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Botulism

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Key facts

- Clostridium botulinum is a bacterium that produces dangerous toxins (botulinum toxins) under low-oxygen conditions.
- Botulinum toxins are one of the most lethal substances known.
- Botulinum toxins block nerve functions and can lead to respiratory and muscular paralysis.
- Human botulism may refer to foodborne botulism, infant botulism, wound botulism, and inhalation botulism or other types of intoxication.
- Foodborne botulism, caused by consumption of improperly processed food, is a rare but potentially fatal disease if not diagnosed rapidly and treated with antitoxin.
- Homemade canned, preserved or fermented foodstuffs are a common source of foodborne botulism and their preparation requires extra caution.

Overview

Foodborne botulism is a serious, potentially fatal disease. However, it is relatively rare. It is an intoxication usually caused by ingestion of potent neurotoxins, the botulinum toxins, formed in contaminated foods. Person to person transmission of botulism does not occur.

Spores produced by the bacteria *Clostridium botulinum* are heat-resistant and exist widely in the environment, and in the absence of oxygen they germinate, grow and then excrete toxins. There are 7 distinct forms of botulinum toxin, types A–G. Four of these (types A, B, E and rarely F) cause human botulism. Types C, D and E cause illness in other mammals, birds and fish.

Botulinum toxins are ingested through improperly processed food in which the bacteria or the spores survive, then grow and produce the toxins. Though mainly a foodborne intoxication, human botulism can also be caused by intestinal infection with *C. botulinum* in infants, wound infections, and by inhalation.

Symptoms of foodborne botulism

Botulinum toxins are neurotoxic and therefore affect the nervous system. Foodborne botulism is characterized by descending, flaccid paralysis that can cause respiratory failure. Early symptoms include marked fatigue, weakness and vertigo, usually followed by blurred vision, dry mouth and difficulty in swallowing and speaking. Vomiting, diarrhoea, constipation and abdominal swelling may also occur. The disease can progress to weakness in the neck and arms, after which the respiratory muscles and muscles of the lower body are affected. There is no fever and no loss of consciousness.

The symptoms are not caused by the bacterium itself, but by the toxin produced by the bacterium. Symptoms usually appear within 12 to 36 hours (within a minimum and maximum range of 4 hours to 8 days) after exposure. Incidence of botulism is low, but the mortality rate is high if prompt diagnosis and appropriate, immediate treatment (early administration of antitoxin and intensive respiratory care) are not given. The disease can be fatal in 5 to 10% of cases.

Exposure and transmission

Foodborne botulism

C. botulinum is an anaerobic bacterium, meaning it can only grow in the absence of oxygen. Foodborne botulism occurs when *C. botulinum* grows and produces toxins in food prior to consumption. *C. botulinum* produces spores and they exist widely in the environment including soil, river and sea water.

The growth of the bacteria and the formation of toxin occur in products with low oxygen content and certain combinations of storage temperature and preservative parameters. This happens most often in lightly preserved foods and in inadequately processed, home-

canned or home-bottled foods.

C. botulinum will not grow in acidic conditions (pH less than 4.6), and therefore the toxin will not be formed in acidic foods (however, a low pH will not degrade any pre-formed toxin). Combinations of low storage temperature and salt contents and/or pH are also used to prevent the growth of the bacteria or the formation of the toxin.

The botulinum toxin has been found in a variety of foods, including low-acid preserved vegetables, such as green beans, spinach, mushrooms, and beets; fish, including canned tuna, fermented, salted and smoked fish; and meat products, such as ham and sausage. The food implicated differs between countries and reflects local eating habits and food preservation procedures. Occasionally, commercially prepared foods are involved.

Though spores of *C. botulinum* are heat-resistant, the toxin produced by bacteria growing out of the spores under anaerobic conditions is destroyed by boiling (for example, at internal temperature greater than 85 °C for 5 minutes or longer). Therefore, ready-to-eat foods in low oxygen-packaging are more frequently involved in cases of foodborne botulism.

Food samples associated with suspect cases must be obtained immediately, stored in properly sealed containers, and sent to laboratories in order to identify the cause and to prevent further cases.

Infant botulism

Infant botulism occurs mostly in infants under 6 months of age. Different from foodborne botulism caused by ingestion of pre-formed toxins in food, it occurs when infants ingest *C. botulinum* spores, which germinate into bacteria that colonize in the gut and release toxins. In most adults and children older than about 6 months, this would not happen because natural defences in intestines that develop over time prevent germination and growth of the bacterium.

C. botulinum in infants include constipation, loss of appetite, weakness, an altered cry and a striking loss of head control. Although there are several possible sources of infection for infant botulism, spore-contaminated honey has been associated with a number of cases. Parents and caregivers are therefore warned not to feed honey to the infants before the age of 1 year.

Wound botulism

Wound botulism is rare and occurs when the spores get into an open wound and are able to reproduce in an anaerobic environment. The symptoms are similar to the foodborne botulism, but may take up to 2 weeks to appear. This form of the disease has been associated with substance abuse, particularly when injecting black tar heroin.

Inhalation botulism

Inhalation botulism is rare and does not occur naturally, for example it is associated with accidental or intentional events (such as bioterrorism) which result in release of the toxins in aerosols. Inhalation botulism exhibits a similar clinical footprint to foodborne botulism. The median lethal dose for humans has been estimated at 2 nanograms of botulinum toxin per kilogram of bodyweight, which is approximately 3 times greater than in foodborne cases.

Following inhalation of the toxin, symptoms become visible between 1–3 days, with longer onset times for lower levels of intoxication. Symptoms proceed in a similar manner to ingestion of botulinum toxin and culminate in muscular paralysis and respiratory failure.

If exposure to the toxin via aerosol inhalation is suspected, additional exposure to the patient and others must be prevented. The patient's clothing must be removed and stored in plastic bags until it can be washed thoroughly with soap and water. The patient should shower and be decontaminated immediately.

Other types of intoxication

Waterborne botulism could theoretically result from the ingestion of the pre-formed toxin. However, as common water treatment processes (such as boiling, disinfection with 0.1% hypochlorite bleach solution) destroy the toxin, the risk is considered low.

Botulism of undetermined origin usually involves adult cases where no food or wound source can be identified. These cases are comparable to infant botulism and may occur when the normal gut flora has been altered as a result of surgical procedures or antibiotic therapy.

Adverse effects of the pure toxin have been reported as a result of its medical and/or cosmetic use in patients, see more on 'Botox' below.

Botox

The bacterium *C. botulinum* is the same bacterium that is used to produce Botox, a pharmaceutical product predominantly injected for clinical and cosmetic use. Botox treatments employ the purified and heavily diluted botulinum neurotoxin type A. Treatment is administered in the medical setting, tailored according to the needs of the patient and is usually well tolerated although occasional side effects are observed.

Diagnosis and treatment

Diagnosis is usually based on clinical history and clinical examination followed by laboratory confirmation including demonstrating the presence of botulinum toxin in serum, stool or food, or a culture of *C. botulinum* from stool, wound or food. Misdiagnosis of botulism sometimes occurs as it is often confused with stroke, Guillain-Barré syndrome, or myasthenia gravis.

Antitoxin should be administered as soon as possible after a clinical diagnosis. Early administration is effective in reducing mortality rates. Severe botulism cases require supportive treatment, especially mechanical ventilation, which may be required for weeks or even months. Antibiotics are not required (except in the case of wound botulism). A vaccine against botulism exists but it is rarely used as its effectiveness has not been fully evaluated and it has demonstrated negative side effects.

Prevention

Prevention of foodborne botulism is based on good practice in food preparation particularly during heating/sterilization and hygiene. Foodborne botulism may be prevented by the inactivation of the bacterium and its spores in heat-sterilized (for example, retorted) or canned products or by inhibiting bacterial growth and toxin production in other products. The vegetative forms of bacteria can be destroyed by boiling but the spores can remain viable after boiling even for several hours. However, the spores can be killed by very high temperature treatments such as commercial canning.

Commercial heat pasteurization (including vacuum packed pasteurized products and hot smoked products) may not be sufficient to kill all spores and therefore the safety of these products must be based on preventing bacterial growth and toxin production. Refrigeration temperatures combined with salt content and/or acidic conditions will prevent the growth of the bacteria and formation of toxin.

The WHO *Five Keys to Safer Food* serve as the basis for educational programmes to train food handlers and educate the consumers. They are especially important in preventing food poisoning.

The *Five Keys* are:

- **keep clean**
- **separate raw and cooked**
- **cook thoroughly**
- **keep food at safe temperatures**
- **use safe water and raw materials.**

WHO's response

Botulism outbreaks are rare but are public health emergencies that require rapid recognition to identify the disease source, distinguish outbreak types (between natural, accidental or potentially deliberate), prevent additional cases and effectively administer treatment to affected patients.

Successful treatment depends significantly on early diagnosis and the rapid administration of the botulinum antitoxin.

WHO's role in responding to outbreaks of botulism that may be of international concern is as follows.

Surveillance and detection: WHO supports the strengthening of national surveillance and international alert systems to ensure rapid local outbreak detection and an efficient international response. WHO's main tool for these activities of surveillance, coordination and response is the use of the International Network of Food Safety Authorities (INFOSAN) which links national authorities in Member States in charge of managing food safety events. This network is managed jointly by FAO and WHO.

Risk assessment: WHO response is based on a risk assessment methodology that includes consideration of whether the outbreak is natural, accidental, or, possibly, intentional. WHO also provides scientific assessments as basis for international food safety standards, guidelines and recommendations developed by the Codex Alimentarius Commission.

Containment at the disease source: WHO coordinates with national and local authorities in order to contain outbreaks at their source.

Delivery of assistance: WHO coordinates between international agencies, experts, national laboratories, airlines and commercial organizations to mobilize response equipment, materials and supplies, including the provision and administration of botulinum antitoxin.

