of water and food has caused outbreaks; respiratory droplet transmission may play a minor role
- Rotavirus is shed in the stool of infected children not only during the acute illness but also several days before and after.

Clinical course of rotavirus infections

- Illness begins from 1 to 2 days after infection, most often with the abrupt onset of vomiting and fever, followed shortly by watery diarrhea
- Diarrhea can be both profuse and frequent, occurring 8 to 20 times per day
- Vomiting is usually brief in duration, and diarrhea resolves in most cases after 3 to 7 days
- Although a third of children manifest a fever of 39°C (102.2°F), up to 25% are afebrile at the onset of clinical disease



Clinical course of rotavirus infections



Diagnostic Approach

- No clinical features reliably distinguish rotavirus disease from that caused by many other gastrointestinal pathogens
- Enzyme-linked immunosorbent assay (ELISA) or latex agglutination tests are available in most clinical laboratories to detect group A virus antigens
- Molecular diagnostic methods improve sensitivity, although increased use of these modalities has led to frequent detection

Treatment

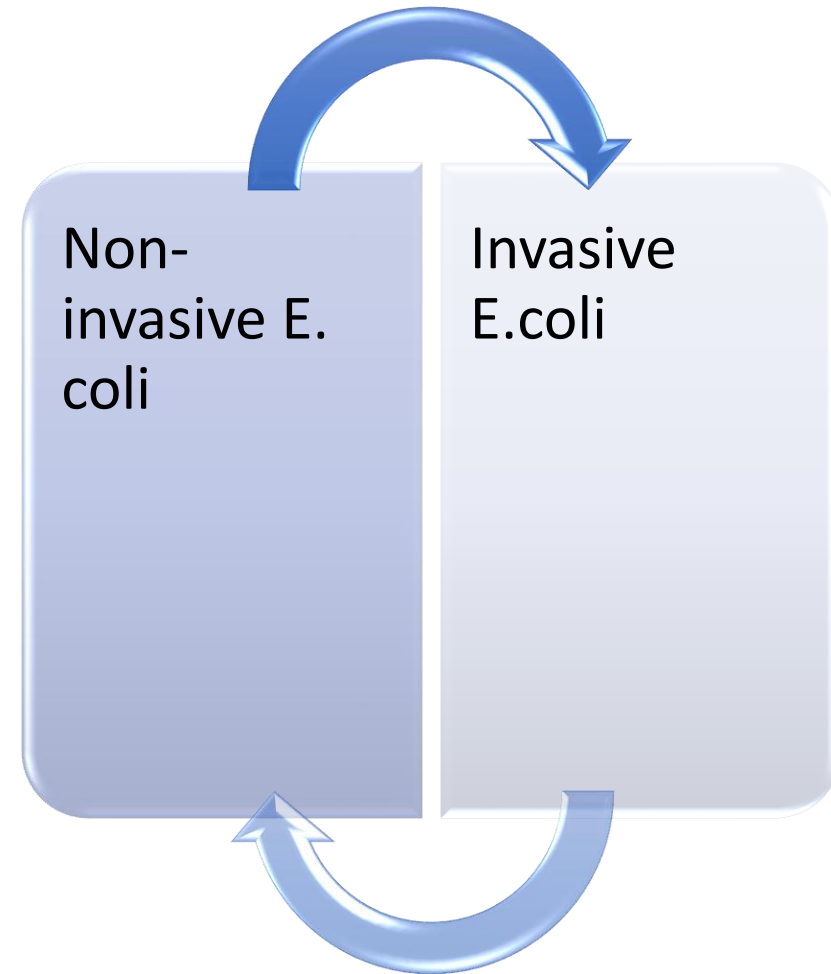
- Treatment of rotavirus gastroenteritis is supportive, directed at restoration and maintenance of vascular volume, electrolyte, and caloric balance
- Illness is self-limited
- There is no antiviral therapy

Prevention and Control

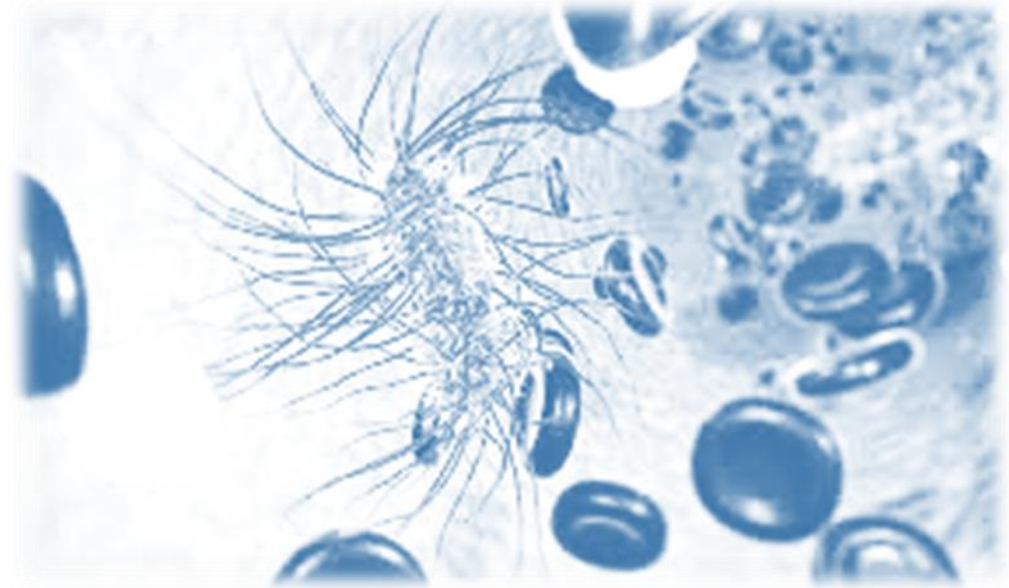
- Breastfeeding, hand washing, maintaining surface cleanliness (particularly in daycare centers), and diligently using contact precautions with hospitalized children are helpful in preventing rotavirus infection
- In the United States, two rotavirus vaccines are recommended for routine infant immunization in the first 8 months of life, including preterm infants
- Both are live, oral vaccines
- They are comparably effective and have resulted in an 80% reduction in rotavirus gastroenteritis of any severity and more than 95% reduction against severe dehydrating gastroenteritis

Escherichia coli

- Enteropathogenic (EPEC)
- Enterotoxigenic (ETEC)
- Enteroinvasive (EIEC)
- enterohemorrhagic (EHEC)
- Enterotoxigenic (EAgEC)
- Enteroadherent (EAdEC)



- Most of the normal intestinal flora
 - In certain conditions, they cause disease
 - ↓
 - conditionally pathogenic bacteria
i.e. “opportunistic”
-
- Etiology
 - G-, facultative anaerobic bacilli
 - Singly, in pairs or irregular groups
 - Fimbriae or pili (role in adhesion)
 - Do not form a capsule (some strains on EM-microcapsule)



Epidemiology

- Most common cause of traveler's diarrhea in developed countries
- Diarrhea in infants and young children in developing countries
- Route of transmission→fecal-oral
- -contact route (children in hospitals)
- -contaminated food, water

Pathogenesis

- Binding of ETEC to specific receptors on the intestinal mucosa (colonization factors-CFA I, II and IV)
- Exotoxin (enterotoxin):
 - -thermolabile-LT
 - -thermostable-ST
- Thermolabile toxin (LT) shows similarity (pharmacological and immunological) to vibrio cholerae toxin
- It is inactivated by a temperature of 60C

Clinical picture

- Weakness, fever
- Profuse diarrhea, green-yellow in color, smells like rot
- No blood or pus

Diagnosis

- Coproculture
- Demonstration of enterotoxins
 - -LT-cell culture method
 - -ST-in vivo examination
- Demonstration of colonization factors (hemagglutination)
- Serology (agglutination reaction)

