

Preventing Foodborne Illness Associated with *Clostridium perfringens*¹

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This is one in a series of fact sheets discussing common foodborne pathogens of interest to food handlers, processors, and retailers.

What causes a *Clostridium perfringens*-associated foodborne illness?

The bacterium *Clostridium perfringens* causes one of the most common types of foodborne gastroenteritis in the United States, often referred to as perfringens food poisoning (FDA 2012). It is associated with consuming contaminated food that contains great numbers of vegetative cells and spores that will produce toxin inside the intestine. There are two forms of disease caused by *C. perfringens*: gastroenteritis and enteritis necroticans. The latter disease, also known as pig-bel disease, is not common in the United States. It is often associated with contaminated pork and can be very severe (FDA 2012).

According to estimates by the Centers for Disease Control and Prevention (CDC), as many as one million individuals are affected by *C. perfringens* each year (Grass et al. 2013; Scallan et al. 2011; CDC 2017) although only a fraction of these are recorded. It was also estimated that *C. perfringens* accounts for 438 hospitalization and 26 deaths annually in the United States (Scallan et al. 2011). The number of

C. perfringens foodborne illnesses is likely under-reported due to the mildness of symptoms, brief illness duration (less than 24 hours), and lack of routine testing by public health officials. The average cost per case (cost-of-illness model includes estimates for medical costs, pharmaceutical costs, productivity losses, possible chronic conditions, and illness-related death) of *C. perfringens* in 2010 was \$482 (Scharff 2011).

Outbreaks Associated with *Clostridium perfringens*

While outbreaks of *C. perfringens* are common, they do not become major headlines because the typical symptoms of the illness are mild, and deaths are extremely rare. Table 1 outlines several confirmed outbreaks of *C. perfringens* that were identified by the CDC in 2015 (the most recent data available).

What is *Clostridium perfringens*?

Clostridium perfringens is an anaerobic, Gram-positive, bacterial pathogen that has the capability of forming endospores. These tough, dormant spores allow for the protection of the bacteria during times of environmental stress (for example lack of water, high temperature, etc.) (Cornell 2017). Sporulation allows *C. perfringens* to survive

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the cooking process. Foods must be kept at 140°F (60°C) or higher after cooking to prevent the growth of the surviving endospores (CDC 2017). While the endospores are not detrimental to humans, spores can change into potentially harmful vegetative cells if exposed to inadequate cooking temperatures and then allowed to cool at temperatures between 54°F (12°C) and 140°F (60°C) for several hours. The optimal growth temperatures of *C. perfringens* range between 109°F (43°C)–117°F (47°C) (CDC 2017). The vegetative cells can produce a toxin that causes gastrointestinal illnesses in humans (Grass et al. 2013).

Clostridium perfringens is found not only in soil and sediment, but is present as a part of the normal intestinal flora of animals and humans. Thus, the organism can be found in sewage and in areas prone to animal and sewage contamination. *Clostridium perfringens* spores have been isolated from raw and cooked foods (Grass et al. 2013).

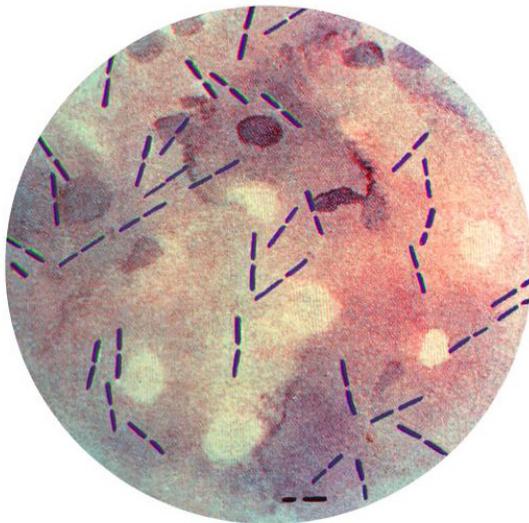


Figure 1. Photomicrographic view of a Gram-stained culture specimen, revealing the presence of numerous *Clostridium perfringens* Gram-positive bacteria.
Credits: CDC (1979) [PHIL #14346]

How is *Clostridium perfringens* spread?

Clostridium perfringens thrives in high-protein foods of animal origin, such as meat and meat products, meat dishes, stews, soups, gravies, and milk (see outbreak data in Table 1). Occasionally, poultry products, pork, lamb, fish, shrimp, crab, legumes (beans), potato salad, and macaroni and cheese may contain *C. perfringens*. These protein-containing foods, when kept at improper storage temperatures, between 54°F (12°C) and 140°F (60°C), provide the greatest risk of infection and disease from *C. perfringens*. This is because spores present after cooking can germinate and potentially grow to high, dangerous

numbers. The danger zone exists between 109°F (43°C) and 117°F (47°C) (CDC 2017). Foods need to be cooled rapidly through this zone on their way to 40°F (4.4°C). The 2013 Food Code recommends that food should not be in this zone for more than 2 hours (FDA 2013). If reheating foods, it is recommended to heat it to at least 165°F (74°C) (CDC 2017). In the majority of illnesses involving these foods, keeping food in the danger zone too long was identified as the cause of the *C. perfringens* food poisoning.

Symptoms of *Clostridium perfringens* Illness

Gastroenteritis, which is the inflammation of the stomach and/or intestines, can occur 6–24 hours after consuming food contaminated with large numbers of the vegetative form of *C. perfringens* (CDC 2017). The infective dose for *C. perfringens* is 100,000 to 1,000,000 cells/spores per gram of food (FDA 2012). Symptoms include severe abdominal cramps and pain, diarrhea, and flatulence (CDC 2017). Because most symptoms usually last approximately 24 hours, many infected individuals believe that they had a case of the “24-hour flu” (Birkhead et al. 1988). Occasionally, less severe symptoms may continue for 1–2 weeks (CDC 2017). These longer episodes are usually associated with the extremely young or the elderly. In severe cases, dehydration and other complications can result in the death of the infected individual.

The gastrointestinal symptoms, typically without fever, precede confirmation by toxin or organism detection in fecal (stool) samples of affected individuals (CDC 2017). The illness can also be confirmed by the detection of *C. perfringens* in the suspected food that was consumed (Birkhead et al. 1988; Dailey et al. 2012).

Another disease caused by *C. perfringens* is called enteritis necroticans or pig-bel disease. It is associated with developing countries, and it is often fatal (Petrillo et al. 2000; FDA 2012). The disease is caused by *C. perfringens* type C, which is often associated with eating contaminated pork or pig intestines (Gui et al. 2002). It can cause vomiting, abdominal pain, bloody diarrhea, swollen abdomen, and necrosis of small intestines (Songer 2010; Gui et al. 2002; FDA 2012). The disease is very rare in the United States. However, it was reported in two diabetic patients, a child, and an adult, who were diagnosed with pig-bel disease in 1998 and 2001, respectively (Petrillo et al. 2000; Gui et al. 2002).

Which populations are at high risk for *Clostridium perfringens* foodborne illness?

Hospitals, nursing homes, prisons, and school cafeterias are locations that pose the highest risk of a *C. perfringens* outbreak (CDC 2017). In these settings, foods are cooked but may not be kept at safe, adequate temperatures prior to serving. Although *C. perfringens* may be present in small numbers in raw foods, improper storage and handling of these foods could allow the pathogen to grow to high, harmful numbers (CDC 2017, FDA 2013). The age group with the highest number of illnesses due to *C. perfringens* is those between the ages of 20–49, with men being more likely to become ill than women (Grass et al. 2013). Immunocompromised individuals may experience longer symptoms and complications (CDC 2017).

How can *Clostridium perfringens* foodborne illness be controlled and prevented?

Since *C. perfringens* can grow rapidly at elevated temperatures and forms heat-resistant spores, preventing growth is paramount. Foods should be cooked to an internal temperature of 165°F (74°C) or higher for 15 seconds to inactivate the pathogen's vegetative cells. Additionally, the cooked food must be chilled rapidly to 41°F (5°C) or less, or kept at hot holding temperatures of 140°F (60°C) or higher to prevent any activation and growth of *C. perfringens* spores.

Large portions of meat, broth, gravies, and other foods commonly associated with *C. perfringens* must meet specific guidelines noted in the 2013 FDA Food Code. These guidelines specify that potentially hazardous food shall be cooled within 2 hours from 135°F (57°C) to 70°F (21°C) and within six hours from the initial 135°F (57°C) to 41°F (5°C). Large containers of food may take an extended period of time to cool to 41°F (5°C) and therefore should be separated into smaller portions. Additionally, storage containers should be stacked to encourage good airflow both above and below to facilitate rapid cooling. Leftover foods should be reheated to 165°F (74°C) or greater while stirring and rotating and allowed to stand covered for 2 minutes. This should inactivate any vegetative cells that have germinated during cooling, as well as other foodborne pathogens which may have cross-contaminated the food (CDC 2017, FDA 2013).

Best Ways to Avoid Illness

The best way to prevent foodborne illness associated with *C. perfringens* is to observe a few proper control measures in food preparation, storage, and temperature controls. These includes measures such as the rapid, uniform cooling of cooked foods; making sure cooked foods remain hot after they are cooked; and when reheating cooled or chilled foods, all parts of the foods should reach a minimum temperature of at least 165°F (74°C) (FDA 2013).

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