

# Microbiology of Gastrointestinal system

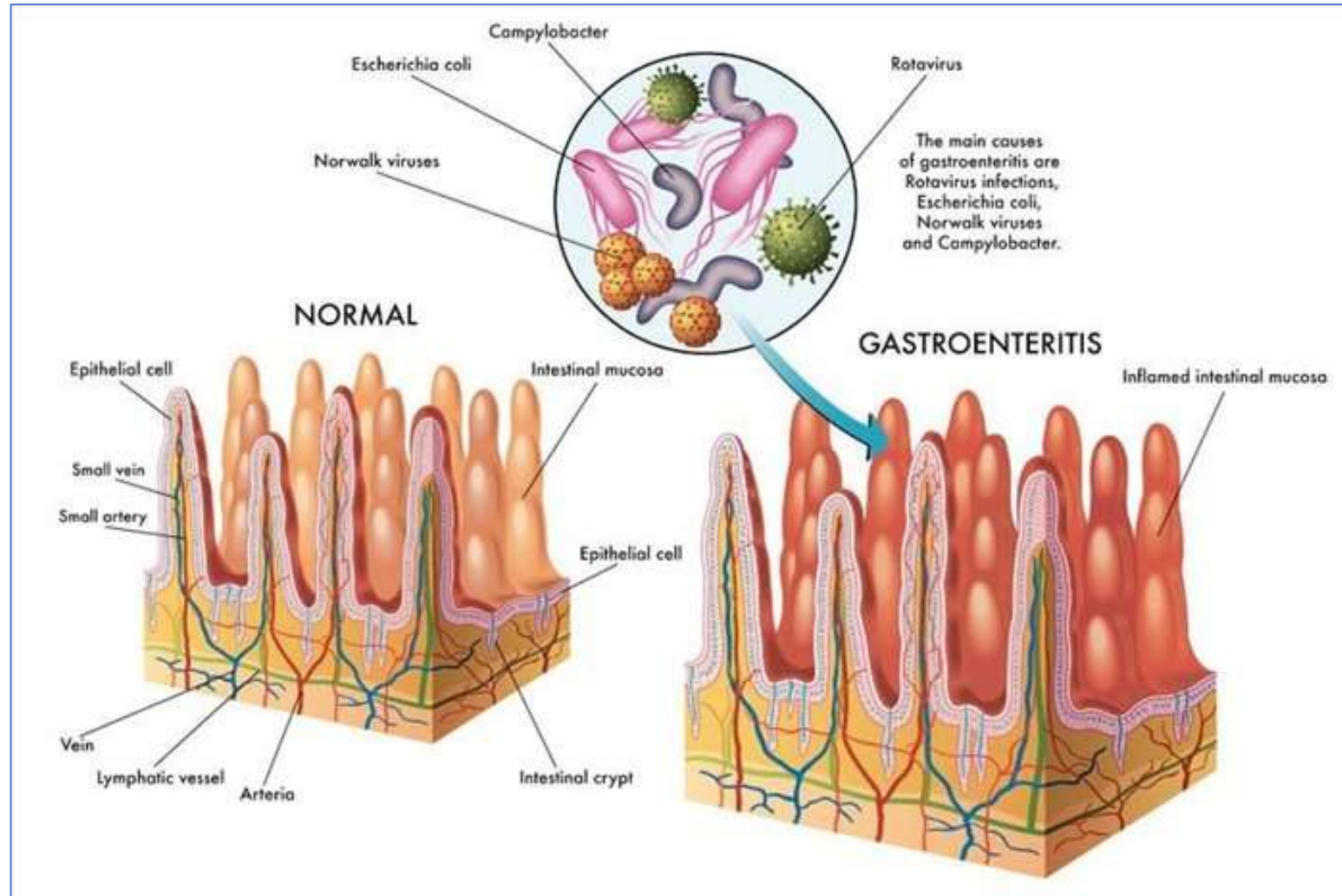
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Anas Abu-Humaidan  
M.D. Ph.D.

Viral gastroenteritis

- **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**.



- Kapikian, A.Z.; Wyatt, R.G.; Dolin, R.; Thornhill, T.S.; Kalica, A.R.; Chanock, R.M. **Visualization by immune electron microscopy of a 27-nm particle associated with acute infectious nonbacterial gastroenteritis.** J. Virol. **1972**, 10, 1075–1081. [PubMed]
- Bishop, R.F.; Davidson, G.P.; Holmes, I.H.; Ruck, B.J. **Virus particles in epithelial cells of duodenal mucosa from children with acute non-bacterial gastroenteritis.** Lancet 1973, 2, 1281–1283. [CrossRef]
- Madeley, C.R.; Cosgrove, B.P. Letter: **28 nm particles in faeces in infantile gastroenteritis.** Lancet **1975**, 2, 451–452. [CrossRef]
- Morris, C.A.; Flewett, T.H.; Bryden, A.S.; Davies, H. **Epidemic viral enteritis in a long-stay children's ward.** Lancet **1975**, 1, 4–5. [PubMed]

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

ALBERT Z. KAPIKIAN, RICHARD G. WYATT, RAPHAEL DOLIN, THOMAS S. THORNHILL,  
ANTHONY R. KALICA, AND ROBERT M. CHANOCK

*Laboratory of Infectious Diseases, National Institute of Allergy and Infectious Diseases,  
National Institutes of Health, Bethesda, Maryland 20014*

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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

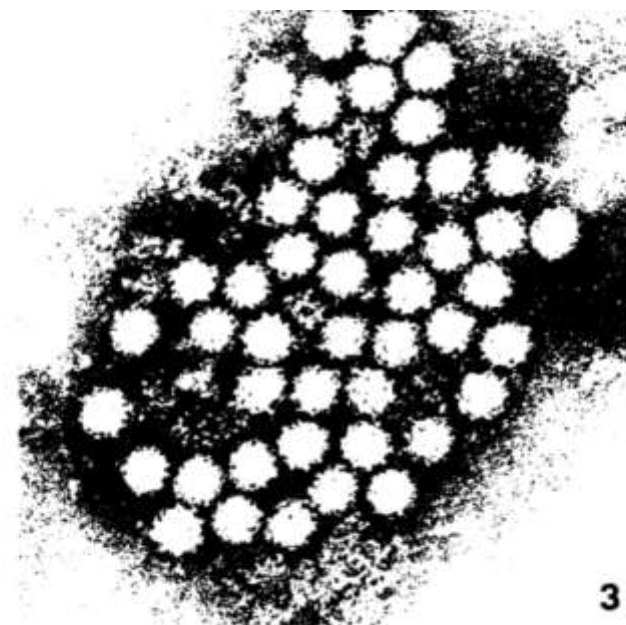


FIG. 3. An aggregate observed after incubation of the stool filtrate with a 1:5 dilution of prechallenge antiserum of volunteer A. The quantity of antibody on these glistening particles was scored as 1+.  $\times 231,500$ .



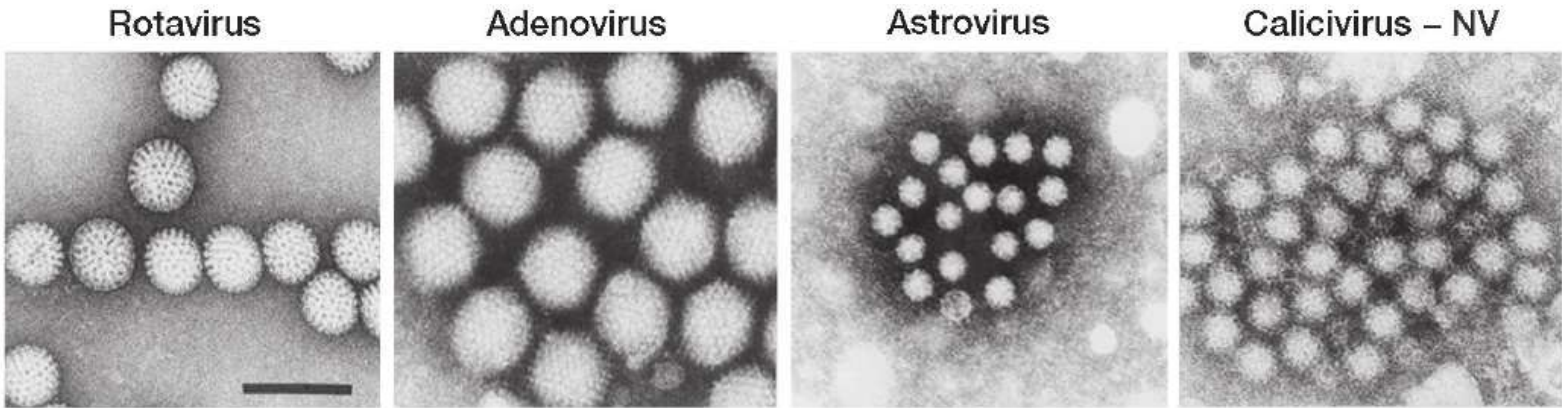
Viral gastroenteritis / etiology

TABLE 98-1

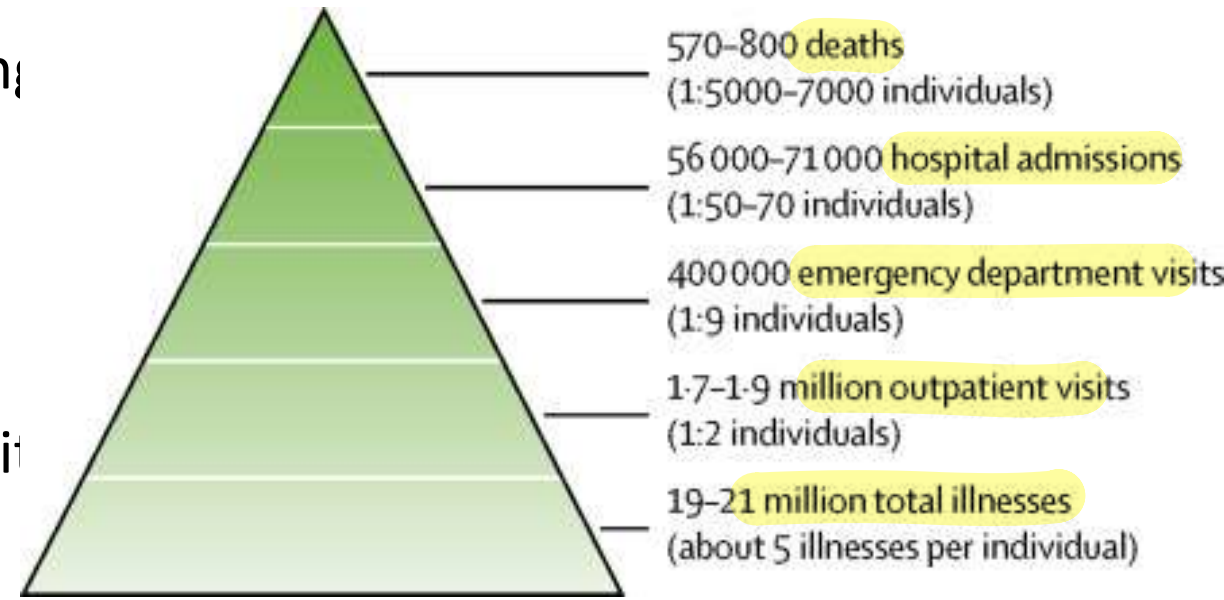
VIRAL CAUSES OF GASTROENTERITIS AMONG HUMANS

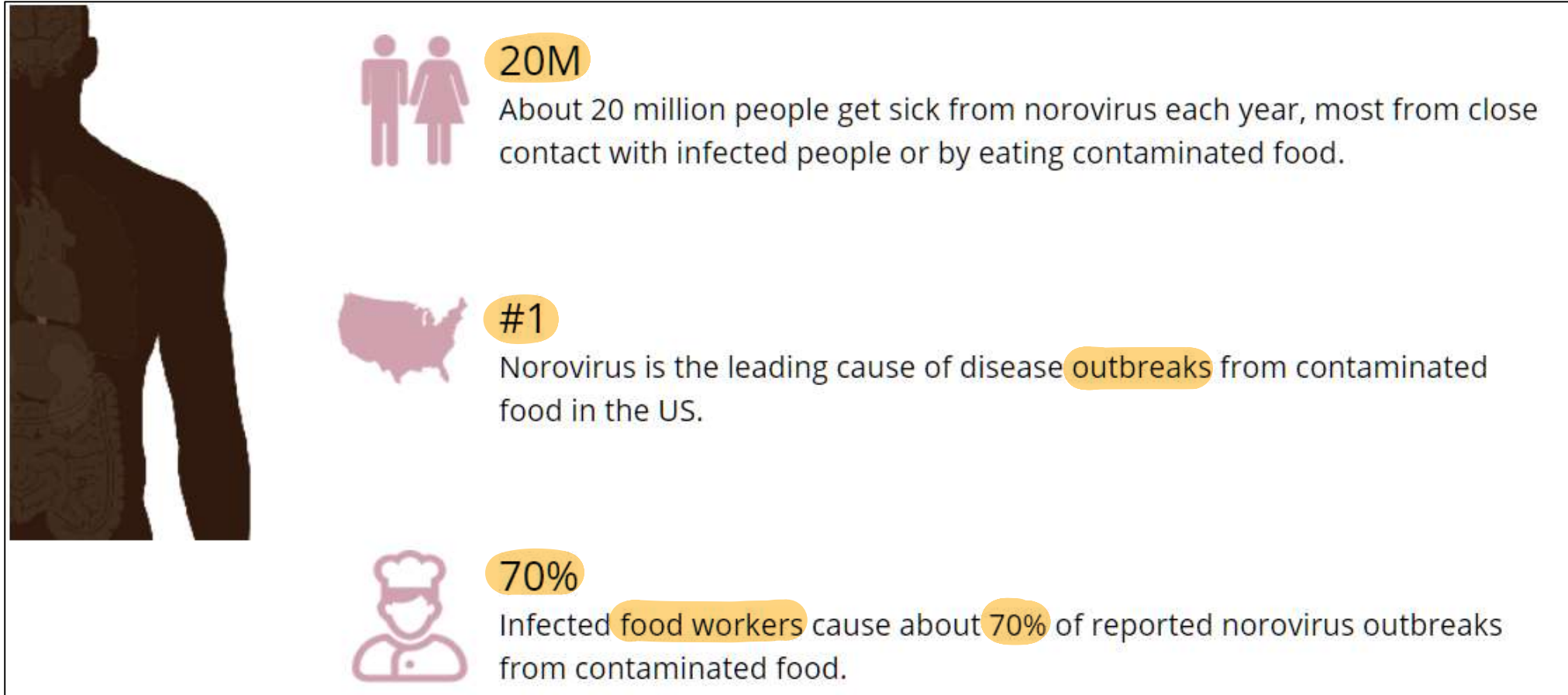
VIRUS	FAMILY	GENOME	PRIMARY AGE GROUP AT RISK	CLINICAL SEVERITY	DETECTION ASSAYS
Group A rotavirus	Reoviridae	Double-strand segmented RNA	Children <5 years	+++	EM, EIA (commercial), PAGE, RT-PCR
Norovirus	Caliciviridae	Positive-sense single-strand RNA	All ages	++	EM, RT-PCR
Sapovirus	Caliciviridae	Positive-sense 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



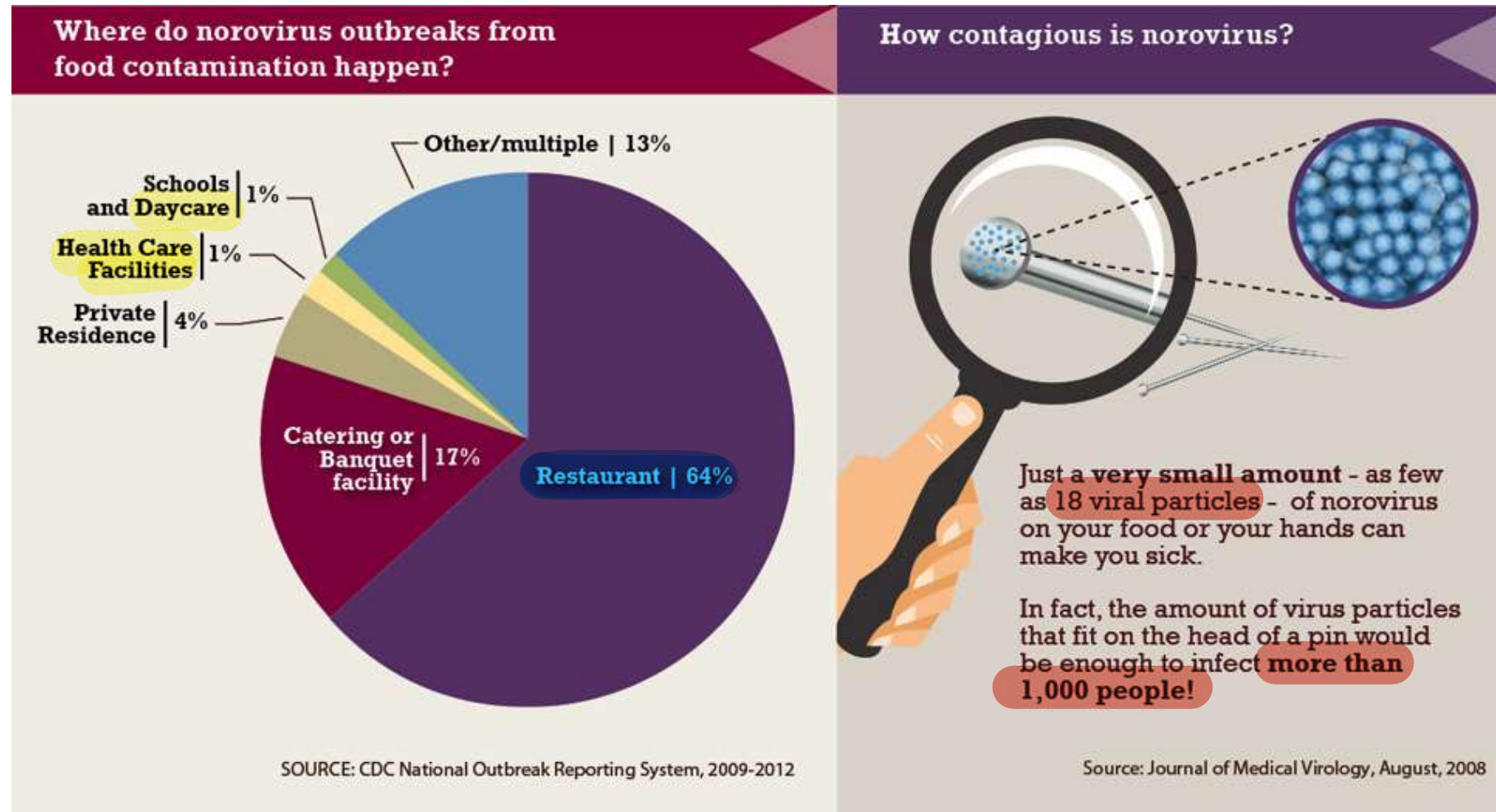
- Acute infectious gastroenteritis is a common illness that affects persons of **all ages worldwide**.
- It is a leading cause of **mortality** among **children** in **developing** countries, accounting for an estimated 0.7 million deaths each year, and is responsible for up to 10–12% of all hospitalizations 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 gastroenteritis is **rarely fatal**.





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

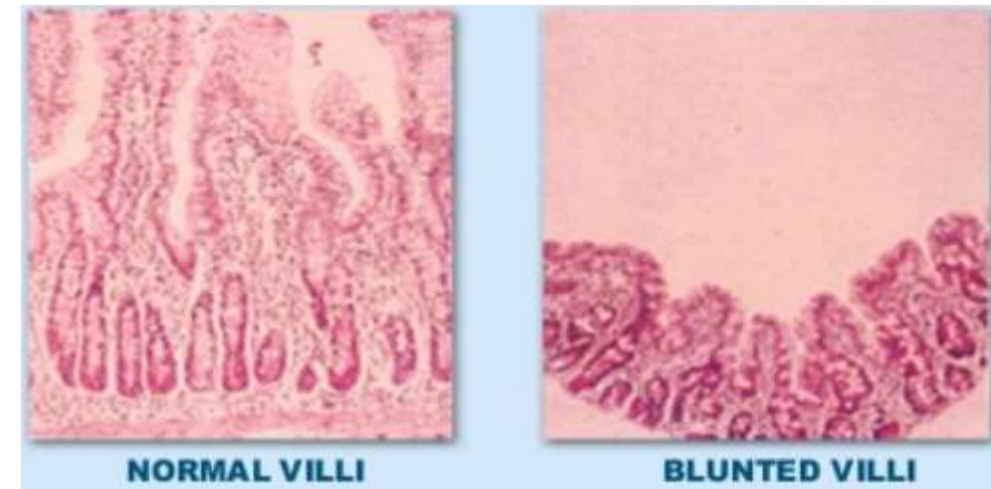
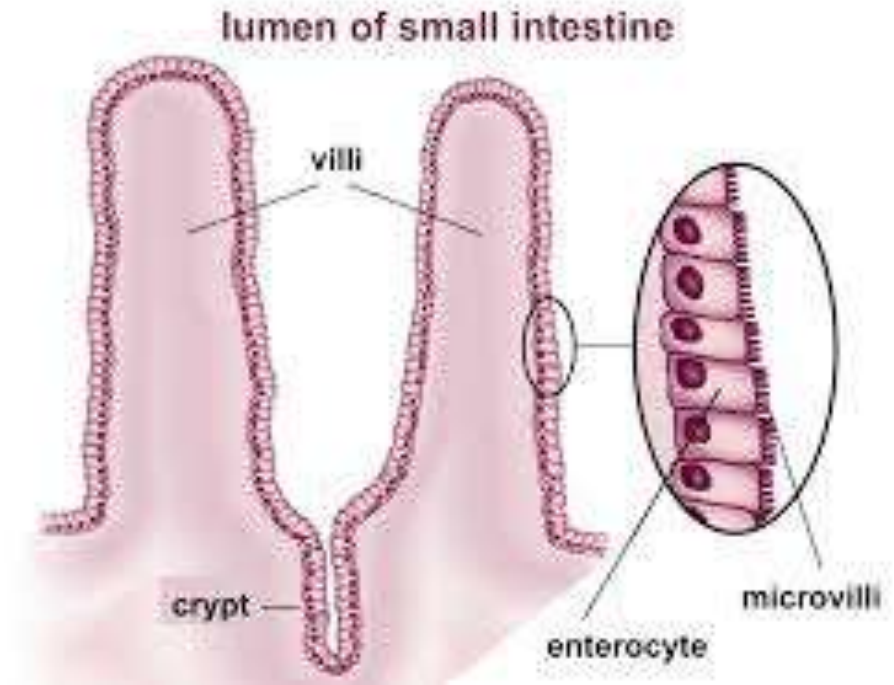
## Viral gastroenteritis / transmission / Noroviruses

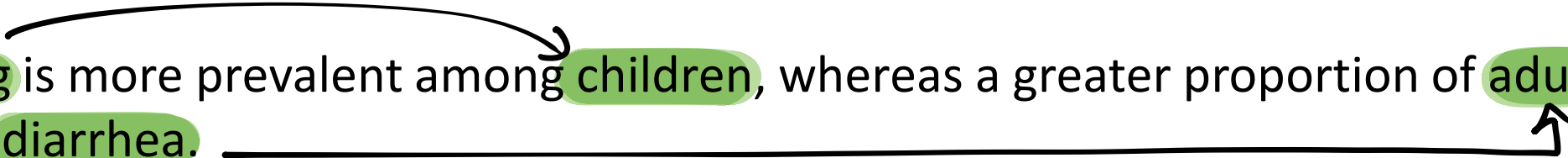



- Virus is transmitted predominantly by the **fecal-oral route** but is also present in **vomit**. Because an inoculum with **very few** viruses can be infectious, transmission can occur by **aerosolization** by contact with **contaminated fomites**, and by **person-to-person contact**.



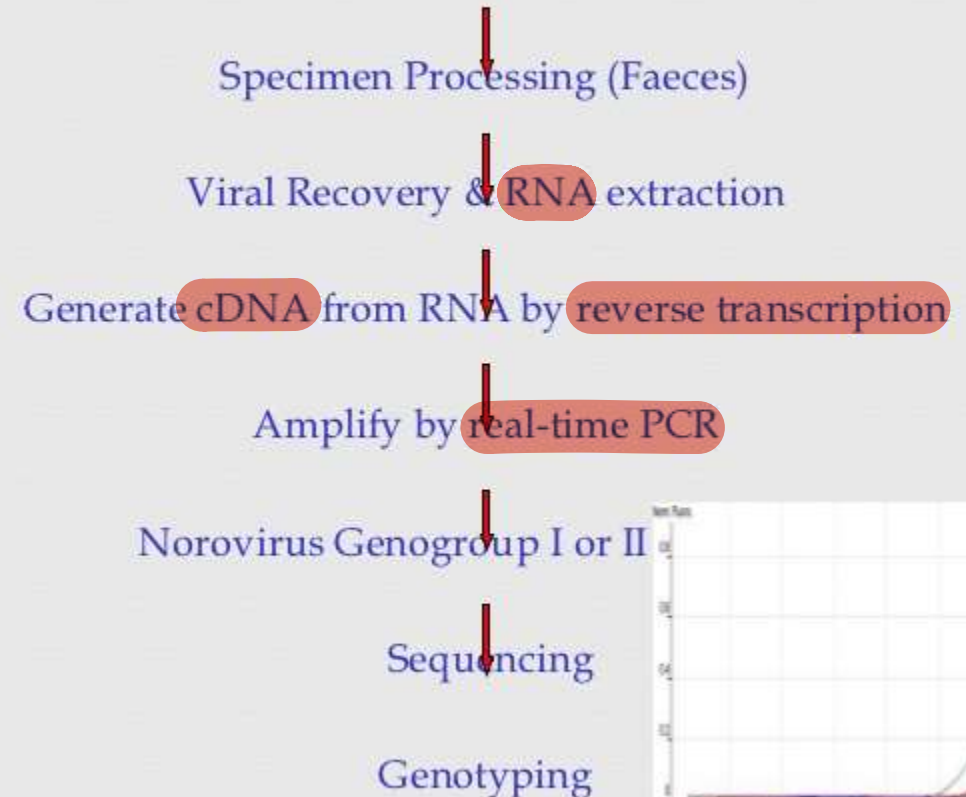
- Carbohydrates present on the gastroduodenal epithelium may serve as ligands for the attachment of Norwalk virus.
- lesions are noted in the upper jejunum, with broadening and blunting of the villi, shortening of the microvilli, vacuolization of the lining epithelium, crypt hyperplasia, and infiltration 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 of the genomes of Norwalk and several other human caliciviruses have allowed the development of assays based on **polymerase chain reaction (PCR)** or detection of virus in **stool** and **vomit**.
- **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**.

## Scheme for molecular detection of Norovirus



- 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

## Diarrhoea and vomiting?

There's no specific cure for **stomach bugs** such as **Norovirus**  
Treat children **at home** with an #EssentialKit while the virus runs its course

 **stay hydrated**

 **take paracetamol**

 **prevent spread**

 **stay at home for two days after symptoms clear**

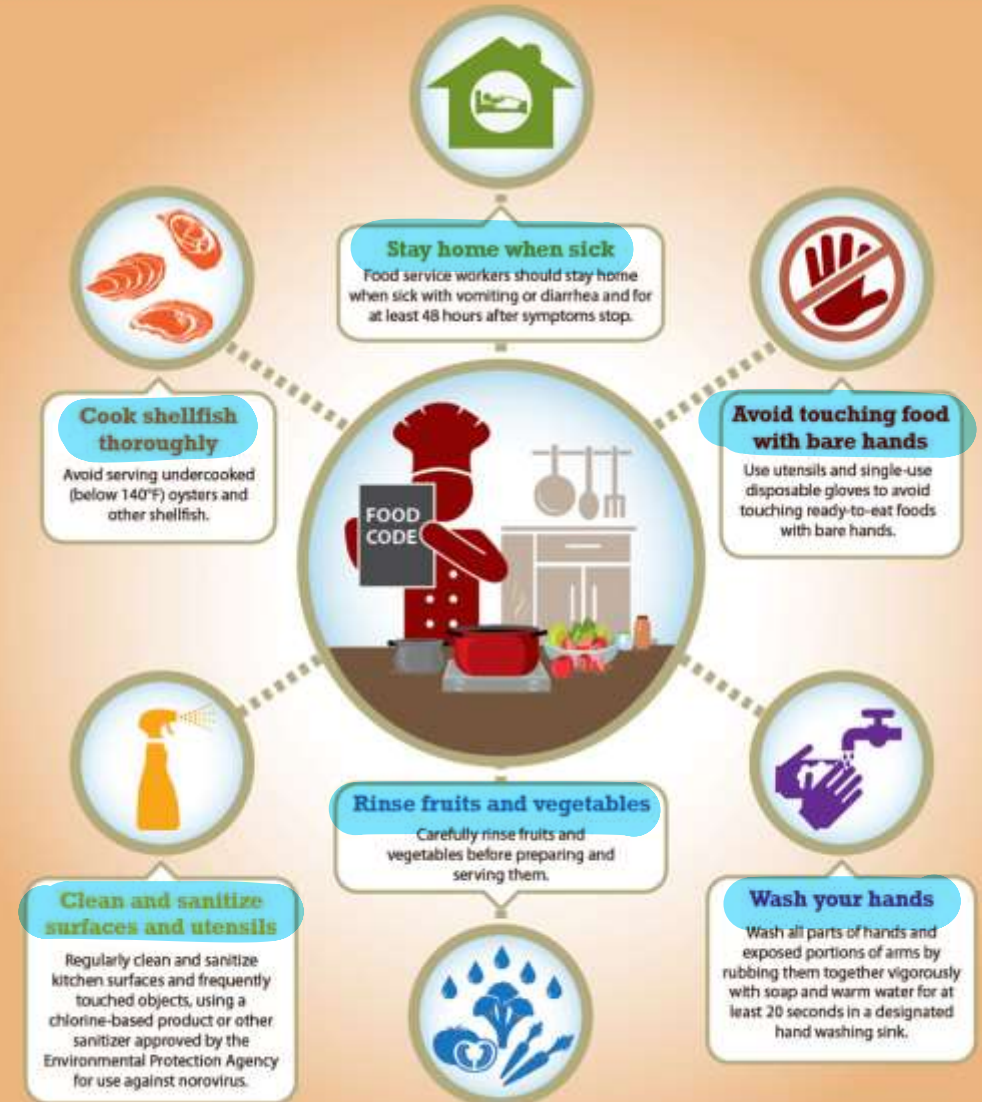
Food Standards Agency NHS



- Epidemic **prevention** relies on situation-specific 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**.

## Ways to prevent norovirus outbreaks from food contamination

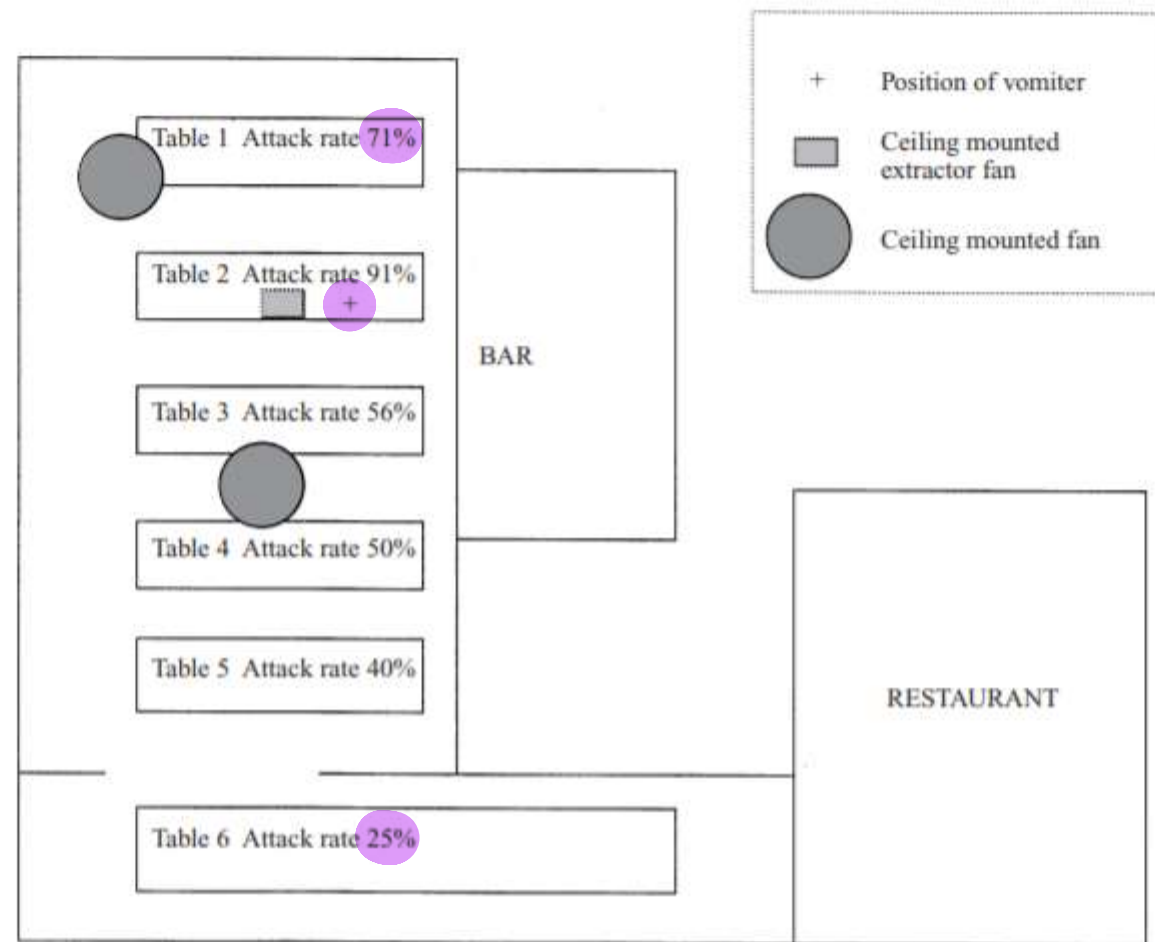
Kitchen managers should be trained and certified in food safety and ensure that all food service workers follow food safety practices outlined in the FDA model Food Code and CDC guidelines.



## Abstract

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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**



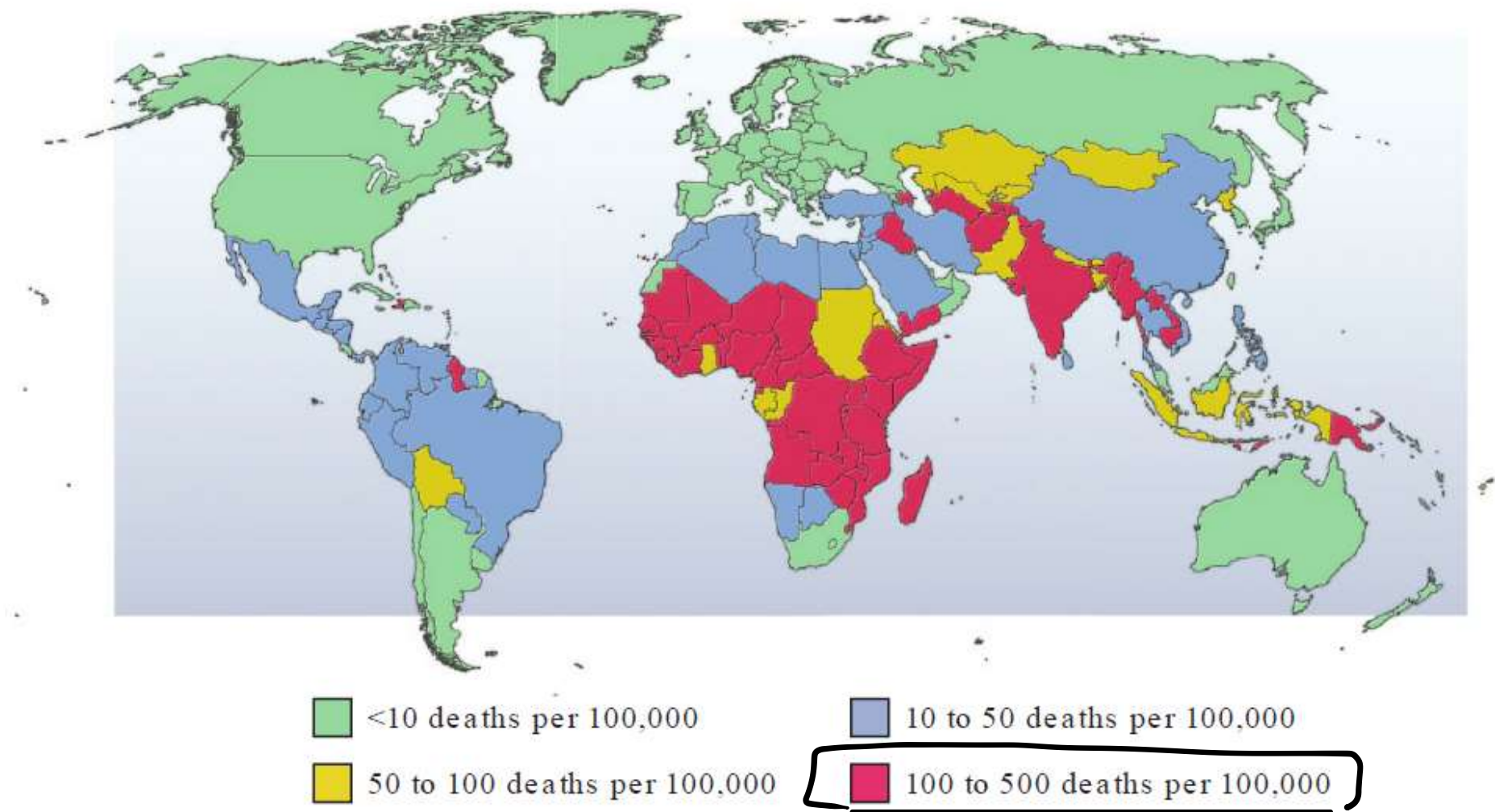
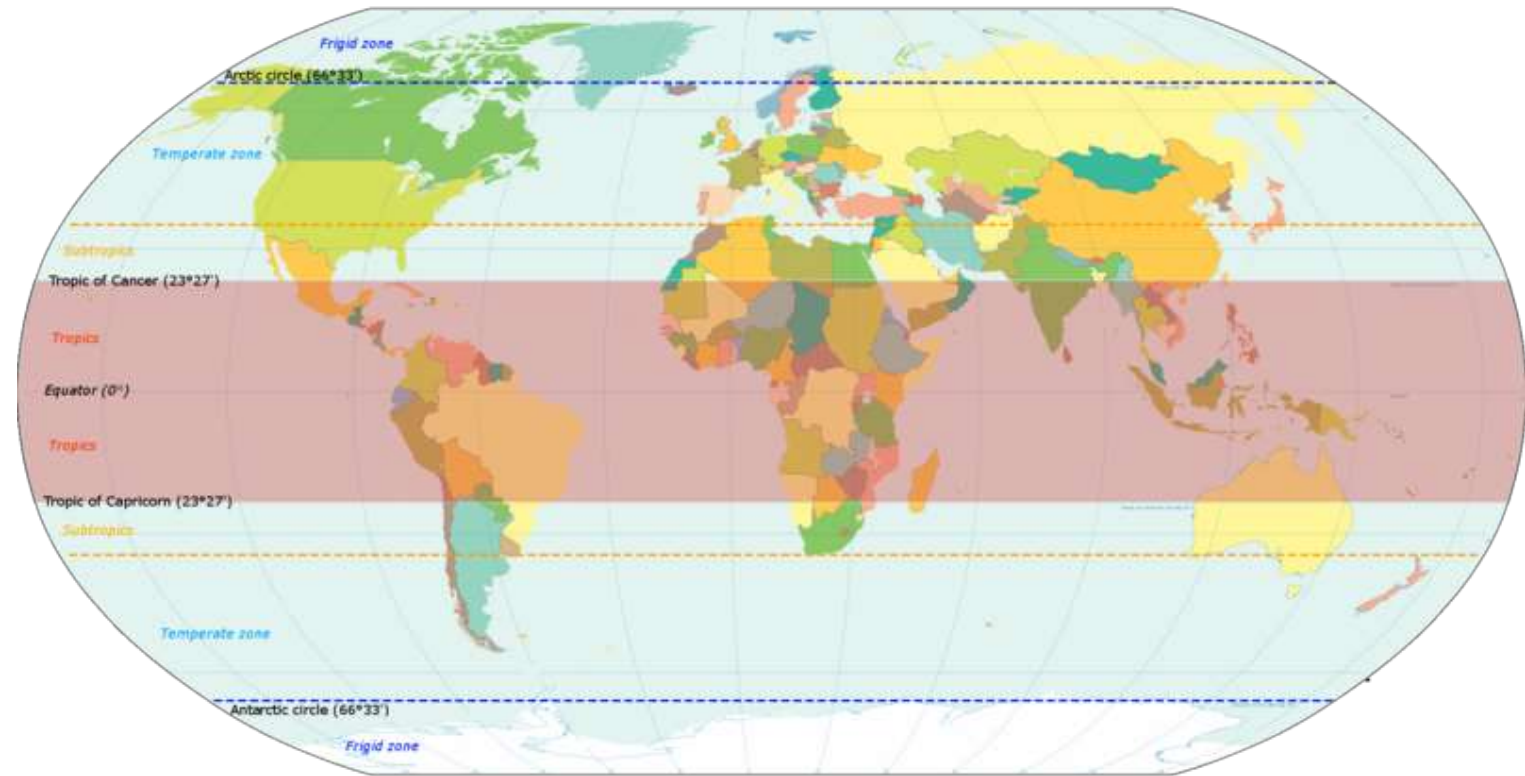


FIGURE 98-2

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.



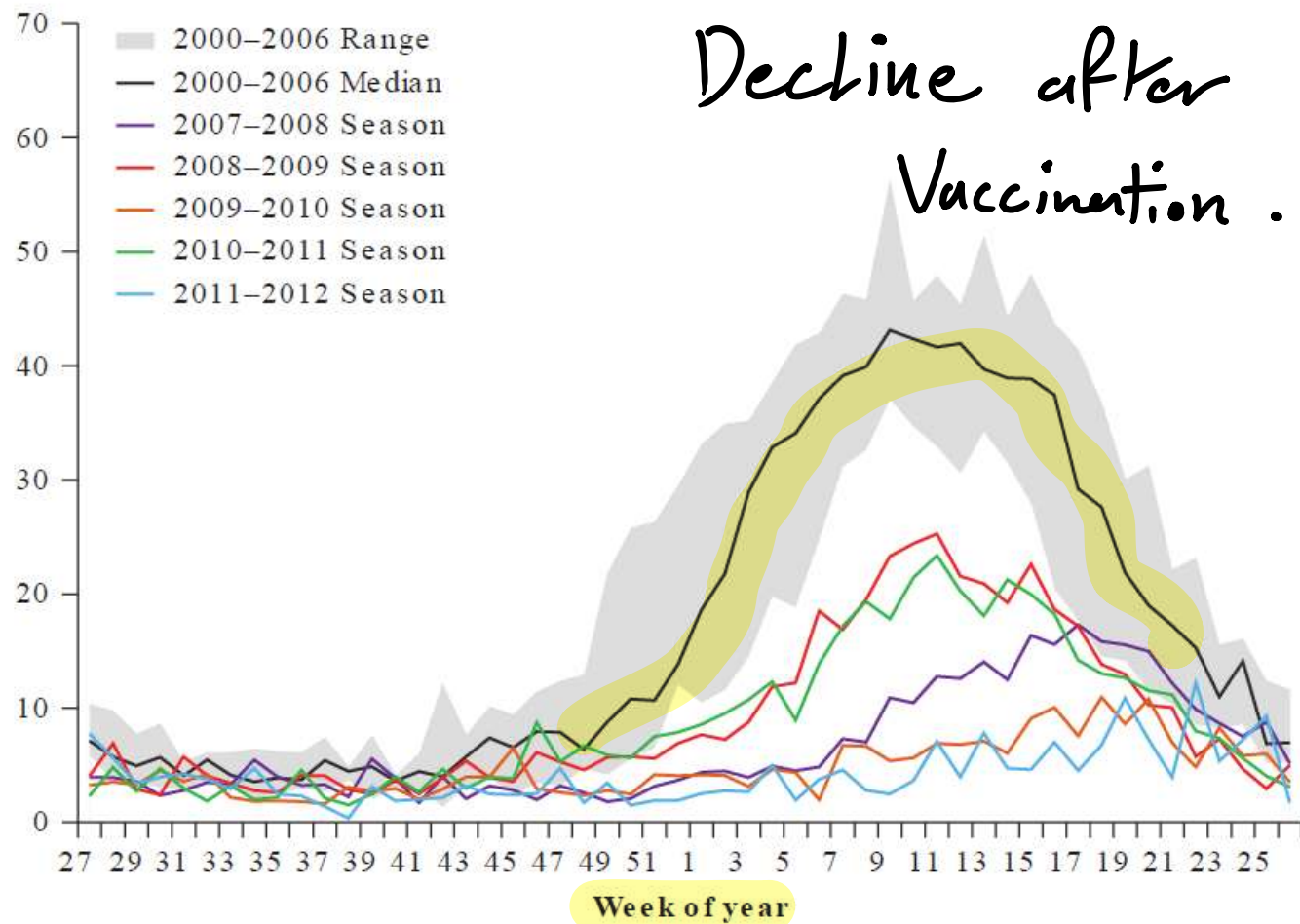


FIGURE 98-3

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.)

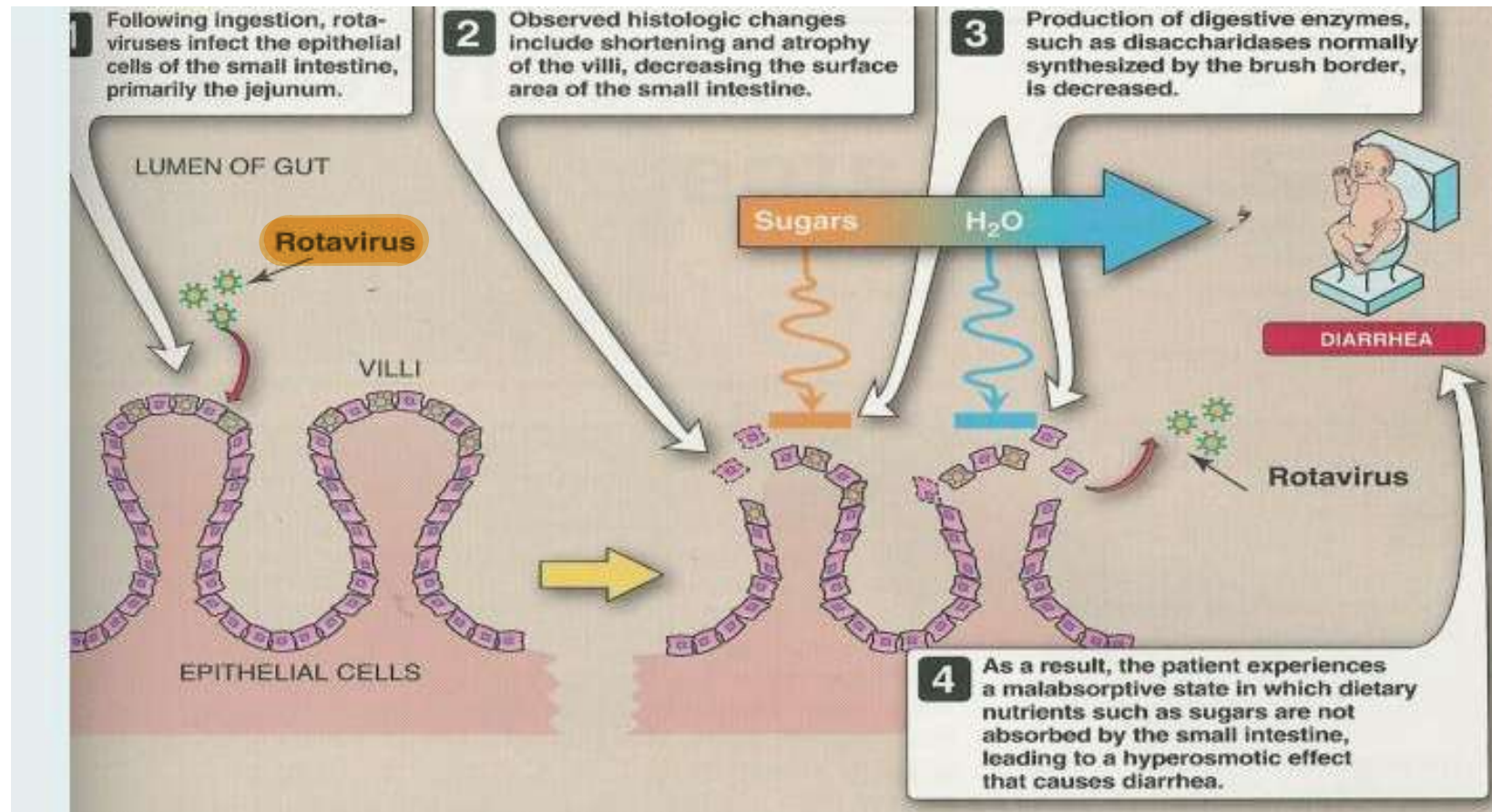


- Rotaviruses infect and ultimately destroy mature enterocytes in the villous epithelium of the proximal small intestine. The **loss of absorptive villous epithelium**, coupled with the **proliferation of secretory crypt cells**, results in **secretory diarrhea**.

⇓ Absorption

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⇑ Secretion





- 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**.  
*Longer than Norovirus*  
*1*  
*Then*  
*2*
- The stools are characteristically **loose and watery** and only infrequently contain red or white cells. Gastrointestinal symptoms generally **resolve in 3–7 days**.  
*also longer ↑ Risk of Dehydration*

## Viral gastroenteritis / diagnosis / Rotaviruses

- 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**.  
X X

- 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 on **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

# THE JORDAN TIMES

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## 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