Food Microbiology

4th year Biology

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Food-Borne intoxication:

Clostridium Species:

The *Clostridia* are obligate anaerobic, gram-positive rods. Many decompose proteins or form toxins, and some do both. Their natural habitat is the soil or the intestinal tract of animals and humans, where they live as saprophytes. Among the pathogens are the organisms causing botulism, tetanus, gas gangrene, and pseudomembranous colitis. *Clostidium* sp. are known for the production of spores that allow survival of the organism under severe nutrient deprivation and dehydration conditions. Spores are even resistant to the actions of common antimicrobial agents and treatments .*Clostridium* spores are usually wider than the diameter of the rods in which they are formed. Placement can be central, subterminal, or terminal .Most species of clostridia are motile and possess peritrichous flagella.

What is Clostridium perfringens?

Clostridium perfringens (formerly called *Welchii*) is a spore-forming gram-positive, rod-shaped anaerobe which forms oval sub-terminal spores, non-motile bacterium that is found in many environmental sources as well as in the intestines of humans and animals, causes a wide range of symptoms, from food poisoning to gas gangrene. Some strains of *C. perfringens* produce a toxin in the intestine that causes illness *C. perfringens* is commonly found on raw meat and poultry. It prefers to grow in conditions with very little or no oxygen, and under ideal conditions can multiply very rapidly.

There are five types of *C. perfringens* (A, B, C, D, and E) based on the production of major lethal toxins (alpha, beta, epsilon, and iota). Type A strains are predominantly involved in food-borne intoxication. Many of these toxins have lethal, necrotizing, and hemolytic properties. The alpha toxin produced by all types *of C. perfringens,* is a lecithinase that lyses erythrocytes, platelets, leukocytes, and endothelial cells.C. *perfringens* also produces an enterotoxin which produced primarily by type A strains ,is an important cause of food poisoning.

What causes C. perfringens *food poisoning?*

Although *C. perfringens* may live normally in the human intestine, illness is caused by eating food contaminated with large numbers of *C. perfringens* bacteria that produce enough toxin in the intestines to cause illness. During cooling and holding of food at temperatures from 12°C-60°C, the spores germinate and then the bacteria grow. The bacteria grow very rapidly between 43°C- 47°C. If the food is served without reheating to kill the bacteria, live bacteria may be eaten.

*Which populations are at high risk for C*lostridium perfringens *food-borne illness?*

Hospitals, nursing homes, prisons, and school cafeterias are places that pose the highest risk of an outbreak of food-borne illness due to *C. perfringens*. In these locations, 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 allow the pathogen to grow to high, harmful numbers. The young and the elderly are most susceptible and are frequent victims of *C. perfringens* poisoning, experiencing longer and more severe symptoms. There are fewer complications in adults under the age of 30 years.

What kinds of foods are associated with Clostridium perfringens?

Clostridium perfringens thrives in high-protein foods of animal origin such as meat and meat products, meat dishes, stews, soups, and milk. To a lesser extent, poultry products, pork, lamb, fish, shrimp, crab, legumes (beans), potato salad, and cheese may contain *C. perfringens*. These protein-containing foods, when kept at improper storage temperatures between 5 °C and 48°C, 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. A danger zone exists between 21°C and 48°C. Foods need to be cooled rapidly through this zone on their way down to 5°C. The food code recommends that food should not be in this zone for more than 2 hours. In the majority of cases involving these foods, keeping food in the danger zone too long was the main cause of *C. perfringens* food poisoning.

How can Clostridium perfringens food-borne 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 74°C or higher to inactivate the pathogen's vegetative cells. Additionally, the cooked food must be chilled rapidly to 5°C or less, or kept at hot holding temperatures of 60°C or higher to prevent any activation and growth of *C.perfringens* spores.

Clostridium botulinum:

Clostridium botulinum is obligate anaerobic bacillus, gram-positive; spore-forming that produces a potent neurotoxin. The spores are heat-resistant to heat, light, drying and radiation; it is found in soil and occasionally in animal feces, can survive in foods that are incorrectly or minimally processed.

What is botulism?

Botulism is a neuroparalytic disease caused by the potent protein toxin released from *C. botulinum*. Seven types (A, B, C, D, E, F and G) of botulism are recognized, based on the antigenic specificity of the toxin produced by each strain. Types A, B, E and F are the principal causes of human illness. Types C and D cause most cases of botulism in animals.

Transmission:

Botulism transmission typically occurs through ingestion of the organism, neurotoxin or spores. If the organism is ingested, it then incubates in the stomach and produce spores which then germinate to release neurotoxin. If spores are ingested, germination follows and neurotoxin is released. Finally if spores have germinated within contaminated food, the neurotoxin itself is ingested, causing rapid progression of the disease. Other forms of transmission involve contamination of open wounds with Clostridial spores. Additionally, inhalation of the neurotoxin is also possible. This is the most likely bioterrorism method that would be used for this agent. No instance of secondary person-to-person transmission has been documented.

Pathogenesis:

After germination, Clostridial spores release neurotoxins .Only a few nanograms of these toxins can cause severe illness.Once released into the bloodstream it irreversibly binds to the acetylcholine receptors in the neuromuscular junction to prevent the release of acetylcholine (Ach). This causes muscular paralysis. The peripheral sensory nerves and the central nervous system are usually not affected

Clinical Findings

Human botulism illness can occur in three forms:

1-Food-borne botulism: occurs when food is contaminated with the botulism toxin and absorbed through the gastrointestinal tract.

2- Infant botulism: Infants <12 months of age are particularly susceptible to *C. botulinum* spores because their digestive tracts are not fully developed and therefore not able to prevent the germination and subsequent toxin production in the intestines.

3- Wound botulism: occurs when *C. botulinum* spores infect and germinate in the wound, producing toxin which is absorbed into the bloodstream.

The ***incubation period*** for botulism varies depending on amount of exposure and route of transmission. Incubation for ingestion botulism, for either infant or child/adult, is undeterminable because the date of spore ingestion is usually unknown. The incubation period for food-borne botulism can range from 6 hours to 8 days and 4-14 days for wound botulism.

The ***clinical signs*** of botulism are similar for all forms of the disease. Gastrointestinal signs (i.e., nausea, vomiting, and diarrhea) are usually the first signs to appear. They are followed acutely by neurological signs, such as bilateral cranial nerve deficits. The victim will have double vision, and difficulty seeing, speaking and swallowing. This soon develops into a descending weakness to symmetrical flaccid paralysis. This paralysis can affect the respiratory muscles and lead to death.

Treatment:

Most cases of botulism require immediate intensive care treatment. A mechanical ventilator will be needed if respiratory failure occurs. An intravenous equine-derived *botulinum* antitoxin is available on a case-by-case basis from the CDC through state and local health departments. Botulism immune globulin was approved for use on 2003 for the treatment of infant botulism caused by types A and G**.**

Prevention and Control:

1- Do not feed honey to children <1 yr of age (Because honey can contain *botulinum* spores and is not chemically treated/ boiled /pasteurized before consuming)

2- Proper home canning and food preservation methods which will destroy the spores:

- Proper time, temperature and pressure.

- 80^{o}C for 30 min or 100^{o}C for 10 min.

3- Prompt refrigeration of foods.

4- Boiling foods, especially those that are home canned, for over 10 min. to destroy the toxin.

5- Decontamination:

- Boil suspected food before discarding for the appropriate time to detoxify it.

- Boil or chlorine disinfect utensils that were in contact with the suspected food.