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ROTA VIRUS INFECTION; MOLECULAR PATHOGENESIS, EPIDEMIOLOGY AND ADVANCES IN VACCINATION STRATEGIES

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ABSTRACT

Rotavirus is a leading cause of acute gastroenteritis in infants and young children worldwide, contributing significantly to morbidity and mortality, particularly in low- and middle-income countries. It is a non-enveloped, double-stranded RNA virus belonging to the family Reoviridae, characterized by a triple-layered icosahedral capsid. Transmission occurs primarily via the faecal–oral route through contaminated food, water, and surfaces, with high environmental stability facilitating rapid spread. Infection mainly targets mature enterocytes of the small intestine, leading to villous atrophy, malabsorption, and secretory diarrhoea mediated in part by the viral enterotoxin NSP4. Clinical manifestations range from mild diarrhoea to severe dehydration, electrolyte imbalance, and shock, especially in infants and immunocompromised individuals.

Vaccination remains the most effective preventive strategy, significantly reducing disease severity, hospitalizations, and mortality worldwide. Currently available oral live- attenuated vaccines have shown substantial success; however, challenges such as variable vaccine efficacy, limited coverage in low-resource settings, rare adverse effects, and emerging viral genotypes persist. Supportive management, including oral rehydration therapy, zinc

supplementation, and nutritional support, remains essential for disease management. Continued research focusing on vaccine optimization, improved accessibility, and understanding viral evolution is critical to achieving sustained global control of rotavirus infection.

KEYWORDS: Rotavirus infection, Acute gastroenteritis, Paediatric diarrhoea, Double stranded RNA Virus, Faecal – oral transmission, Molecular pathogenesis, Epidemiology, Rotavirus vaccination, public health impact.

INTRODUCTION

Rotavirus is one of the most important viral pathogens responsible for acute gastroenteritis, primarily affecting infants and young children worldwide. It belongs to the family Reoviridae and is a non-enveloped, double-stranded RNA virus with a triple-layered icosahedral capsid. Since its discovery in 1973, rotavirus has been recognized as a leading cause of severe diarrheal illness, accounting for a significant proportion of paediatric hospitalizations and mortality, particularly in low- and middle-income countries. Transmission occurs predominantly through the faecal–oral route, facilitated by contaminated hands, surfaces, food, and water, with high stability in the environment contributing to its widespread infectivity.

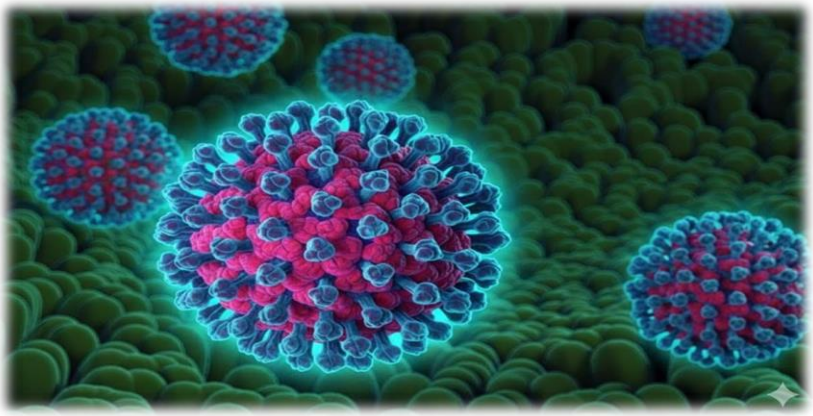
The global burden of rotavirus disease remains substantial despite advances in sanitation and healthcare, due to its highly contagious nature and low infectious dose. Clinical manifestations range from mild, self-limiting diarrhoea to severe dehydration, electrolyte imbalance, and shock, which can be life-threatening without timely medical intervention. The virus exhibits marked seasonal variation in many regions and significant genetic diversity, driven by reassortment and evolution of its genome segments, leading to multiple circulating genotypes.

Vaccination has emerged as the most effective strategy for disease prevention, with WHO-prequalified oral vaccines significantly reducing severe cases in countries that have implemented routine immunization. However, challenges such as vaccine effectiveness variability, genotype replacement, limited coverage in certain regions, and the need for improved next-generation vaccines continue to demand attention. Understanding rotavirus virology, pathogenesis, epidemiology, immune response, and vaccine performance is essential for developing sustained control strategies and reducing disease impact.

This review aims to provide a comprehensive synthesis of current knowledge on rotavirus infection, recent advances in prevention and management, and the existing gaps that shape future research priorities.

DETAILS

Rotavirus is a contagious virus causing gastroenteritis, mainly in young children, leading to severe watery diarrhoea, vomiting, fever, and stomach pain, with dehydration being the biggest risk, treatable with fluids and rest but sometimes needing hospitalization. Spread faecal-orally (person-to-person, contaminated surfaces/food), it's very common, but vaccines significantly reduce illness severely.



DISCOVERY AND HISTORY

First identified in 1973 by Ruth Bishop and colleagues in Australia.

The name rotavirus comes from the Latin word rota meaning wheel, due to its wheel- like appearance under electron microscopy.

CLASSIFICATION

Family: Reoviridae

- Genus: Rotavirus
- Genome: Double-stranded RNA (11 segments)
- Serogroups: A-J
- Group A: Most common cause of human infections
- Groups B and C: Less common in humans.

STRUCTURE

- Icosahedral -enveloped virus

- capsid with three protein layers
- Non-Key proteins:
- VP4: Responsible for viral attachment and penetration
- VP7: Outer capsid glycoprotein, important for immune

TRANSMISSION

- Foco-oral route (most common)
- Contaminated food and water
- Person-to-person contact
- Poor hand hygiene
- Virus is highly stable in the environment

PATHOGENESIS

- Infects mature enterocytes of the small intestine.

CAUSES

- Villous atrophy
- Reduced absorption of nutrients and water
- Viral toxin NSP4 acts as an enterotoxin → causes secretory diarrhoea
- Leads to dehydration and electrolyte imbalance.

ROTAVIRUS SYMPTOMS

Usually starting about two days after exposure and last-Ing 3 to 8 days, leading to dehydration which shows as dry mouth, fewer tears/urination, sunken eyes, and lethargy, especially dangerous in infants.

Early signs often include stomach pain and vomiting, followed by diarrhea, with loss of appetite also common.

- Vomiting
- Loss of appetite
- Irritability or lethargy
- Gastrointestinal symptoms
- Watery diarrhoea (frequent, severe, and non-bloody)
- Abdominal pain or cramps
- Nausea
- Signs of dehydration** (important and serious)
- Dry mouth and tongue
- Sunken eyes or sunken fontanelle (in infants)
- Reduced or no tears while crying
- Decreased urination (fewer wet diapers).

VACCINATION

The rotavirus vaccine is a safe, oral (by mouth) vaccine given to infants to prevent severe diarrhoea, vomiting, and dehydration caused by rotavirus, a very common and contagious virus, with doses typically starting around 2 and 4 months, and sometimes 6 months, but must begin before 15 weeks and finish by 8 months.

It is a live, weakened virus that protects babies and reduces community spread, with rare mild side effects like fussiness or slight diarrhoea, though severe symptoms warrant immediate

medical attention.

WHAT IT IS AND WHY IT IS GIVEN FOR;

- Protects against severe diarrhoea:
- Rotavirus is a leading cause of severe,
- Dehydrating diarrhoea in young children, sometimes requiring hospitalization.
- Oral liquid: It's given as drops by mouth, not a shot.
- Live vaccine: Contains weakened rotavirus, teaching the immune system to fight the real virus.
- When it's given (Schedule)

Dose	Age Range	Notes
Dose 1	6 weeks – 20 Weeks	Can start as early as weeks
Dose 2	24 Weeks	Must be completed by Weeks

CHALLENGES

Rotavirus presents challenges through severe diarrhoea & dehydration (especially in kids), vaccine access/supply issues in low-income nations, rare side effects like intussusception, diagnostic confusion with other bugs, and the need for strong health systems to manage outbreaks & ensure vaccine uptake, with ongoing research targeting broader protection and better delivery. Key issues include vaccine financing, cold chain, and ensuring equitable distribution Severe Dehydration: The biggest threat, causing convulsions, shock, and death, especially in infants.

Difficulty: Symptoms mimic other stomach bugs, making specific diagnosis tricky without tests.

Varying Disease Burden: High impact in developing countries, with seasonal/year-round outbreaks influenced by climate, population, etc.

Immunocompromised Risks: Severe illness can occur in those with weakened immune systems.

Complications: Intussusception (bowel blockage) linked to infection and vaccine; neurological issues (seizures, encephalitis) are rare but possible.

Key steps for recovery

1. **Prevent dehydration (most important)**

- ❖ Give ORS (Oral Rehydration Solution) frequently in small sips
- ❖ For infants: breastfeeding or formula
- ❖ Signs to watch for: dry mouth, fewer wet diapers, lethargy, sunken eyes.

2. **Diet**

- ❖ Once vomiting reduces, start light food; Rice, banana curd (yogurt), toast, porridge
- ❖ Avoid: Sugary drinks, fruit juices, soft drinks, Fried or spicy foods.

3. **Zinc supplementation (for children)**

- ❖ Recommended for 10-14 days
- ❖ Helps reduce duration and severity of diarrhea.

4. **Probiotics (optional, if advised by doctor)**

- ❖ May help restore gut balance.

CONCLUSION

Rotavirus infection continues to pose a significant global public health challenge, particularlyamong infants and young children in low- and middle-income countries. Despite major improvements in sanitation and healthcare access, the highly contagious nature of the virus and its ability to cause severe dehydration make it a persistent cause of childhood morbidity and mortality. The virus's unique structural characteristics, diverse genotypes, and efficient faecal–oral transmission contribute to its widespread distribution and clinical impact. Understanding its molecular pathogenesis, especially the role of viral proteins such as VP4, VP7, and NSP4, has been essential in explaining disease severity and guiding preventive strategies.

The introduction of rotavirus vaccines has been one of the most significant public health achievements in reducing severe diarrheal disease and related hospitalizations worldwide. Vaccination not only protects individual children but also contributes to herd immunity, reducing transmission within communities. However, challenges such as limited vaccine coverage, cold-chain requirements, variations in vaccine effectiveness, and rare adverse events continue to hinder complete disease control, particularly in resource-limited settings. Effective management of rotavirus infection relies heavily on early recognition, prompt

rehydration therapy, appropriate nutritional support, and preventive measures such as zinc supplementation. Continued public health education, improved sanitation, and strengthened immunization programs are essential for reducing disease burden. Future research focusing on next-generation vaccines, broader strain coverage, and enhanced delivery strategies will be crucial in achieving long-term control. Overall, a comprehensive approach combining vaccination, early treatment, and public health interventions remains the cornerstone for reducing the global impact of rotavirus infection.

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