

# Chapter 13: *Clostridium perfringens*

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## Potential Food Safety Hazard

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Food poisoning caused by *Clostridium perfringens* may occur when foods such as meat or poultry are cooked and held without maintaining adequate heating or refrigeration before serving. The presence of small numbers of *C. perfringens* is not uncommon in raw meats, poultry, dehydrated soups and sauces, raw vegetables, and spices. Because the spores of some strains are resistant to temperatures as high as 100°C for more than 1 h, their presence in foods may be unavoidable. Furthermore, the oxygen level may be sufficiently reduced during cooking to permit growth of the clostridia. Spores that survive cooking may germinate and grow rapidly in foods that are inadequately refrigerated after cooking. Thus, when clinical and epidemiological evidence suggests that *C. perfringens* is the cause of a food poisoning outbreak, the presence of hundreds of thousands or more of these organisms per gram of food substantiates the diagnosis.

Illness typically occurs 8-15 h after ingestion of the contaminated food. The symptoms, which include intense abdominal cramps, gas, and diarrhea (nausea and vomiting are rare), have been attributed to a protein enterotoxin produced during sporulation of the organism in the intestine. The enterotoxin can be detected in sporulating cultures, and a method for this purpose is included. A high correlation has been established between the ability of *C. perfringens* strains to produce enterotoxin and their ability to cause food poisoning. However, it is difficult to obtain consistent sporulation with some strains (Rhodehamel and Harmon, 1998).

## Control Measures

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Control measures emphasize proper food preparation and storage techniques, especially temperature control. Control measures include:

1. Rapid, uniform cooling of cooked foods to <math><10^{\circ}\text{C}</math> (50°F) within 2-3 h;
2. Hot holding of cooked foods at or above 60°C (140°F);
3. Reheating cooled or chilled foods to a minimum internal temperature of 75°C (167°F) immediately before serving;
4. Not leaving foods at room temperature or thawing frozen foods at room temperature;
5. Preventing cross-contamination of cooked foods with bacteria from raw foods by using separate food-contact surfaces for preparing raw and cooked food items, or by thoroughly cleaning and sanitizing food-contact surfaces after being used for raw products;
6. Maintaining food preparation areas so that they are free of soil and dust;
7. Cleaning and sanitizing meat slicers, meat-cutting equipment, food-contact surfaces, and other equipment after use; and
8. Using good personal hygiene methods, and thoroughly washing hands frequently when handling food products, especially after handling raw products and before handling cooked products (Labbe, 1989; Reed, 1994).

## FDA Guideline

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FDA to assess situations on a case by case basis.

## Growth

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[Table A-4. Limiting conditions for pathogen growth.](#)

## Heat Resistance

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Heat resistance of *C. perfringens* spores.

Temp.		D-Value (min.)	Strain	Medium	Reference
(°C)	(°F)				
55	131	179	NCTC 8798	Ground beef	Roy et al., 1981
57	134.6	34.9	NCTC 8798	Ground beef	Roy et al., 1981
59	138.2	16.9	NCTC 8238	Ground beef	Roy et al., 1981
61	141.8	3.9	NCTC 8238	Ground beef	Roy et al., 1981
98.9	210.0	31.4	NCTC 8798	Beef gravy	Bradshaw et al., 1977
100	212	17.6	NCTC 8238	SEC broth	Weiss and Strong, 1967
104.4	219.9	8.0	NCTC 10240	Beef gravy	Bradshaw et al., 1977
110.0	230	0.95	NCTC 10240	Beef gravy	Bradshaw et al., 1977
115.6	240.1	0.21	NCTC 10240	Beef gravy	Bradshaw et al., 1977

## Analytical Procedures

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[Food sampling and preparation of sample homogenate \(USFDA\)](#) [Top](#)

[Definition of Terms](#) (HC Appendix A); [Collection of samples](#) (HC Appendix B); [Supplement to All Methods in the HC Compendium: General Microbiological Guidance](#) (HC Appendix I) [General Microbiological guidance on Pre-warming of Broths in All Qualitative Methods in the \[HC\] Compendium](#) (HC Supplement to Appendix I) [Top](#)

[Clostridium perfringens](#) (USFDA) [Top](#)

[Enumeration of Clostridium perfringens in foods](#) (HC MFHPB-23) [Top](#)

**Other analytical procedures** [Top](#)

- *Clostridium perfringens* from shellfish (AOAC, 1995c)
- *Clostridium perfringens* in foods: alpha-toxin estimation method (AOAC, 1995b)
- *Clostridium perfringens* in foods: Microbiological method (AOAC, 1995a)
- MPN method for *C. perfringens* in shellfish (Abeyta and Wetherington, 1994)

## Commercial Test Products [Top](#)

Commercial test products for *C. perfringens*.

Test Kit	Analytical Technique	Approx. Total Test Time <sup>1</sup>	Supplier
<i>Clostridium Perfringens</i> Test [A presumptive test for <i>Clostridium perfringens</i> ]	Uses prepared traditional media	48 h	Biomedix Contact: Claver Bundac 1105 #F North Golden Springs Dr. Diamond Bar, CA 91765 Phone: 800/674-8648 #4282; 909/396-0244 E-mail: <a href="mailto:cb4biomedx@aol.com">cb4biomedx@aol.com</a>
ISO-GRID Method for <i>Clostridium perfringens</i> Count using Modified TSC agar	Membrane filtration with selective culture medium	24-72 h (24 h for presumptive enumeration and 48 h additional to confirm presumptive positive results)	Neogen Corporation 620 Leshler Pl. Lansing, MI 48912 Phone: 517/372-9200 E-mail: <a href="mailto:NeogenCorp@aol.com">NeogenCorp@aol.com</a> Web: <a href="http://www.neogen.com/isogridgen.htm">www.neogen.com/isogridgen.htm</a>
PET-RPLA TD930 [Used to identify <i>C. perfringens</i> type A enterotoxin]	Reversed passive latex agglutination	24 h (feces) 48 h (bacterial culture)	Oxoid, Inc. Contact: Jim Bell 217 Colonnade Rd. Nepean, Ontario K2E 7K3 Canada Phone: 613/226-1318 E-mail: <a href="mailto:jbelle@oxoid.ca">jbelle@oxoid.ca</a>

<sup>1</sup>Includes enrichment

## References

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