Listeriosis in Ruminants and its Zoonotic Importance: A Review

Temesgen Zekarias and Temesgen Dema

1Ethiopian Institute of Agricultural Research, Debre Zeit Agricultural Research Center, Debre Zeit, P. O. Box 32, Ethiopia
2Animal Health, Livestock and Fisheries Development Office, Ofa Woreda, Wolayta Zone, Ethiopia

Abstract: Listeriosis is an infectious and fatal disease of animals, birds, fish, crustaceans and humans. It is one of the important food-borne bacterial zoonotic diseases worldwide, caused by Listeria spp. There are 6 species of Listeria, from them L. monocytogenes is the most pathogenic for both humans and animals. Soil contamination and ingestion of contaminated silage are the primary modes of transmission. Poor quality silage, a pH greater than 5.5 is commonly implicated and accounts for listeriosis. Both host management and the pathogen itself has different contributions for the occurrence of the disease. The great effect of listeriosis in small ruminants and cattle is due to the consequence of severe damage on brain. Those diseases affecting the nervous system should be differentiated from listeriosis. People susceptible for acquiring listeriosis should not consume unpasteurized milk and milk products. Listeria species are Ubiquitous and multiplication occurs more frequently at pH values greater than 5. Therefore, Silage should be stored in the pH below 4.5 to maintain its quality. Veterinary and public health authorities should educate food producers about food borne diseases and the methods of production of microbiologically safe food to the consumer.

Key words: Animals • Food-Borne • Humans • Listeria Species

INTRODUCTION

Listeriosis is an infectious disease of man and animals with a worldwide distribution [1, 2]. It is an infectious and fatal disease of animals, birds, fish, crustaceans and humans where septicemia and encephalitis are predominantly observed [3, 4]. It is caused by Listeria monocytogenes [5].

There are multiple species of Listeria [6]. Three of which are pathogenic. Listeria monocytogenes the most important of these pathogens, has been implicated worldwide in disease of many animal species and human. The other two pathogen Listeria ivanovii and Listeria innocua are less frequently implicated in disease of animals [7, 8].

In ruminants, among which sheep are the ones more commonly affected, the main clinical features are encephalitis, septicemia, abortion, mastitis and gastroenteritis. Listeriosis is of major importance in ruminants [5, 8]. In ruminants it also produces syndrome of septicemia, spinal myelitis, uveitis, gastroenteritis and mastitis. Occasional septicemic disease occurs in horses and pigs [9]. Ruminants are the most frequently affected domestic animals [10].

Bovine listeriosis is a sporadic bacterial infection most commonly manifested by encephalitis or meningoencephalitis in adult animals associated with feeding poorly fermented silage during the winter months [2]. This risk in winter season can be associated with silage feeding and/or because Listeria can grow at temperatures where growth of other pathogens is inhibited due to excessive cold [5]. Listeriosis is a disease that is most frequently encountered in sheep, goats and cattle. Listeria encephalitis in small ruminants is more commonly found in sheep than goats with higher mortality rate than that observed in cattle. The great effect of listeriosis in small ruminants and cattle is the severe influence on brain [8, 11].

Listeriosis is also a zoonosis, occurring either after direct contact with affected animals or more frequently as foodborne disease [5]. It is of great public health concern because of its high mortality (20 to 30%) and its common
source epidemic potential [12]. The disease primarily affects older adults, pregnant women, newborns and adults with weakened immune systems [2, 13]. *Listeria monocytogenes* has been associated with major economic losses in animals causing abortion and encephalitis [14].

Thus, the objectives of this article are to review listeriosis in ruminants and its zoonotic importance and also to provide some information about the epidemiology, associated risk factors and the veterinary and the public health measures for disease prevention and control.

**Etiology:** There are currently six species classified within the genus *Listeria* [8, 15]. Three of which are pathogenic [7, 8]. *Listeria monocytogenes* the most important of these pathogenic, has implicated worldwide in disease of many animal species and human. The other two pathogen *Listeria ivanovii* and *Listeria innocua* are less frequently implicated in disease of animals. *Listeria* can replicate in the environment [7]. It is Gram-positive, facultative anaerobic, non-sporeulating, motile and small rod bacteria [2, 9]. It is an intracellular, food- borne and zoonotic pathogen [16]. The organism is ubiquitous and inherently robust and can thus survive in food-processing and refrigeration of contaminated meat and dairy product [17].

**Virulence Factors:** *Listeria* possesses unique virulence factors to invade host, evade immune cells and to cause infection (Table 2) [4]. *Internalin A* (In. IA) is an 800-amino acid surface protein required for internalization of *L. monocytogenes* into host epithelial cells, such as macrophages, fibroblasts and epithelial cells. In. IB (*internalin B*) is a 630-amino acid protein located on the same operon as in IA and is required for *L. monocytogenes* to be able to internalize fibroblasts, hepatocytes, epithelial and endothelial host cells. LLO (*Listeriolysin O*) is a pore-forming toxin, essential for lysing the vacuolar membrane in the host cell, thus facilitating the escape of *L. monocytogenes* from the vacuole. *Listeria monocytogenes* uses Hexose phosphate transporter (Hpt) to get sugar from the cytosol of the host cells [4, 12]

**Listeria species** strains are stereotyped based on the cellular (O) and flagella (H) antigens [18]. *Listeria monocytogenes* has thirteen serotypes, but, only three serotypes; serotype 4b, 1/2a and 1/2b are responsible for the majority of veterinary and human listeriosis cases. Serotype 4b has been identified as the cause of most human listeriosis cases whereas serotypes 4a and 4c are most of the time limited to animals (Table 3) [2].

**Epidemiology**

**Occurrence:** Listeriosis is seen worldwide, more frequently in temperate and colder climates [19]. It is important in North America, Europe, the UK, New Zealand and Australia [15].
Table 4: Source of infection

<table>
<thead>
<tr>
<th>Source of infection</th>
<th>Citation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Poor quality silage</td>
<td>[20]</td>
</tr>
<tr>
<td>Infected animals faeces, urine, aborted fetuses, uterine discharge and milk should be considered as source of infection</td>
<td>[5, 20]</td>
</tr>
<tr>
<td>Asymptomatic carrier animal</td>
<td>[10]</td>
</tr>
</tbody>
</table>

Listeria species are widely distributed and can be recovered from herbage, faeces of healthy animals, sewage effluent and bodies of fresh water [7]. Listeria spp occur (apparently as saprotrophs) e.g. in soils, decaying plant matter, silage, etc. and have been isolated from e.g. faeces of healthy humans and animal [9]. Clinical diseases in animals occur mainly in the northern and southern latitudes and are more common in temperate climates. In the northern hemispheres, listeriosis has a distinct seasonal occurrence, probably associated with seasonal feeding of silage, with the highest prevalence in the months of December to May [16].

Source of Infection: The evidence indicates that animal listeriosis is frequently associated with stored forage and with the environment as the main source of contamination. In the environment, this saprophytic microorganism can live in soil, water and decaying vegetables from which it could contaminate animal feed. Silage is the most frequent source (Table 4) [20].

The organism is commonly isolated from animal feces, human feces, farm slurry, sewerage sludge, soil, farm water troughs, surface water, plants, animal feed and the walls, floors, drains etc of farms and other environments since Listeria has ubiquitous nature in the environment. Listeria monocytogenes have the potential to be found in most feeds like hays, grains and formulated feeds but, its multiplication is restricted due to low level of available water in food. In ruminants, L. monocytogenes can be isolated from the feces and nasal secretions of healthy animals known as asymptomatic carriers of germs and therefore constitute an important reservoir of germs. The main source of L. monocytogenes in raw milk is mostly the gastrointestinal tract of animals and the environment, skin of the teats, in particular shedding of Listeria into milk due to mastitis [2]. The natural habitat of these bacteria is thought to be decomposing plant matter, in which they live as saprophytes [5].

Risk Factors: A number of predisposing factors have been observed, or proposed, as risk factors for the disease. These include factors that cause a lowering of the host animal’s resistance and factors that increase the infection pressure of the organisms [8].

Animal Risk Factor and Management Risk Factors: Regarding sensitivity, virtually all wild or domestic animals are susceptible to infection caused by Listeria [2]. Poor Nutritional status, sudden changes of weather to very cold and wet late pregnancy and parturition stresses, transport, long periods of flooding with resulting poor access to pasture and overcrowding and insanitary conditions with poor access to feed supplies are management risk factors [5, 8 & 15].

Overcrowding and insanitary conditions with poor access to feed supplies may predispose housed sheep [15]. Stress factor predisposing to clinical disease include nutritional deficiency, environmental conditions (including iron contamination), underlying cause and pregnancy. An asymptomatic carrier can be a source for further contamination of the environment and therefore an indirect source of infection [10].

Pathogen Risk Factors: Introduction of virulent strains to the flock may also occur via carrier animals. They may carry a heavy population of the bacteria and can contaminate feed or pastures for silage. The organism persists for as long as 3 months in sheep feces and has been shown to survive for up to 11.5 months in damp soil, up to 16.5 months in cattle feces, up to 207 days on dry straw and for more than 2 years in dry soil and feces. It is resistant to temperatures of -20°C [-6°F] for 2 years and is still viable after repeated freezing and thawing [15].

Cellular Products of Listeria Contributing to its Virulence, these include Act-A, it is a protein that is important in intracellular movement by acting polymerization and is also thought to play a role in cell tropism [adhesion] and invasion. Internalins, they are surface proteins responsible for adhesion and entry into target cells. Listeriolysin O (LLO), it is a pore-forming cholesterol dependent cytolysin used in the release of L. Monocytogenes from the phagosome into the cytosol following phagosome acidification; under which conditions LLO is the most active. Other roles include lysis of ferritin vacuoles and perhaps its effect on secondary vesicles formed during L. monocytogenes movement from cell to cell. LLO is also thought to induce apoptosis in hepatocytes. Ivanolysin, it is another cholesterol-dependent cytolysin (a counterpart in L. ivanovii). Phospholipase C; phosphatidylinositol
specific phospholipase-C and lecithinase are important in mediating membrane lysis and bile salt hydrolase promotes survival and persistence of Listeria in the intestinal lumen [8].

Transmission: Soil contamination and ingestion of contaminated feed are the primary modes of transmission of Listeria. Listeriosis can be transmitted through the ingestion of food and water contaminated with saliva, faeces, nasal secret ions and aborted material from infected animals [4, 15]. Poor quality silage, with a pH greater than 5.5, is commonly implicated and accounts for listeriosis often being referred to as “silage disease”. An asymptomatic carrier can be a source for further contamination of the environment and therefore an indirect source of infection (Fig 1) [10].

Lambs which develop septicemic disease may acquire infection from contamination on the ewe's teat, from the ingestion of milk containing the organism from ewes or does with subclinical bacteremia, through the navel from the environment [15].

The encephalitic form of the disease results from infection of the terminals of the trigeminal nerve consequent to abrasions of the buccal mucosa from feed or browse or from infection of tooth cavities. Spinal myelitis is believed to result from growth up spinal nerves subsequent to body area infections [8, 15].

Unpasteurized milk or contaminated after pasteurization, milk by-products and raw vegetables, ready-to-eat foods and inhalation of dust and soil infected with bacteria play a crucial role in the transmission of listeriosis to human [4]. Ingestion of contaminated foods like fresh and soft cheese, meat and fish may be the cause of sporadic cases or outbreaks [16].

Pathogenesis: Listeria possesses unique virulence factors to invade host and to cause infection [4]. Exposure to Listeria occurs via the oral route. Entry into intestinal epithelial cells or M cells is mediated by internalin, a surface protein and its interaction with host cell receptors. After passage through the intestinal barrier, Listeria can be observed in phagocytic cells within the lumina propria. Further dissemination occurs via the bloodstream [10] and results in a clinically in-apparent infection with localization of bacteria in various organs, or a fatal septicemia [2].

Listeria can be internalized by phagocytic cells or by non-phagocytic cells through induced phagocytosis. After internalization, it escapes from the phagosome, becomes associated with actin filaments in the cytoplasm and propels itself to the cell’s plasma membrane via actin polymerization. In this way, it is able to pass to neighboring cells in plasma membrane protrusions and thus avoid host defense mechanisms [10].
In pregnant animals invasion of the placenta and fetus may occur within 24 hours of the onset of bacteremia. Edema and necrosis of the placenta leads to abortion, usually 5-10 days post infection. Infection late in pregnancy results in stillbirths or the delivery of young that rapidly develop a fatal septicemia [15].

CNS infection in humans, it is assumed that L. monocytogenes passes the gastrointestinal barrier and spreads haematogenously to the brain. In ruminants, there are indications that the pathogen enters the cranial nerves via the oral epithelium or conjunctivae. Moving within the axons, it reaches the brain stem and spreads further to other regions of the brain via axonal pathways [21].

Clinical Signs: The clinical outcomes of listeriosis depends on the number of organisms ingested, pathogenic properties of the strains and the immune status of the host [16]. Listeriosis is manifested by three major clinical signs such as meningoencephalitis, abortion and septicemia [2, 8]. In addition to these three major signs of disease, mild mastitis, uveitis, ophthalmitis, iritis and/or keratoconjunctivitis have also been associated with L. monocytogenes [2]. Incubation periods vary with the pathogenesis of the disease. Thus, 1-2 days are usual for septicæmic disease, 2 weeks for abortion and longer for the encephalitic form (4-6 weeks) [5].

Encephalitis: Encephalitis in ruminants occurs as an acute inflammation of the brainstem and is usually unilateral [15]. The encephalitic form, sometimes called “circling disease,” is the most common form in ruminants. In cattle, it is subacute to chronic. Signs include depression, anorexia and tendency to circle in one direction, head pressing or turning of the head to one side, unilateral facial paralysis and bilateral keratoconjunctivitis [10, 22].

In sheep, early signs are separation from the flock and depression with a hunched stance [15]. The neurologic signs of listeriosis in sheep reflect dysfunction of caudal brainstem, cerebellar peduncles and/or cranial nerves III through XII. Sheep with CN VII loss have a deviated philtrum. The loss of levator nasolabial function is best detected by observation of the muscular contraction on the dorsum of the nose during inspiration. Loss of lip and cheek muscle tone is best detected by observation of drooling of saliva from the lateral side of the mouth and by palpation of the lips and nostrils signs common to CNS infection include apathy, fever, anorexia, depression, conscious proprioceptive deficits, head pressing, propulsive walking or compulsive circling and centrally located cranial nerves deficiencies. Fever occurs early and often disappears after 3-5 days [5, 23].

Abortion: In sheep and goats, abortions occur from the 12th week of pregnancy onwards [15]. Fever, depression or endometritis may occur with bloodstained vaginal discharge present for several days [5]. There may be some deaths of ewes from septicemia if the fetus is retained. In both species the rates of abortion in a group are low but may reach as high as 15% [15]. The fetus may be macerated or delivered weak and moribund. Retained placenta and metritis may be resulted [8]. In cattle, abortion or stillbirth occurs sporadically and usually in the last third of pregnancy; retention of the afterbirth occurs commonly, in which case there is clinical illness and fever of up to 40.5°C (105°F) [15].

Septicemic Listerialis: The septicemic form marked by depression, in appetite, fever [15] and death is most common in neonates [10]. The septicemic disease in sheep and goats usually occurs within 2 days of introduction to silage and abortions 6 - 13 days later [8].

Ophthalmitis, Iritis and Keratoconjunctivitis: There is swelling of the iris and constriction of the pupil; white focal lesions are evident on the internal surface of the cornea with floccular material in the anterior chamber. Advanced cases have pannus and corneal opacity. One or both eyes are affected [15].

Necropsy Findings: With central nervous system involvement, the cerebrospinal fluid may be cloudy and the meningeal vessels congested [5, 10]. Occasionally, areas of softening in the medulla are observed. Focal necrosis and microglia and neutrophilic infiltrates are seen in parenchymal tissue. In the septicemic form, multiple foci of necrosis in the liver and, less frequently, the spleen may be noted [8, 10 & 15]. In the aborted fetus of ruminants, gross lesions are minimal [10].

Autolysis is usually present as a result of the dead fetus being retained for a period before being expelled [10]. Aborted fetuses are usually edematous and autolyzed, with very large numbers of bacteria visible microscopically in a variety of tissues. In aborting dams, there is placental and endometritis in addition to the lesions in the fetus [15].
Diagnostic Techniques: Listeriosis can be diagnosed in the laboratory by cultivation of the organism, demonstration of the infection agent or its products in tissues or body fluids, detection of a specific immune or, in the encephalitic form of the disease, only by demonstration of the pathognomonic histological lesions [3]. Histopathologically, the main feature is meningoencephalitis of the pons and medulla oblongata, with multifocal micro abscesses, perivascular cuffing with lymphocytes, focal meningitis and gliosis [5].

Tentative Diagnosis: The diseases can be tentatively diagnosed based on history, clinical signs, epidemiological findings and post mortem findings [2].

Laboratory Diagnosis: Isolation of L. monocytogenes and histological examination are the classical methods used for the laboratory diagnosis of Listeriosis [5]. Appropriate specimens for laboratory examination depend on the form of the disease Cerebrospinal fluid (CSF) and tissue from the medulla and Pons of animals with neurological signs should be sampled. Fresh tissue is required for isolation of organisms and fixed tissue for histopathological examination. Specimens for cases of abortion should include cotyledons, fetal abomasal contents and uterine discharges. Suitable samples from septicemic cases include fresh liver, spleen or blood [8, 15]. Spinal fluid, blood, brain tissue, spleen, liver, abomasal fluid and/or meconium are cultured, depending on signs and tissues available [10, 15].

Direct Microscopy: A direct smear of infected tissue may reveal numerous Gram-positive rods in septicemias and abortions; however, only few numbers of organisms are observed in the encephalitis form [10]. Histopathological examination of fixed (10% formalin) brain tissue can often give a presumptive diagnosis of neural listeriosis. Micro abscesses in the brain stem usually unilateral together with perivascular cuffing are very characteristics of Listeriosis [8].

Isolation: Specimens from cases of abortion and septicemia can be inoculated directly onto blood agar, selective blood agar containing 0.05% potassium tellurite [inhibitory to Gram-negative bacteria] and MacConkey agar. The plates are incubated aerobically at 37°C for 24 to 48 hours. Commercial selective and indicator media are available, such as Listeria selective agar (Oxoid) and these are designed mainly for the isolation of Listeria from human foodstuff [2].

A ‘cold-enrichment’ procedure is necessary for brain tissue. Small pieces of spinal cord and medulla are homogenized and a 10% suspension is made in a nutrient broth. The suspension is held at 4°C in the refrigerator and sub cultured onto blood agar once weekly for up to 12 weeks. Small transparent colonies with smooth borders appear on blood agar in 24 hours, becoming grayish white in 48 hours. All the Listeria species hydrolyze esculin (esculin broth). Listeria monocytogenes, particularly, shows the characteristic ‘tumbling motility when a 2-4 hour broth is cultured, incubated at 25°C and examined by the hanging-drop method. Catalase test is positive for Listeria species [8].

Animal Inoculation: Inoculation of a drop of broth culture into conjunctiva of rabbit or guinea pig causes purulent keratoconjunctivitis within 24-36 hours of inoculation [8]. Mouse inoculation causes death within 5 days, with necrotic foci present in the liver [10]. Both L. monocytogenes and L. ivanovii are pathogenic for mice [8].

Immunodiagnosis: Serology has not been useful for diagnosis due to the prevalence of positive titers in apparently normal animals and cross-reactions with S. aureus, enterococcus faecalis and Arcanobacterium pyogenes [10].

Differential Diagnosis: Encephalitis was differentiated from Pregnancy toxemia in sheep, Nervous ketosis in cattle, Rabies, Gid and Scrapie [15]. Rabies, it often occurs in a number of animals at one time due to the ease with which a number of sheep and goat can be bitten by a dog or fox. Sexual excitement, vocalization, attacking human being or each other, vigorous wool pulling, aggressiveness, hyper excitability, hyperesthesia can be manifested as a clinical signs [8].

Gid (Coenurus or Sturdy): It is a disease caused by invasion of the brain and spinal cord by the intermediate stage of Taenia multiceps. Blindness, deviation of the head with circling in the direction of the blind eye occurs. At necropsy, thin walled cysts may be present anywhere in the brain, but most commonly found on external surface of cerebral hemisphere [5, 8 & 15].

Scrapie and Pregnancy Toxemia: It is a non-febrile, chronic disease of adult sheep and goats characterized clinically by pruritus and abnormalities of gait and a very
Table 5: Transmission way to human

<table>
<thead>
<tr>
<th>Transmission via</th>
<th>Citation</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 Direct contact</td>
<td>[4, 20 &amp; 24]</td>
</tr>
<tr>
<td>2 Vertical either transplacental after maternal primary infection or milk borne</td>
<td>[2, 24]</td>
</tr>
<tr>
<td>3 Ingestion of contaminated food</td>
<td>[6, 24]</td>
</tr>
</tbody>
</table>

long incubation period (1-7 years). It is also characterized by behavioral changes that include withdrawal from the flock nervousness, aggression toward inanimate objects. Pregnancy toxemia, it is usually suspected in late pregnant ewes and does which show nervous signs and having a history of exertion, stress or sudden deprivation of food. It is readily differentiated by the presence of ketonuria [8, 15].

Zoonotic Importance: Zoonoses (“zoonosis” is singular) are diseases the agents of which are transmitted between vertebrate animals and people (Table 5) [24]. Many food-borne zoonoses are of serious public health concerns with long-term sequel to various organs. Among these, listeriosis can cause severe and life-threatening complications [4]. *Listeria* is an opportunistic intracellular pathogen that has become an important cause of human food borne infections worldwide [2]. Only *L. monocytogenes* has been found to be implicated in human disease [6]. The case fatality is high and overall approximately 25% of reported cases die [15].

Listeriosis is predominantly a food borne disease which mostly affects people with a compromised immune system, older people, pregnant women and newborns. Since the immune response to *Listeria* infection is mostly cell mediated, people with compromised cell-mediated immunity, such as patients with HIV-infection associated immunosuppression or patients who underwent organ transplantation and pregnant women are more likely to catch listeriosis. Cell-mediated immunity decreases during pregnancy, so pregnant woman are at higher risk of getting *L. monocytogenes* infection [2, 6]. Use of antacids or H+ pump inhibitors [e.g., Losec] leads to decrease in stomach acidity and thus *L. monocytogenes* may avoid lethal effects from gastric acid [12].

There are two main forms of illness in human associated with *L. monocytogenes* infection such as invasive (fatal form) and non-invasive forms (mild form) [2]. The invasive forms of listeriosis in humans include septicaemia, meningitis (meningoencephalitis) and encephalitis (rhombencephalitis). Gastroenteric manifestations with fever also occur. Although the morbidity of listeriosis is relatively low, the mortality can reach values around 30%. In pregnant women, infection may result in abortion, stillbirth or premature birth and may be preceded by influenza-like signs including fever [20].

The incubation period in humans varies from 1 day to 3 months based on the form of listeriosis. Clinical signs of listeriosis include fever, meningitis/encephalitis, neck stiffness, ataxia, tremors, seizures and erratic consciousness. *Listeria monocytogenes* causes endocarditis, brain abscess, lung infection, arthritis and bone and gall bladder infection. Headache, nausea/vomiting, malaise, pneumonia and conjunctivitis may also occur. Cases of conjunctivitis in poultry workers at processing plants have been documented while handling of apparently normal but *Listeria*-carrying chickens. Disease onset is rapid and death within 24-48 hours may occur [4].

**Treatment, Prevention and Control**

**Treatment:** Treatment must be administered for a prolonged period of time because recovery may take as long as a month. *Listeria monocytogenes* is susceptible to most commonly used antimicrobial drugs. Recommended treatments include either oxytetracycline twice daily or penicillin-G (3 to 4 times per day for 7 days). Administration of dexamethasone is recommended to treat inflammation in the brain [8]. The treatment is more effective in cattle because the course of the disease is longer and less severe in cattle [2]. However, the response of ovine encephalitis cases to antibiotic therapy is generally poor [3].

Animals that remain ambulatory are likely to recover but recumbent or comatose animals rarely survive and spontaneous recovery rarely occurs. Although the optimal antibiotic treatment regimens for the various forms of listeriosis have not been established in experimental and clinical trial, cases with non-nervous signs (abortion, septicaemia and iritis) respond well to antibiotic treatments [2]. If severe clinical signs are already evident, death usually follows in spite of treatment [15]. Drug of choice for listeriosis was known to be ampicillin [4, 16].

Practically all common antibiotics, except cephalosporins, are active against *L. monocytogenes* in vitro. However, in vivo, a low efficiency may be expected and is probably in part due to the organism’s intracellular
location [3]. Chlortetracycline at 10 mg/kg BW per day administered for 5 days intravenously is effective in encephalitis cases of cattle [4, 7]. Penicillin at 44,000 IU/kg BW IM can be given daily for 7 days along with supportive therapies such as rehydration with electrolytes [4, 8].

In the early stages of septicemic listeriosis, response to therapy is usually satisfactory [7]. Treatment of *Listeria* iritis is with systemic antibiotics in the early stages coupled with sub palpebral corticosteroid and atropine to dilate the pupil [15]. Treatment of uveitis includes the use of systemic antibiotics, but subconjunctival corticosteroids and topical atropine are essential for effective resolution [6]. In the treatment of human listeriosis, either ampicillin or amoxicillin together with gentamycin is the primary choice of therapy [3].

Other therapeutic factors include the correction of dehydration and acidosis by intravenous administration of fluids and bicarbonate. Administration of vitamin B1 is indicated, because the decreased ruminal activity leads to reduced production of this vitamin by ruminal microorganisms. Administration of corticosteroids is not generally considered, although they are considered to prevent the formation of micro abscesses by inhibiting the infiltration by mononuclear cells [5].

**Prevention and Control:** Control is difficult because of the ubiquitous occurrence of the organism, the lack of a simple method of determining when it is present in high numbers in the environment and a poor understanding of the risk factors other than silage [15]. Control measures include reduction or elimination of feeding of silage, particularly poor-quality silage. All forms of stress should be minimized. Affected animals should be isolated and infected materials disposed of properly [7, 10].

Crucial factors for disease prevention include timely detection, keeping away/eliminating possible sources of infection, maintaining high hygiene/sanitation standards. Avoiding consumption of *Listeria*-contaminated foodstuffs prevents incidences of disease in human beings [4].

Tetracyclines can be fed in the ration of animals at risk in a feedlot. When possible, the obviously spoiled areas of silage should be separated and not fed [15]. After abortion, animals may become chronic carriers and should be culled from the flock [5].

The silage a few inches from the front, top and sides of a clamp should not be fed and after feeding any silage remains should be removed [3]. Sanitation of pens, water supply, pasture and housing should be improved [8]. Proper disposal of contaminated materials, beddings and litters and infected carcasses should be done carefully by incineration or burning methods [4].

If a doe has listeriosis, fed kid pasteurized colostrum, milk or milk substitute [8] because pasteurization eliminates *Listeria* from dairy products [2]. It is recognized that pasteurization at 71.6°C or higher destroys *Listeria* after 15 seconds, but the resistance of intracellular bacteria is still under investigation [25].

Bacteriocins, disinfectants, proper processing and packaging practices in food processing industries can limit spread of *Listeria* to human population through the food chain. Implementation of good management practices, strict biosecurity measures, raising standards of hygiene and sanitation, timely follow-up of appropriate isolation and quarantine practices and suitable trade restrictions need to be considered for effective prevention and control of *Listeria* and its public health implications [4].

Immunocompromised individuals must not eat soft cheeses and veterinarians must take precautions during delivery and particularly during abortions and autopsies [16]. We have to wear latex gloves when handling placenta membranes [8]. Animals with encephalitis or those that have aborted should be isolated and their placentas and fetuses destroyed. Recently acquired animals should only be added to a herd after undergoing a reasonable period of quarantine [16]. Prevention is based on hygienic measures, including effective disinfection of surfaces contaminated by abortions [25].

**Vaccination:** Vaccination with killed vaccines, which do not induce an effective cell-mediated response, is not protective because *L. monocytogenes* is the intracellular pathogen [8]. Live, attenuated vaccines, which are available in some countries, are reported to reduce the prevalence of listeriosis in sheep [8, 15]. Genetically modified *L. monocytogenes* is also being considered as an effective vaccine vector for the expression, secretion and intracellular delivery of foreign antigens for the induction of potent immune responses against viral antigens and tumor cells [20].

**Disease Status in Ethiopia:** Listeriosis, a bacterial disease in humans and animals, is mostly caused by ingestion of *L. monocytogenes* via contaminated food and/or water, or by a zoonotic infection [2]. Information on the status of food-borne listeriosis is very limited both in the veterinary and public health sectors in Ethiopia [26]. Few studies have been done and among those studies done by Molla
Table 6: Systematic summary of study done on foodborne *Listeria* spp in Ethiopia

<table>
<thead>
<tr>
<th>Location</th>
<th>Sample type</th>
<th>No. of samples examined for <em>Listeria</em> spp.</th>
<th>No. [%] of samples positive for <em>Listeria</em> spp.</th>
<th>Dominant <em>Listeria</em> species isolated [%]</th>
<th>Citation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Addis Ababa</td>
<td>Raw meat</td>
<td>60</td>
<td>68.34</td>
<td><em>L. monocytogenes</em> [19.7%]</td>
<td>[28]</td>
</tr>
<tr>
<td></td>
<td>Raw milk</td>
<td>60</td>
<td>10</td>
<td><em>L. innocua</em> [39.4%]</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Cottage cheese</td>
<td>60</td>
<td>10</td>
<td><em>L. seelingeri</em> [4.5%]</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Cream cake</td>
<td>60</td>
<td>21.67</td>
<td><em>L. welshimeri</em> [12.12%]</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td><em>L. murrayi</em> [13.6%]</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td><em>L. grayi</em> [1.5%]</td>
<td></td>
</tr>
<tr>
<td>Addis Ababa</td>
<td>Pasteurized milk</td>
<td>101</td>
<td>0</td>
<td><em>L. monocytogenes</em> [4.8%]</td>
<td>[27]</td>
</tr>
<tr>
<td></td>
<td>Cheese</td>
<td>102</td>
<td>0</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Ice cream</td>
<td>101</td>
<td>43</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Cake</td>
<td>101</td>
<td>12</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Minced beef</td>
<td>102</td>
<td>48</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Pork</td>
<td>102</td>
<td>63</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Addis Ababa</td>
<td>Minced beef</td>
<td>61</td>
<td>29</td>
<td><em>L. monocytogenes</em> [5.1%]</td>
<td>[26]</td>
</tr>
<tr>
<td></td>
<td>Pork</td>
<td>53</td>
<td>37</td>
<td><em>L. innocua</em> [21.2%]</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Chicken</td>
<td>52</td>
<td>8</td>
<td><em>L. seeligeri</em></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Fish</td>
<td>43</td>
<td>8</td>
<td><em>L. welshimeri</em></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Cottage cheese</td>
<td>61</td>
<td>1</td>
<td><em>L. murrayi</em></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Ice cream</td>
<td>46</td>
<td>20</td>
<td><em>L. grayi</em></td>
<td></td>
</tr>
</tbody>
</table>

*et al.* [26], Frehiwot [28] and Edget *et al.* [27] tried to determine the occurrence and distribution of *Listeria monocytogenes* and other *Listeria* species in Addis Ababa (Table 6).

**CONCLUSIONS**

Listeriosis is one of the important food-borne bacterial zoonotic diseases worldwide, caused by *Listeria* spp. *Listeria monocytogenes* is most pathogenic for both humans and animals. *Listeria monocytogenes* is an intracellular opportunistic organism found as contaminants of environment and different materials. Carrier animals contaminate foods of animal origin such as meat and dairy products. There is a well-established linkage between silage feeding and listeriosis. The complete elimination of *L. monocytogenes* on the farm level and from the food processing facilities, as indicated by the different researchers has been said to be difficult as *Listeria* species are ubiquitous to the environment. Therefore, the following recommendations are forwarded. Silage should be stored in the pH below 4.5 to maintain its quality. Susceptible animals should not be exposed to wet, cool and unhygienic environment. Veterinarians should use disposable gloves and sleeves and washing with germicidal soap after obstetrical procedures or the handling of an animal suspected of having listeriosis to prevent human infection from direct zoonosis. Responsible veterinary and public health authorities should educate food producers about foodborne diseases and the methods of production of microbiologically safe food to the consumer.

**REFERENCES**


