

Preventing Foodborne Illness: Typhoid Fever—*Salmonella* Typhi¹

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What is typhoid fever?

Typhoid fever is a blood infection caused by the consumption of food or water contaminated with the bacterium *Salmonella enterica*, subspecies *enterica*, serovar Typhi, which is commonly referred to as *Salmonella* Typhi, *Salmonella* Typhi, or *S. Typhi*. Not to be confused with other members of the bacterial group *Salmonella* (often called "non-typhi *Salmonella*"), which invade the intestines to cause *Salmonella* food poisoning or salmonellosis; *Salmonella* Typhi has no known reservoir outside of humans.

Typhoid fever is easily controlled and relatively uncommon in industrialized nations like the United States. An estimated 9.2 million people per year are affected by typhoid fever, including regions in Asia, Africa, and South America. Of the approximately 5,700 cases of typhoid fever each year in the US, most are acquired through international travel to these regions (CDC 2024).

What causes typhoid fever?

Humans are the only known reservoir of this organism. Infected individuals carry *S. Typhi* in their intestinal tract and bloodstream and periodically "shed" the bacteria in their stool (CDC 2013, Gopinath et al. 2012) and less commonly in their urine. Transmission from host to host occurs if food or water contaminated with such fecal matter is ingested. This is known as the fecal-oral pathway. Blood from an infected person also could transmit the bacterium to other people. Following ingestion of contaminated food or water, *S. Typhi* enters the small intestine, multiplies, and spreads into the bloodstream. The resulting infection is systemic. The gallbladder, liver, intestines, and spleen are commonly affected.

In addition to actively infected individuals, shedding of *S. Typhi* also occurs in the stool of chronic carriers, those that continue to carry the disease and may or may not exhibit symptoms. The carrier state, representing 3%–5% of infected individuals, is thought to be the result of *Salmonella* biofilms that form on the surface of gallstones in the gallbladder and persist for decades (Gonzalez-Escobedo et al. 2011).

What are the symptoms associated with typhoid fever?

Typhoid fever may result in sudden onset of symptoms including sustained fever as high as 104°F, headache, nausea, constipation, diarrhea, rose-colored spots across the abdomen, and loss of appetite (CDC 2024). Damage to internal organs is the leading cause of death associated with the illness. Multiplication of *S. Typhi* can result in inflammation and perforation of the intestinal wall, which is associated with high morbidity and mortality (Memon 2001). Perforation of the gall bladder is also possible but more frequently associated with immunocompromised patients and the young (Sukanya et al. 2013). Many other complications can also occur ranging from a ruptured spleen to meningitis, and even coma.

If left untreated, bacteria present in the bloodstream and intestines could cause a sustained high fever lasting anywhere from weeks to months. An estimated 20% of untreated individuals die from infection-related complications, while only 1%–4% of treated individuals experience the same risk (CDC 2024). The incubation period of *S. Typhi* is between 3–60 days, but symptoms are typically presented within 1–2 weeks of infection (Chatterjee et al. 2021).

Rose-colored spots on the lower abdomen and/or upper torso are generally a characteristic symptom in the diagnosis of *S. Typhi* infection. However, confirmation of typhoid fever requires isolation of *S. Typhi* in stool, blood, or bone marrow samples. If all tissues are cultured, infected patients will be detected with a sensitivity rate of more than 90%. If only blood is cultured, test sensitivity is reduced to 45%–70% (Gilman et al. 1975). For patients presenting clinical symptoms but negative cultures, PCR can be performed to reinforce an early clinical diagnosis (Song et al. 1993). This is particularly useful in regions in which typhoid fever is endemic.

Who is at risk?

While no particular group of people is more or less susceptible to typhoid fever, those living in or traveling to developing countries, which have populations with poor

hygiene, inadequate sewage disposal, or a limited capacity for water treatment, are at higher risk.

The Centers for Disease Control and Prevention (CDC) recommends that travelers to regions where typhoid fever is common get vaccinated to prevent infection. Such vaccinations are available in both inactivated or live, attenuated form. The inactivated typhoid vaccine is delivered as a shot in one dose, should be administered at least two weeks prior to travel, and requires a booster shot every two years. The live, attenuated vaccine is administered in four oral doses at least one week prior to travel and requires a booster dose every five years (CDC 2012). Additionally, it is recommended that travelers heed the following guidelines regarding food and beverage consumption:

1. Avoid raw fruits and vegetables that cannot be peeled.
2. Do not buy foods from street vendors.
3. Do not eat "bushmeat" including monkeys, bats, or other wild game.
4. All food consumed should be thoroughly cooked and still hot and steaming. Intact meats should be cooked to an internal temperature of 145°F, and ground meats and leftovers should be cooked to 160°F (measured with a food thermometer).
5. Drink only bottled (or boiled) water, bottled and sealed carbonated drinks, and pasteurized milk.

The typhoid vaccine is also recommended to individuals in close contact with an *S. Typhi* carrier and individuals working with the bacteria in laboratory settings (CDC 2019).

What foods have been commonly associated with typhoid fever?

Contaminated food and drinking water represent the main sources of *S. Typhi* transmission. Most often, food and beverages become contaminated through handling by infected individuals with poor personal hygiene practices. Water can also become contaminated through contact with raw sewage. Additionally, though shellfish are not carriers of *S. Typhi*, they may become contaminated if harvested from beds contaminated with sewage (WHO 2023). Eating raw vegetables that have been fertilized by contaminated soil or water can also be a danger.

In short, *any* food allowed to come into contact with body fluids (e.g., feces, vomit, urine) from infected individuals can be contaminated with *S. Typhi*.

What sanitation methods have been used to prevent the spread of typhoid fever?

Because the only mode of transmission of typhoid fever is through the ingestion of human feces containing *S. Typhi*, personal hygiene, proper sewage handling, and the presence of treatment facilities in industrialized countries like the United States minimize the spread of disease.

Personal Hygiene

As with true foodborne diseases, and as a good general sanitary practice, both personally and professionally, proper handwashing is very important.

The major cause of foodborne illness related to retail establishment settings is poor personal hygiene. Inadequate hand washing increases the potential for contamination because dirty hands contaminate food. This is especially true of typhoid fever-causing bacterium *S. Typhi*, as it travels from host to host through contact with human waste.

Bacteria are too small to be seen with the naked eye. Hands may be contaminated with disease-causing bacteria even when they look clean. For this reason, hands should be washed before preparing food and rewashed after contact with items not part of the assembly process. The same is true even while wearing gloves.

Millions of bacteria and other germs can be transferred on contact. Here is a list of times when you should wash your hands:

- before handling, preparing, or serving food
- before handling clean utensils or dishware
- after using the restroom
- after touching your face, cuts, or sores
- after smoking, eating, or drinking
- after handling raw meat—especially poultry
- after touching unclean equipment, working surfaces, soiled clothing, soiled wiping cloths, etc.
- after collecting and taking out the garbage

What is the proper procedure for hand washing?

- Wet your hands with warm water.
- Apply soap and wash your hands for 20 seconds.
- Rinse with potable water and then dry with a single-use paper towel.

Historical Interest: Typhoid Mary

In the early 1900s, a woman by the name of Mary Mallon was the first "healthy carrier" of typhoid fever in the United States (Rosenberg 2015). It is estimated that 47 people were infected by Ms. Mallon; of those 47 people, three died.

Mallon worked as a cook for very wealthy families. After half of the household of one such family became ill with typhoid fever, they hired investigators to determine the cause. Eventually, she was implicated as the source of the illness in that household and several others. Health officials were notified, and eventually, she was detained, despite much resistance.

She was taken to a hospital in New York, where stool samples were taken. She tested positive for typhoid bacteria, even though she remained symptom-free. The health department then transferred her to an isolated area on North Brother Island, NY, where she spent a couple of years but was eventually released. She was given strict guidelines by health officials to stay away from any work that would involve food preparation or any type of care for people.

Approximately five years after her release, an outbreak of typhoid fever in a Manhattan, NY, hospital was reported. Twenty-five persons became ill, two of which died. It was soon discovered that Mary Mallon was working there as a cook, under a fictitious name. At this point she was recaptured and again isolated on North Brother Island for the remainder of her life, about 28 years.

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