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Research Article



Foodborne Bacteria

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Abstract

Food borne illness spreading through food or beverages are a common, distressing, and sometimes life-threatening problem for millions of people that results from eating contaminated food particularly with food borne bacteria and other microbes. Although most food borne infections go undiagnosed and unreported but annually 48 million people get sick, 128,000 are hospitalized, and 3,000 die of food borne diseases. An outbreak of foodborne illness occurs when a group of people consume the same contaminated food and many of them come down with the same illness. Raw foods of animal origin are the most likely to be contaminated; that is, raw meat and poultry, raw eggs, unpasteurized milk, and raw shellfish. Percentages of bacteria which are involved in causing food borne diseases are: *Campylobacter jejuni* 77.3%, *Salmonella* 20.9%, *Escherichia coli O157:H7* 1.4%, and all others less than 0.56%. There is a strict requirement around the globe to monitor food to ensure food safety.

Keywords: Hyper - endemic , Septicemia , Sporadic human cases , Botulinum toxin , Pigbel- Syndrome, Guillain - Barre syndrome.

Introduction

There are thousands types of bacteria that are naturally present in our environment, some are beneficial and rest is pathogenic. Few types of human pathogenic foodborne bacteria pose one of the greatest health hazards to all human beings. Millions of them live in our homes, hotels, shops, supermarkets, bars and restaurant kitchen, spreading foodborne illness which can prove fatal to humans. Millions cases of foodborne illness are recorded each year.

Compylobacter jejuni

The term *Compylobacter jejuni* refers to a species of bacteria that is the main cause of food poisoning in humans. It is Gram-negative, non-spore forming, curved, helical –shaped and microaerophilic (Ryan KJ, 2004). Studies and surveys have shown that *C.jejuni* is the main and leading cause of bacterial foodborne

illness in United States, because it causes more disease than *Shigella* spp. And *Salmonella* spp. Combined.

C.jejuni is commonly found in intestinal tracts of animals (mainly chicken) and in untreated non-chlorinated water, thus it can be easily found in undercooked meat, raw-milk. Surveys have shown that 20 to 100% of retail chickens are contaminated... It is also seen in healthy animals. These bacteria do not grow in food but are transmitted to humans by consumption of contaminated food. Once they enter in body, they cause an unpleasant disease. Another main source of its contamination is animal feces. This bacterium was also carried by flies that contaminate the food. The food contaminated with this pathogen smell and taste normal.

When methods for its isolation from feces were developed (before 1972) , it was believed to be primarily an animal pathogen causing abortion and enteritis in sheep and cattle , but further studies have shown that it is the most common pathogenic agent of foodborne illness in humans. The disease cause by *C.jejuni* is Campylobacteriosis also known as Gastroenteritis that has been linked with subsequent development of Guillain-Barré syndrome (GBS) that develops after 2-3 weeks of initial illness (Lancet 1990; 35:1350). In US , there are probably numbers of cases in excess of the estimated cases of salmonellosis (2- to 4,000,000/year).The Human feeding studies suggest that nearly 400-500 bacteria cause illness in some individuals.This conducted volunteer human feeding study suggests that host susceptibility also dictates infectious dose to some degree.

In 2000, the first Full-genome sequence of *C.jejuni* was performed (strain NCTC11168 with a circular chromosome of 1,641,481 base pairs) (Parkhill et al, 2000). This pathogen is easily killed by heat (120 F), its multiplication can be inhibited by acid, salt and drying, it never multiplies at temperature below 85 F. *C.jejuni* produces a heat – labile toxin that is pathogenic to humans, due to this property its multiplication can be controlled by temperature. It can also be act as an invasive organism. Although anyone can have a *C. jejuni* infection, children under 5 years and young adults (15-29 years old) are more frequently afflicted than other age groups. Thus in developing countries *C.jejuni* is hyper-endemic in children.

Listeria monocytogenes

Listeria monocytogenes is an intracellular pathogenic bacterium which is known as the causative organism in several outbreaks of foodborne illness. These bacteria are commonly found in soft cheese mostly now days and in other dairy products (as well as in other food items like meat, defrost items etc). Sometimes , it becomes difficult to know that which food is responsible for infection , since symptoms are shown after 4-5 days , sometimes the incubation period of *Listeria* becomes as long as 70 days after exposure.

Although the infection caused by *Listeria* is relatively uncommon in healthy persons but it becomes fatal for pregnant women .That's why now a days, doctors not to eat soft cheese (and its products) and other unhygienic and contaminated food items to pregnant women. It's the only bacteria, which is known more for abortion and stillbirth cases, than any other bacteria. The manifestations of listeriosis include Septicemia , meningitis , encephalitis , corneal ulcer , pneumonia (while diarrhea , vomiting , nausea are the symptoms of milder infections) .But in pregnant women it causes intrauterine or cervical infections , which may result in spontaneous abortion (2nd -3rd trimester) or stillbirths.

Older persons, newborns and persons with weak immune system are also at high risk of listeriosis and thus they can get more severe symptoms of infection in short time, so they should also avoid contaminated food and other unhygienic food items. The fatality rate can be as high as 30% amongst at –risk people. Unless and until it is recognized and treated, *Listeria* infections can result in significant mortality.

An early study suggested that *L. monocytogenes* is unique among Gram-positive bacteria in that it might possess lipopolysaccharide, which serves as an endotoxin. Later it was found to not be a true endotoxin. *Listeria* cell walls consistently contain lipoteichoic acids.

The genus *Listeria* belongs to the class, Bacilli, and the order, Bacillales, which also includes *Bacillus* and *Staphylococcus*. It includes six different species, but only *L. monocytogenes* is consistently associated with human illness. There are 13 serotypes of *L. monocytogenes* that can cause disease, but more than 90 percent of human isolates belong to only three serotypes: 1/2a, 1/2b, and 4b.*L. monocytogenes* serotype 4b strains are responsible for 33 to 50 percent of sporadic human cases worldwide and for all major foodborne outbreaks in Europe and North America since the 1980s.

Listeria is named after Dr. Joseph Lister, an English surgeon who introduced sterilization into surgery. This bacterium was first recognized over 80 years ago, the first outbreak confirming an indirect transmission from animal to humans was reported in 1983, in Canada. In that outbreak cabbages were contaminated with *Listeria* via exposure to infected sheep manure.

Another outbreak, in 1985 in California, the role of food in disseminating listeriosis was conformed. Since then *Listeria* has been implicated in many outbreaks of foodborne illness.

It was studied that, an estimated 1,600 illnesses and 260 deaths in the United States annually, are caused by Listeriosis. The mortality rate is greater than 25 percent, due to this bacteria found in food items. Up to 10 % of human gastrointestinal tracts may be colonized by *L.monocytogenes*. Due to its widespread presence in the environment and food items, the intake of *Listeria* has been described as an “Exceedingly common occurrence”.

Clostridium botulinum

It is a group of bacteria that are mostly found in soil, dust particles and in water but not in air. So, food gets contamination when it is improperly cooked or packed. It is also a leading cause of foodborne illness in humans. When the growing conditions of these bacteria become un-favorable, it has ability to form spores. During the spore formation a toxic is released, known as Botulinum, which causes the disease botulism, which has severe and even fatal results on human health.

Botulinum is the toxin, which is the cause of foodborne illness in humans. It is the most potent naturally produced toxin, and is a category A biological threat agent. This toxin blocks the acetylcholine release in a dose-dependent fashion, which results in symmetric symptoms of illness. There are 7 types of botulinum toxin viz , A , B , C , D , E , F , and G. When this toxin enters in body , it results in illness. Type A , B , and E are associated with botulism in humans . Type A and B are in soil bacteria mostly and Type E is in water (seafood).*Clostridium botulinum* is a diverse group of bacteria which is grouped together by their ability to produce botulinum toxin and known as four distinct groups, *C. botulinum* groups I-IV. All these four groups as well as some strains of *Clostridium butyricum* and *Clostridium baratii* are the bacteria responsible for producing botulinum toxin. Most strains of these bacteria produce one type of neurotoxin but strains producing multiple toxins have been described. *Clostridium botulinum* producing B and F toxin types have been isolated from human botulism cases in New Mexico and California.

There are many types of botulism caused by these bacteria, in which foodborne botulism is one leading cause of deaths due to foodborne illness; other types are wound botulism and infant botulism. Infant botulism, results when spores of *C. botulinum* is ingested, which starts growing in intestines of humans. Honey is a cause of infant botulism in infants. Bacteria are present in form of spores in honey, which starts growing in infant’s intestine. That’s why many doctors advice to parents , not to give too much honey to infants (1-12 months in age).The U.S. Food and Drug Administration, the Centers for Disease Control and Prevention, and the American Academy of Pediatrics recommend that honey not be given to children under 1 year of age. Also, fruits and vegetables should be washed before being fed to infants. Wound botulism happens when botulinum toxin from wound contaminates the food or directly enters in body. But foodborne botulism is a public health emergency. In the United States, an average of 145 cases is reported each year. Of these, approximately 15% are foodborne, 65% are infant botulism, and 20% are due to wound botulism. That’s why in recent decades, botulism illness have been linked with food.

Botulism is a paralytic disease, its toxin i.e., botulinum binds to nerve endings that join muscles. This prevents the nerves from signaling the muscles to contract causing paralysis from top to bottom, starting with the eyes and face and moving to the throat, chest, and extremities. When paralysis reaches the chest, death results due insufficient oxygen unless the patient is ventilated. The early symptoms include nausea , vomiting , fatigue , double vision , dry skin ,mouth and throat , dropping eyelids , difficulty swallowing , slurred speech , muscle weakness , body aches , while in infants it results in constipation , a weak cry , poor appetite , drooling , lethargy. Most people develop symptoms 12 to 36 hours after eating or drinking food containing the toxin produced by *C. botulinum* bacteria. The earlier the symptoms appear, the more serious the disease. Its Treatment requires quick medical attention and an antitoxin. In the early stages of botulism, the injection of an antitoxin can lessen the severity of the disease by neutralizing any toxin that has not yet bound to nerve endings. However, due to the risk of serious side effects, the antitoxin cannot always be used. If foodborne illness is not cured on time, it can prove fatal; usually death is caused by respiratory failure and airway obstructions. When the diaphragm and chest muscles become fully involved,

breathing is affected and results in death from asphyxia. With proper treatment, the fatality rate of *C. botulinum* cases can be as low as five to ten per cent. Another aspect of botulism is that majority of patients never fully recover their pre-illness health. After 3 – 12 months of recovery, persisting side-effects become permanent. These long-term effects include fatigue, weakness, dizziness, dry mouth, and difficulty in performing many active tasks. Patients also report a less happy and some disturbed psychological state than before their illness.

All we can do to prevent foodborne botulism is to be aware ourselves with it and by adapting preventive measures for it. With the help of modern clinical practice and cures, the botulism mortality rates reduced from approximately 60% to < or =10%. In the past 50 years, the proportion of deaths with botulism has fallen from about 50 % to 3-5 %.

Clostridium perfringens

Hundreds of food -poisoning cases is recorded in hospitals, cafeterias, nursing homes, prisons, where a large quantity of meal is cooked several hours before serving. *C. perfringens* is the main cause of this happening, since this organism grows due to reheating of food, improper cooling of food etc. *Clostridium perfringens* is the bacterium of clostridium species (formerly known as *C. welchii*, or *Bacillus welchii*). It is the 3rd leading cause of food-poisoning, but its symptoms are common, less severe are rarely fatal. Mostly people take its symptoms as 24 hours -flu, but normally its symptoms include stomach cramps, abdominal pain, fatigue, loss of appetite, vomiting and fever are mostly excluded in its case. In a very severe case, its symptoms last for 2-3 weeks, most likely in young's and adults of middle ages.

The most common bacterial agent for gas gangrene is *C. perfringens*, which leads to necrosis, purification of tissues, and gas production. *C.perfringens* releases an Alpha-toxin, which inserts into plasma membrane of intestinal cells of human, producing gaps in it that disrupt normal cellular function .The gases form bubbles in muscle and a specific smell in decomposing tissue. After rapid and destructive local spread (which can take only hours), systemic spread of bacteria and bacterial toxins may cause death. This is a problem in major trauma. Another fatal complication of *C.perfringens* infection is Pigbel-syndrome (death of

intestinal cells), which involves “type-C “strains of this bacterium, this strain produce a potentially ulcerative -toxin. This strain is most frequently encountered in Papua New Guinea. Since, this infection occurs due to a toxin, it never spread from person to person .The only cause of this illness is eating contaminated food. A recent research published in 2014 suggested that a strain of *C. perfringens* might be implicated in MS (multiple sclerosis). When it is tested on mice for conformation, it was found that a toxin made by a rare strain of *C. perfringens* cause MS-like damage in brain, and earlier work had identified this strain of *C. perfringens* in a human with MS.

There are many evidence and cases of food-poisoning and deaths due to this foodborne bacterium .On May 7, 2010, 42 residents and 12 staff members at a Louisiana state psychiatric hospital experienced vomiting, abdominal cramps, and diarrhea. Within 24 hours, three patients had died. The outbreak was linked to chicken which was cooked a day prior to being served and was not cooled down according to hospital guidelines. The outbreak affected 31% of the residents of the hospital and 69% of the staff who ate the chicken. It is unknown how many of the affected residents ate the chicken. Perfringens poisoning is one of the most commonly reported foodborne illnesses in the U.S. and other countries including Pakistan. There were 1,162 cases in 1981, in 28 separate outbreaks. At least 10-20 outbreaks have been reported annually in the U.S. for the past 2 decades. In Pakistan, typically dozens or even hundreds of person are affected. It is probable that many outbreaks go unreported because the implicated foods or patient feces are not tested routinely for *C. perfringens* or its toxin. Many people never take it serious since this infection is milder in symptoms and mostly remain for only 24 hours, so they never bother to have some medication properly for it.

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