# Viral gastroenteritis

| Types | Genome | Envelope | Family | Structure | Microscopic appearance | Resistance properties | Age group |
|---|---|---|---|---|---|---|---|
| Rota | dsRNA<br>• composed of 11 RNA segments | non envelope | Reoviridae | has a triple layered structure with:<br>• outer capsid composed of VP4 (P protein) and VP7 (G protein)<br>Functions:<br>1. Determine serotype specificity<br>2. Induce neutralizing protective antibodies<br>• inner capsid contains (VP6)<br>• Central Core | E.M: wheel-like structure with radiating spokes. "Rota = wheel" | Environmentally stable and resistant to elimination by routine handwashing | Infants and young children |
| Noro | +ssRNA | non envelope | Caliciviridae<br>↳ Noro<br>↳ Sapo | — | — | • Alcohol-based hand sanitizers are ineffective against Norovirus<br>• Recommended hand hygiene: Handwashing with soap and water for at least 20 sec.<br>• Outbreaks control is difficult and requires:<br>* aggressive environmental cleaning<br>* bleach-based disinfectants<br>* strict soap and water hand hy. | Adults |
| Astro | +ssRNA | non envelope | Astroviridae | Small in size<br>* Serotypes<br>- Eight serotypes exist<br>- Type 1 is the most common | E.M: Five or six pointed star appearance | — | 2–10% of viral gastroenteritis in children |
| Adeno | non-enveloped double-stranded DNA virus | non envelope | Adenoviridae | — | — | • Adenoviruses are often resistant to common disinfectants and may remain infectious for prolonged periods on medical instruments and surfaces | Adenovirus gastroenteritis occurs most commonly in children, immunocompromised patients |

# Retrovirus

* **Clinical features:**

① Severe diarrhea in infants and young children

② It can be symptomatic and asymptomatic

- high Fever
- nausea
- vomiting
- watery diarrhea

* **Seasonal:**

peak in winter (November-April)

* **Incubation period** (1-3 days)

* **Duration of illness** (5-7 days)

* longer than Noro (3-9) → Rotavirus diarrhea

* **Vaccine:**

Rotavirus vaccine

* **Peak incidence:**

between 3 months when maternal antibody level of protection may wane

* most infants impacted by the age of 2 years

* **Risk groups**

- Immunocompromised patients
- Elderly people
- Travelers

* **Diagnosis/tests**

Stool antigens testing

→ **Vaccination recommendations:**

all infants without contraindications because of the high infant morbidity

| First vaccine (Rota Shield) | Current vaccines (Rota Teq) (Rotarix) |
|---|---|
| Side effect: increasing the risk of the intussusception 3-20 days after vaccination<br>* withdrawn from market | (Rota Teq)<br>• live oral reassortment vaccine<br>• contains 5 viral strains<br>**Schedule**<br>2 months, 4 months, 6 months<br>**Effectiveness**<br>• 98% reduction in severe Rota virus gastroenteritis<br>• 74% protection against gastroenteritis of any severity in the first year.<br>• 96% reduction in hospitalizations |
| | Rotarix<br>• Live oral vaccine<br>• contains 1 strain<br>**Schedule**<br>Given as 2 oral doses at:<br>• 2 months<br>• 4 months<br>**Effectiveness**<br>• 85% - 96% protection against severe disease<br>• 96% reduction in hospitalizations over two seasons |

# Norovirus

## 1. Clinical features:

① Prolonged diarrhea may occur in:
- ④ children
- ② chronically immunosuppressed patients.

② Vomiting results from
- * delayed gastric emptying
- * abnormal gastric motor function

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* **Seasonal patterns:**
* outbreaks occur most commonly in winter ("winter vomiting disease")

## 2. Importance / Epidemiology

* Was the first agent proven to cause gastroenteritis.
* The major pathogen because of:
  1. The very low infectious dose required for transmission
  2. prolonged viral shedding
  3. The ability to survive the environment.

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* causes about 18% of gastroenteritis cases worldwide
* Leading cause of foodborne illness in the united states.

## 3. Epidemiology / outbreaks

According to the CDC, Norovirus causes annually:
* 19-21 million illnesses
* 56,000-71,000 hospitalizations
* 570-800 deaths

● GII strain is the most common norovirus genotype.

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Common outbreak settings include:
- cruise ships
- nursing homes
- schools
- workplaces

## 4. Incubation period:

is short (12-48 hours)
Followed by:
① acute onset of nausea
② Vomiting
③ watery diarrhea

## 5. Duration of illness:

usually lasts <48 hours, but viral shedding may continue for weeks, even in asymptomatic individuals

## 6. Factors contributing to explosive outbreaks:

- Close-contact environments
- High infectivity
- Environmental persistence
- Prolonged viral shedding
- Lack of long-lasting immunity

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● Most worldwide outbreaks in the past decade have been associated with the GII.4 strain of Norovirus.

## 7. Diagnosis:

- Specific stool antigen tests are available for identification of Norovirus.

## 8. Transmission / Contagiousness:

- Noroviruses are among the most contagious enteric viruses because of the very low infectious dose and high environmental stability

## 9. Infection Control / Management:

- Hospitalized patients should be placed in contact isolation. Have rooms disinfected with chlorine bleach 1000-5000 ppm Approximately 1:50-1:10 dilution of household bleach.

## Astrovirus

### 1. Clinical features:

* Usually causes mild gastroenteritis and hospitalization is rarely required

### 2. Diagnosis:

* Identified using multiplex molecular testing of stool samples

## Adenovirus

### 1. Other diseases caused by adenoviruses:

* Adenoviruses commonly cause respiratory and ocular infections

### 2. Epidemiology:

* Adenoviruses cause 1.5-5% of viral gastroenteritis in children <2 years

### 3. Seasonality:

* Unlike rotavirus, adenovirus gastroenteritis does not show clear seasonality

### 4. Incubation period:

* Adenovirus gastroenteritis has a longer incubation period than rotavirus or norovirus at about 8-10 days

### 5. Duration of illness:

* The illness duration is usually 5-12 days

### 6. Diagnosis:

* Diagnosis is based mostly using multiplex PCR testing of stool samples

### 7. Age groups:

* Adenovirus gastroenteritis occurs most commonly in children, immunocompromised patients

### 8. Resistance properties:

* Adenoviruses are often resistant to common disinfectants and may remain infectious for prolonged periods on medical instruments and surfaces

### 9. Other diseases caused by adenoviruses:

* Adenoviruses commonly cause respiratory and ocular infections

# Sapovirus

## * General information:

Sapovirus cause acute gastroenteritis in → humans, animals

- They belong to the genus Sapovirus within the family Caliciviridae

## * Incubation period

Ranges from less than 1 day to 4 days

## * Clinical features:

① Diarrhea
② Vomiting
→ Major symptoms

① nausea
② Stomach /abdominal cramps
③ chills
④ headache
⑤ myalgia, or malaise
→ additional constitutional symptoms

* Fever is a rare clinical symptom
* Diarrhea usually resolves within 1 week.
* Individuals showing symptoms for a longer time (i.e., from over a week to up to 20 days) were also reported.
* In general, the severity of sapovirus gastroenteritis is milder than that for rotavirus and norovirus

# Patho physiolagy of Rotaviruss:-

Disease mechanisms:

① malabsorption
② Secretory diarrhea
③ ENS activation

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## ① Oral ingestion of the virus

The virus reaches the small intestine
Targeting the enterocytes

↓

## ② Attachment and entry into enterocytes

the virus contains:
VP4 -spike protein
cleaved by Trypsin
into

↓

**VP8 (attachment)**
binds host receptors such as:-
- Sialic acid
- Histo-blood group antigens (HBGAs)

**VP5 (membrane penetration)**
helps the virus penetrate the enterocyte membrane

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## ③ Viral entry and replication

After entry into the enterocyte:
↓
The outer capsid is removed
↓
Viral replication begins
↓
Viral replication occurs in cytoplasmic structures called viroplasms.

## ④ NSP4 enterotoxin production and action

Rotavirus enterotoxin (NSP4) is the major pathogenic enterotoxin of rotavirus. It functions as a viroporin forming a calcium-conducting ion channel causing release of $Ca^{2+}$ from the endoplasmic reticulum leading to increased intracellular $Ca^{2+}$.

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## ⑤ Effects of increased intracellular $Ca^{2+}$

Ⓐ Microvillus damage
- Reduced absorptive surface area

Ⓑ Reduced disaccharidase enzyme activity
- Carbohydrates are not properly digested

Ⓒ Inhibition of SGLT1 (Sodium-Glucose Cotransporter 1)
- ↓ Sodium absorption
- ↓ Glucose absorption
- ↓ Water absorption

Ⓓ Enterocyte dysfunction and necrosis
- The infected enterocytes become damaged and may die.

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## ⑥ Development of malabsorption

Destruction of enterocytes leads to malabsorption which causes:
- Reduced absorptive capacity
- Decreased $Na^+$ and water absorption
- Reduced digestive enzymes

**Osmotic diarrhea**
because unabsorbed substances remain in the lumen and draw water osmotically.

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## ⑦ Secretory component of diarrhea

The secretory component is mediated by:
NSP4 enterotoxin together with ENS activation causing:
- Increased intestinal secretion
- Fluid loss into the intestinal lumen

**Secretory diarrhea**

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## ⑧ ENS-mediated effects

ENS activation contributes to:

Diarrhea | Vomiting | Intestinal hypermotility

Mechanisms involve:
- Serotonin pathways
- Nitric oxide signaling

Increased intestinal motility reduces absorption time and worsens diarrhea.

Immune response involves

① innate immunity

② cellular immunity

③ hormonal immunity

- Protective antibodies develop mainly against: VP4, VP7

* Single infection
  doesn't provide lifelong immunity

* Repeated asymptomatic infections
  ↓
  help maintain long-term protection

* After first infection
  - 38% protected from reinfection
  - 77% protected from diarrhea
  - 87% protected from severe disease

With repeated exposure,

Immunity and protection increase progressively

# Norovirus Gastroenteritis – Pathophysiology

## ① Target cells

- Norovirus primarily targets immune cells, including:
  - macrophages
  - dendritic cells
  - B cells
  - T cells

## ② Role of M cells

- Microfold (M) cells are specialized epithelial cells in gut-associated lymphoid tissue (GALT).
- Norovirus exploits M cells to cross the intestinal epithelium and reach immune target cells.
- The virus crosses the epithelium by transcytosis.
- Therefore, productive epithelial infection is not required.
- It avoids direct enterocyte damage.

## ③ VP1 and susceptibility

- Norovirus VP1 binds to HBGAs.
- This binding influences susceptibility to infection.

# Role of Gut Microbiota in Norovirus Infection

## ① Effect of gut microbiota

- Gut microbiota strongly influence norovirus infection.
- Commensal bacteria express HBGA-like molecules.
- These molecules promote norovirus infection of B cells.

## ② Evidence from antibiotic studies

- Antibiotic treatment in mice decreased norovirus replication.
- Restoring microbiota restores infectivity.
- Therefore, gut bacteria facilitate viral replication.

## ③ Effect on antiviral immunity

- Gut microbiota suppress type III interferon antiviral activity.
- This promotes:
  - viral persistence in the colon
  - prolonged viral shedding

## ④ Clinical significance

- This may explain chronic shedding after symptoms resolve.