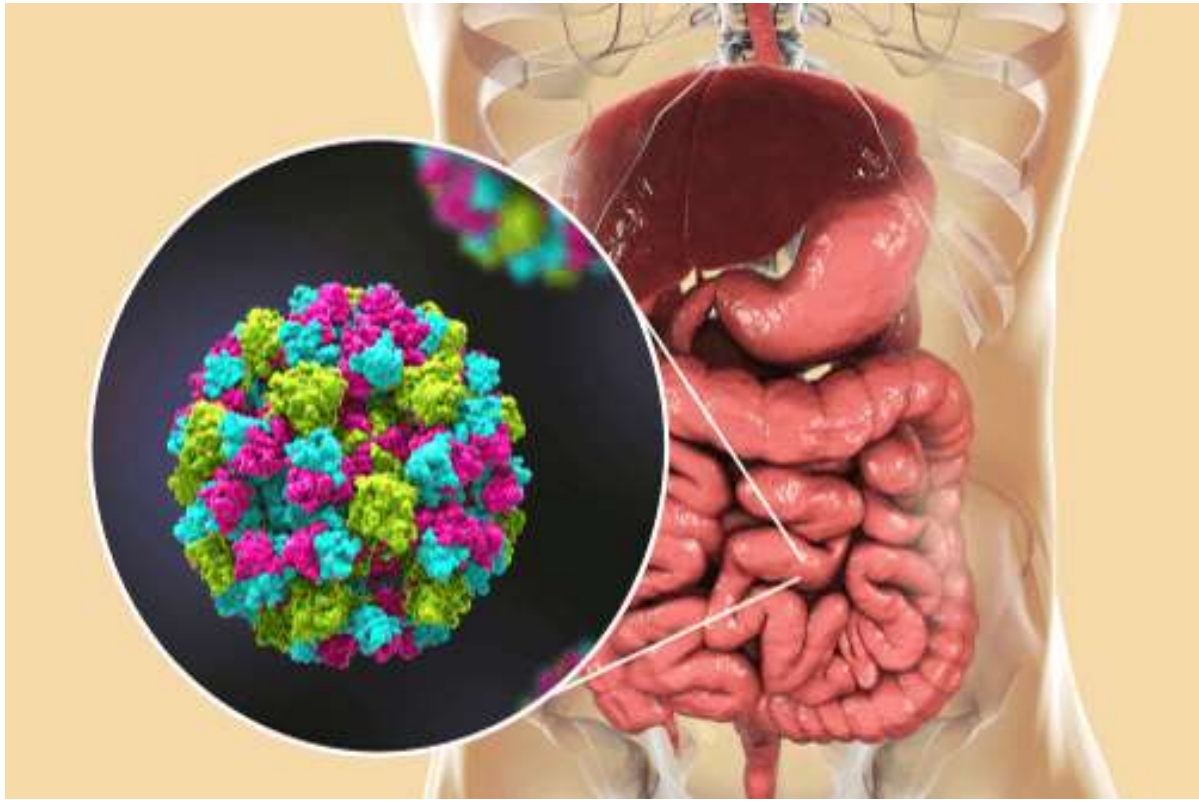
Microbiology of Gastrointestinal system

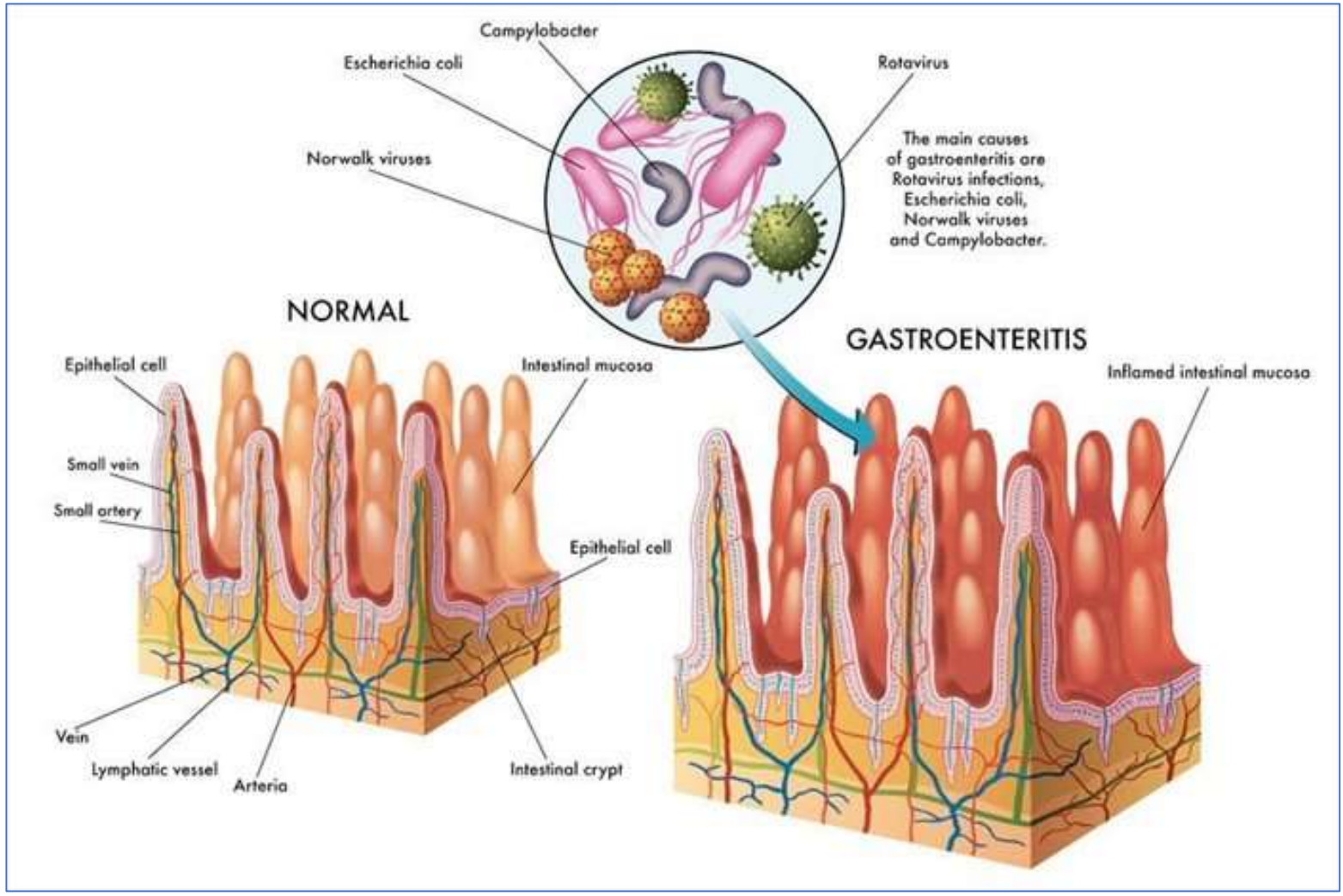


Anas Abu-Humaidan
M.D. Ph.D.

Viral gastroenteritis

Gastroenteritis / overview

- **Gastroenteritis** is inflammation of the gastrointestinal tract—the stomach and small intestine.
- Can be caused by **viruses**, bacteria, fungi and parasites.
- Mostly **infectious,** rather than **non-infectious** (caused by drugs, certain foods, etc..).
- Gastroenteritis is characterized by **vomiting** and **diarrhea**.



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Visualization by Immune Electron Microscopy of a 27-nm Particle Associated with Acute Infectious Nonbacterial Gastroenteritis

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A 27-nm particle was observed by immune electron microscopy in an infectious stool filtrate derived from an outbreak in Norwalk, Ohio, of acute infectious nonbacterial gastroenteritis. Both experimentally and naturally infected individuals developed serological evidence of infection; this along with other evidence suggested that the particle was the etiological agent of Norwalk gastroenteritis.

Caliciviruses

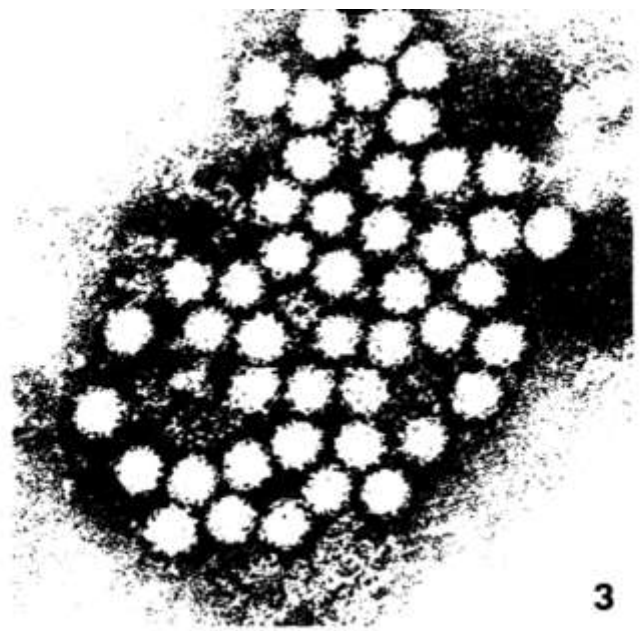


FIG. 3. *An aggregate observed after incubation of the stool filtrate with a 1:5 dilution of prechallenge antiserum of volunteer A. The quantity of antibody on these glistening particles was scored as 1+. ×231,500.*

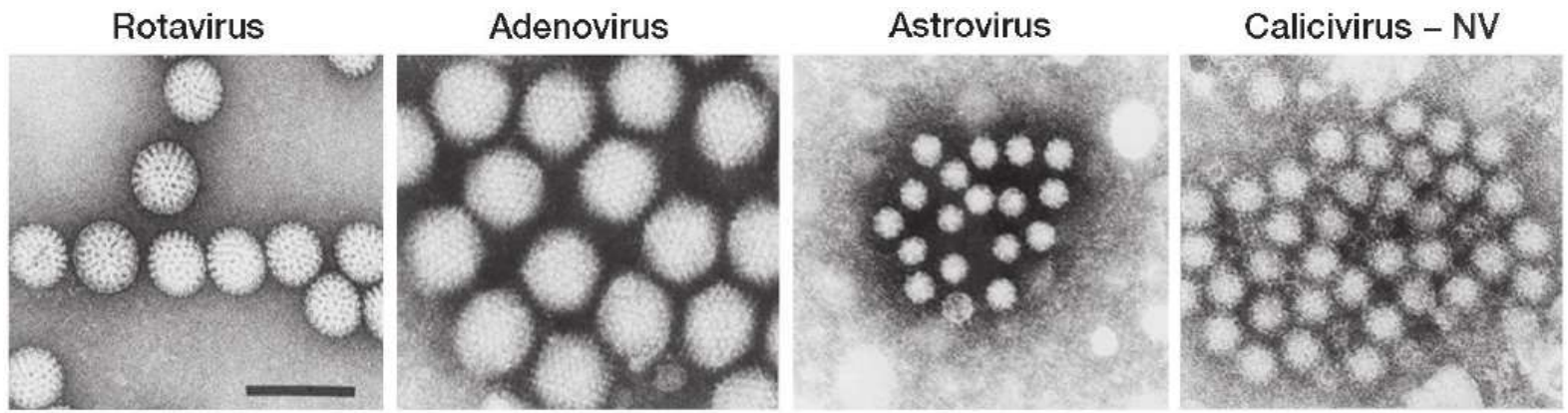
Viral gastroenteritis / etiology

TABLE 98-1

VIRAL CAUSES OF GASTROENTERITIS AMONG HUMANS

VIRUS	FAMILY	GENOME	PRIMARY AGE GROUP AT RISK	CLINICAL SEVERITY	DETECTION ASSAYS
Group A rotavirus	Reoviridae	Double-strand segmented RNA	Children <5 years	+++	EM, EIA (commercial), PAGE, RT-PCR
Norovirus	Caliciviridae	Positive-sense single-strand RNA	All ages	++	EM, RT-PCR
Sapovirus	Caliciviridae	Positive-sense single-strand RNA	Children <5 years	+	EM, RT-PCR
Astrovirus	Astroviridae	Positive-sense single-strand RNA	Children <5 years	+	EM, EIA, RT-PCR
Adenovirus (mainly types 40 and 41)	Adenoviridae	Double-strand DNA	Children <5 years	+/++	EM, EIA (commercial), PCR

Abbreviations: EIA, enzyme immunoassay; EM, electron microscopy; PAGE, polyacrylamide gel electrophoresis; PCR, polymerase chain reaction; RT-PCR, reverse-transcription PCR.

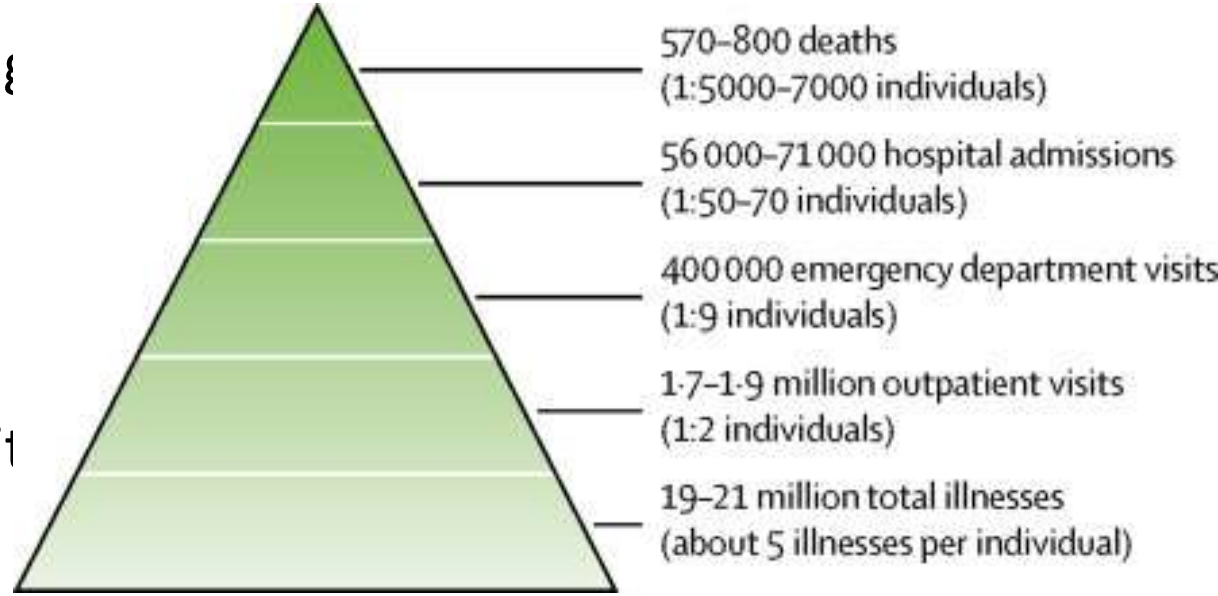


- Acute infectious gastroenteritis is a common illness that affects persons of **all ages worldwide**.

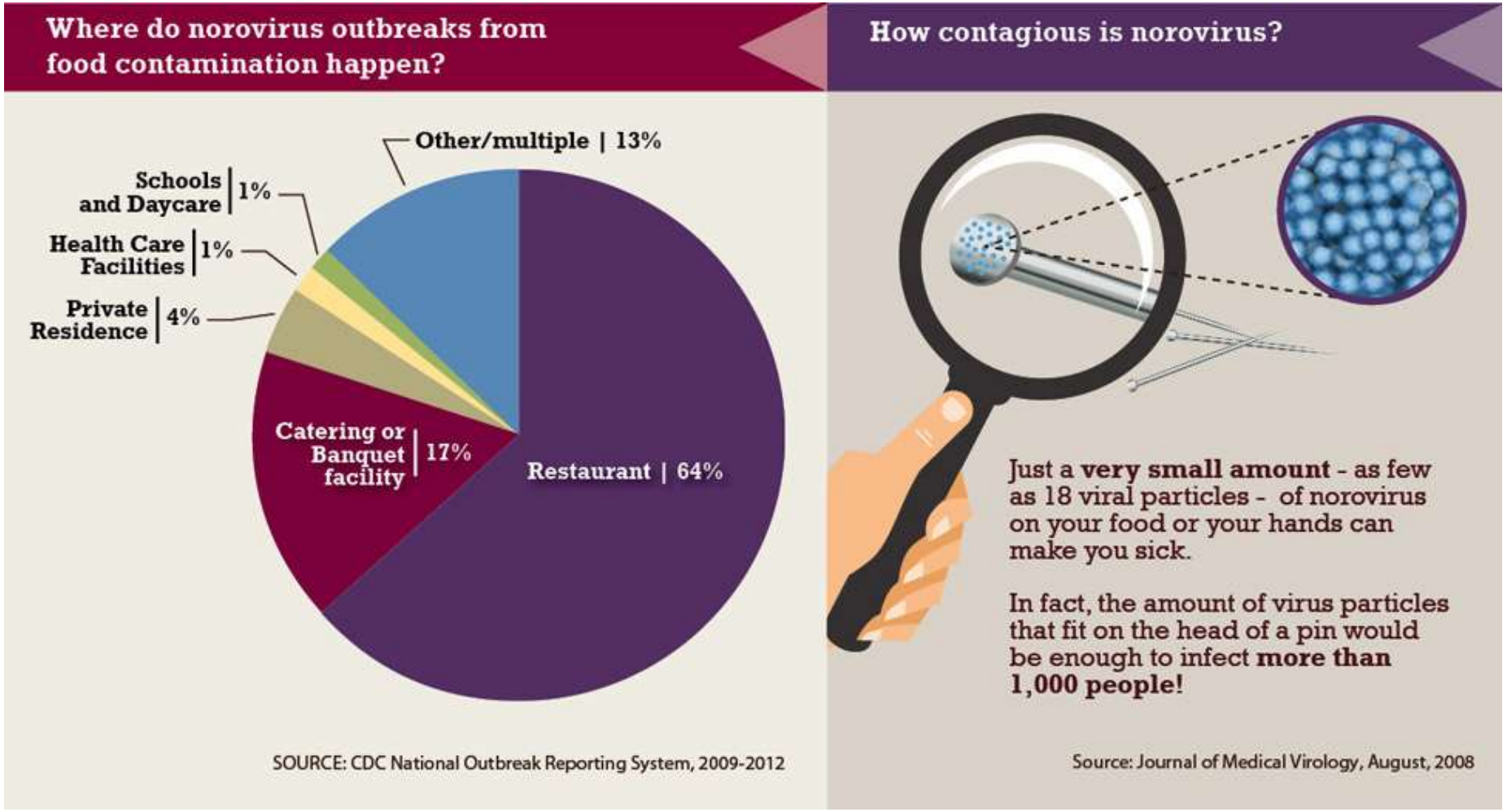
- It is a leading cause of mortality among **children** in developing countries, accounting for an estimated 0.7 million deaths each year, and is responsible for up to 10–12% of all hospitalizations among children in industrialized countries.

- **Elderly** persons, especially those with debilitating health conditions, also are at risk of severe complications and death from acute gastroenteritis.

- Among healthy **young adults**, acute gastroenteriti is rarely fatal.



- Infections with the Norwalk and related human caliciviruses are common worldwide, and **most adults have antibodies to these viruses**.

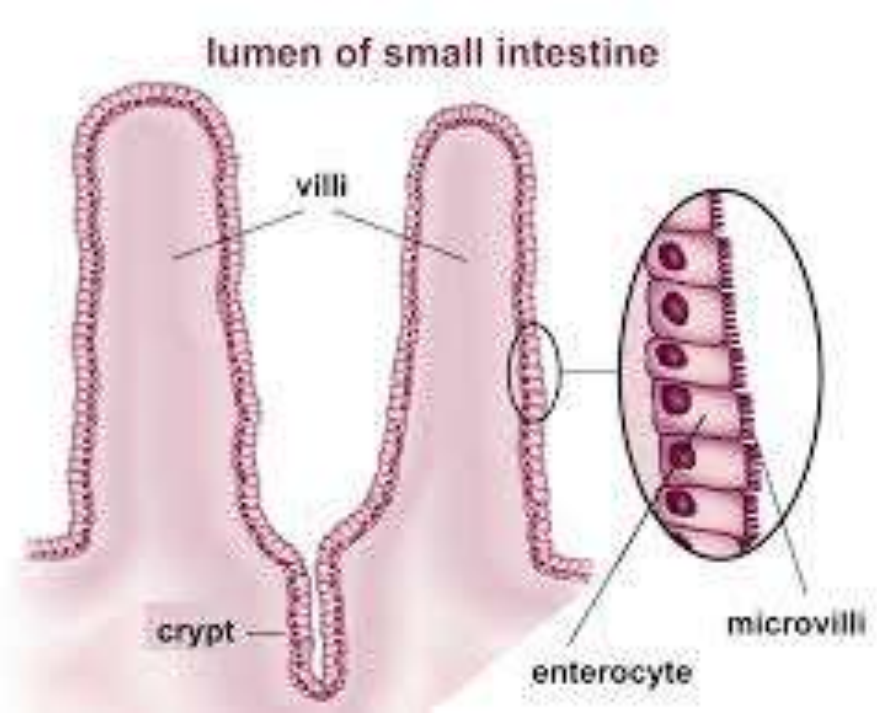


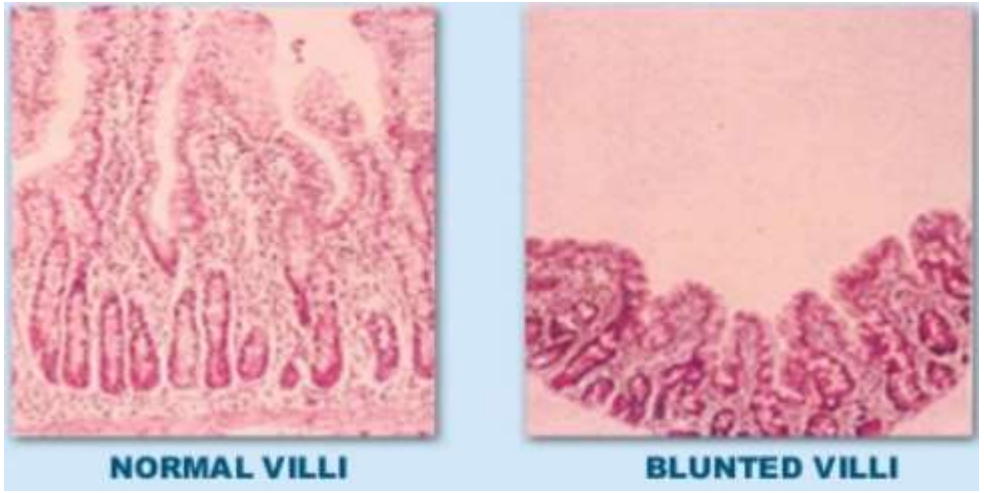
- Virus is transmitted predominantly by the **fecal-oral route** but is also present in **vomitus**. Because an inoculum with **very few viruses can be infectious**, transmission can occur by **aerosolization**, by contact with **contaminated fomites**, and by **person-to-person contact**.

- Carbohydrates present on the gastroduodenal epithelium may serve as ligands for the attachment of Norwalk virus.

- lesions are noted in the upper jejunum, with broadening and blunting of the villi, shortening of the microvilli, vacuolization o the lining epithelium, crypt hyperplasia, and infiltration of the lamina propria by polymorphonuclear neutrophils and lymphocytes.

- No histopathologic changes are seen in the stomach or colon usually.



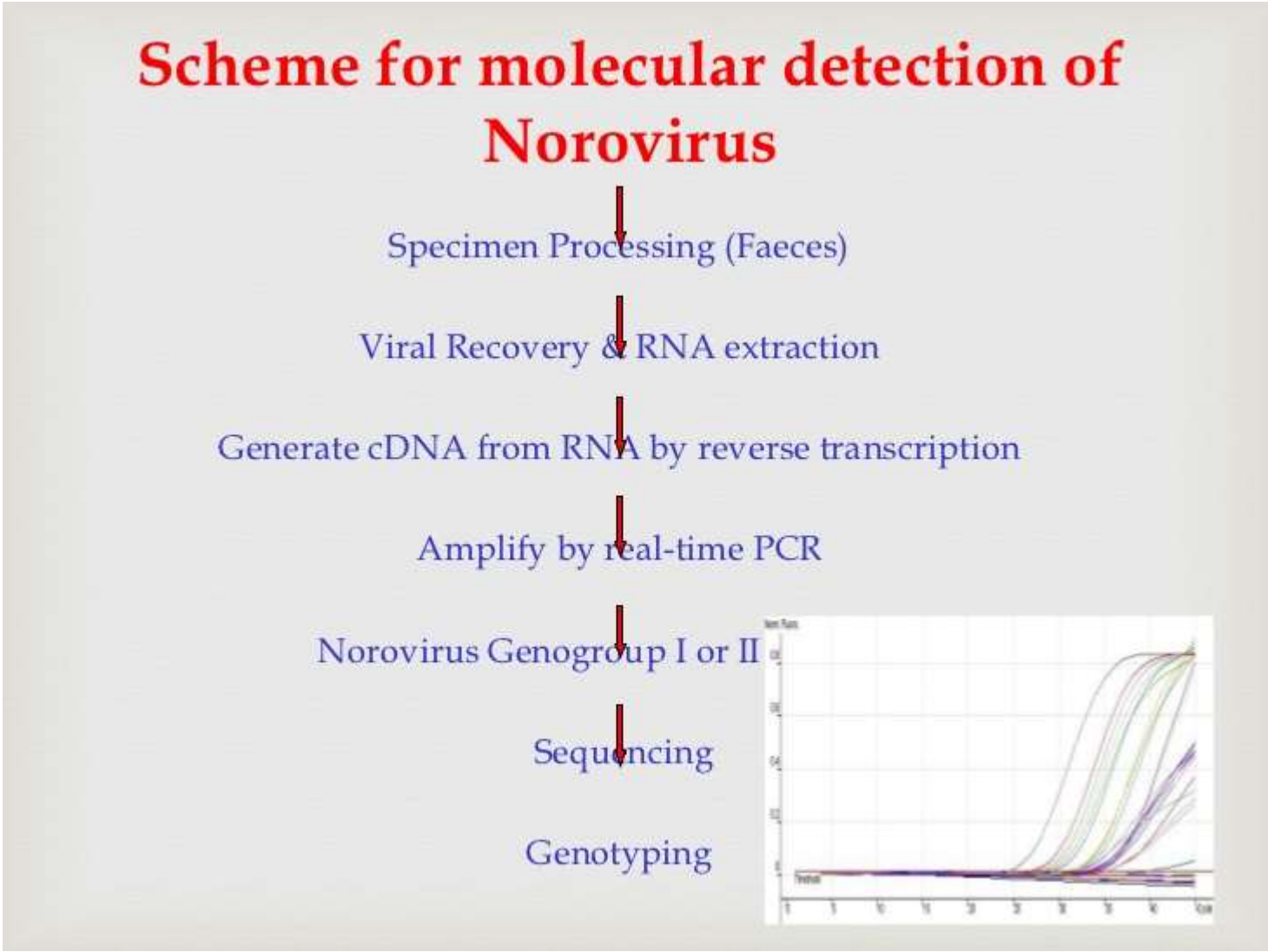


- Gastroenteritis caused by Norwalk and related human caliciviruses has a **sudden onset** following an average **incubation period of 24 h.**
- The illness generally lasts 12–60 h and is characterized by one or more of the following symptoms: **nausea, vomiting, abdominal cramps,** and **diarrhea.**
- Vomiting is more prevalent among children, whereas a greater proportion of adults develop diarrhea.
- **Constitutional symptoms** are **common**, including headache, fever, chills, and myalgias.
- The stools are characteristically loose and watery, without blood, mucus, or leukocytes

- Cloning and sequencing o the genomes o Norwalk and several other human caliciviruses have allowed the development o assays based on **polymerase chain reaction (PCR)** or detection o virus in stool and vomitus.

- **Enzyme immunoassays (EIAs)** for detection of Virus particles in stool can be used.

- No currently available single assay can detect all human caliciviruses because of their great genetic and antigenic diversity.



- The disease is **self-limited**, and oral **rehydration** therapy is generally adequate.
- If severe dehydration develops, **IV fluid** therapy is indicated.
- **No specific antiviral** therapy is available

- Epidemic prevention relies on situation-specifc measures, such as **control of contamination of food and water, exclusion of ill food handlers**, and reduction of person-to-person spread through good **personal hygiene** and **disinfection of contaminated fomites**.

Viral gastroenteritis / Noroviruses / clinical case

Abstract

An outbreak of gastroenteritis followed a meal in a large hotel during which one of the diners vomited. The clinical features of the illness suggested Norwalk-like virus (NLV, small round structured virus) infection, and this was confirmed by electron microscopy and reverse transcriptase polymerase chain reaction (RT-PCR) of stool samples. Further characterization of the virus by nucleotide sequence analysis of the PCR amplicons revealed identical strains in all the affected individuals. The foods served at the meal could not be demonstrated to be the cause of the outbreak. Analysis of attack rates by dining table showed an inverse relationship with the distance from the person who vomited. No one eating in a separate restaurant reported illness. Transmission from person-to-person or direct contamination of food seems unlikely in this outbreak. However, the findings are consistent with airborne spread of NLV with infection by inhalation with subsequent ingestion of virus particles.

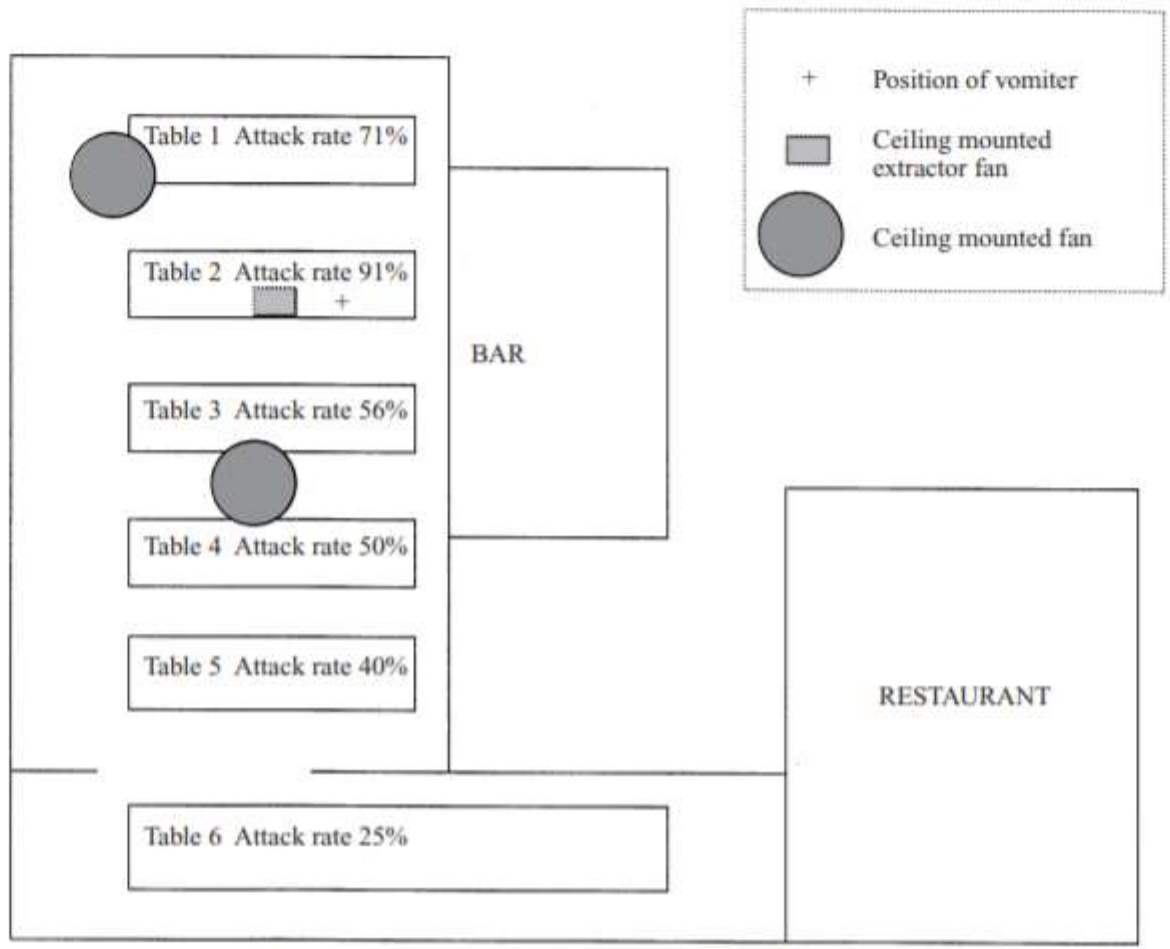


Fig. 3. Plan of the layout of tables in the restaurant. The locations of the index case and those who subsequently became ill are indicated.

- Worldwide, **nearly all children** are infected with rotavirus by 3–5 years of age.
- **Neonatal infections** are common but are often **asymptomatic** or mild, presumably because of protection by maternal antibody or breast milk
- First infections after 3 months of age are likely to be **symptomatic**, and the **incidence** of disease **peaks** among children **4–23 months** of age.
- Because of suboptimal access to hydration therapy, **rotavirus is a leading cause of diarrheal death among children in the developing world**

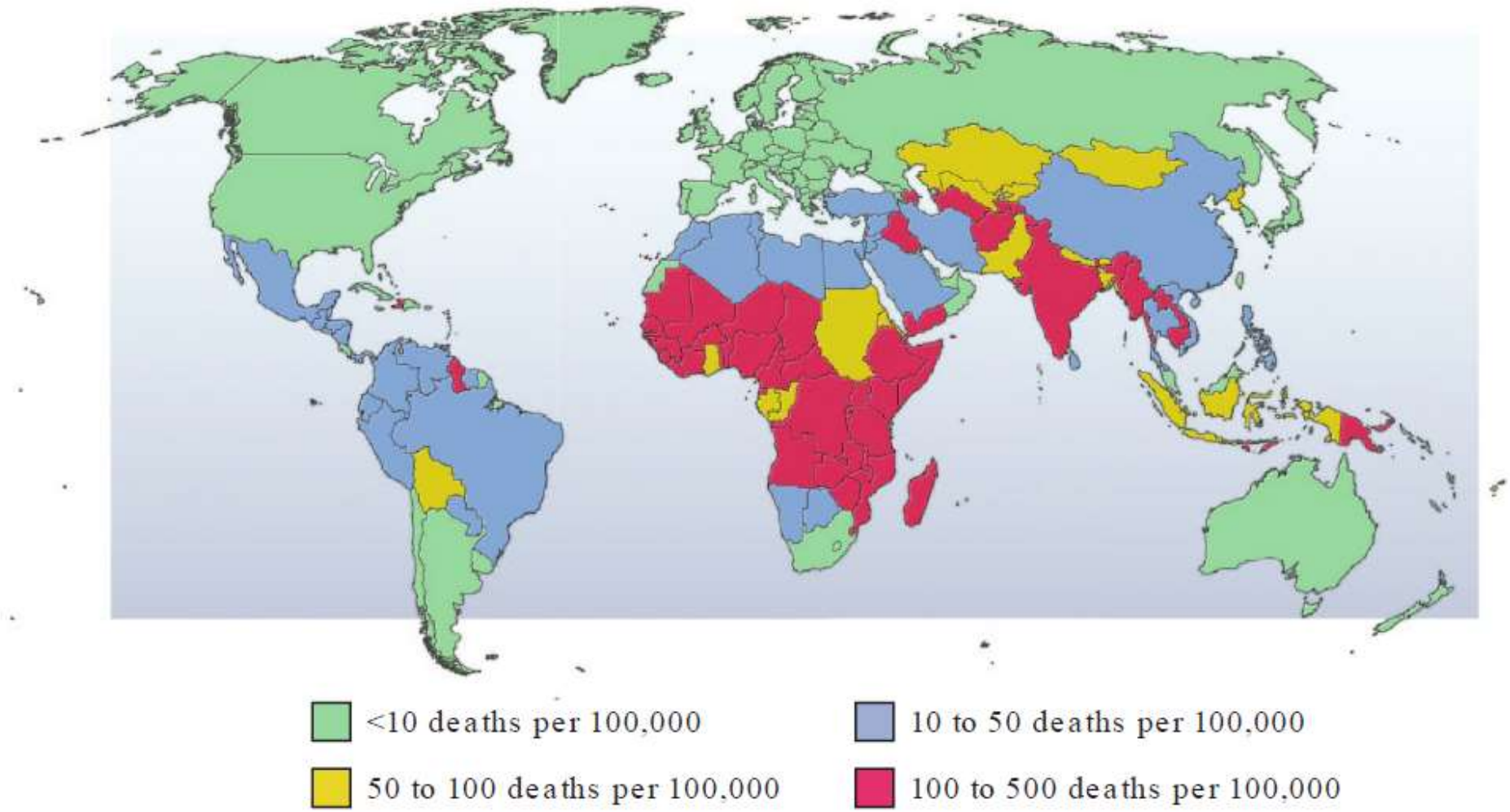
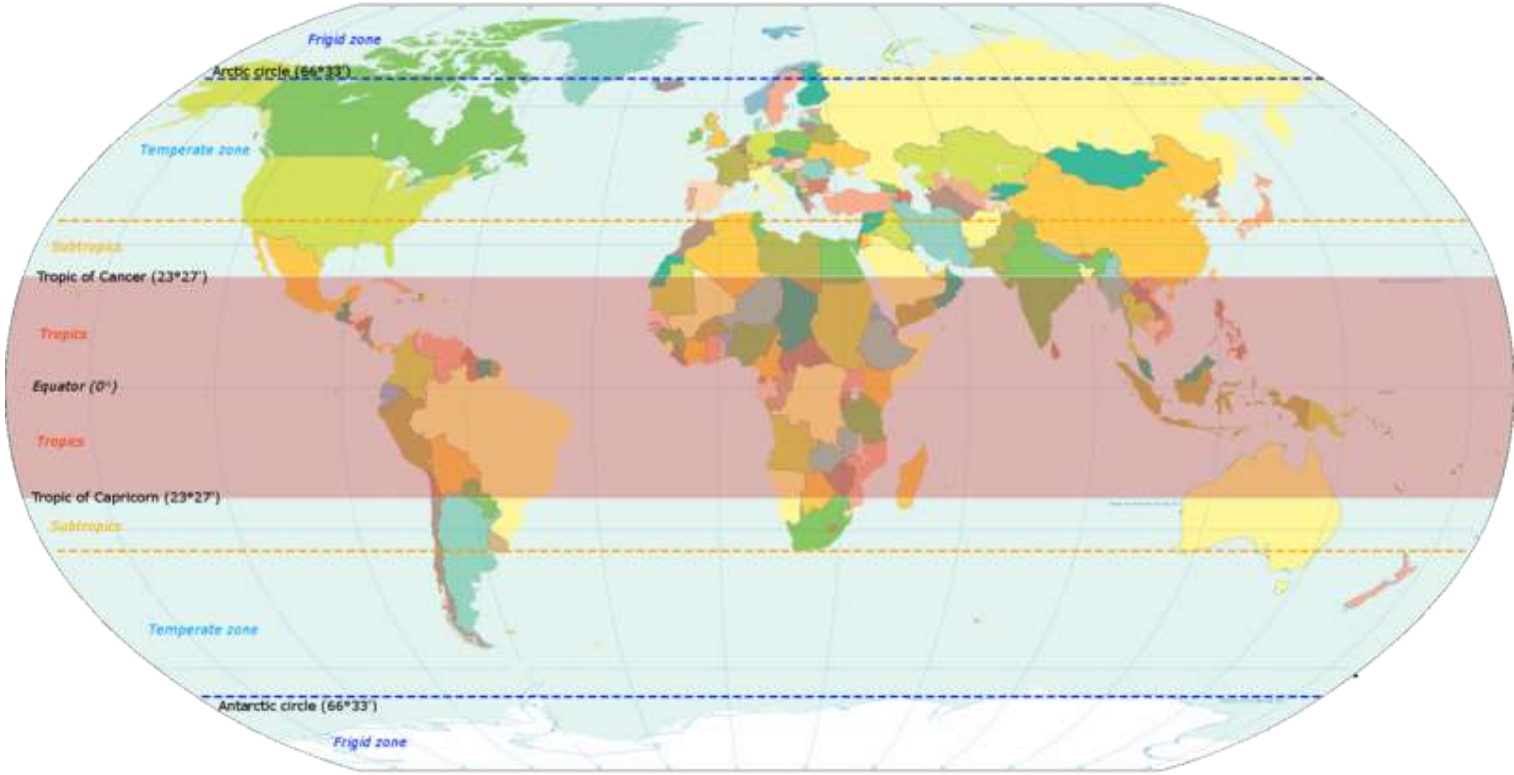


FIGURE 98-2
Rotavirus mortality rates by country, per 100,000 children <5 years of age. (Reproduced with permission from UD Parashar et al: J Infect Dis 200:S9, 2009.)

- In **tropical** settings, rotavirus disease occurs **year-round**, with less pronounced seasonal peaks than in **temperate** settings, where rotavirus disease occurs predominantly during the cooler and **winter months**.

- The implementation of **routine vaccination** of U.S. infants against rotavirus in 2006, was accompanied by substantial **declines in rotavirus detections** by a national network of sentinel laboratories.



Viral gastroenteritis / epidemiology / Rotaviruses

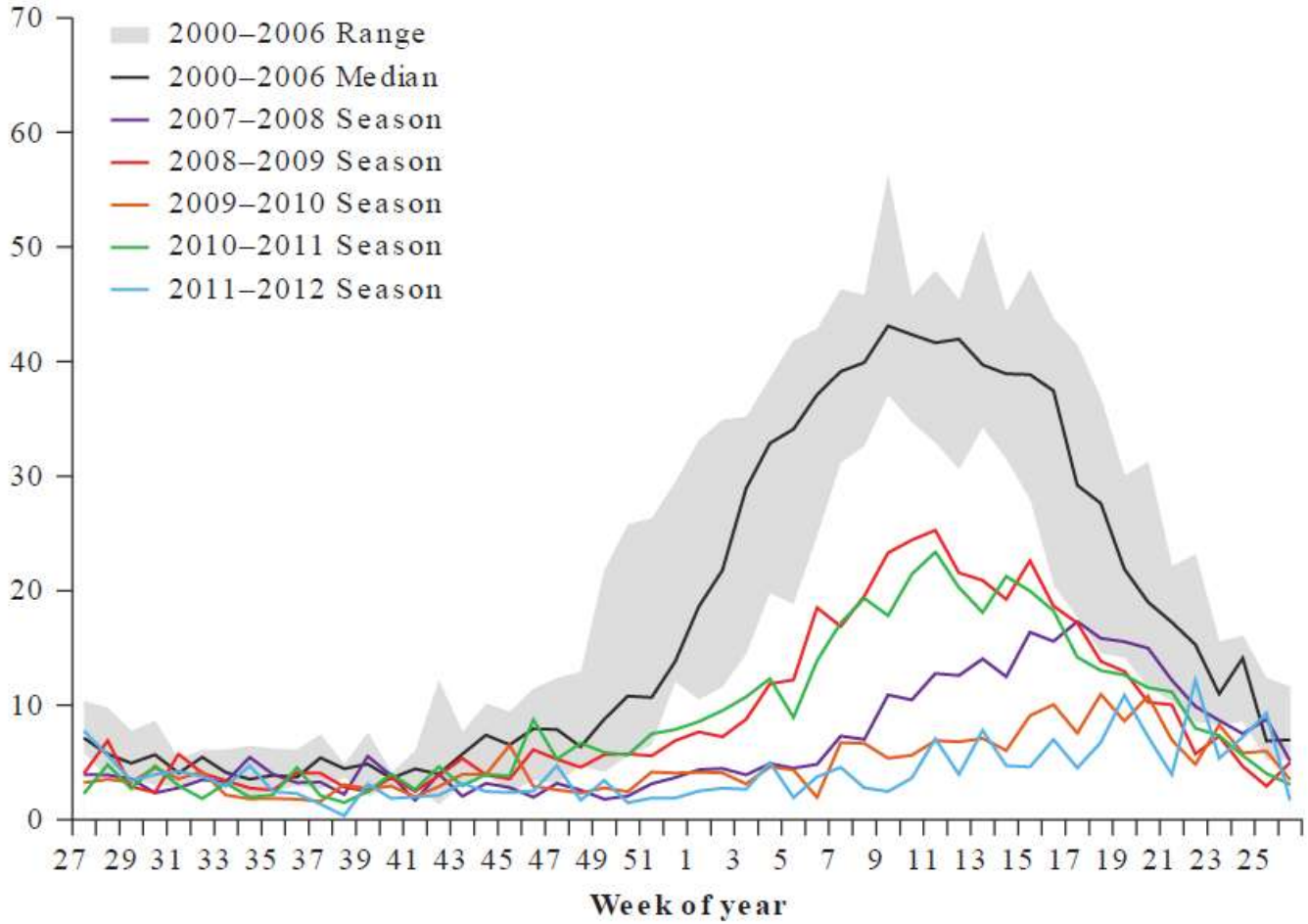
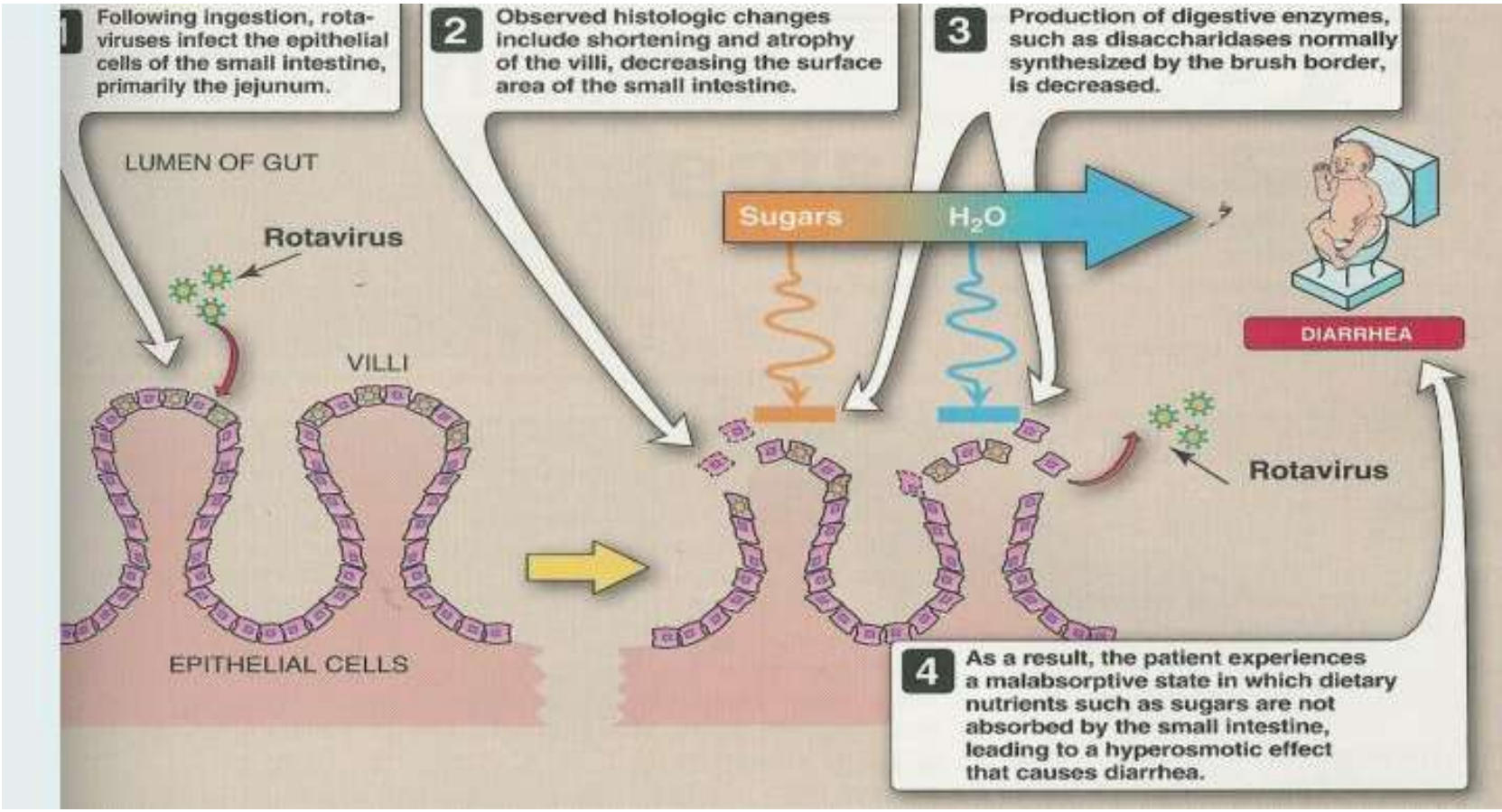


FIGURE 98-3
Percentage of rotavirus tests with positive results, by week of year, July–June, 2000–2012. The maximal or minimal percentage of rotavirus-positive tests for 2000–2006 may have occurred during any of the six baseline seasons. Data are from the National Respiratory and Enteric Virus Surveillance System. (Adapted from Centers for Disease Control and Prevention, 2012.)

- Rotaviruses infect and ultimately destroy mature enterocytes in the villous epithelium of the proximal small intestine. The **loss of absorptive villous epithelium**, coupled with the **proliferation of secretory crypt cells**, results in **secretory diarrhea**.



- The clinical spectrum of rotavirus infection ranges from subclinical infection to severe gastroenteritis leading to life-threatening dehydration.

- After an incubation period of 1–3 days, the illness has an abrupt onset, **with vomiting frequently preceding the onset of diarrhea**.

- The stools are characteristically **loose and watery** and only infrequently contain red or white cells. Gastrointestinal symptoms generally **resolve in 3–7 days**.

- Illness caused by rotavirus is difficult to distinguish clinically from that caused by other enteric viruses.

- Because large quantities of virus are shed in feces, the diagnosis can usually be confirmed by a wide variety of commercially available **EIAs** or by techniques for **detecting viral RNA**, like PCR or probe hybridization.

- Rotavirus gastroenteritis can lead to severe dehydration. Thus appropriate treatment should be instituted early.

- **Standard oral rehydration therapy** is successful for most children who can take fluids by mouth, but **IV fluid replacement** may be required for patients who are severely dehydrated or are unable to tolerate oral therapy because of frequent vomiting.

- Antibiotics and antimotility agents **should be avoided**.

- Efforts to develop rotavirus vaccines were pursued because it was apparent—**given the similar rates in less developed and industrialized nations**—that improvements in hygiene and sanitation were unlikely to reduce disease incidence.

- In 2006, **promising safety and efficacy** results or **two new rotavirus vaccines** were reported. Both vaccines are now **recommended for routine immunization**, and their use has rapidly led to a >70–80% decline in rotavirus hospitalizations and emergency department visits at hospitals

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Home » Local » Rotavirus vaccination drive begins next Sunday

Rotavirus vaccination drive begins next Sunday

By JT - Feb 25,2015 - Last updated at Feb 25,2015

AMMAN — The Health Ministry on Wednesday said it will begin immunising children against the rotavirus on Sunday after its inclusion in the national vaccination programme.

Viral vs bacterial gastroenteritis

TABLE 98-2

CHARACTERISTICS OF GASTROENTERITIS CAUSED BY VIRAL AND BACTERIAL AGENTS

FEATURE	VIRAL GASTROENTERITIS	BACTERIAL GASTROENTERITIS
Setting	Incidence similar in developing and developed countries	More common in settings with poor hygiene and sanitation
Infectious dose	Low (10–100 viral particles) for most agents	High (>10^5 bacteria) for Escherichia coli, Salmonella, Vibrio; medium (10^2–10^5 bacteria) for Campylobacter jejuni; low (10–100 bacteria) for Shigella
Seasonality	In temperate climates, winter seasonality for most agents; year-round occurrence in tropical areas	More common in summer or rainy months, particularly in developing countries with a high disease burden
Incubation period	1–3 days for most agents; can be shorter for norovirus	1–7 days for common agents (e.g., Campylobacter, E coli, Shigella, Salmonella); a few hours for bacteria producing preformed toxins (e.g., Staphylococcus aureus, Bacillus cereus)
Reservoir	Primarily humans	Depending on species, human (e.g., Shigella, Salmonella), animal (e.g., Campylobacter, Salmonella, E coli), and water (e.g., Vibrio) reservoirs exist

Viral vs bacterial gastroenteritis

TABLE 98-2

CHARACTERISTICS OF GASTROENTERITIS CAUSED BY VIRAL AND BACTERIAL AGENTS

FEATURE	VIRAL GASTROENTERITIS	BACTERIAL GASTROENTERITIS
Fever	Common with rotavirus and norovirus; uncommon with other agents	Common with agents causing inflammatory diarrhea (e.g., Salmonella, Shigella)
Vomiting	Prominent and can be the only presenting feature, especially in children	Common with bacteria producing preformed toxins; less prominent in diarrhea due to other agents
Diarrhea	Common; nonbloody in almost all cases	Prominent and occasionally bloody with agents causing inflammatory diarrhea
Duration	1–3 days for norovirus and sapovirus; 2–8 days for other viruses	1–2 days for bacteria producing preformed toxins; 2–8 days for most other bacteria
Diagnosis	This is often a diagnosis of exclusion in clinical practice. Commercial enzyme immunoassays are available for detection of rotavirus and adenovirus, but identification of other agents is limited to research and public health laboratories.	Fecal examination for leukocytes and blood is helpful in differential diagnosis. Culture of stool specimens, sometimes on special media, can identify several pathogens. Molecular techniques are useful epidemiologic tools but are not routinely used in most laboratories.
Treatment	Supportive therapy to maintain adequate hydration and nutrition should be given. Antibiotics and antimotility agents are contraindicated.	Supportive hydration therapy is adequate for most patients. Antibiotics are recommended for patients with dysentery caused by Shigella or diarrhea caused by Vibrio cholerae and for some patients with Clostridium difficile colitis.

Further reading:

- Harrison's Infectious Diseases 3rd Edition

SECTION 5: Viral Infections, Chapter 98