

# Microbiology of Gastrointestinal system

---

Edited by : **MAHDI MASARWA**

Corrected: **ABOOD KLEFAT**

وليس يشبهه في الناسِ منه أحدُ  
فهو الكريمُ رفيعُ الخلقِ والخلقُ  
أزكى الأنامِ وخيرُ الناسِ لا جدُّ  
القاتلِ الحقِّ دوماً دونما قَلْبُ

- **عليه السلام** -



**Viral gastroenteritis**

- **Gastroenteritis** is inflammation of the gastrointestinal tract—the stomach and small intestine.

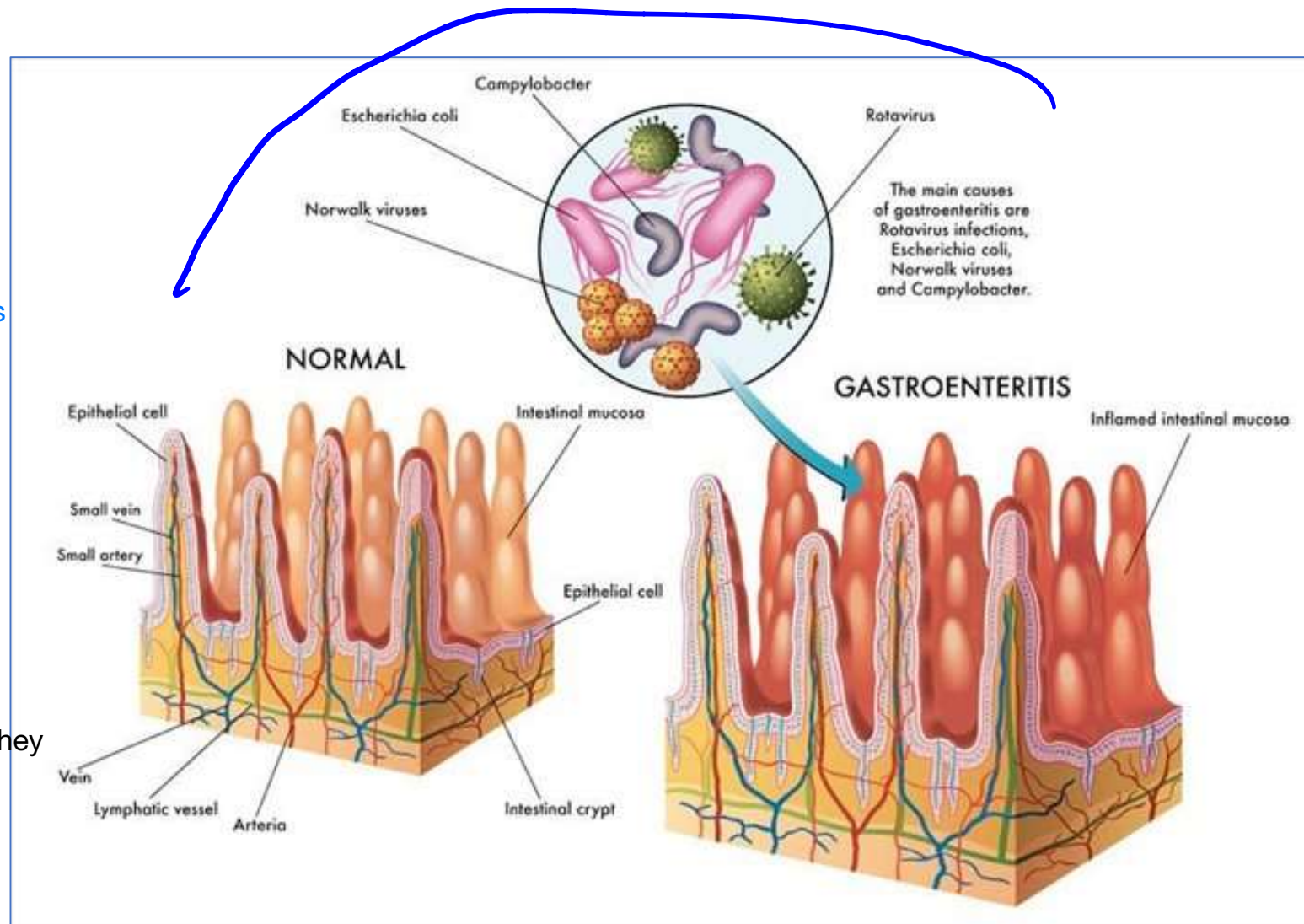
Most common cause of gastroenteritis

- Can be caused by **viruses**, bacteria, fungi and parasites.

- Mostly **infectious**, rather than **non-infectious** (caused by drugs, certain foods, etc..).

Ex: NSAIDS & Gluten Aallergy Like Celiac disease they can't tolerate gluten.

- 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] [They discovered that viruses can cause gastroenteritis](#)

# 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*

Received for publication 3 August 1972

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**. Now it is called **Noro viruses**

Caliciviruses

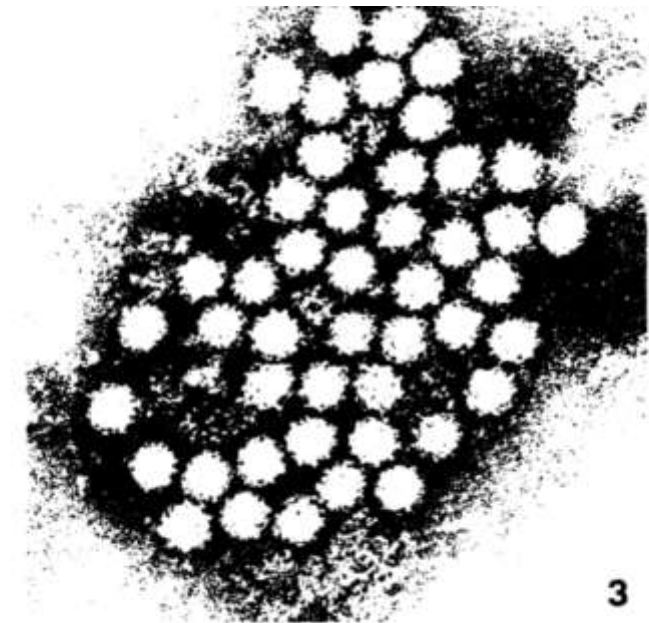


FIG. 3. An aggregate observed after incubation of the stool filtrate with a 1:5 dilution of prechallenge antiserum of volunteer A. The quantity of antibody on these glistening particles was scored as 1+.  $\times 231,500$ .



# Viral gastroenteritis / etiology

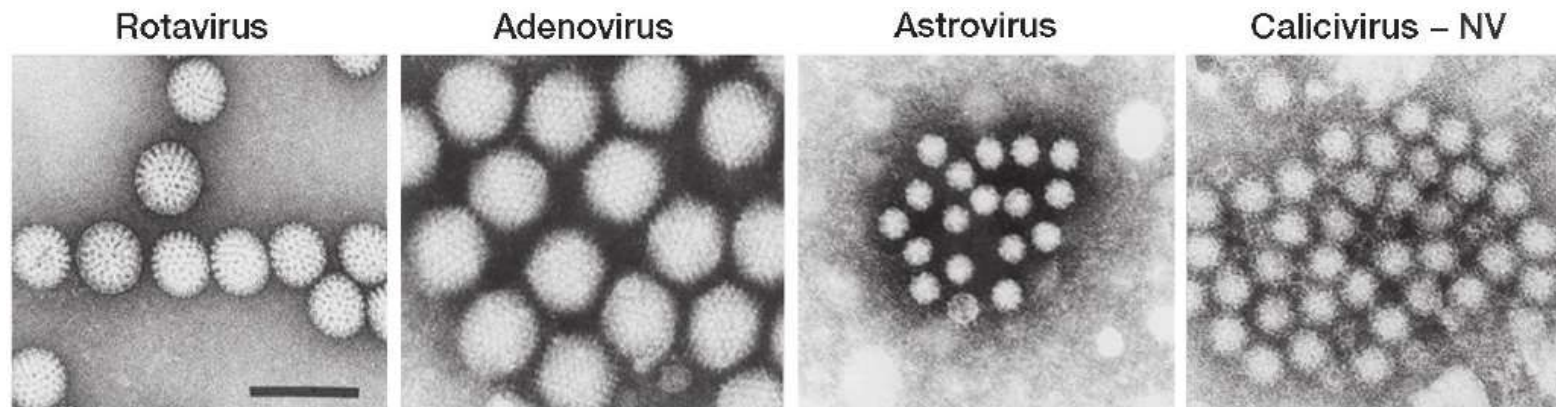
TABLE 98-1

## VIRAL CAUSES OF GASTROENTERITIS AMONG HUMANS

VIRUS	Most imp 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

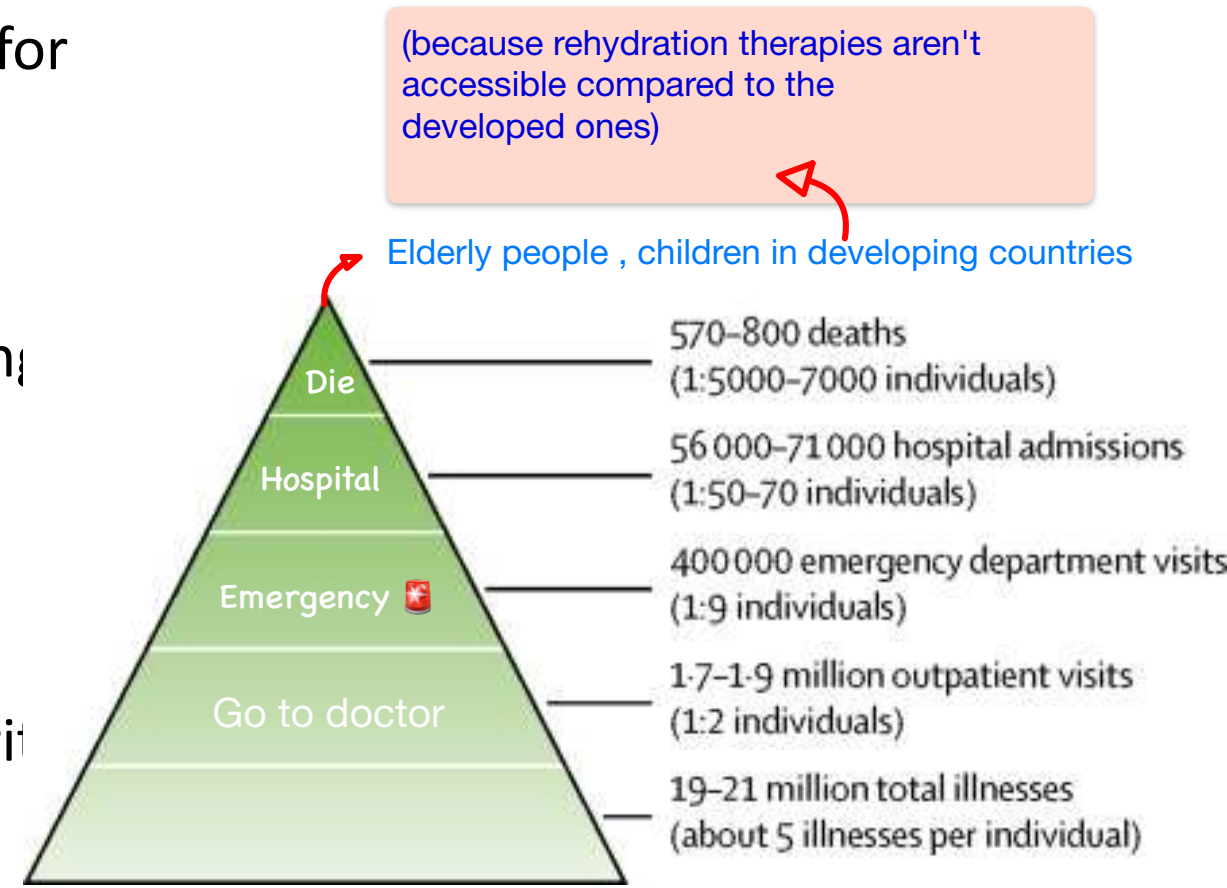
All RNA viruses except adenoviruse

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

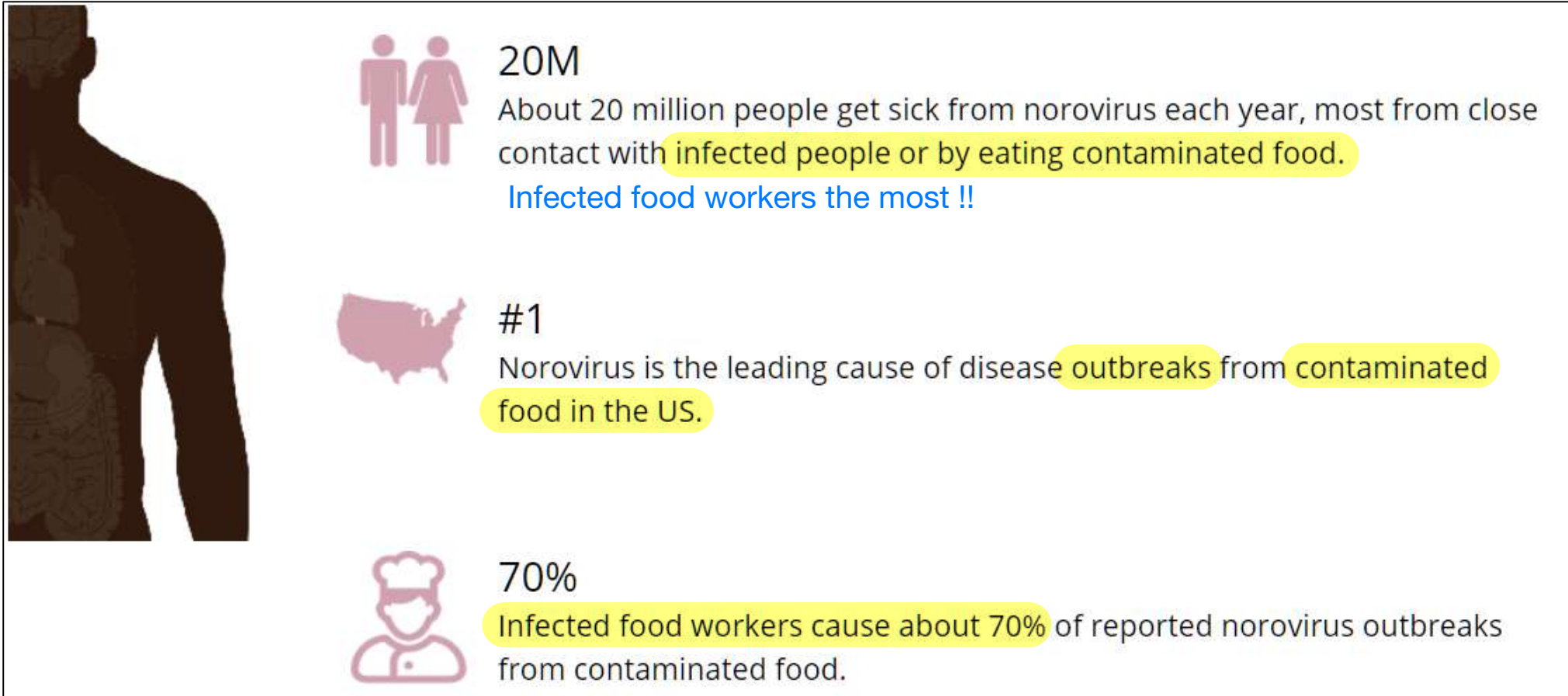


Microscopic appearance

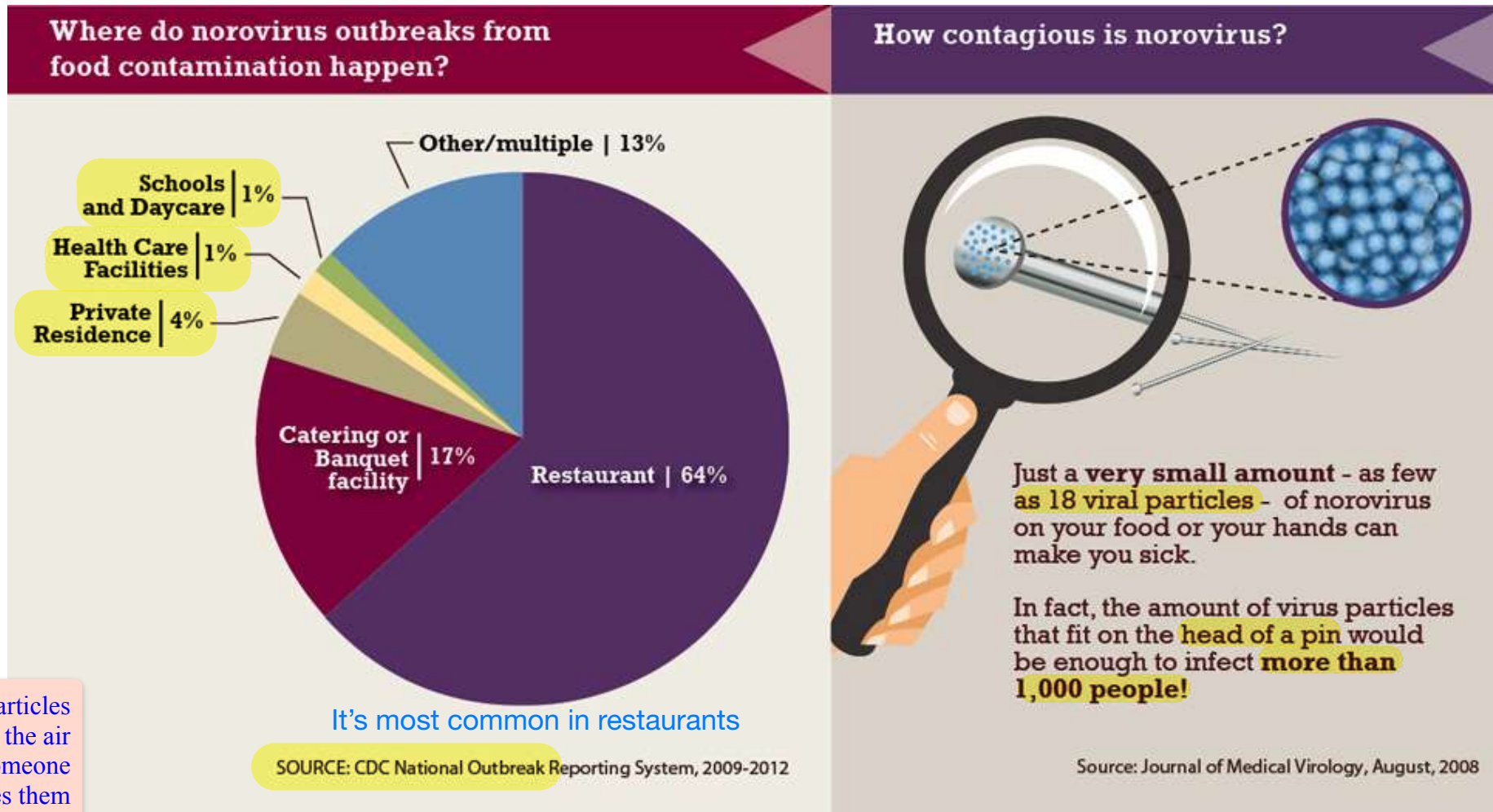
- Acute infectious gastroenteritis is a common illness that affects persons of **all ages worldwide**.
- It is a leading cause of mortality among **children** in developing countries, accounting for an estimated 0.7 million deaths each year, and is responsible for up to 10–12% of all hospitalizations 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. **When?** If not managed with **rehydration**



## Viral gastroenteritis / epidemiology / Noroviruses



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



Virus particles spread into the air and someone inhales them

Highly contagious! 😬 😬

If someone get in contact with the vomit they could be infected

- 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**.

Touch things

Shake hands



Similar to one that make up the blood group

So some peoples are more susceptible to the virus due to the presence of these carbohydrates on their epithelium),

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

After attachment and internalization, it causes cytopathic effect

- 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.

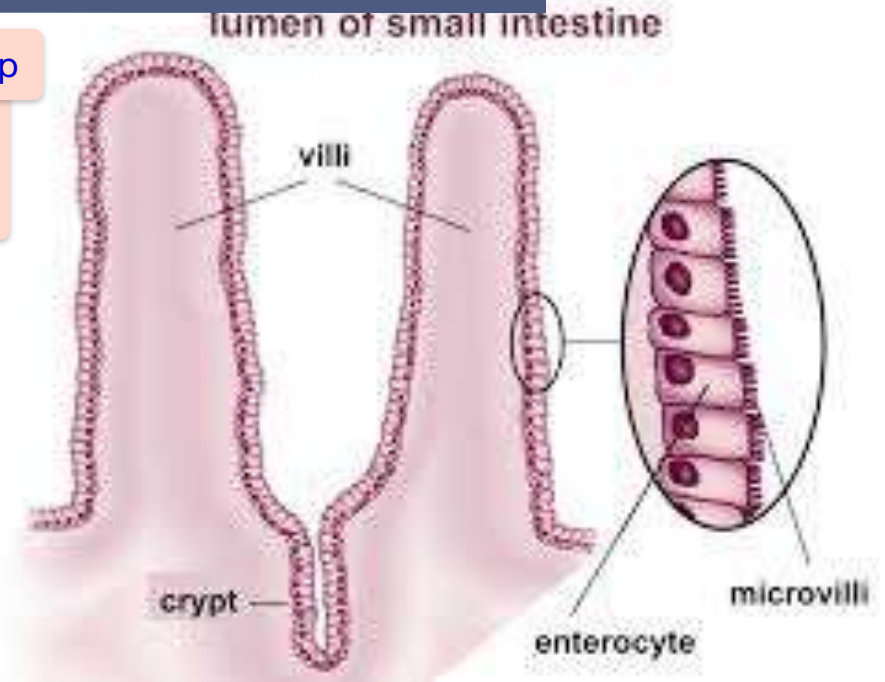
not as pointy as normal, and there will be less absorption look at the pictures

increase secretions

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

(colon usually is spared)

.These manifestations can also be seen in celiac disease •



pathological changes

- 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

Prominent

Remember **blood** can be found in bacterial infections

Someone started vomiting after 24 hours of eating contaminated food in a restaurant: gastroenteritis, we should figure out whether it's viral or bacterial.

Diagnosis by exclusion, culturing, to prove it's nonbacterial gastroenteritis, then PCR, or EIAs.

Remember Exclusion first

- 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 vomitus.

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

(we use antibodies to detect specific antigens on the virus).

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

## Scheme for molecular detection of Norovirus

Specimen Processing (Faeces)

Viral Recovery & RNA extraction

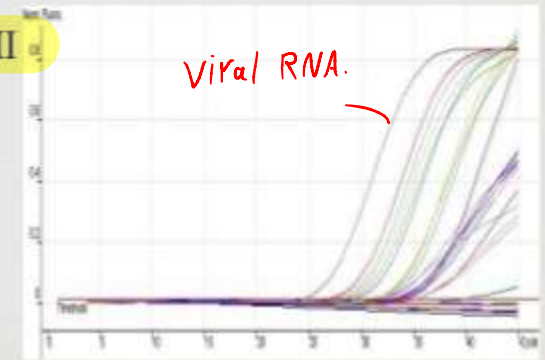
Generate cDNA from RNA by reverse transcription

Amplify by real-time PCR

Norovirus Genogroup I or II

Sequencing

Genotyping



Small note bro 😎: The electron microscope is used for **research purposes**, not diagnostic ones

- The disease is **self-limited**, and oral **rehydration** therapy is generally adequate.
- If severe dehydration develops, **IV fluid** therapy is indicated.  
    ↳ Keep vomiting 🤢
- **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

The infographic features four icons with corresponding text boxes below them: a water bottle for 'stay hydrated', a bottle pouring red liquid for 'take paracetamol', a tissue box and soap for 'prevent spread', and a digital clock showing '48 HOURS' for 'stay at home for two days after symptoms clear'. Handwritten red text includes 'Good hygiene' with a magnifying glass over the soap icon and 'Fever/myalgia' at the bottom.

stay hydrated

take paracetamol

prevent spread

stay at home for two days after symptoms clear

*Good hygiene*

*Fever/myalgia*



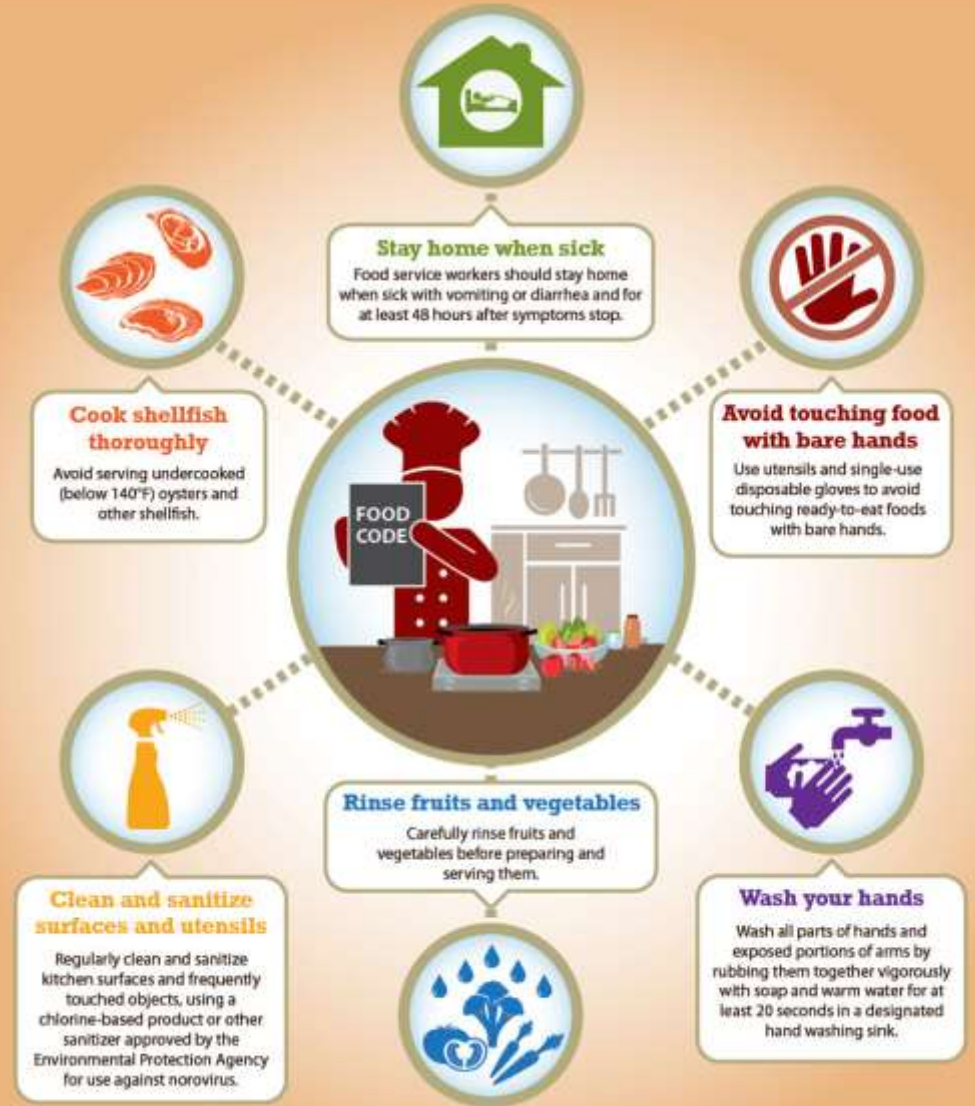
More important 🐼 --- 🐼

- 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**.

Read the figure it's important!

# 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

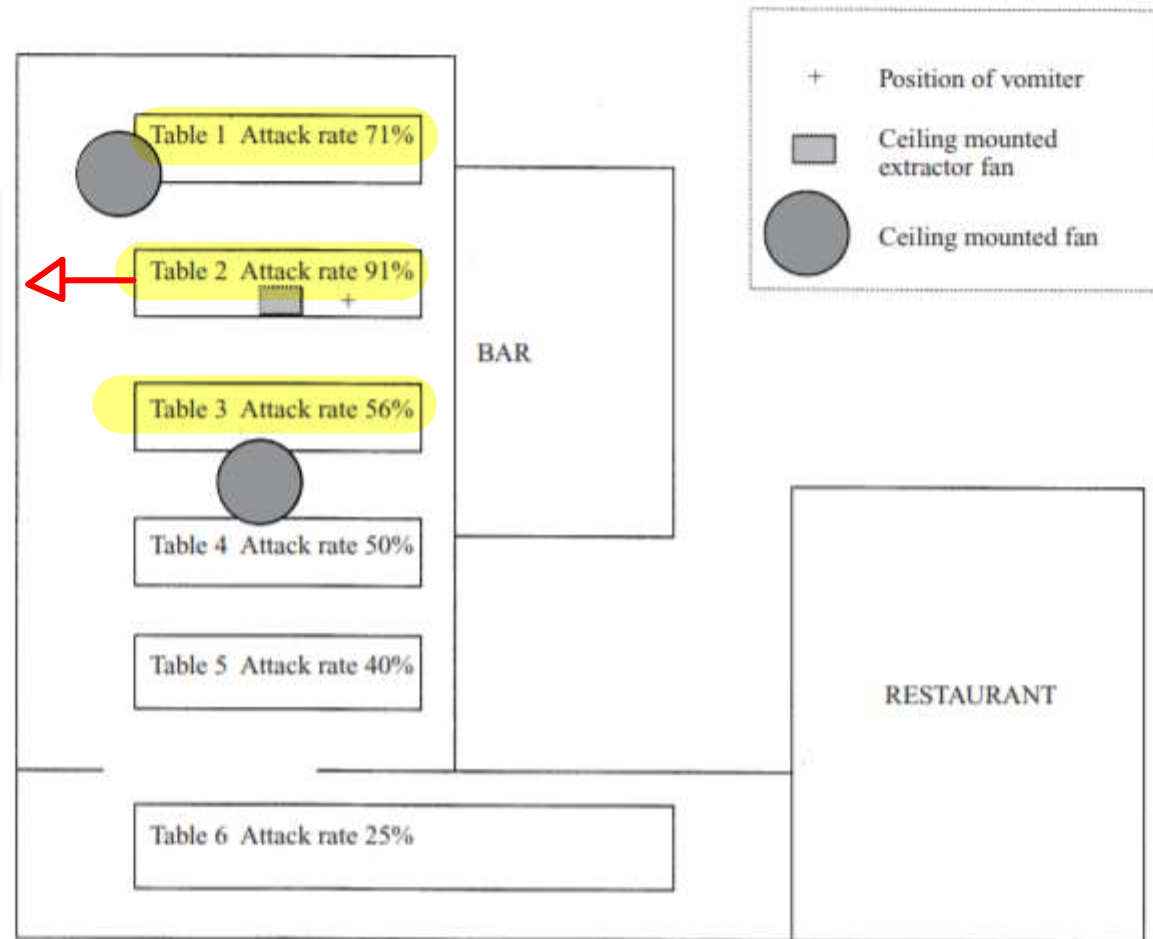
---

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.

Because everyone is getting the same gastroenteritis, they thought the food is contaminated, but they couldn't find anything, so they started to analyze what happened and drew a pattern

The link for the article:  
[https://  
www.ncbi.nlm.nih.gov/  
pmc  
/articles/PMC2810934/](https://www.ncbi.nlm.nih.gov/pmc/articles/PMC2810934/)

The lady who vomited was seated at table 2, which had the highest attack rate, with the attack rate decreasing with spatial distance from her.



There is a highly significant relationship between distance from the vomiter and the risk of becoming ill with no significant deviation from that trend.

**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.

The outbreak described here is consistent with airborne transmission of NLV from a subject who vomited during the meal, leading to inhalation and subsequent ingestion of the virus by other persons in the same room. It suggests that any vomiting can potentially generate aerosols of the virus 🦠 which pose a significant risk of transmission of the virus.

- 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**



Viral gastroenteritis / epidemiology / Rotaviruses

The incidence is similar

the deaths are (Mortality rate)  
much higher in sub-saharan Africa and some areas  
in Asia  
-due to poor access to hydration therapy

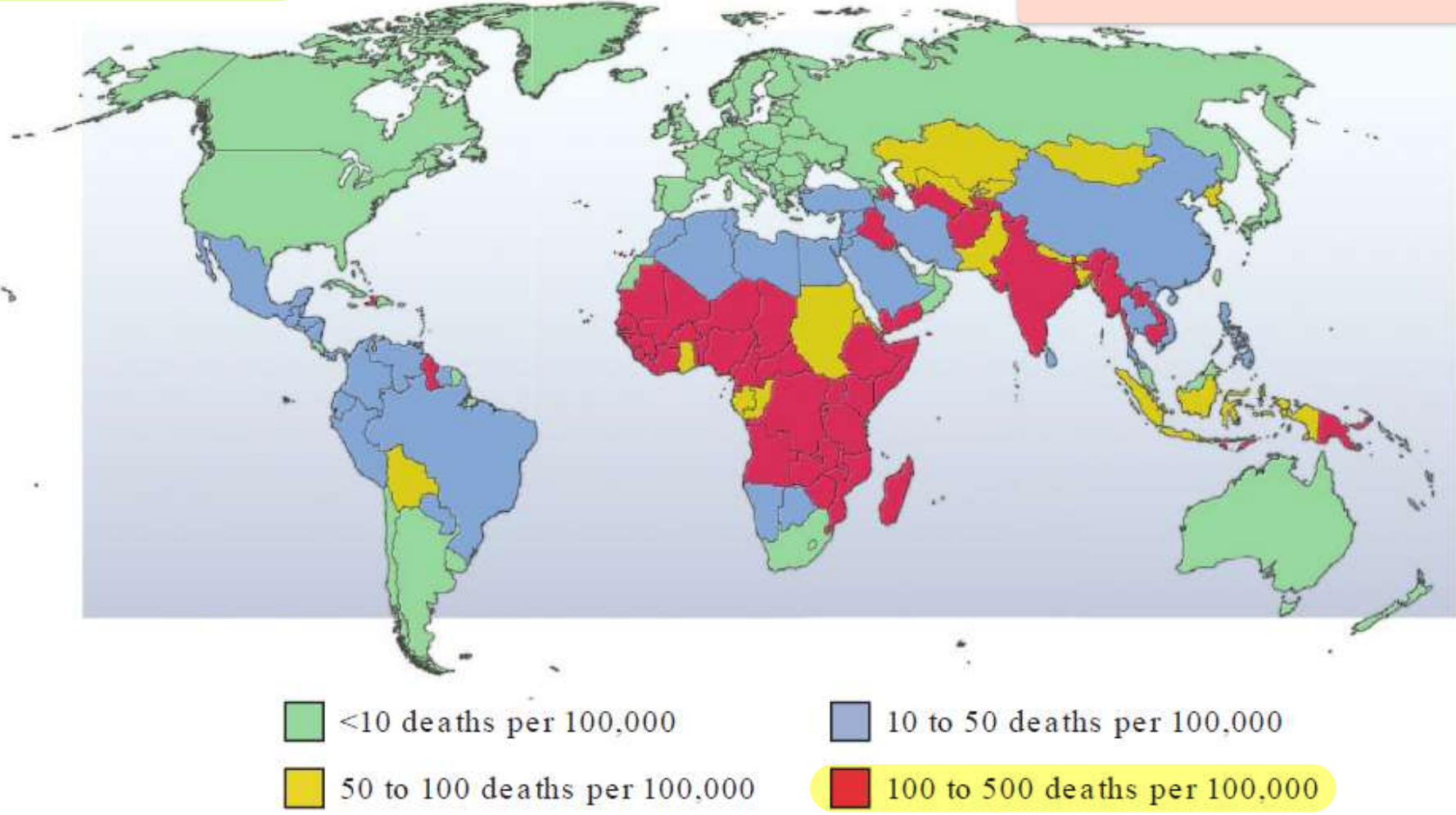
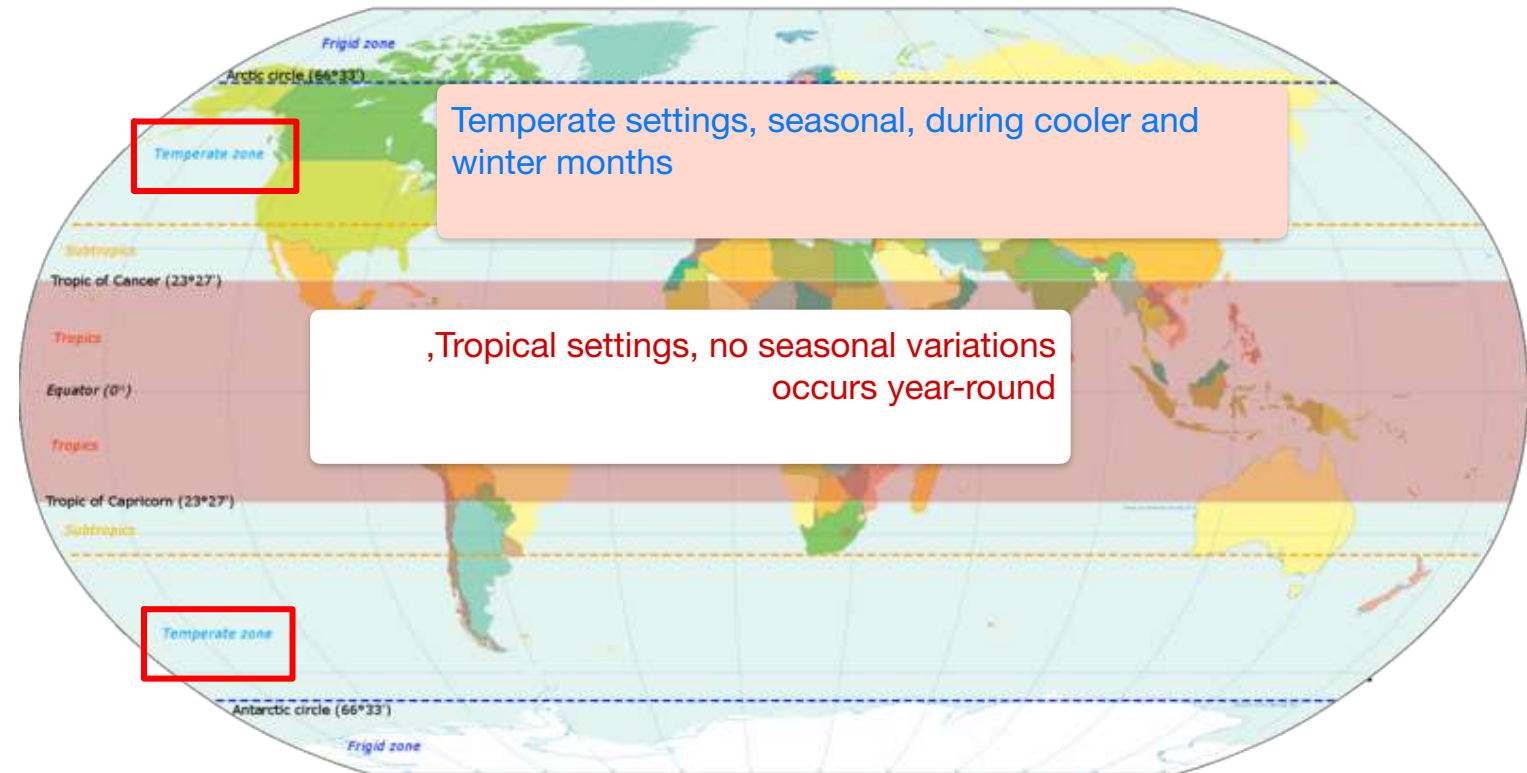


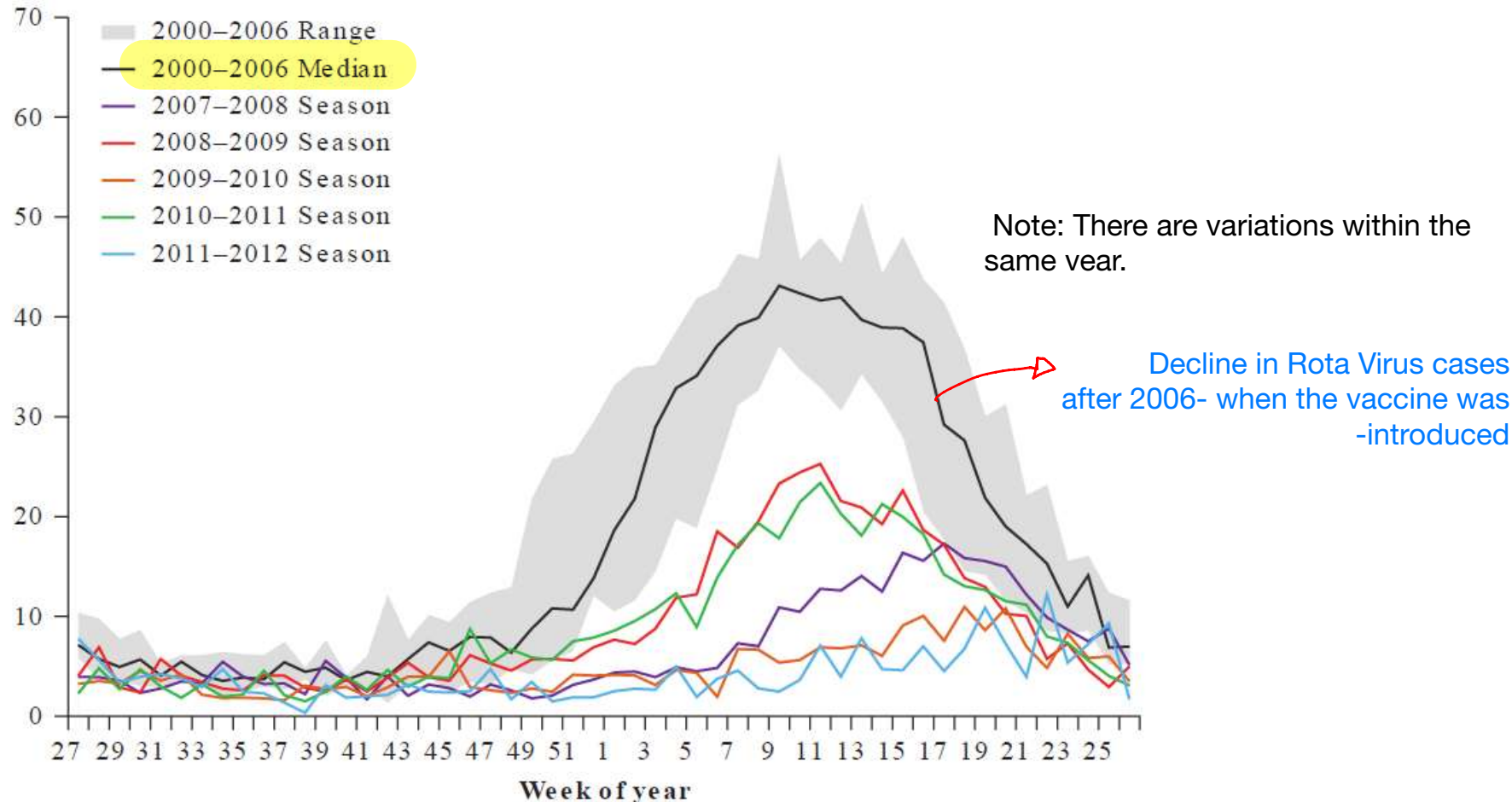
FIGURE 98-2

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.)

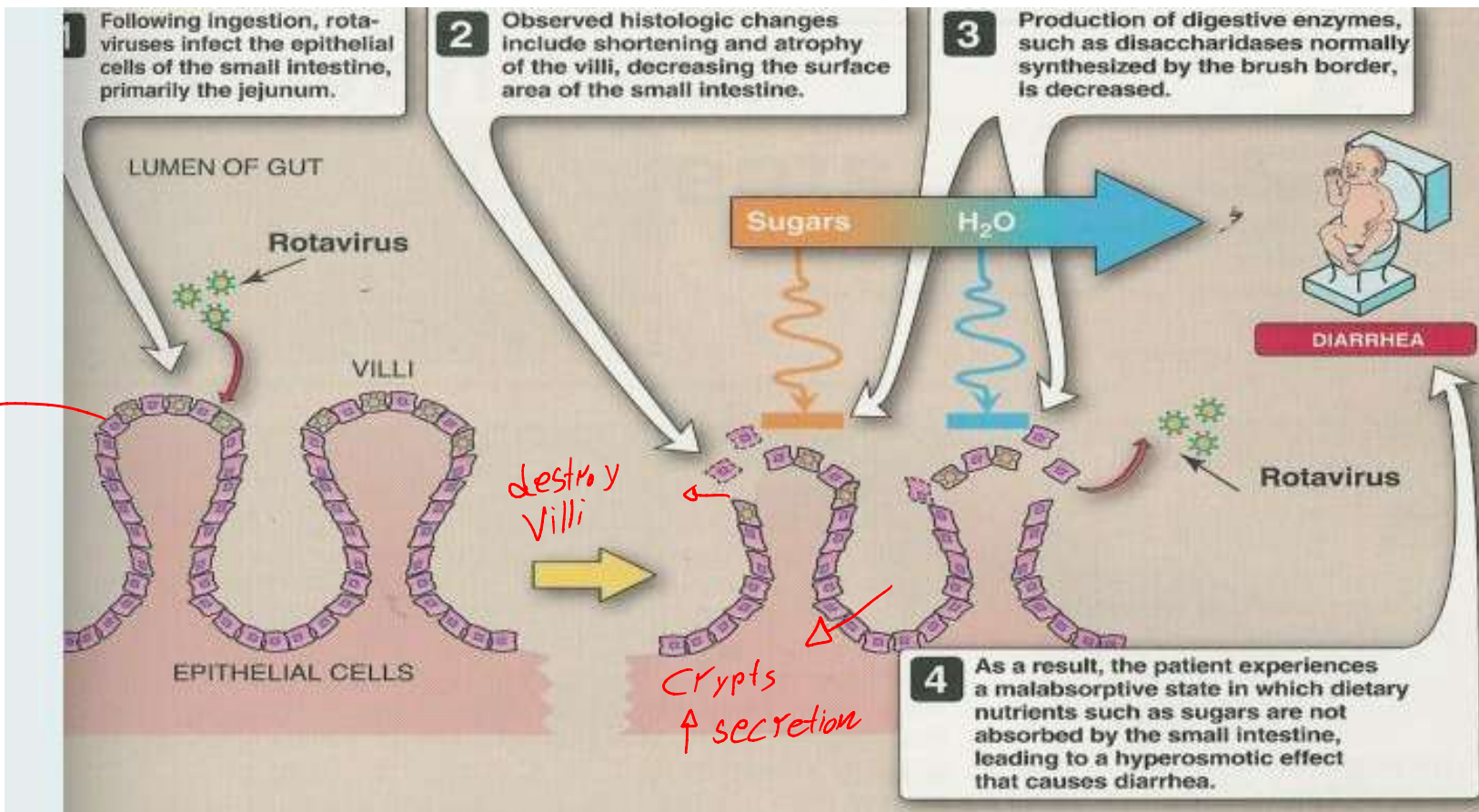


Decrease absorption+ increase secretion = watery diarrhea  
Similar to the norovirus

- 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.

they become blunted and shorter,

*infect epithelium  
cells especially  
in Jejunum  
lead to decrease  
absorption*





- 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.**

bit longer than what we see in noroviruses

last longer than norovirus, so in developing countries where there is poor hydration therapy, after 1 days the baby will die

## 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.

The techniques are the same as the norovirus

Add **stool** then add **antibodies**



ELISA for rotavirus in the feces, by adding the samples in the microwells and then adding the antibodies against the antigens on rotavirus so you can detect the places where there are signals, meaning the presence of the virus

- 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**

**THE JORDAN TIMES** WEATHER, J

Home Local Region World Business Sports Features Opinion Letters Biz Club

[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

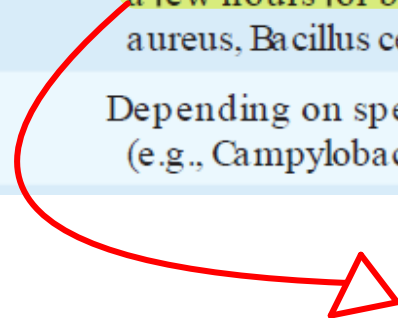
**AMMAN** — The Health Ministry on Wednesday said it will begin immunising children against the rotavirus on Sunday after its inclusion in the national vaccination programme.



# 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 <sup>5</sup> bacteria) for <i>Escherichia coli</i> , <i>Salmonella</i> , <i>Vibrio</i> ; medium (10 <sup>2</sup> –10 <sup>5</sup> bacteria) for <i>Campylobacter jejuni</i> ; low (10–100 bacteria) for <i>Shigella</i>
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., <i>Campylobacter</i> , <i>E coli</i> , <i>Shigella</i> , <i>Salmonella</i> ); a few hours for bacteria producing preformed toxins (e.g., <i>Staphylococcus aureus</i> , <i>Bacillus cereus</i> )
Reservoir	Primarily humans	Depending on species, human (e.g., <i>Shigella</i> , <i>Salmonella</i> ), animal (e.g., <i>Campylobacter</i> , <i>Salmonella</i> , <i>E coli</i> ), and water (e.g., <i>Vibrio</i> ) reservoirs exist



Longer incubation, but if there is preformed toxin then, the symptoms will appear within hours

## 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:

" ما سُلِبَتِ النِّعَمُ إِلَّا بِتَرْكِ تَقْوَى اللَّهِ ، وَالْإِسَاءَةِ إِلَى النَّاسِ "

الإمام **ابن القيم** رحمه الله

وَأَيْسَ يَشْبَهُهُ فِي النَّاسِ مِنْ أَحَدٍ  
فَهُوَ الْكَرِيمُ رَفِيعُ الْخَلْقِ وَالْخَلْقِ

أَزْكَى الْأَنْبَاءِ وَخَيْرُ النَّاسِ لَا جَدَلَ  
"الْمُتَأَمِّلُ الْحَقَّ دَوْمًا دَوْمًا تَلَقَّ"

— 

- Harrison's Infectious Diseases 3rd Edition  
SECTION 5: Viral Infections, Chapter 98

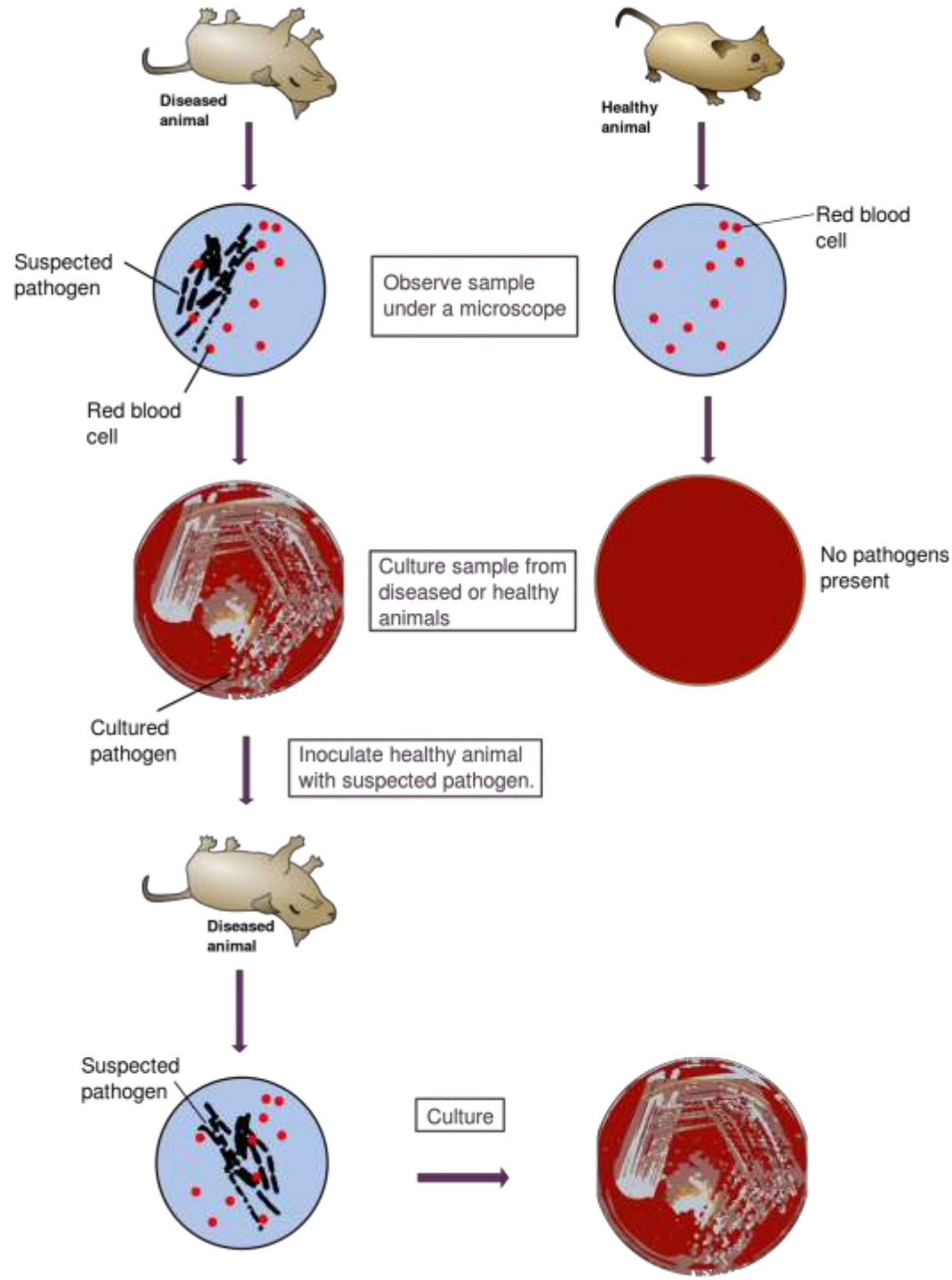
# Koch's Postulates:

① The microorganism must be found in abundance in all organisms suffering from the disease, but should not be found in healthy organisms.

② The microorganism must be isolated from a diseased organism and grown in pure culture.

③ The cultured microorganism should cause disease when introduced into a healthy organism.

④ The microorganism must be reisolated from the inoculated, diseased experimental host and identified as being identical to the original specific causative agent.





esophagitis

**Inflammation of the oesophagus**, generally non- infectious (e.g. gastrooesophageal reflux), but may also be caused by a variety of infectious agents, usually in the context of **impaired immunity**

*HSV*— usually seen in those with significant immunosuppression; rare in healthy adults. HSV- 1 is commoner than HSV- 2.

*CMV*— seen usually in AIDS patients (the cause in around 30% of such patients reporting oesophageal symptoms) or the severely immunosuppressed.