Chapter 5

Foodborne Bacteria: Potential Bioterrorism Agents

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Additional information is available at the end of the chapter

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Abstract

Bioterrorist attacks are usually associated with airborne infections because of their easy dissemination and maximal effect on the human population. However, foodborne pathogens represent potential bioterrorist weapons, as the consumption of safe food affects every individual in the society. Most of the foodborne microorganisms can be readily isolated from natural sources and can cause severe outbreaks with a number of hospitalized persons. Biological agents, which may contaminate food products, are bacteria, viruses, yeasts, parasites, or chemical substances with microbial origin. They cause more than 200 diseases—ranging from diarrhea to cancers. Typical symptoms of food poisoning are abdominal cramps, nausea, vomiting, upset stomach, diarrhea, fever, dehydration, and others. Most isolated bacterial agents responsible for foodborne infections include bacteria from genera such as *Salmonella, Shigella, Bacillus, Clostridium, Listeria, Campylobacter, Escherichia, Staphylococcus, Vibrio, Enterobacter*, and *Yersinia*. In this chapter, we discuss the bacterial species causing food poisoning in the context of a potential bioterrorist attack. We review in a concise manner their morphological and biochemical characteristics, as well as the treatment and possible prevention measures. Popular examples of attacks with food poisoning agents and their impact on the society are also given.

Keywords: food poisoning, public health, bioterrorist agents, bacterial infections, prevention

1. Introduction

Bioterrorism refers to the use of infectious agents or other harmful biological or biochemical substances for terroristic purposes. Usually, the measures against bioterrorist attacks are focused on the aerosol infections, as airborne microorganisms can easily affect many people and lead to maximal morbidity when entering the respiratory tract. However, in some cases, the aim of a bioterrorist attack is not to achieve high lethality but also to produce fear, panic, and chaos in the community. In this context, the intentional dissemination of bacterial agents causing food poisoning is a potential bioterrorist threat.

The first attempts to use the pathogenic properties of some microorganisms in a destructive manner dated many centuries ago. In particular, bacteria causing food poisoning were extremely suitable as many of them (plague, cholera) were epidemically spread in the past and easily available for war and bioterrorist purposes. The plague is a typical example with many naturally occurred outbreaks and one well-documented intentional epidemic in human history: in 1346, during the Tatar siege of Caffa on the Crimean Peninsula, infected corpses have been catapulted in the city to cause a local outbreak which finally resulted in one of the most devastating epidemics in Europe—the Black Death [1].

In the beginning of the twentieth century, biological agents were used on a scientific basis by different national governments for war purposes. The effects of anthrax, cholera, glanders, dysentery, tetanus, typhus, salmonella, tularemia, and typhus with pox were less or more successfully studied and tested on animals and humans [1–3]. Comprehensive studies on the use of botulinum toxin were also undertaken during World War II, especially by the US government which intended to use prostitutes to assassinate Japanese officers by gelatin capsules loaded with botulinum toxin [4].

In the next decades, despite the ratification of a Convention on the prohibition of the development, production and stockpiling of bacteriological (biological) and toxin weapons and on their destruction (usually referred to as the Biological Weapons Convention) in 1972–1975, most of the countries have continued to work and design new biological agents to be used as weapons in eventual war conflicts. In such a way, fundamental knowledge was gained and it was just a question of time to be used for destructive purposes.

At the end of the twentieth century, the changed geopolitical situation resulted in less confrontation between the countries but in the appearance of different political, religious, or nationalistic extremist movements with well-qualified and motivated members, prepared to use the available knowledge and technologies. Between 1990 and 1995, at least three bioterrorist attacks with botulinum neurotoxin failed in Japan [5]. During the same decade, the international community found thousands of litters of botulinum toxin, anthrax, and aflatoxin in Iraq that were ready to be used as mass destruction weapons [6].

The biggest bioterrorist attack in the USA occurred in 1984 with a foodborne pathogen—*Salmonella typhimurium*—which was used to contaminate salad bars in restaurants in Oregon [7]. Members of the religious commune “Bhagawan Shree Rajneesh” tried to sabotage the local elections and succeeded in infecting 751 persons.

In 1996, intentionally contaminated muffins and doughnuts caused severe gastroenteritis in 12 laboratory staff members in a large laboratory in the USA [8]. The investigations revealed *Shigella dysenteriae* type 2, identical to the laboratory’s stock strain, as the causative agent of the outbreak. However, the origin and the purpose of this attack remained unknown.

The most popular bioterrorist attacks occurred in 2001 over the whole territory of the USA when spores of *Bacillus anthracis* were sent via post letters to different governmental and public institutions. As a result of these attacks, 22 persons were infected and 5 of them died.

In the twenty-first century, with the enlarged terrorist activity, the preparedness of society for bioterrorist attacks, including intentional food poisoning, should also expand to guarantee quick response and adequate action. The main foodborne pathogens with a potential to be used as a biological weapon should be known, as well as their prevention and treatment.

2. Classification of foodborne bacteria as potential bioterrorist weapons

The Centers for Disease Control and Prevention (CDC) recognizes three categories of biological agents in respect of bioterrorism [9]:

- Category A: These are high-priority agents posing a risk to national security because of their easy dissemination, high mortality rates, and high public health impact. They require special action for public health preparedness.
- Category B: These are the second highest priority agents. They have moderately easy dissemination, moderate morbidity rates, and low mortality rates. These microbes require specific enhancements of diagnostic capacity and enhanced disease surveillance.

Bacterial species	Disease
Category A	
Bacillus anthracis	Anthrax
Clostridium botulinum	Botulism
Yersinia pestis	Plague
Category B	
Brucella spp.	Brucellosis
Enterobacteria (*Salmonella spp*, *Shigella spp.*, *Escherichia coli O157:H7*)	Salmonellosis, dysentery, other gastrointestinal diseases
Staphylococcus aureus	Food intoxication
Clostridium perfringens	Food intoxication, gas gangrene
Vibrio spp.	Cholera and cholera-like diseases
Category C	
Not cited	

Table 1. Categories of foodborne bacteria (and their corresponding diseases) as possible bioterrorist agents (according to [9]).

- Category C: These include the third highest priority agents, which are emerging pathogens that could be easily engineered. They have potential for high morbidity and mortality rates and major health impacts.

Table 1 shows which foodborne bacterial pathogens fall into these three categories of potential biological weapons. *Bacillus anthracis* is the bacterium most likely to be used as a bioterrorist agent because its spores are widely spread in nature and it easily grows under nonspecific conditions in the laboratory. Anthrax spores can be released at any place as aerosols but also can be put in food and drink. However, airborne route of transmission is more dangerous for the society and therefore preferred for terroristic purposes. Historically no intentional cases of foodborne transmission of anthrax are cited and as the objective of this chapter is to summarize food poisoning agents as potential biological weapons, *Bacillus anthracis* should not be considered further in the text.

3. Foodborne bacteria that can be used as potential bioterrorist agents

3.1. *Clostridium botulinum*

Clostridium botulinum is a Gram-positive, anaerobic spore-forming bacterium, which is common in soils, sediments, animal excrements, and gastrointestinal tract of birds and mammals. It causes botulism. The three forms of the disease are known—foodborne, wound, and infant botulism. The foodborne botulism is the most common form and represents an intoxication which occurs after the ingestion of food contaminated with botulinum toxin. It is mainly caused by botulinum toxin type A, B, and E [10]. The wound botulism is a result of the invasion of a wound with *C. botulinum*. Finally, the infant botulism is an intestinal infection of the non-matured gastrointestinal tract of babies after the consumption of food contaminated with *C. botulinum* (usually honey or water). The symptoms start 18–24 h after the consumption of infected food or after the entry of bacteria into the traumatized tissue. The disease is usually severe—in the foodborne form, it manifests with abdominal cramps, headaches, and vomiting. In all forms of the disease, late symptoms include paralysis of eye muscles (ptosis of eyelid and damage of accommodation), difficulty in swallowing, speech, and breathing.

Diagnosis of botulism is often difficult and consists of toxin demonstration in serum, fecal, or food samples. Patients suspicious of botulism should be hospitalized immediately and the treatment should start immediately with antitoxin administration. The therapy includes intubation and ventilation, as paralysis of respiratory muscles is the primary cause of death from botulism [11]. Antibiotic treatment with penicillin, tetracycline, metronidazole, and chloramphenicol is also recommended but aminoglycosides should be avoided as they may cause additional complication.

The botulinum toxin is a neurotoxic protein of two polypeptide chains linked with a disulfide bond [12]. Nine types of the toxin exist—from A to H (C is divided into C1 and C2) [13]. The mechanism of action consists of the inhibition of the acetylcholine release in the neuromuscular synapses, which results in blocking the neural impulse transmission and muscle paralysis.

Currently, botulinum toxin is considered as the strongest toxic substance in the world—1 g may cause the death of millions of people. The symptoms of botulism, as well as the bacterial characteristics, classify *Clostridium botulinum* in category A of biological agents with the potential to be used as a terroristic tool (**Table 1**). The disease is associated with severe neuromuscular damage, urgent need of hospitalization, and intubation. In the case of massive infection, the hospital infrastructure of any country could not provide adequate care for all patients. In addition, the bacterium has a high morbidity and relatively easy cultivation and transport. The transmission via aerosols is considered to be the most dangerous in a potential bioterrorist attack, but the alimentary mechanism of infection spread is also possible, as it is historically well known although logistically limited [5, 6].

The typical clinical manifestation of descendent flaccid paralysis put botulism in a specific category but misdiagnosis is common and represents an additional issue in a hypothetical bioterrorist act. In 1985, a major outbreak of botulism in Vancouver had remained unrecognized for a long time. Twenty-eight individuals were infected with contaminated restaurant food but were hospitalized with different diagnoses before the proper epidemiological investigation [14].

3.2. *Yersinia pestis*

Yersinia pestis is a Gram-negative, rod-shaped bacterium, which causes plague. Currently, *Yersinia pestis* strains are endemic in areas in Southeast Asia, Africa, and North and South America. Natural reservoirs are wild and synanthropic rodents, which are infected by fleas bites. People are usually accidental hosts but are extremely sensitive to the infection [15].

Yersinia pestis produces both exo- and endotoxins and a variety of different enzymes to enhance its virulence. The generation time is very short and infection with one bacterial cell may result in the death of the host.

The plague is a high-priority pathogen with endemic occurrence and with a high tendency for epidemic and pandemic spread. The main clinical forms are bubonic, pneumonic, intestinal, and septicemic. The proper diagnosis is based on the symptoms of the patient and the epidemiological history. The bubonic plague manifests with swollen lymph nodes, fever, malaise, and fatigue. The septicemic and pneumonic forms are more challenging for diagnosis, as their symptoms are identical to those of other Gram-negative septicemia and respiratory diseases [16].

The treatment involves streptomycin, tetracycline, or levofloxacin administration. Antibiotic resistance is rarely observed, but the therapy should start in time.

Pneumonic plague may be a devastating weapon in biological war. In contrast to the bubonic form of the disease, it can be transmitted person to person via air droplets [17]. Epidemiology of an intentionally caused outbreak will differ significantly from the naturally occurring infections. The most possible way of transmission will be again the release of bacteria in the form of aerosols [18], but other attacks, such as food or water poisoning, are also possible. The first symptoms of such a hypothetical epidemic will be indistinguishable from other pneumonic or intestinal diseases. The size of the damage will depend on the quantity of the material used for the attack, the strain characteristics, and the environmental conditions. Symptoms will appear 1–6 days after the exposition and the lethal cases will be reported rapidly. The occurrence of morbidity in non-endemic areas, as well as the lack of dead rodents, should be the first signs to consider an intentionally caused plague epidemic [19].

3.3. *Brucella spp.*

Brucella species are Gram-negative coccobacilli or short rods. Three major human pathogens cause the zoonotic infection brucellosis—*B. melitensis, B. abortus,* and *B. suis*. The source and reservoir of the bacteria are sick animals—goats, sheep, cows, pigs, and dogs. Main transmission routes are contact, erogenic, and alimentary (foodborne). After an incubation period of 1–6 weeks, nonspecific symptoms such as fatigue, fever, sweating, and muscle pain occur. Enlarged lymph nodes and liver are frequently found. Arthritis, meningitis, encephalitis, pyelitis, and so on may develop in severe forms. Some signs and symptoms may persist for longer periods of time.

Tetracycline, ampicillin, or streptomycin are administered for therapy. Longer treatment of 2–3 weeks is often required, as brucellae localize intracellularly.

Brucellae are category B organisms used as potential agents of bioterrorism (**Table 1**). Due to effective veterinary measures to protect public health, brucellosis has become a rare disease in developed countries and no application in a bioterrorist attack has been reported so far [20].

3.4. Enterobacteria

3.4.1. Salmonella spp.

The genus *Salmonella* is part of the family *Enterobacteriaceae* and consists of rod-shaped, Gram-negative, flagellated facultative anaerobes.

Salmonellae are divided into two categories: invasive typhoidal serotypes causing typhoid fever and non-typhoidal *Salmonella* causing salmonellosis [21].

Unlike typhoidal salmonellae (*Salmonella Typhi* and *Salmonella Paratyphi)*, where humans are the only recognized reservoir, the main reservoir of non-typhoidal *Salmonella* is the intestinal tract of different domestic animals which often results in the contamination of foodstuffs [22]. Salmonella is predominantly found in eggs, poultry, dairy products, fresh fruits, and vegetables [23].

Gastrointestinal symptoms usually start 4–72 h after the ingestion of contaminated food or water and last for 4–7 days. They include fever, chills, nausea, vomiting, abdominal cramping, and diarrhea. Diarrhea is usually self-limiting and may be grossly and bloody. After the onset of the disease, salmonellae are excreted in feces for approximately 5 weeks.

Although salmonellosis is regarded as a relatively mild disease, severe illness and death can occur in some cases—particularly in infants, elderly, and immuno-compromised patients [24]. Bacteremia appears in 5–10% of infected persons and in some cases may progress to focal infection, such as meningitis, bone, and joint infection [25].

Salmonella infections generally do not require treatment. A correct rehydration is the most important, while antibiotics are prescribed only in severe cases.

The safety measures for the prevention of Salmonella infection include washing hands before food processing and especially after handling raw meats; cooking meat, and eggs thoroughly; avoiding consumption of foods containing raw eggs or milk; and avoiding direct contact between uncooked meat with food that will not be cooked.

As *Salmonella spp*. are readily available and have the potential to cause outbreaks with moderate morbidity, but with significant effects on public health, they are included in group B of possible biological agents (**Table 1**). Organizations or individuals with limited biological knowledge and laboratory access can easily use them for bioterrorist purposes, as in the case of the biggest bioterrorist attack in the USA (see the Introduction, section [7]).

3.4.2. Shigella spp.

Bacteria of the genus *Shigella* are a common cause of bacterial diarrhea worldwide, especially in developing countries. There are four different species: *Shigella dysenteriae* (serogroup A), *Shigella flexneri* (serogroup B), *Shigella boydii* (serogroup C), and *Shigella sonnei* (serogroup D) [26]. Shigellae are Gram-negative, non-motile, and facultative anaerobic pathogens [27].

Humans are the only reservoirs for these bacteria and the disease is transmitted person to person by the fecal-oral route.

Shigella is highly contagious and 10–100 bacteria can initiate infection when sanitation or personal hygiene is poor. Patients at the highest risk for disease are young children in daycare centers, refugee camps, and nurseries [28].

Shigella, unlike *Vibrio cholerae* and most *Salmonella* species, is acid resistant and survives passage through the stomach to reach the intestine. Shigellae attach to, invade, and replicate in the mucosal epithelium of the distal ileum and colon, causing inflammation and ulceration [28]. Shigella infection is generally limited to the intestinal mucosa, and bacteremia due to *Shigella* is rare.

S. dysenteriae produces a (Shiga) toxin, which can cause damage to the intestinal epithelium and glomerular endothelial cells, the latter leading to kidney failure [28].

Shigellosis is characterized by fever, abdominal pain, and watery diarrhea with traces of blood and pus. The disease is usually self-limiting but may become life threatening if patients are immuno-compromised or if adequate medical care is not available. The treatment consists of oral rehydration and antibiotics administration [29].

Shigella may be released through the deliberate contamination of food or water supplies during a hypothetical terrorist attack. Secondary transmission can result from exposure to the stool of infected individuals because the diarrheal fluids are highly infectious.

To prevent the spread of bacteria, appropriate sanitation measures should be taken: sewage disposal and water chlorination, insect control, handwashing, and proper cooking of food [28].

3.4.3. Escherichia coli O157:H7

Escherichia coli is the most common and important member of the genus *Escherichia*. This organism is a Gram-negative, rod-shaped, facultative anaerobic bacterium. Most *E. coli* strains are part of the normal intestinal flora of healthy humans and animals. However, there are some strains associated with a variety of diseases, including gastroenteritis, urinary tract infections, and meningitis. Among them, enterohemorrhagic *E. coli* (EHEC) are defined as pathogenic *E. coli* strains that produce Shiga toxins and can cause severe illness such as hemorrhagic colitis and the life-threatening sequelae hemolytic uremic syndrome, characterized by hemolytic anemia, thrombocytopenia, and renal injury. *E. coli* O157:H7 was first recognized as a pathogen in 1982 during an outbreak investigation of hemorrhagic colitis in Oregon and Michigan, the USA [30]. This *E. coli* O157:H7 outbreak was linked to under-cooked ground beef hamburgers and cheeseburgers sold from a fast-food restaurant chain. The most frequent route of transmission for *E. coli* O157:H7 is via the consumption of contaminated food and water Raw or undercooked meat, unpasteurized dairy products, and fruit juices have been frequently implicated in reported outbreaks [31]. In addition, *E. coli* can also spread directly from person to person, particularly in child day-care units. *E coli O157:H7* has a low infectious dose and resists in the environment for more than 10 months [32]. A potential airborne transmission has also been reported [33].

The essential factor of *E. coli O157:H7* pathogenesis is the production of Shiga toxins (Stx-1, Stx-2, or both), which disrupt protein synthesis of the host. Stx-1 is identical to the Shiga toxin I produced by *Shigella dysenteriae*, while Stx-2 is more toxic [32].

The diseases caused by EHEC ranges from mild, uncomplicated diarrhea to hemorrhagic colitis with severe cramping (abdominal pain) and bloody diarrhea. The incubation time is from 3 to 4 days. Occasionally vomiting occurs in approximately half of the patients. Fever is either low grade or absent. The illness lasts for 4–10 days and is usually self-limited.

All people are susceptible to hemorrhagic colitis, but young children and the elderly are affected more seriously. In a terrorist attack, *E. coli* would most likely spread via food and water contamination. Secondary transmission can result from exposure to the stool of already infected patients, as diarrheal fluids are highly infectious. The period of infectivity of stool is typically a week or less in adults but 3 weeks in one-third of children.

Patients can be protected with standard sanitation precautions and handwashing is of particular importance. For uncomplicated cases, rehydration is the only treatment needed. Fluid and electrolyte replacement is important when diarrhea is watery or there are signs of dehydration. Antibiotics are often avoided in *E. coli O157:H7* infections since some evidence suggests that antibiotic treatment may lead to complications.

Currently, no vaccine is available to prevent *E. coli O157:H7* infections.

3.5. *Staphylococcus aureus*

Staphylococcus aureus is the second leading cause of gastroenteritis in the world (after salmonellosis) [34]. Its food-poisoning property is due to the production of staphylococcal enterotoxins preformed in the food.

Staphylococci are non-spore-forming cocci, arranged in clusters. They are osmo-tolerant to high sugar (up to 20%) and salt (up to 10%) concentrations. These bacteria can propagate in a wide range of temperatures from 6°C to 45–47°C [35]. Although they cannot survive at high cooking temperatures, their toxins (A, B, C1, C2, C3, D, E, G, K, I, and J) are resistant to heat and can be cooked for hours at 100°C without destruction. In addition, staphylococcal enterotoxins do not affect the smell and the taste of the food.

Staphylococcus aureus is found on the skin, mammary glands, nose, and throat of about 25% of healthy people [36]. So, the personnel in restaurants can be a significant source of contamination, as one of the typical ways of infection spread is the contact-alimentary route.

Staphylococcal toxins are extremely fast-acting—the incubation period is from 20 to 30 min to 6–8 h after the consumption of contaminated food. Vomiting, nausea, abdominal cramps, and diarrhea are common symptoms and they usually resolve in 1–2 days. Only in rare cases, deaths have been reported, as a result of acute hypotension. Treatment is supportive with fluid and electrolyte replacement.

The prophylactics of staphylococcal food poisoning is done by using proper hygiene and sanitation measures when preparing food. The most critical are handwashing with soap or alcohol; wearing gloves; fast cooling; and fridge storage of prepared food [37].

Staphylococcal toxins could be successfully used as a biological weapon by both food contamination or aerosolization. In this context, enterotoxin B, which may cause fever, cough, difficulty in breathing, headache, vomiting, and nausea, is the most promising [36]. It is stable and water soluble, can be easily aerosolized, but however is rarely lethal [38]. Only higher exposure to the toxin could lead to septic shock and death in some people.

3.6. *Clostridium perfringens*

Clostridium perfringens is a Gram-positive spore-forming bacterium. Spores can be found in soil, while the vegetative forms are normal flora of gut and vagina. Depending on the entry portal into the host, *Clostridium perfringens* causes gas gangrene (clostridial myonecrosis) or food toxicoinfection. It is classified into five serotypes (A, B, C, D, and E) on the basis of production of four main toxins—alpha, beta, epsilon, and iota [39].

The gas gangrene is an acute, severe wound infection with a highly invasive character. Bacteria propagate in the traumatized tissue (muscles) and produce a variety of toxins. The most important is the α-toxin (lecithinase), which destroys the cell membranes, including those of the erythrocytes, and leads to hemolysis. The enzymatic activity is responsible for gas release in the infected tissues. Clinically, the infection manifests as pain, edema, cellulitis, and necrosis in the wound area. The mortality rate is relatively high. Laboratory diagnosis consists of anaerobic cultivation and biochemical tests. Penicillin G is the preferred antibiotic, but more important is the chirurgical treatment of the wound.

The incubation period of the foodborne infection is 8–16 h and the disease is characterized by watery diarrhea, cramps, and vomiting. Usually, it gets resolved in 12–24 h and the treatment is predominantly symptomatic [40].

Clostridium perfringens produces at least 12 toxins and one or more of them can be used as a biological weapon. The neurotoxin epsilon is the most promising as biological agent [9]. It is found in zoonotic *C. perfringens* type B and D [38]. The zoonosis represents as rapid toxemia usually in sheep but also in goat and cattle. The ingested spores germinate rapidly, propagate, and produce a non-active protoxin of 311 amino acids. After an intestinal proteolysis, a potent and lethal necrotizing toxin is synthetized. It enters the blood stream and causes kidney damage and pulmonary edema [41]. The toxin also has extreme neurotropism which results in serious neurological injury [42].

Knowledge about the effect of the toxin on humans is not available—all data are obtained from animal experiments. However, one can speculate that to produce a significant impact on the society, the aerosolic form of the toxin should be used [43].

3.7. Pathogenic *Vibrio species*

V. cholerae, V. parahaemolyticus, and *V. vulnificus* are the most important species responsible for food poisoning among the Gram-negative, comma-shaped bacteria from the genus *Vibrio*.

Three types of *V. cholerae* are known: type 01, type 0139, and type non-01 [44]. Type 01 is typically linked with classic cholera (biotypes Inaba, Ogawa, Hykoschima and El Tor), while type 0139 can cause cholera-like illness and atypical infections. These bacteria are found in sea and ocean coastal waters. Approximately two-thirds of *V. cholerae* food poisoning is linked to the consumption of raw or not sufficiently heat-treated sea products. The vibrios easily survive under 10°C and multiply fast under temperatures of 30–37°C with a generation time of 12–18 min in raw seafood. Vibrio species can divide in an alkaline environment and under the high concentration of NaCl (up to 10%) but cannot resist high temperatures (>70°C) and dehydration.

Vibrios of type 01 cause classic cholera, which is transmitted usually by drinking water but also with contaminated food and human contacts. The incubation period is relatively short—from 6 h to 5 days—and the most typical symptom is the watery diarrhea with profuse, "rice-water" stool. The massive water and electrolyte loss, as well as the severe intoxication, is due to the cholera toxin, produced during the intestine colonization. The diarrhea lasts for 6–7 days and in the cases of cholera gravis, which results in severe dehydration, up to 60% of patients can die.

V. parahaemolyticus usually causes milder cholera-like infections [45] and only 3% of all strains are pathogenic and responsible for acute gastroenteritis. Typical symptoms are nausea, vomiting, stomach aches, sub-febrile temperature, and watery or watery-bloody diarrhea. The incubation period is 12–96 h after the consumption of contaminated food or water and the disease lasts up to several days but in rare cases, it can extend to 10 days with septicemia and host death.

V. vulnificus is associated with wound infections after a contact with contaminated seawater or sea animal species. It causes septicemia with a lethality of approximately 50% and rarely induces gastroenteritis in individuals with liver damage.

The treatment of cholera requires urgent, adequate, and well-timed rehydration. Usually, oral rehydration with low osmolarity or cereal-based solution and, when necessary, replacement of intravenous fluids and electrolytes are sufficient to reduce the lethal cases to 1% of all infected patients [46, 47]. In addition, zinc supplementation can reduce the duration and the severity of diarrhea in children with cholera [48]. Antibiotics, although a secondary measure, also help, as they limit the duration of the disease. They are recommended in moderately and severely ill patients, but their choice should be determined by the local antibiotic sensitivity patterns. Doxycycline is recommended as a first-line treatment for adults, while azithromycin is recommended for children and pregnant women [36].

As cholera is a typical water- and foodborne infection the prophylaxis is associated with high personal hygiene and sanitation measures. Bottled, boiled, or treated water should be used for drinking and food preparing in endemic areas or during outbreaks. Any seafood should also be freshly cooked and served hot. Vaccination, although not generally recommended, is useful for travelers to areas of active cholera transmission.

Because *Vibrio cholerae* is a waterborne bacterium, the most likely bioterrorism use will be via contaminated water and/or food. In 1961, China alleged that cholera has been used as a weapon in Hong Kong by the US army. In 1969, Egypt also alleged the “imperialistic aggressors” of using cholera in Iraq in 1966 [49]. However, due to the regular chemical treatment of public water supplies (at least in the developed countries), it will be difficult to cause a high-scale damage.

4. Conclusion

Foodborne bacterial pathogens, although less attractive as possible bioterrorist weapons, are of interest as they possess several important advantages. First, they can be readily found in nature and their isolation and multiplication are relatively easy. No specific knowledge is needed. Second, their diffusion does not require expensive and complicated devices and technologies—they can be released by simple contamination of food or drinks in any catering establishment. Third, the intentionally caused outbreaks will be almost indistinguishable from the naturally occurring epidemics, especially in the beginning. Finally, food poisoning can affect a large number of people before recognizing the source of contamination and hence produce significant panic and chaos in the society.

Conflict of interest

Authors declare the absence of any conflict of interest related to this work.

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