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FSHN035

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* foodborne illness?

The bacteria *Clostridium perfringens* is one of the leading causes of foodborne gastroenteritis in the United States. According to the Centers for Disease Control and Prevention (CDC) estimates, as many as one million individuals are affected by *C. perfringens* each year (Grass et al. 2013; Scallan et al. 2011) although only a fraction of these are actually recorded. The number of *C. perfringens* foodborne illnesses is likely underreported due to the mildness of symptoms, brief illness duration, and lack of routine testing by public health officials. The average cost per case (cost-of-illness model includes estimates for medical costs, productivity losses, and illness-related death) of *C. perfringens* is $539 (Scharff et al. 2009) with a 13 year total (1998–2010) of just over $8 million dollars (Grass et al. 2013).

Outbreaks associated with *Clostridium perfringens*

While outbreaks of *C. perfringens* are common, they do not become major headlines, as the typical symptoms of the illness are mild and deaths are extremely rare. Most of the symptoms only last about 24 hours, so identifying an outbreak in that limited amount of time is difficult (Murray et al. 2007). Table 1 outlines several of the outbreaks that were identified by the CDC in 2011 (the most recent data available).

What type of bacterium 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 2014). This sporulation allows *C. perfringens* to survive the cooking process if the food is not heated above 140°F. While the endospores are not detrimental to humans, these spores can change into potentially harmful vegetative cells if exposed to low cooking temperatures and then allowed to remain at temperatures between 54°F and 140°F for several hours. The range of 109°F–117°F is particularly conducive to this occurrence (CDC 2013). These vegetative cells can produce a toxin that will cause 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

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contamination. *Clostridium perfringens* spores have also been isolated from raw and cooked foods (Grass et al. 2013).

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 and 140°F, provide the greatest risk of infection and disease from *C. perfringens*, since spores present after cooking can germinate and potentially grow to high, dangerous numbers. The danger zone exists between 109°F and 117°F (CDC 2013). Foods need to be cooled rapidly through this zone on their way to 41°F. The 2009 Food Code recommends that food should not be in this zone for more than two hours (FDA 2009). 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 2013). Symptoms include severe abdominal cramps and pain, diarrhea, and flatulence (CDC 2013). 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 2013). These longer episodes are usually associated with the extremely young or the elderly. In severe cases, dehydration and other complications can result in 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 2013). 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).

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 2013). 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 2013; FDA 2009). 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).

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

Since *Clostridium 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 or higher to inactivate the pathogen's vegetative cells. Additionally, the cooked food must be chilled rapidly to 41°F or less, or kept at hot holding temperatures of 140°F 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 2009 FDA Food Code. These guidelines specify that potentially hazardous food shall be cooled within two hours from 140°F to 70°F, and within six hours from the initial 140°F to 41°F. Large containers of food may take an extended period of time to cool to 41°F 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 or greater, which should inactivate any vegetative cells that have germinated during cooling, as well as other foodborne pathogens which may have cross-contaminated the food (CDC 2013; FDA 2009).

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 include measures such as the rapid, uniform cooling of cooked foods; making sure cooked foods remain hot after they're cooked; and when reheating cooled or chilled foods making sure foods reach a minimum internal temperature of at least 165ºF.

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Table 1. Outbreaks of *Clostridium perfringens* in 2011

Year	Month	State	Genus Species	Status	Location of Consumption	Total Ill	Total Hospitalized	Total Deaths	Food Vehicle	Contaminated Ingredient
2011	February	Illinois	*Clostridium perfringens*	Confirmed	School	30	0	0	chicken, BBQ	chicken
2011	March	Minnesota	*Clostridium perfringens*	Confirmed	Prison, jail	32	0	0	potato, scalloped	
2011	April	Idaho	*Clostridium perfringens*	Confirmed	Restaurant—Sit-down dining	23	0	0	enchilada, chicken	chicken
2011	March	Florida	*Clostridium perfringens*	Suspected	Restaurant—"Fast-food" (drive-up service or pay at counter)	4	0	0		
2011	May	Kansas	*Clostridium perfringens*	Suspected	Prison, jail	115	0	0	chili macaroni	turkey
2011	May	Wisconsin	*Clostridium perfringens*	Suspected	Private home	12	0	0	beef, roast with gravy	
2011	June	Louisiana	*Clostridium perfringens*	Confirmed		30	0	0		
2011	March	Colorado	*Clostridium perfringens*	Confirmed	Caterer	27	0	0	beef, brisket; potato, mashed	beef, brisket; gravy, beef; potatoes
2011	June	Connecticut	*Clostridium perfringens*	Confirmed	Restaurant—Sit-down dining	4	0	0	chicken, stew	
2011	March	California	*Clostridium perfringens*	Suspected	Private home	19	0	0	refried beans, unspecified	
2011	August	Minnesota	*Clostridium perfringens*	Confirmed	Workplace, not cafeteria	5	0	0		
2011	November	Ohio	*Clostridium perfringens*	Confirmed	Private home	101	0	0	turkey, roasted	turkey
2011	October	Colorado	*Clostridium perfringens*	Suspected		40	1	0	rice	rice
2011	December	New York	*Clostridium perfringens*	Suspected	Restaurant—Sit-down dining	17	0	0	steak, prime rib	beef
2011	November	Arizona	*Clostridium perfringens*	Suspected	Other	45	0	0	mashed potato/ gravy; stuffing/ gravy	
2011	December	Iowa	*Clostridium perfringens*	Confirmed		21	0	0		
2011	December	Nevada	*Clostridium perfringens*	Confirmed	Workplace, not cafeteria	21	0	0	ham	ham
2011	December	Ohio	*Clostridium perfringens*	Confirmed	Workplace, not cafeteria	10	0	0	turkey, roasted	turkey

2011	November	North Dakota	*Clostridium perfringens*	Confirmed	Prison, jail	88	0	0		
2011	November	North Dakota	*Clostridium perfringens*	Suspected	Banquet facility	23	0	0		

Data from the Centers for Disease Control and Prevention's Foodborne Outbreak Online Database (Food) (http://wwwn.cdc.gov/foodborneoutbreaks/)