



Show Me the Science:

The **CONTAMINATION** of **SURFACES** and **HANDS**

Have you ever had the stomach flu?
There is more to it than you think.

By Dr. Gavin Macgregor-Skinner

Have you ever had the stomach flu? What you probably had was gastroenteritis—which is not actually a flu at all. Gastroenteritis is an inflammation of the lining of the intestines caused by a virus, bacteria, or parasites. Gastroenteritis caused by viruses is the second most common illness in the United States. Symptoms include diarrhea, abdominal pain, vomiting, headache, fever, and chills.

These viruses are called enteric viruses and include more than 100 different varieties. In humans, these are related to a broad range of clinical features, including gastroenteritis, but also hepatitis. The main representatives in humans are rotavirus, norovirus, astrovirus, adenovirus, enterovirus, hepatitis A virus (HAV), and hepatitis E virus (HEV).

Enteric viruses are found in the intestines of humans and animals. Large amounts of these viruses can be released into the environment and spread to people. Enteric viruses are nonenveloped viruses and can remain infectious outside of the body in the

environment. They can survive in food and water, but also on surfaces (fomites).

Contamination of environmental surfaces plays an important role in the spread of these infections, especially in indoor facilities, such as convention centers, restaurants, hospitals, schools, day care centers, and institutions for the elderly. Many enteric viruses have been associated with infections via contaminated hands and surfaces. High-touch surfaces, such as door handles, clothes, telephones, toilet seats, flush handles, handrails, thermometers, gloves, and papers, can be contaminated and serve as vehicles of transmission for the virus.

Surfaces or objects can be contaminated by:

- Deposition of virus particles from the air (greatest on upward-facing surfaces).
- Direct emission through coughing, sneezing, talking, breathing, etc.
- Aerosolization of enteric viruses due to vomiting, diarrhea, and toilet flushing (highest on surfaces near sources).
- Hand touching (greatest on high-touch surfaces).

What influences virus survival on surfaces (fomites)?

The prevention of enteric virus-related infections requires a good understanding of virus persistence in the environment and the role of contaminated surfaces and objects in virus transmission. Factors that influence survival of enteric viruses on surfaces include the virus itself, surface properties, and extrinsic environmental factors, such as temperature or humidity.

Virus types: Enteric viruses are nonenveloped and have been reported to persist on surfaces for several weeks to months. Differences between the groups of viruses involved in gastroenteritis influence survival. Hepatitis A virus and rotavirus have been shown to be more resistant than adenovirus and enterovirus.

Surface types (fomites): Surfaces are generally classified as porous (e.g., papers and clothes) or nonporous (e.g., stainless steel, plastic, and glass). Available data suggests that most viruses persist longer on nonporous surfaces. However, this also depends on the viral type.

Environmental factors: Environmental factors include air temperature and humidity, but the length of virus viability may also depend on the cleanliness of the surface, which can be determined, for example, by the presence or not of organic material or by the number of viruses on the surface. Environmental factors that are important determinants of virus survival on surfaces include:

- Low temperatures have been reported to promote a longer persistence.
- The effect of humidity is less consistent.

- It has been reported that decreases in humidity could preserve the infectivity of hepatitis A virus, rotavirus, and adenovirus.

- Another study found viruses have better survival at both low and high humidity, while intermediate humidity (e.g., between 40-70%) is deleterious.

- Humidity level is thought to play an important role in virus persistence in the environment, and it has been suggested to explain the seasonality of rotavirus infections.

- It has been shown that absolute humidity (temperature independent) rather than relative humidity (temperature dependent) could explain the seasonality of infections, such as norovirus outbreaks.

Evidence of transmission of enteric viruses from surfaces

Contamination and the survival of enteric viruses on surfaces and objects can explain a significant proportion of acute viral diarrhea illnesses. But direct evidence of virus transmission via surfaces is difficult to obtain because other routes, such as person-to-person transmission, are usually suspected. Examples of enteric viruses found on surfaces and fomites associated with disease outbreaks include:

- Rotaviruses on fomites in child day care centers, pediatric hospital units, and hospital intensive care units.
- Rotavirus on toys associated with an outbreak in a pediatric oncology unit.
- Noroviruses found on surfaces and objects around patients during outbreaks in hospitals, hotels, aircraft, and cruise ships.
- Norovirus outbreak in a long-term care center found virus on dining room tables and elevator buttons.
- Norovirus outbreak in a soccer team linked to touching a reusable grocery bag.
- Adenovirus contamination of surfaces in hospitals and pediatric units was found to be infectious.
- Astroviruses on environmental surfaces were detected during a hospital outbreak.
- Hepatitis A virus was spread by a barman on drinking glasses that resulted in an outbreak linked to a bar.

Survival of enteric viruses on surfaces

Adenoviruses—Common viruses that cause a range of illnesses. They can cause cold-like symptoms, fever, sore throat, bronchitis, pneumonia, diarrhea, and pink eye (conjunctivitis). The U.S. Centers for Disease Control and Prevention (CDC) state they spread from infected people to others through close personal contact, such as touching or shaking hands, the air by coughing and sneezing, and touching objects or surfaces with adenoviruses on them then touching your mouth, nose,

or eyes. They can survive on surfaces for more than one month between 39-68°F (4-20°C) and survive longer on paper than on aluminum.

Astroviruses—CDC states they are a significant cause of diarrheal illness in young children worldwide. In temperate climates, infection is highest during winter months, possibly due to lower temperatures enhancing the stability of the virus. In tropical regions, infection is highest during the rainy season. They have been shown to survive for a long time on both porous and nonporous surfaces. Survival is higher at low temperatures and on porous surfaces—up to 90 days at 39 degrees Fahrenheit or 4 degrees Celsius on paper.

Enteroviruses—CDC states that non-polio enteroviruses cause about 10 to 15 million infections and tens of thousands of hospitalizations each year in the United States. Most people who get infected have only mild illnesses. But some people can have serious complications, especially infants and people with weakened immune systems. Hand, foot, and mouth disease is very contagious and is caused by coxsackievirus A16. Coxsackieviruses can remain viable on hard, nonporous surfaces for upwards of two weeks in conditions of high and low

temperature and humidity.

Hepatitis A—CDC states it is primarily a human pathogen transmitted by person-to-person contact or ingestion of contaminated food or water. Still, contaminated surfaces can play a role in transmission. It can survive for more than two months on surfaces and has better resistance on nonporous surfaces. It can remain infectious for at least one month at room temperature on the flush handle of a toilet.

Norovirus—CDC states is a very contagious virus that causes vomiting and diarrhea. You can get norovirus from having direct contact with an infected person, consuming contaminated food or water, touching contaminated surfaces, and then putting your unwashed hands in your mouth. It only takes a minimal amount of norovirus particles (fewer than 100) to make you sick. People with norovirus illness shed billions of virus particles in their stool and vomit. Human norovirus has been found to remain infective beyond 70 days on stainless steel and plastic at both 44 degrees Fahrenheit or 7 degrees Celsius and room temperature.

Rotavirus—CDC states is the leading cause of diarrhea-related illnesses worldwide among children less than five years

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old, accounting for most diarrhea-related deaths. Rotavirus is resistant to most disinfectant products. It can survive for a few hours on human hands and days on hard surfaces. Rotavirus has been found to remain infectious on a metal surface for at least two months at various temperatures and humidity levels. Surfaces likely to be contaminated include infected individuals' hands, doorknobs, sinks, toilets, and faucets. In daycares, up to 19% of surfaces were found to be contaminated with rotavirus during an outbreak.

Surface contamination network and its role in disease spread

Hao Lei and others conducted a study of aircraft cabins published in 2017 and found that when we touch an object, we transfer viruses to a surface or accumulate more viruses on our hands and create a surface contamination network. This network exhibited a community structure, with small communities connected by the aisle seatback surfaces and toilets, which are high-touch surfaces. In less than two to three hours, most high-touch surfaces in the cabin were contaminated, and within five to six hours, nearly all touchable surfaces were contaminated. During short-haul flights, aisle passengers have higher fomite exposure. The existence of a surface touch network means that many surfaces can be contaminated.

This was the first study to identify the existence of a surface contamination network in a crowded environment. They simulated their study model with two reported outbreaks of norovirus on planes. They found that aisle seatback surfaces are high-touch surfaces that can be rapidly contaminated, leading to the aisle passenger having a higher infection risk than others. The two reported inflight outbreaks of norovirus were:


Norovirus outbreak occurred on October 8, 2008, during a three-hour Boeing 737 flight from Boston to Los Angeles. Six of 35 tour group members experienced vomiting or diarrhea. Five vomited into sickness bags while in their seats. After the flight, seven of the 82 non-tour group passengers had norovirus illness.

Norovirus outbreak occurred on a 12.5-hour Boeing 747-400 flight from Los Angeles to Auckland, New Zealand, on January 19, 2007. Two passengers had norovirus during the flight. After the flight, 52 of 222 passengers had norovirus illness.

They concluded that the commonly repeated advice to wash our hands frequently might be replaced by more strategic advice, such as to immediately clean surfaces or advice based on who should wash their hands, and when.

We know that contaminated surfaces and objects can transmit diseases and improving surface cleaning and hand

hygiene can decrease infection. The CDC recommends cleaning and disinfecting high-touch surfaces on a more frequent basis than minimal-touch surfaces.

In practice, the most significant public health gain would be implementing a strategy involving more routine surface cleaning and disinfection and increased hand hygiene practices to significantly reduce the risk of viral transmission in any indoor space. 



Dr. Gavin Macgregor-Skinner is the senior director of the Global Biorisk Advisory Council™ (GBAC), a division of ISSA. He also serves as an associate professor at the Penn State College of Medicine.

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