



Viral Gastroenteritis

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Dr. Sulaiman Mahmoud Bani Abdel-Rahman

MBBS, Mutah university

MSC Medical Microbiology – University of Manchester

PhD Medical Virology - University of Manchester



Common Causes of Viral Gastroenteritis

- Rotavirus
- Calicivirus (norovirus)
- Adenovirus

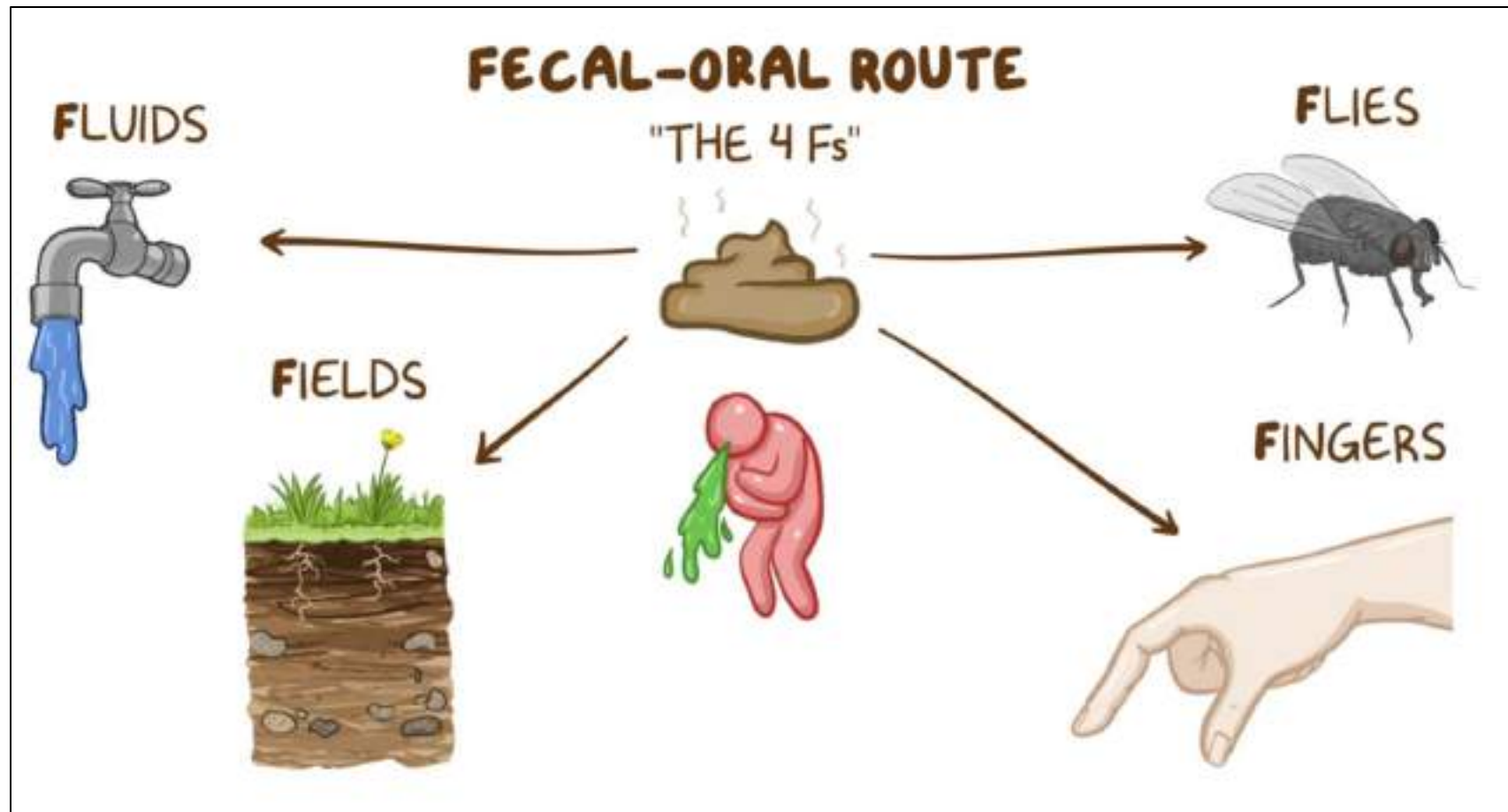


Rotavirus - Epidemiology and Burden

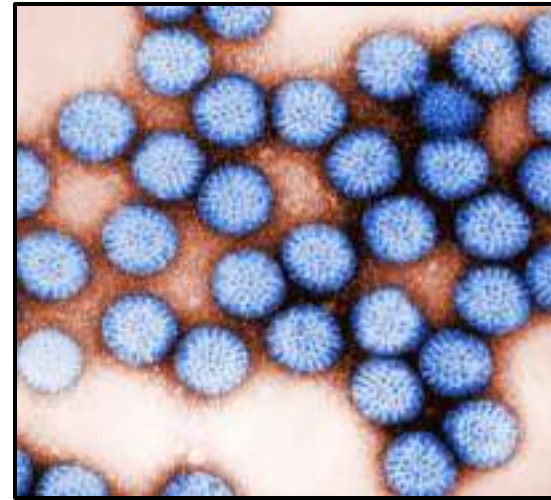
- A common cause of severe gastroenteritis **in children <5 years**
 - Historically most common in children, now declining in countries with vaccination
 - The leading cause of acute gastroenteritis in the US is norovirus infection. Rotavirus infection in the US has been on the decline since the introduction of the vaccine.
- **Peak incidence:** 6-24 months of age
 - Neonates relatively protected due to maternal antibodies
- **Low infectious dose:** 10-100 viral particles sufficient
- Resistant to many common disinfectants
- Transmission: Highly contagious; fecal-oral route, contaminated surfaces



Rotavirus - Epidemiology and Burden (cont.)



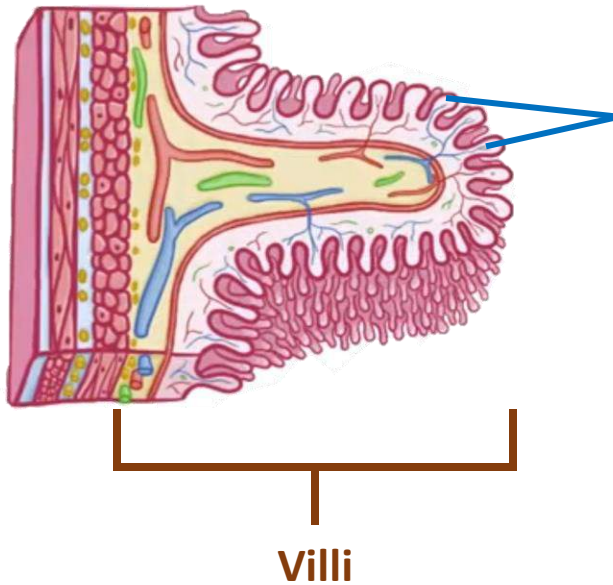
Rotavirus - Virology



- **Family:** Reoviridae
- **Structure:** non-enveloped, 11-segmented dsRNA genome
- Unique “wheel-like” morphology on electron microscopy (“rota” = wheel).
- Resistant to stomach acid → reach the small intestine
- **Specific Pathophysiology**
 - **NSP4** protein acts as an enterotoxin → stimulates fluid secretion.
 - Infects mature enterocytes in the small intestine → villous atrophy.



Rotavirus - Pathophysiology



Microvilli

Brush Border

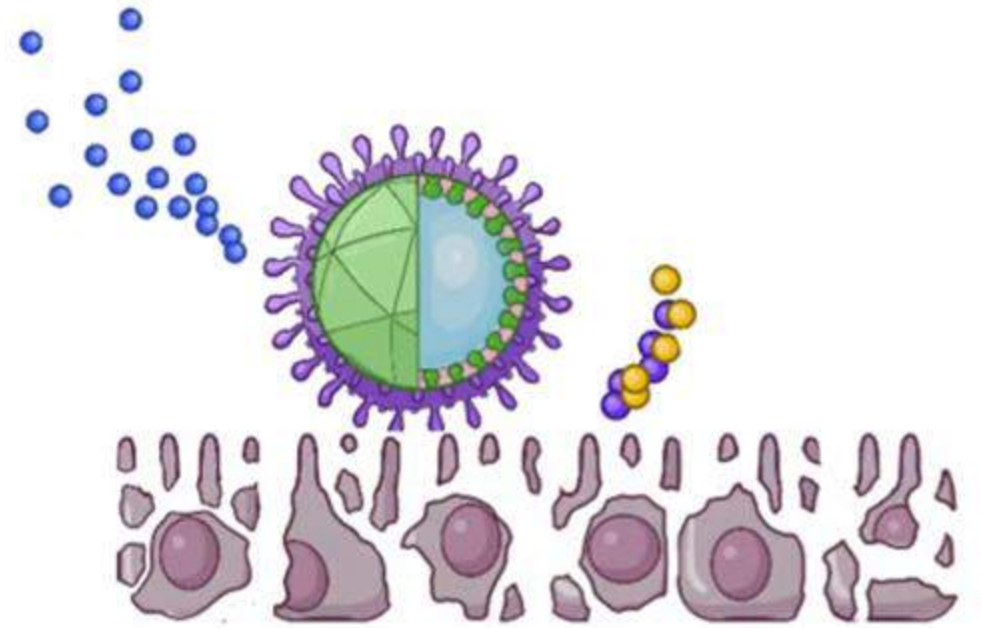
- ~ surface area → absorb nutrients
- ~ Digestive enzymes produced by enterocytes

ROTAVIRUS

- * ↓ Activity of digestive enzymes (e.g. **maltose** & **lactose**)
- * Produces **Non-structural protein 4**

Watery Diarrhea

- * **Malabsorption of nutrients**
- * ↓ **brush border enzyme activity**
- * ↑ **intestinal secretion**



- NSP4: Viral enterotoxin (critical for pathogenesis)
 - Disrupts calcium homeostasis
 - Alters cell permeability
 - Induces chloride secretion
 - Disrupts tight junctions
 - Induces apoptosis of enterocytes



Rotavirus - Clinical Features

- Incubation period: 1–3 days
- Fever, malaise
- Abdominal pain
- Vomiting and watery diarrhea (First infection typically most severe)
 - Can be severe: > 10 loose, watery stools within 24 hours
 - Usually lasts 3–7 days
- Mild to severe dehydration
- Repeat infections are often less severe than initial infection due to the generation of protective secretory IgA against rotaviral antigens



Rotavirus - Complications

- Severe dehydration
- Temporary lactose intolerance
 - Secondary to lactase deficiency
- Intussusception (due to vaccine)



Rotavirus - Diagnosis

- **Diagnosis is usually clinical.**
- **Laboratory diagnosis:**
 - Antigen detection (ELISA, latex agglutination)
 - PCR techniques (Mostly used for epidemiological or research purposes)
 - Electron microscopy (historical)
- **Differential diagnoses**
 - Norovirus infection
 - Bacterial gastroenteritis
 - Food poisoning



Rotavirus - Treatment

- **Treatment is supportive**
 - Fluid replacement (Oral Rehydration Therapy (ORT))
 - Electrolyte repletion
 - Antiemetics
- Patients with severe gastroenteritis or signs of significant dehydration may require inpatient treatment, including IV fluid resuscitation.



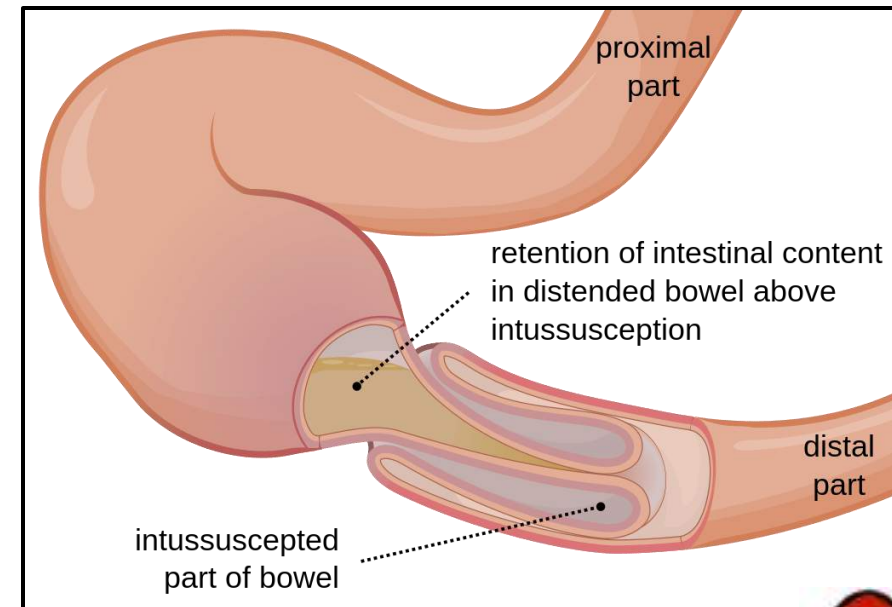
Rotavirus - Treatment

- For outpatients, educate patients and/or caregivers on:
 - The expected duration of illness (Usually lasts 3–7 days)
 - Return precautions (E.g., signs of significant dehydration, altered mental status, prolonged or atypical symptoms)
 - Prevention of rotavirus transmission
- **Important:** Antidiarrheal medications are **not recommended**
 - Will delay viral clearance from intestines



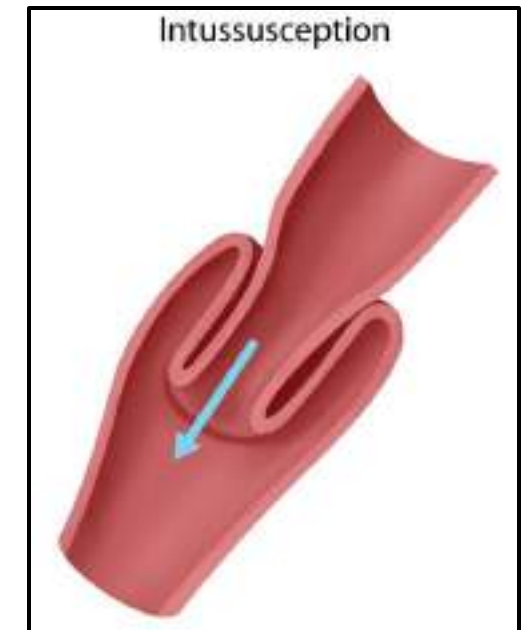
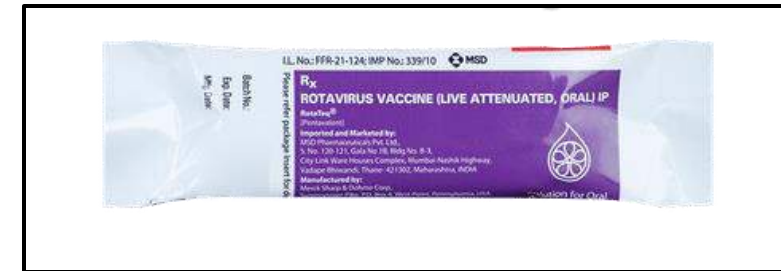
Rotavirus – Vaccination – first trials ☹️

- **1998:** First rotavirus vaccine (RotaShield) approved by FDA
- **Effectiveness:** 80-100% against severe rotavirus diarrhea
- **Safety Signal:** Increased risk of intussusception detected (~1 case per 5,000 - 10,000 vaccinated infants)
- **1999:** withdrawn from market within 1 year of introduction
- **Impact:** Led to enhanced safety monitoring for subsequent rotavirus vaccines

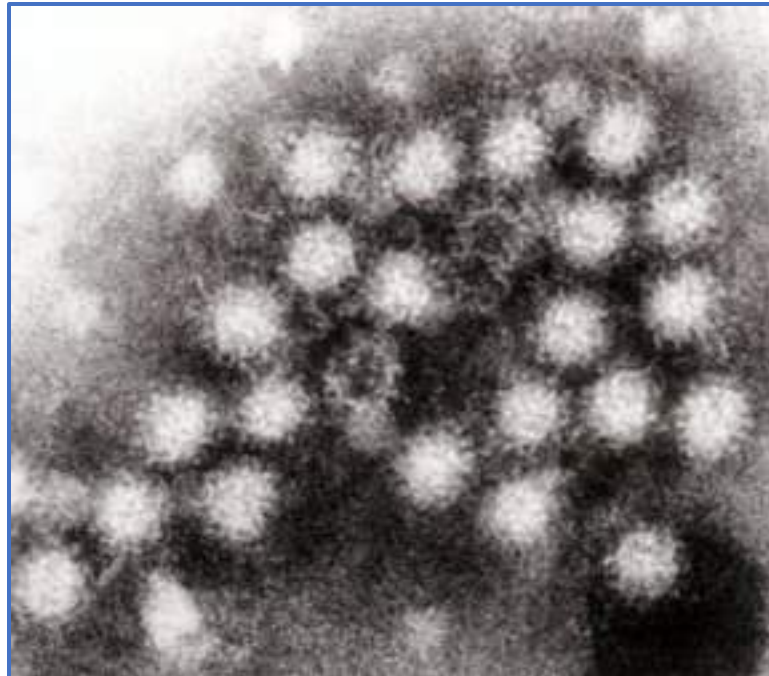


Rotavirus – Vaccination 😊

- **Available vaccines (oral live attenuated):**
 - Rotarix (monovalent)
 - RotaTeq (pentavalent)
- **Indications:** recommended for all infants unless there is a contraindication
- **Contraindications to rotavirus vaccination**
 - Severe combined immunodeficiency (SCID)
 - History of **intussusception**: Rotavirus vaccine is associated with intussusception.
 - Both Rotarix and RotaTeq can still cause intussusception, but at a much lower rate than RotaShield.



Norovirus



Transmission electron micrograph of
Norovirus virions



Norovirus

- Previously known as "Norwalk virus" after 1968 outbreak in Norwalk, Ohio
- Named "Norovirus" in 2002 by the International Committee on Taxonomy of Viruses
- **Significance in Clinical Medicine**
 - Leading cause of acute gastroenteritis worldwide
 - High contagiousness
 - Environmental stability



Norovirus - Virology and Classification

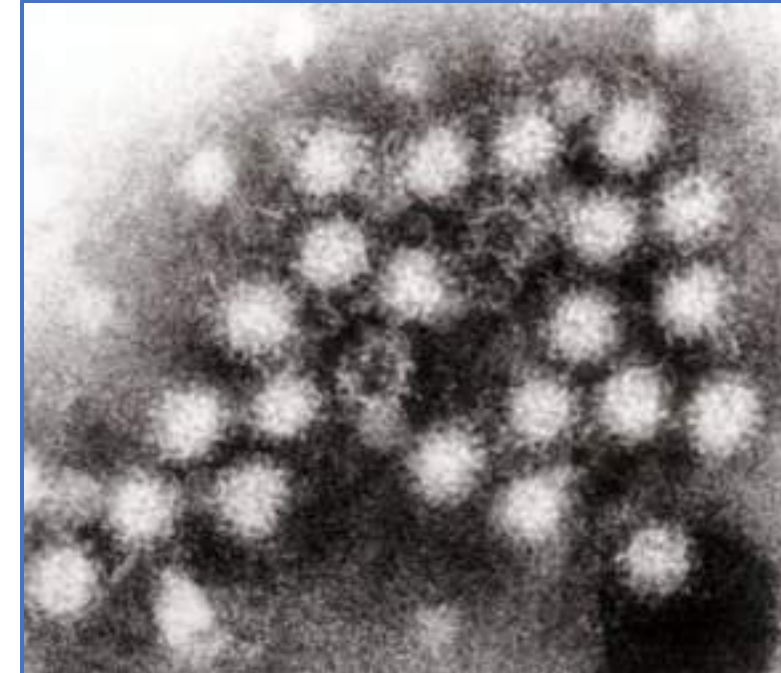
- **Basic Characteristics**

- **Family:** Caliciviridae

- **Structure:**

- Nonenveloped, icosahedral symmetry
 - Single-stranded, positive-sense RNA virus
 - Size: 27-32 nm in diameter
 - Cup-shaped depressions on surface (calyx = cup in Latin)

- Highly stable in environment and Resistant to many common disinfectants
 - Acid-resistant (survives gastric acid)



Transmission electron micrograph of Norovirus virions

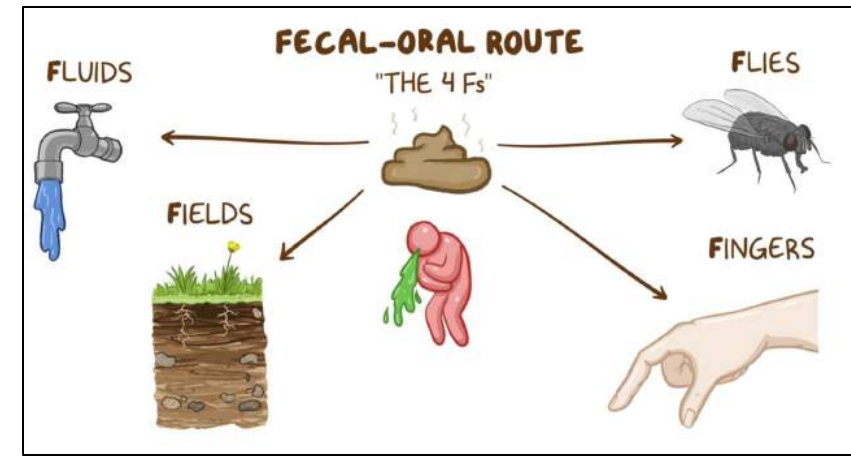


Norovirus - Epidemiology

- **Peak incidence:** November–March (winter months) → Norovirus infection is also known as "winter vomiting disease."
- Community outbreaks (in nursing homes, hospitals, preschools, cruise ships, etc.) are common → Due to the close proximity of individuals
- Most common cause of:
 - Adult gastroenteritis (Over 50% of cases are attributed to norovirus)
 - Severe acute gastroenteritis in children younger than 5 years of age



Norovirus - Transmission



- **Fecal-oral route** through contaminated food or water, person-to-person contact, via airborne droplets, and contact with contaminated surfaces
- **The virus is highly virulent** → Less than 18 viral particles are needed to cause infection.
- Individuals are highly infectious during the acute phase and 24–72 hours following onset of symptoms



Norovirus – Clinical features

- Incubation period: 12–48 hours
- Nausea and acute-onset vomiting
- Watery, non-bloody diarrhea
- Abdominal cramps
- Fever
- Symptoms resolve after 48–72 hours.

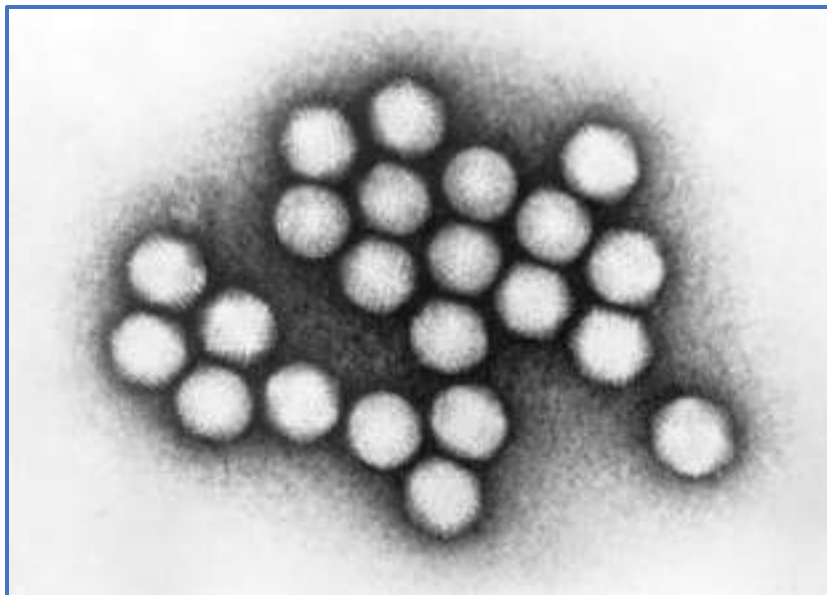


Norovirus – Diagnosis & Treatment

- Diagnosis is usually clinical
- Laboratory studies
 - Reverse transcription-quantitative PCR (RT-qPCR): preferred
 - Multiplex assays: allow for detection of multiple pathogens
 - Others (not routinely used in clinical practice): e.g., enzyme immunoassays
- Treatment:
 - Same approach as for rotavirus infection
 - No vaccine (in 2025, there is one under clinical trials)



Adenovirus

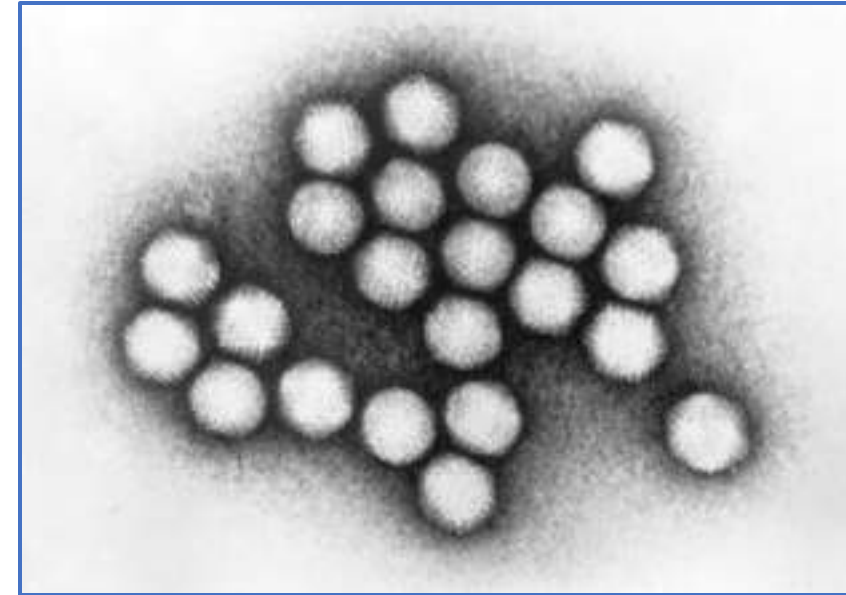


Electron micrograph of adenoviruses



Adenovirus – Historical Context

- First isolated in 1953 from adenoid tissue (hence the name)
- Initially recognized as respiratory pathogens
- Enteric adenovirus types identified in the 1970s
- Now recognized as important causes of gastroenteritis, especially in children



Electron micrograph of adenoviruses



Adenovirus – Structure & characteristics

- Non-enveloped ds DNA virus.
- Infects mucoepithelial cells of respiratory, GI and GU tracts
- Enter via epithelium, replicate and spread to lymphoid tissue.
- Stable in the environment and in GI tract.
- Relatively resistant to disinfection (nonenveloped)



Adenovirus – Structure & characteristics (cont.)

- Viral shedding in faeces may persist for years.
- Sub-grouped into 7 groups A-G (according to DNA sequence), with 60 serotypes in all the groups.
- Certain serotypes are associated with certain infections e.g. types 1-4, 7, 14 and 21 are associated with respiratory infections, **types 40 & 41 associated with Gut infection**, types 8, 19 and 37 associated with epidemic keratoconjunctivitis



Adenovirus –Clinical Significance

- Diverse clinical manifestations:
 - Respiratory infections
 - Conjunctivitis
 - Gastroenteritis
 - Hemorrhagic cystitis
 - Meningoencephalitis
- Third most common viral cause of gastroenteritis in children (after rotavirus and norovirus)



Adenovirus – Virology and Classification

- **Basic Characteristics**

- Family: Adenoviridae
- Structure:
 - Nonenveloped, icosahedral capsid
 - Double-stranded DNA genome
 - Size: 70-90 nm in diameter
 - Fiber projections from each vertex



Adenovirus – Epidemiology

- **Global Impact**

- Enteric adenoviruses account for 5-15% of viral gastroenteritis
- Second most common viral cause of diarrhea in children <2 years in many regions
- Estimated 5-15% of diarrheal hospitalizations worldwide

- **Population Distribution**

- Peak incidence: 6-24 months of age. Most cases in children <5 years

- **Outbreaks reported in:**

- Daycare centers, Pediatric hospitals, Swimming pools, Military facilities

- **Transmission**

- Fecal-oral route, Respiratory route (less common for enteric types)



Adenovirus – Clinical Presentation

- **Incubation Period:** 3-10 days (longer than other viral gastroenteritis)
- **Cardinal Symptoms of Enteric Adenovirus Infection**
 - Diarrhea: Watery, non-bloody, Prolonged duration (5-12 days)
 - Vomiting
 - Fever (Low to moderate): Present in 50-60% of cases
- **Associated Symptoms**
 - Abdominal pain/cramps, Anorexia, Malaise, Weight loss
 - Respiratory symptoms in 30-50% of cases:
 - Rhinorrhea, Pharyngitis, Cough, Conjunctivitis
- **Bowel intussusception**



Adenovirus – Diagnosis & Treatment

- Clinical Diagnosis
- Lab methods
 - Enzyme immunoassay (EIA)
 - Electron microscopy
 - PCR (preferred method)
- Treatment & prevention:
 - Same approach as for rotavirus infection
 - There is no vaccine for adenovirus 40/41.
 - **Note:** For respiratory infections, a vaccine is available for military people and not the civilians.
 - The vaccine is given orally and it contains 3 serotypes, 4, 7 and 21 (but not for 40 & 41)



Feature	Rotavirus	Norovirus	Adenovirus
Incubation Period	1-3 days	12-48 hours	3-10 days
Duration of Illness	3-8 days	24-72 hours	5-12 days
Vomiting	+++ (prominent, often precedes diarrhea)	+++ (prominent feature)	+ (mild to moderate)
Diarrhea	+++ (watery, may have mucus)	++ (watery)	+++ (watery, prolonged)
Abdominal Pain	++ (moderate)	++ (moderate)	++ (moderate)
Respiratory Symptoms	Rare	Rare	Common (30-50% of cases)
Dehydration Risk	High	Moderate	Moderate





Thank you



Step 1 – ID: 1498

A diarrheal outbreak is reported at a private school in Columbus, Ohio. Six healthy children age 10-11 and two teachers developed acute vomiting and diarrhea within a 2-day period. They describe the diarrhea as watery and without blood or mucus. Three of those affected are febrile during their illness. None of the patients have traveled abroad recently, and all are up to date with their vaccinations. Stool test results are pending. Which of the following pathogens is the most likely cause of the illness?

- A. Adenovirus
- B. *Campylobacter jejuni*
- C. *Clostridioides* (formerly *Clostridium*) *difficile*
- D. Enterotoxigenic *Escherichia coli*
- E. Norovirus
- F. Rotavirus
- G. *Salmonella typhi*



Step 1 – ID: 1497

During the course of a week at an overnight summer camp, 4 children age 7-9 are sent to the camp health center. They each have fever, cough, congestion, sore throat, and red eyes. Physical examination of the children shows bilateral conjunctival injection and an erythematous oropharynx. Auscultation of one child also reveals crackles in the left lower lung field. All the children's symptoms improve over 7 days with supportive care. Which of the following is the most likely cause of the outbreak?

- A. Adenovirus
- B. Coxsackievirus
- C. Influenza virus
- D. Norovirus
- E. Parvovirus
- F. Respiratory syncytial virus



Step 1 – ID: 15215

A 3-year-old girl is brought to the emergency department with abrupt-onset vomiting followed by frequent, large-volume, watery diarrhea for the last day. She has no prior medical conditions but has not received recommended vaccinations. Temperature is 37.8 C (100 F). Physical examination shows mild dehydration. The abdomen is soft and mildly tender to palpation throughout. Bowel sounds are increased. Polymerase chain reaction testing of the stool sample yields a virus with a segmented, double-stranded RNA genome. Which of the following pathologic findings is most likely to be present in this patient?

- A. Blunting of the villi in the duodenum and proximal jejunum
- B. Extensive colonic mucosal injury with yellow-white adherent layer
- C. Flask-shaped ulcerations in the cecum and ascending colon
- D. Foamy macrophages in the small intestinal lamina propria
- E. Inflammatory infiltration and necrosis of the Peyer patches



Step 2 – ID: 17748

A 16-year-old girl is brought to the clinic due to vomiting and abdominal pain. Since this morning, the patient has had multiple episodes of nonbilious, nonbloody emesis as well as intermittent nausea and abdominal pain. She has also had 3 episodes of watery diarrhea. The patient attended a school cookout approximately 36 hours prior to her first bout of emesis, and several of her friends who also attended have similar symptoms. Temperature is 37.4 C (99.1 F), blood pressure is 115/75 mm Hg, and pulse is 95/min. She appears uncomfortable but is alert and interactive. Mucous membranes are slightly dry. There is diffuse tenderness to deep palpation on abdominal examination but no masses or hepatosplenomegaly. The skin is well perfused, and no rashes are evident. Which of the following is the most likely etiology of this patient's illness?

- A. *Bacillus cereus*
- B. Norovirus
- C. Rotavirus
- D. *Shigella sonnei*
- E. *Staphylococcus aureus*



Step 2 – ID: 105673

A 3-year-old, previously healthy boy is brought to the emergency department due to a daylong history of vomiting, diarrhea, abdominal pain, and fever. The patient has vomited 3 times and had 5 watery stools. He has no ear pain or urinary symptoms, and he has voided 3 times today. Temperature is 38 C (100.4 F), blood pressure is 100/70 mm Hg, pulse is 102/min, and respirations are 20/min. On physical examination, the patient is not in acute distress. Buccal mucous membranes are slightly dry. Capillary refill is 2 seconds. Skin turgor is normal. The patient has mild discomfort on deep palpation on the center of the abdomen; there is no rigidity, rebound, or guarding. Bowel sounds are hyperactive. What is the most appropriate next step in management?

- A. Admit to the hospital for intravenous fluids
- B. Discharge home with oral rehydration solution
- C. Obtain abdominal x-ray
- D. Obtain fecal leukocyte testing
- E. Obtain stool cultures



Step 2 – ID: 8951

A 6-month-old girl is brought to the office for a well-child visit and routine vaccinations. The patient is exclusively breastfed and is urinating and stooling normally. One month ago, she was hospitalized for intussusception that was reduced successfully by air enema. The patient lives in a small apartment with her mother, brother, and maternal aunt, who is pregnant. Vital signs are normal. On examination, she has mild nasal congestion and clear rhinorrhea. The remainder of the examination is normal. Her mother is very concerned about the potential side effects of vaccinations. Which of the following is this patient's contraindication to the rotavirus vaccination?

- A. Administration of inactivated immunizations on the same day
- B. Exclusive breastfeeding
- C. History of intussusception
- D. Pregnant household member
- E. Viral upper respiratory infection

