Rotavirus

Family *Reoviridae*
Genus Rotavirus

Virus

anses
French agency for food, environmental and occupational health & safety

Nature and sources of rotavirus

Main microbiological characteristics

Human rotaviruses (HRV) belong to the *Reoviridae* family and are responsible for acute gastroenteritis (AGE). They are non-enveloped wheel-shaped viruses 100 nm in diameter. Their icosahedral capsid is made up of three concentric protein layers. Their genome consists of 11 segments of double-stranded RNA (dsRNA). They are classified into seven serogroups (A to G) based on their antigenic properties. Groups A, B and C infect humans and animals, while the other groups have only been observed so far in animals. Group A rotaviruses are the most important in human pathology and on the basis of their VP7 (type G for glycoprotein) and VP4 (type P for protease-sensitive) outer capsid proteins, they can be classified into 19 G genotypes and 31 P genotypes. There is therefore considerable diversity in rotavirus strains, with some found worldwide and others limited to certain regions. A few genotypic combinations alone explain over 90% of rotavirus infections in humans. Strains belonging to the same serogroup can be rearranged by exchanging genomic fragments during co-infections to create new viruses.

Sources of the hazard

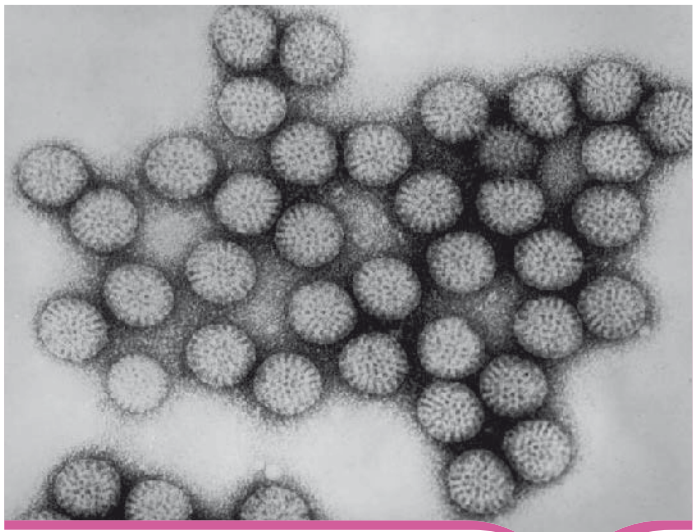
Humans are the main reservoir of human rotaviruses. However, cases of infection with group A rotaviruses have been observed in animals, meaning that they can be regarded as potential reservoirs.

The virus is present in all regions of the globe. It develops through winter outbreaks in temperate countries and throughout the year in tropical countries.

Because of the protection offered by their three protein layers, rotaviruses persist for several weeks in the environment.

Transmission routes

The most common mode of HRV transmission is the faecal-oral route. During the acute phase of the disease, patients may excrete up to 10^{12} viral particles per gram of stool. The virus's presence and persistence in the environment, on porous and non-porous surfaces and hands, allow its direct transmission through contact. Rotaviruses can survive several hours on hands, 9 days in aerosol form (from vomiting) and more than 64 days at 20°C in tap water. Contamination by ingestion of water or food contaminated with faeces is also possible.



Rotavirus (MET) © CDC Dr. Erskine Palmer

Human foodborne illness

Nature of the disease

Acute rotavirus gastroenteritis is the leading cause of viral diarrhoea in infants and young children. The most serious forms appear in the first two years of life. Rotavirus infection is characterised by a short incubation (average 3 days) and the onset of watery diarrhoea, abdominal pain, vomiting and fever, often leading to dehydratation (86%) and more rarely hospitalisation of infants (6%). The disease is resolved in 3 to 8 days. Rotavirus is also the leading cause of nosocomial infections in paediatric wards, especially during the winter seasonal peak (February-March).

Specific diagnosis is made by identification of the virus in patients' stools by immunology (ELISA) or RT-PCR.

Data sheet on foodborne biological hazards
April 2012

Table 1. **Characteristics of the disease**

Mean incubation period	Population most at risk	Main symptoms	Duration of symptoms	Duration of the contagious period (shedding)	Complications	Asymptomatic forms
3 days	Children under five years old	• Rapid onset of vomiting and diarrhoea • Rapid dehydratation • Mild fever	3-7 days	During the symptomatic phase and up to 8 days after symptoms disappear	Meningitis, encephalitis in very rare cases Lethality: 0.5-1.6 deaths/1 million children	Especially in adults

Susceptible population groups: there are no risk groups apart from children under 5 years of age. Adults may be contaminated and thus spread the virus, but the infection is often asymptomatic. Rotavirus infections are prolonged in immunocompromised patients.

Dose-effect (1) and dose-response (2) relationships

The infectious dose has been evaluated in humans as one PFU (plaque forming unit). The low infectious dose and very high excretion rate explain its rapid spread in populations.

Epidemiology

Monitoring methods and epidemiological data

In France, several systems provide mutually complementary surveillance of gastroenteritis: Inserm's Réseau Sentinelles network, the emergency services network of the InVS (Institute for Public Health Surveillance), mandatory notification of foodborne outbreaks and the National Centre of Reference (NCR) for enteric viruses.

Rotaviruses cause a large number of diarrheal episodes since it is considered that virtually all children aged 5 years have had rotavirus diarrhoea.

In France, the number of hospitalisations due to rotavirus infections is estimated at 18,000 per year and the number of deaths is estimated at 13-14 per year among children under three years old. Worldwide, deaths due to rotaviruses could be as many as 600,000 per year, mainly in developing countries.

Vaccination

Two live attenuated vaccines against rotavirus infections, administered orally to infants, are available on the market.

Role of foods

Main foods to consider

Drinking water, water from the public supply and recreational water may be contaminated and involved in the transmission of rotaviruses to humans. All kinds of food can be involved: foods of animal or plant origin, raw or undercooked foods, ready-to-eat foods or food ingredients. Food contamination can occur at different stages of the food chain: cultivation, treatment, harvesting, packing, preparation. The two main sources of contamination are operators throughout the chain and the water used, especially during crop irrigation but also when washing fruits and vegetables, for example.

Regarding the contamination of water intended for human consumption, it is systematically associated with either a malfunction in the production system or contamination of the distribution system. Bivalve shellfish can also become contaminated through filtration of contaminated water. The health risk is even higher with contaminated foods that do not undergo before consumption treatments that can reduce the viral load - such as cooking or washing.

Foodborne infection can cause secondary cases by inter-human transmission.

Inactivation treatments in industrial environments

The application of hygiene rules, compliance with cleaning and disinfection procedures and the selection of raw materials (traceability, risk of viral contamination, etc.) contribute to better control of the viral risk. Rotaviruses are resistant to chemical and physical agents (resistance to freezing, light cooking, some disinfectants), which confers prolonged survival in the environment, particularly on surfaces. Generally, to be considered effective, virucidal treatments should achieve a 4-log reduction in viral titre. Overall, rotaviruses (like other enteric viruses) are less susceptible to disinfectants when adsorbed onto food matrices or surfaces than when in suspension. Similarly, the presence of faecal matter protects them from inactivation. The results of inactivation tests may depend on the virus strain used (human, simian (3) strain, etc.), pH and temperature, and contact time.

Table 2. **Inactivation treatment for rotaviruses**

Inactivation treatment	Matrix	Number of log_{10} reduction in viral titre
Heat treatment		
There are few data relating to rotaviruses in food matrices, although these have a significant effect on viral thermosensitivity, either protective (sugar/fat) or synergistic (pH, specific molecules).		
50°C, 30 min	Viral suspension of the simian strain (SA11)	2
60°C, 10 min		7
Boiling water, 16 min	Crab preparation (souche SA11)	>4
Disinfectants		
Water, 0.5 min	Strawberries (15 g in 200 ml of water)	1,5
Hypochlorite 200 ppm, 0.5 min	Strawberries (15 g in 200 ml of water)	>3
Ozone 0.05 mg/L, 10 sec, pH 6 or 7	Viral suspension of the human strain (WA)	>5
Monochloramine is ineffective in inactivating rotavirus.		
High Pressure		
300 MPa / 25°C / 2 min	Viral suspension of a human strain	8
Irradiation		
2,4 KGy	Oysters and clams	1
1,29 kGy *(±0,64)*	Spinach	1
1,03 kGy *(±0,05)*	Lettuce	1
UV		
28 - 42 mJ/cm^2	Viral suspension of the simian strain (SA11)	3

(1) Relationship between the dose (the quantity of microbial cells ingested during a meal) and the effect *on an individual*.

(2) For a given effect, the relationship between the dose and the response, i.e., the probability of this effect appearing *in the population*.

(3) The simian strain is also conventionally used as a model for assessing the efficacy of treatments.

Monitoring in food

Rotaviruses are not routinely screened for in either water or food. In cases of suspected food poisoning outbreaks, the stools of patients are sent to the National Reference Centre (NRC) for enteric viruses. An environmental survey is conducted by the Interregional Epidemiology Unit (CIRE) in relation with the Regional Health Agency (ARS) to determine the source of contamination. Samples of water and/or food are sent for analysis to the ANSES Maisons-Alfort Laboratory for Food Safety. If shellfish are suspected to be the cause of viral contamination, they are analysed at the National Reference Laboratory (IFREMER). RT-PCR is the technique of choice for detecting viral genomes after concentration of viral particles present in the food. Rotaviruses can be cultivated and this method is used to evaluate the effectiveness of treatment.

There is no standard method relating to screening for rotaviruses in food.

Recommendations to operators

- **Good farming practices should be applied to minimise the risk of contamination of raw materials by potentially contaminated irrigation or marine water.**
- **Kitchen staff or anyone handling foods, especially if those foods are intended to be consumed raw or undercooked, must be made aware of the faecal-oral transmission and the food hygiene measures. Staff must be aware of the importance of not handling food if they present any symptoms of gastroenteritis.**
- **Compliance with cleaning and disinfection procedures and the selection of raw materials (source, geographical origin, risk of viral contamination, etc.) contribute to better control of the viral risk.**
- **The water used in the food manufacturing process (especially the final wash) must be drinkable or clean.**

Domestic hygiene

Rotaviruses are resistant to conventional cold preservation methods for foods (refrigeration and freezing).

Recommendations to consumers

- **All persons handling foods, especially if those are intended to be consumed raw or undercooked, should be made aware of the faecal-oral transmission and food hygiene measures. It is necessary to insist on washing hands thoroughly after using the toilet, before preparing or eating food, and after changing a child's nappy (especially if he has diarrhea).**
- **Infected people should avoid handling food.**
- **Before consumption, fruits and vegetables eaten raw should be thoroughly rinsed with drinking water.**
- **Only shellfish from an authorised and inspected area should be consumed (in case of doubt about the origin of shellfish, they must be thoroughly cooked).**

References and links

General references

- AFSSA (2007). State of knowledge about food- and water-borne viruses.
- Baert, L J. Debevere *et al.* (2009). "The efficacy of preservation methods to inactivate foodborne viruses" International Journal of Food Microbiology 131 (83 – 94).
- Hirneisen, K.A., E-P-Black *et al.* (2010). "Viral Inactivation in Foods: A review of traditional and novel food-processing technologies". Comprehensive Reviews in Food Science and Food Safety 9 (3 – 20).
- Kapikian AZ, Hoshino Y, Chanock RM. Rotaviruses. In Knipe DM, Howley PM (Eds.), Fields Virology, 4th ed. Lippincott. Williams & Wilkins, Philadelphia, Pa. 2001: 1787-1833.

Useful links

- National Reference Centre (NRC) for enteric viruses, CHU de Dijon http://www.chu-dijon.fr/page.php?url=directory/centre-national-de-reference-des-virus-enteriques
- French Institute for Public Health Surveillance (InVS): www.invs.sante.fr
- Centers for Disease Control and prevention (CDC): www.cdc.gov
- Eurosurveillance: www.eurosurveillance.org
- Sentiweb: www.b3e.jussieu.fr