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# Growing Importance of Listeriosis as Foodborne Disease

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Received date: October 8, 2017; Accepted date: November 1, 2017; Published date: November 10, 2017

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#### Abstract

Foodborne diseases are among the most widespread public health problems and are human infections transmitted through ingested food, and caused by pathogens whose natural reservoir is a vertebrate animal species. Globally, foodborne diseases resulted in over 600 million illnesses and 420,000 deaths in 2010. The majority of the pathogens causing microbial foodborne diseases are considered to be zoonotic. Presently, there are more than 350 zoonoses of multiple etiologies, which are reported from developing as well as developed nations of the world. However, listeriosis has received special attention due to the severity of infections resulting into high morbidity and mortality. Among the various species of the genus Listeria, Listeria monocytogens is recognized as the principal cause of listeriosis in humans as well as animals including birds. The most common route of infection of humans is consumption of foods contaminated by L. monocytogenes. Raw milk, pasteurized milk, soft cheeses, ice cream, meat and meat products, fish and fish products, eggs and egg products, fruits and vegetables may serve as important sources of L. monocytogenes. The organism can survive and grow over a wide range of environmental conditions such as refrigeration temperatures, low pH and high salt concentration. This allows the pathogen to overcome food preservation and safety barriers, and pose a potential risk to human health. In humans, it can lead to meningitis, encephalitis, septicemia, abortion, pneumonia, endocarditis, urethritis, diarrhea, conjunctivitis, and skin infections. The vulnerable groups are pregnant women, infants, older persons, and individuals with weakened immune system. It is recommended to undertake more sincere efforts to make sure the safe handling of various foods to minimize the contamination of L. monocytogenese, which has emerged as an important foodborne pathogen of global significance.

**Keywords:** Foodborne diseases; Life threatening infection; Listeriosis; Public health; Zoonosis

# Introduction

Everyone expect that food they eat should be safe and suitable for consumption. Illness caused due to the consumption of contaminated foods has a worldwide economic and public health impact. Outbreaks of foodborne illness can damage trade and tourism, and lead to loss of earnings, unemployment and litigation [1]. Foodborne diseases in humans are transmitted through ingestion of contaminated food [2].The World Health Organization estimates that unsafe food sickens one in three people every year worldwide, but the actual incidence of foodborne illness is probably much higher [3]. It is mentioned that about 20% people suffer annually from foodborne infections in industrialized countries [4]; and the fraction attributable to zoonotic organisms is around 50% [5].

Food normally becomes a potential source of human infection by contamination, during production, collection, transport and preparation (e.g. meat, milk, fruit, vegetables, soft drinks, etc.) or during processing, and the sources of zoonotic contamination are usually feacally contaminated soil or water [6]. The number of contaminating organisms will vary depending upon the route or vehicle of contamination [7]. The majority of the pathogens causing microbial foodborne diseases are considered to be zoonotic. In addition, zoonoses are transmitted to humans by routes other than food (for example, by direct contact with animals), and are reported to affect over 380,000 European Union (EU) citizens each year [8,9]. In the EU, campylobacteriosis, salmonellosis and yersiniosis are the most commonly reported zoonotic infections in humans. Listeriosis and *Verotoxigenic Escherichia coli* (VTEC) infections are also important due to their severity [9]. The isolation of *L. monocytogenese* from foods require the use of cold enrichment and selective nutrient media. Most of the food safety authorized of developed countries has notified regulations with zero tolerance for presence of *Listeria* in milk, meat and their products [10,11]. The health education of food handlers about the principles of food hygiene is of pivotal importance to control foodborne diseases including listeriosis. The present communication is an attempt to delineate the growing significance of listeriosis as a foodborne zoonotic disease.

# Listeriosis

Listeriosis is one of the important emerging bacterial zoonotic diseases of worldwide distribution. The causal agent of listeriosis was first isolated in 1926 from a natural disease of rabbits characterised by mononuclear leucocytosis and therefore, named *Bacterium monocytogenes* by Murray and co-investigators [12]. Subsequently, Pirie who isolated a similar bacillus from liver of gerbils in 1927, named it *Listerella hepatolytica* in honour of surgeon Joseph Lister [13] and finally renamed it as Listeria in 1940 due to taxonomic reasons [14].

Among the different species of the genus *Listeria, Listeria monocytogens* is the major pathogenic species affecting humans and also many species of animals [15,16]. The first confirmed role of food in the transmission of listeric infection was provided by the outbreak that occurred in 1977 in Boston (USA) in which 20 persons were reported to have developed listeriosis by eating contaminated raw celery of tomatoes and lettuce [17]. The major outbreaks of human listeriosis in the USA [18], Canada [19], Western Australia [20], Europe [21], France [22] and Switzerland [23] contributed to the recognition of *L. monocytogenes* as a significant food-borne pathogen.

In the year 1986, the World Health Organization has recognised *Listeria monocytogenes* as an important emerging food-borne pathogen.

The most common route of infection of humans is consumption of foods contaminated by *L. monocytogenes* [16]. Inadequately pasteurized milk or milk contaminated post-pasteurization, soft cheeses, ice cream and other dairy products also are important sources of *L. monocytogenes* [24]. Milk and milk products are considered as risk foodstuffs for *L. monocytogenes* [25] and also meat and meat products, fish, eggs and egg products, fruits and vegetables [26].

*Listeria monocytogenes* can continue to stay alive and grow over a broad range of environmental condition such as low pH, refrigeration temperatures and high salt concentration. This allows the pathogen to overcome food preservation and safety barriers, and pose a potential risk to human health.

In 99% cases, listeriosis is caused by consumption of food contaminated with *L. monocytogenes*, and rarely from the environment [27]. The clinical picture in diseased humans and animals is manifested in similar way. The infection in humans may cause abortion, meningitis, encephalitis, septicemia, diarrhea, skin infections, etc. *Listeria monocytogenes* primarily infects infants, elderly, pregnant women, and immunosuppressed persons [6,27].

The listeriosis presence in human population is low in the percentages (1%), but with high fatal outcome (30%) [28]. It is estimated that listeriosis annually causes 2500 of serious cases of illness with approximately 500 deaths [29]. In a study, this organism was found in the intestinal tract of 5 to 10% of healthy humans without any obvious symptoms of the disease [27].

Reports indicate that listeriosis has emerged to be more important in developing countries but is reported less frequently in developed countries [30]. This could be associated with lack of awareness of laboratory technicians or lack of diagnostic facilities and limited resources together with the presence of other disease epidemics that claim more priority than listeriosis in developing countries [15].

# In Humans

Listeriosis has been recognized as a human disease since the 1930s. Human infections mainly result from consuming contaminated foods, which may lead to serious and potentially life-threatening listeriosis [31]. Pregnant women, children, elders, people with inadequate immune system [32], alcoholics, drug abusers, patients with corticosteroid therapy and AIDS patients are particularly susceptible to listeriosis [33], which typically presents as septicaemia, meningitis, or meningoencephalitis, intrauterine infection; and sometimes death are reported [31,32].

Infection acquired in early pregnancy may lead to abortion, still birth or premature delivery; when listeriosis is acquired in late pregnancy, it can be transmitted transplacentally and lead to neonatal listeriosis [33].

Human listeriosis generally presents in three clinical forms namely febrile gastroenteritis, maternal-fetal/neonatal listeriosis, or bacteremia with or without cerebral infections such as meningitis, meningoencephalitis, rhombencephalitis or brain abscess [28]. Less common focal infections derived from hematogenous spread which includes endocarditis, peritonitis, septic arthritis or endopthalmitis [34]. Focal infections with cholecystitis, prosthetic joint infection and infections of arterial grafts have also been observed [35]. Lastly, cutaneous listeriosis may complicate those with eczematous skin and occupational exposure to infected animals [36].

The epidemiological patterns of human listeriosis include a background level of sporadic cases with occasional outbreaks [37,38]. A minimal infective dose has not been determined in human infection studies and estimates vary from  $10^2$  colony-forming units (cfu) to  $10^9$  cfu, depending on the immunological status of the host. The incubation period for the disease varies from 11 to 70 days (median 21 days) in humans [39].

Type of listeriosis	Nature of infection	Severity	Time to onset
Infection during pregnancy (Listeriosis)	Acquired following the consumption of contaminated food	Mild flu-like illness or asymptomatic in the mother but serious implications for unborn infant including spontaneous abortion, fetal death, stillbirth and meningitis. Infection more common in third trimester.	Varies from 1 day to several months
Neonatal infection (Listeriosis)	Infection of new- born babies from infected mother during birth or due to cross- infection from one neonate in the hospital to other babies	Can be extremely severe, resulting in meningitis and death.	1-2 days usually from congenital infection prior to birth
Infection of non-pregnant adults and children >1 month (Listeriosis)	Acquired following the consumption of contaminated food	Asymptomatic or mild illness, which may progress to central nervous system infections such as meningitis. Most commonly seen in immunocompromised or elderly persons.	Illness may occur within 1 day or up to several months

**Table 1:** Listeriosis illness [40].

# In Animals

Listeriosis affects domestic and wild animals, most often sheep and cattle, rarely goats, horses and poultry. The detailed list of animals affected with *L. monocytogenese* infections is summarized in "Zoonoses" book authored by Pal [16]. Cows can excrete *Listeria* after miscarriage or during udder infections followed by mastitis, through milk. This was observed in some cases for several years. Contamination of milk by these bacteria can also be of faecal origin. Paralysis and circling movement was observed in sheep affected by listeriosis in late stage of the disease [41].

In animals, listeriosis usually occurs in five distinct clinical presentations, of which encephalitis is by far the most common form, followed by abortions, whilst neonatal septicemia, mastitis, and keratoconjunctivitis/uveitis occur quite rarely. These syndromes seldom overlap within the same animal or the same flock. Some authors speculate that encephalitis occurs as a distinct syndrome and more frequently than other clinical syndromes in farm ruminants because immunity acquired through ingestion of contaminated silage protects against septicemia and abortion but is not fully effective in protection against encephalitis [42]. In these cases, contamination of milk can be due to direct shedding of *Listeria*, which mean faecal contamination during the milking or slaughtering process [39]. Furthermore, ruminants may commonly be asymptomatic intestinal carriers of the organism [43].

#### **Zoonotic Potential**

Currently, over 350 zoonotic diseases of multiple etiologies are known today, but listeriosis is given particular attention due to the unique and changing concept of zoonoses [44]. In the early 1980s, listeriosis was classified under anthropozoonoses, which was changed to amphixenoses in the late 1990s. It lacks its true definition of zoonotic disease because of involvement of an inanimate reservoir (food) as the major cause of listeriosis. Up to 1961, L. monocytogenes was regarded as the one and only species of genus Listeria but later other species have been identified [44]. Listeriosis is of great public health concern because of its high mortality (20 to 30%) and its common source epidemic potential [44]. In healthy people, serious illness from Listeria observed rarely but in susceptible populations (pregnant women, newborns or people with impaired immune function) serious illness is observed frequently [45]. During pregnancy, listeriosis can cause flu-like symptoms with fever and chills and may lead to premature birth or loss of the fetus. Meningitis, septicemia and gastrointestinal symptoms were observed in some individuals [46]. The mortality from listeric meningitis may be as high as 70%. The time of onset of the disease can range from a few days to several weeks. In 1987, the Center for Disease Control estimated that there were at least 1,600 cases with 415 deaths per year in the US [46].

# **Common Diagnostic Approaches**

The disease can be diagnosed on the basis of clinical symptoms and demonstration of the organisms in smear by Gram's staining, peroxideanti-peroxide method; or by fluorescent antibody technique (FAT). To confirm the diagnosis of listeriosis, pathogen can be isolated from clinical specimens such as blood, cerebrospinal fluid (CSF), meconium of newborns or foetus in abortion cases, vomitus, food stuffs or animal feed and vaginal secretions of infected individuals or animals [16]. Detection of soluble antigen in CSF in meningitis cases of humans, polymerase chain reaction are the other confirmatory diagnostic methods [16].

# **Prevention and Control**

Strict sanitation and hygiene during production, processing is must for ensuring food safety pertaining to *Listeria*. Also care must be taken that products should not get contaminated during subsequent stages of transport and distribution. As this organism needs moisture to grow, drying helps to cause the significant reduction in the occurrence of *Listeria* on floors and food contact surfaces. It is imperative that floors should be kept drained of standing water and as dry as possible. The effectiveness of sanitation and the discovery of potential sources of contamination should be established by conducting base line microbial testing of both environmental and contact surfaces [47].

Prevention of listeriosis as a food illness requires effective sanitation of food contact surfaces. Alcohol is an effective topical sanitizer against *Listeria*. Quaternary ammonium can be used in conjunction with alcohol as a food contact safe sanitizer with increased duration of the sanitizing action [47]. People at risk of infection such as pregnant woman or person with a weak immune system should take additional precautions with these types of foods. It is pertinent to mention that proper hygiene, and sanitation in food establishments, pasteurization of dairy products, cooking of meat, and fish and health education of high risk groups about the severity of disease, mode of transmission, and preventive measure will certainly help to reduce the incidence of listeriosis [48].

#### Conclusion

Foodborne diseases are among the most widespread public health problems. *L. monocytogenes* is ubiquitous, opportunistic and important food-borne pathogen that continues to pose worries to the food industry and health authorities. The disease is caused by consumption of food contaminated with *L. monocytogenes* and rarely from the environment. Ready-to-eat foods, meat and meat products, and milk and milk product are the major source of outbreaks. It has emerged to be more important in developing countries but is reported less frequently in developed countries. The epidemiological studies would help in better understanding of the sources of infection and their risk assessment, routes of transmission, clinical forms and better management of the infection. Standard and hygienic operating methods in the farming, processing and marketing of foods are the way forward to reduce the incidence of listeriosis, which has emerged an important foodborne zoonosis.

#### Acknowledgments

We are very grateful to Prof. Dr. R.K. Narayan for going through the manuscript and Anubha for helping us in computer work.

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