

Listeriosis in humans and animals: A comprehensive review of *Listeria monocytogenes* infection

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ABSTRACT

Listeria monocytogenes is a facultative intracellular Gram-positive bacterium with strong environmental adaptability that causes listeriosis, a foodborne zoonotic illness. The disease has a high clinical severity and significant mortality despite its relatively low occurrence, especially in vulnerable populations like pregnant women, newborns, the elderly, and immunocompromised people. This review presents a comprehensive overview of listeriosis in humans and animals, covering aspects of etiology, epidemiology, pathogenic mechanisms, clinical manifestations, diagnostic approaches, and control strategies. Consumption of contaminated food, such as processed meat, unpasteurized milk, and ready-to-eat items, is the main way that the disease is spread. The durability and worldwide spread of *L. monocytogenes* are attributed to its capacity to endure refrigerated temperatures, develop biofilms, and endure industrial food conditions. Clinically, human infections can include maternal and neonatal problems, invasive forms including sepsis and meningitis, and mild gastroenteritis. Listeriosis frequently manifests as encephalitis, septicemia, or reproductive problems in animals, particularly ruminants. Primary therapy uses antibiotics that are effective against intracellular bacteria, while microbiological culture and molecular methods are used to establish the diagnosis. An integrated strategy that includes food safety, environmental sanitation, and reliable surveillance systems is necessary for disease control. A crucial foundation for comprehending how humans, animals, and the environment interact in the dynamics of *L. monocytogenes* infection is provided by the One Health concept. This study demonstrates that listeriosis is still a global health concern that calls for coordinated preventative and control measures.

Introduction

Listeria monocytogenes, a Gram-positive, facultative intracellular bacteria with a high degree of environmental adaptability, is the cause of the infectious disease listeriosis (Manyi-Loh and Lues, 2025). Despite having a lower incidence than other enteric pathogens, this bacteria is part of the category of zoonotic foodborne illnesses that significantly affect the health of both humans and animals (Matle *et al.*, 2020). Listeriosis is a serious concern for food safety and global public health due to its invasive clinical features and high mortality rate in susceptible groups (Yangchen *et al.*, 2025).

In terms of biology, *L. monocytogenes* has a special capacity to endure and flourish in a range of harsh environmental circumstances, such as high salt concentrations, low pH, and refrigeration temperatures (Osek *et al.*, 2022). Because of these modifications, the bacteria can continue to exist throughout the food manufacturing chain and contaminate food items that are ready to eat (Kragh *et al.*, 2026). Additionally, because this pathogen is intracellular, it can avoid humoral immune defense mechanisms, which enables the infection to develop into severe systemic forms (Pizarro-Cerdá and Cossart, 2018).

Listeriosis can cause a wide range of clinical symptoms, from mild gastroenteritis to invasive illnesses like meningitis, sepsis, and infections of the central nervous system (Budvytyte *et al.*, 2024). Infections can spread quickly and cause major consequences like miscarriage, stillbirth, or neonatal death in susceptible groups, such as pregnant women, newborns, the elderly, and people with impaired immune systems (Koopmans

et al., 2023). This indicates that listeriosis has a substantial clinical impact on both individuals and the population, despite its rarity (Allerberger and Wagner, 2010).

According to epidemiology, listeriosis is found all throughout the world, and eating tainted food is strongly associated with both sporadic and outbreak patterns (Vázquez-Boland *et al.*, 2001). Processed meats, unpasteurized dairy products, and ready-to-eat food items are frequently recognized as the main sources of illness (Lamont *et al.*, 2011). The persistence of contamination and the challenge of eliminating it from the production environment are other factors caused by *L. monocytogenes'* capacity to develop biofilms on surfaces used in the food industry (Poutou-Piñales *et al.*, 2026).

Ruminants are the most impacted category from a veterinary standpoint, especially when it comes to encephalitis, sepsis, and abortion (Masoud *et al.*, 2025). Through contaminated feed, especially silage with low fermentation quality, animals can serve as environmental reservoirs and contribute to the cycle of bacterial transmission (d'Ovidio *et al.*, 2026). The idea that listeriosis is a pertinent illness under the One Health paradigm is strengthened by this interplay between people, animals, and the environment (Končurat and Sukalić, 2024).

The intricacy of etiology, clinical diversity, and control issues continue to be significant barriers to the management of listeriosis worldwide despite much study (Farber *et al.*, 2021). There is a significant chance of underreporting due to variations in monitoring capability, the random character of disease occurrences, and the poor diagnostic capabilities in developing nations (Mohapi and Nkhebenyane, 2025). Thus, it is crucial

to have a thorough understanding of etiology, epidemiology, pathophysiology, diagnosis, and control methods.

This review aimed to provide a comprehensive overview of *L. monocytogenes* infection in humans and animals, emphasizing the interrelationships between microbiological, clinical, and public health aspects. It is anticipated that this information integration will offer a solid scientific foundation for the creation of listeriosis prevention and control methods that are more successful and long-lasting.

Etiology

The Gram-positive, short, rod-shaped, facultative intracellular bacterium *L. monocytogenes* is the cause of listeriosis (Vázquez-Boland et al., 2001). Although there are multiple species in the genus *Listeria*, *L. monocytogenes* is the main agent linked to illness in both humans and animals (Quereda et al., 2021).

According to taxonomy, *L. monocytogenes* belongs to the *Listeriaceae* family (d'Ovidio et al., 2026). This bacterium contains multiple serotypes based on genetic and antigenic traits; serotypes 1/2a, 1/2b, and 4b are mostly linked to human clinical cases (Jamshidi and Zeinali, 2019). Particularly, serotype 4b is more virulent than other serotypes and is often implicated in widespread outbreaks (Gorski et al., 2025).

Because it has peritrichous flagella, *L. monocytogenes* is morphologically motile at 20–25°C with a distinctive “tumbling motility” pattern (Meloni, 2014). At host body temperature (37°C), however, the expression of these flagella declines, indicating adaptability to the intracellular environment (D’Orazio, 2019). This bacterium is tolerant to low pH and high salt concentrations, which facilitates its persistence in the environment and processed foods (Ryzhova et al., 2025). It can thrive over a broad temperature range, including refrigeration temperatures (around 4°C) (Novak and Juneja, 2003).

The pathogenicity of *L. monocytogenes* is influenced by a number of important virulence-related variables that are controlled by regulatory genes including *prfA* (Quereda et al., 2021). These virulence factors include ActA, which promotes intracellular mobility via actin polymerization, listeriolysin O (LLO), which permits phagocytic vacuole lysis, and internalins (InlA and InlB), which are involved in host cell invasion (Johansson and Freitag, 2019). Without coming into contact with the extracellular immune system, this combination of processes enables the bacterium to live, multiply, and propagate across host cells (Cossart and Lecuit, 1998).

The environment, which includes soil, water, vegetation, and animal digestive tracts, is the main source of *L. monocytogenes* (Yangchen et al., 2025). Livestock can contaminate food products obtained from animals and behave as asymptomatic carriers (Schoder et al., 2022). The persistence of the bacteria in the food chain is also facilitated by cross-contamination in food processing facilities (Poutou-Piñales et al., 2026).

Listeriosis is classified as a foodborne zoonotic illness since it is mostly transmitted orally through the eating of contaminated food (Koopmans et al., 2023). *L. monocytogenes* is a significant causative agent in systemic infections in humans and animals due to its adaptable traits, capacity to endure in harsh conditions, and extensive reservoir (Quereda et al., 2021).

Epidemiology

Listeriosis is found across the world, with irregular incidence patterns and the potential for large outbreaks in different areas (Manyi-Loh and Lues, 2025). Nearly every continent has had reports of illnesses, especially in nations with well-established food and health surveillance systems (EFSA Panel on Biological Hazards (BIOHAZ) et al., 2018). Therefore, disparities in the ability to detect and record cases are a major factor in the variability in incidence rates between nations (Borena et al., 2022).

Compared to other foodborne illnesses, listeriosis is generally less common in humans, although hospitalization and death rates are quite high (Hernandez-Milian and Payeras-Cifre, 2014). High-income nations

in Europe, North America, and Oceania report cases most frequently because they have more severe food surveillance programs and more sensitive, intrusive case reporting systems (de Noordhout et al., 2014). In these areas, eating tainted ready-to-eat food items is the main cause of listeriosis (EFSA Panel on Biological Hazards (BIOHAZ) et al., 2018).

According to surveillance systems, listeriosis tends to rise in older age groups in Europe, which is consistent with changes in population demographics (Goulet et al., 2008). Dairy products, processed meats, and ready-to-eat meals that are widely spread throughout nations have been connected to several significant epidemics (Gillespie et al., 2010). In contrast, large-scale industrial food products are frequently linked to isolated cases and outbreaks in North America, illustrating the intricacy of the contemporary food supply chain (Mohapatra et al., 2024).

Listeriosis epidemiological statistics are still scarce in underdeveloped nations, most likely as a result of underdiagnosis, a lack of laboratory facilities, and the absence of *L. monocytogenes*-specific surveillance systems (Manyi-Loh and Lues, 2025). However, the existence of this bacterium in food products, livestock, and the environment suggests that the danger of infection is still present and may go unnoticed (Pal et al., 2022).

Listeriosis is widespread in animals, especially ruminants, and is more common in regions with inadequate feed storage procedures, especially the use of inferior silage (Hoelzer et al., 2012). Animal cases are frequently reported seldom, but on farms with inadequate feed management and sanitation, clusters may arise (de Sousa et al., 2025).

Climate variables, food industry practices, consumer consumption trends, and food safety laws all have an impact on the geographic variation in listeriosis incidence (Zoellner et al., 2019). In food production settings, cold and humid conditions might encourage the persistence of *L. monocytogenes*, raising the possibility of long-term contamination (Belias et al., 2022).

Pathogenesis

The pathogenesis of listeriosis starts when germs enter the body through contaminated food, especially food items kept in a refrigerator (Vázquez-Boland et al., 2001). The significant risk of transmission via the food chain is a result of the bacteria’s capacity to flourish in cold environments, tolerance to severe pH, and resilience to high salt concentrations (Gandhi and Chikindas, 2007).

Following ingestion, the bacteria make it through the stomach’s acidic environment and enter the small intestine, where they begin to colonize and invade (Oliveira et al., 2025). Internalin proteins (InlA and InlB) mediate the invasion process by interacting with certain intestinal epithelial cell receptors to promote internalization through induced endocytosis (Pentecost et al., 2010). Following their entrance into the cell, the bacteria live in endosomal vacuoles until listeriolysin O (LLO) and phospholipases (PlcA and PlcB) lyse the phagosomal membrane, releasing the germs into the cytoplasm (Fields et al., 2025).

In order to facilitate intracellular mobility and direct cell-to-cell transmission through membrane protrusions, *L. monocytogenes* actively replicate within the cytoplasm and uses the ActA protein to cause host actin polymerization (Cheng et al., 2018). Through this technique, the bacteria are able to avoid being exposed to humoral immune system components and antibodies (Ireton, 2026). Figure 1 illustrates the pathogenesis of *L. monocytogenes* infection, beginning with the ingestion of contaminated food products, particularly those stored under refrigeration conditions that favor bacterial survival and growth.

Once the bacteria have penetrated the intestinal mucosa, they can enter the systemic circulation through the blood and lymphatics, resulting in bacteremia, which serves as the foundation for their spread to the target organs (Osek and Wiczorek, 2022). The liver and spleen are the first sites of replication in primary organ tropism, which then spreads to the placenta and central nervous system in vulnerable people (Teixeira et al., 2026).

Penetration of the blood-brain barrier leads to invasion of the central nervous system, which can cause encephalitis or meningitis (Ghosh and Higgins, 2018). The bacterium can pass through the placental barrier during pregnancy and cause intrauterine infection, which can result in stillbirth, abortion, or illness of the newborn (Lamond and Freitag, 2018). The interaction between bacterial virulence factors and the expression of certain receptors in host tissues affects this tropism (Osek and Wiczorek, 2022).

The capacity of *L. monocytogenes* to live intracellularly and avoid immune clearance plays a major role in its effective pathogenesis (Quereda et al., 2021). These tactics include avoiding phagolysosome fusion, cytoplasmic replication, and cell-to-cell transmission without a substantial extracellular phase (Teixeira et al., 2023).

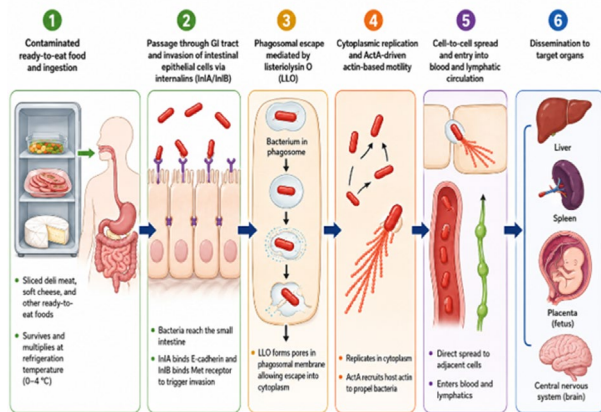


Figure 1. Pathogenesis of *Listeria monocytogenes* infection.

Immune response

Because *L. monocytogenes* is facultatively intracellular and can reproduce within the cytoplasm of the host cell, cellular immunity mechanisms dominate the immune response to infection (Pizarro-Cerdá and Cossart, 2018). The innate immune system serves as the first line of defense after the pathogen successfully penetrates the epithelial barrier and enters the tissue, aiding in the early detection and management of the infection (Shang et al., 2025).

Using pattern recognition receptors (PRRs), such as Toll-like receptors (TLRs), which identify bacterial components like lipoteichoic acid and peptidoglycan, macrophages and dendritic cells are essential for identifying *L. monocytogenes* (Schuppler and Loessner, 2010). When these receptors are activated, pro-inflammatory cytokines including TNF- α , IL-1 β , and IL-6 are produced (Jia et al., 2026). These cytokines aid in the local inflammatory response and draw immune cells to the infection site (D'Orazio, 2019).

By phagocytosing bacteria and generating reactive oxygen species

(ROS) to destroy them, neutrophils also contribute to the early stages of infection (Witter et al., 2016). However, *L. monocytogenes*' capacity to endure and multiply inside phagocytic cells through lysosomal evasion may restrict the efficacy of neutrophils (Fliss et al., 2025).

Adaptive immunity plays a crucial role in the eradication of pathogens in later stages of illness (Hong et al., 2024). T cell responses—in particular, CD8+ T cells—are essential for identifying and eliminating infected cells via cytotoxic processes (Chávez-Arroyo and Portnoy, 2020). Bacterial antigens are presented on infected cells by MHC class I molecules, which activates CD8+ T lymphocytes (Tvinneim and Harty, 2000). Furthermore, Th1-type CD4+ T cells help by generating interferon- γ (IFN- γ), which increases macrophage microbicidal activity (Tubo and Jenkins, 2014).

Because it stimulates macrophages to increase phagolysosomal activity and the creation of nitric oxide (NO), which is bactericidal, IFN- γ is a key cytokine in managing *Listeria* infection (Leenen et al., 1994). Elimination of intracellular germs is unsuccessful without a sufficient Th1 response, which raises the risk of systemic infection (Barber et al., 2005).

Because the bacteria conceal themselves inside host cells, B cells and antibodies have a comparatively small role during the acute phase of listeriosis (Portnoy et al., 2002). However, antibodies can help in the early stages of infection by aiding in opsonization to improve phagocytosis and neutralizing extracellular bacteria prior to cellular penetration (Kolb-Mäurer et al., 2001).

Under some circumstances, *L. monocytogenes* can influence the host immune response by evading detection by the innate immune system and inhibiting host cell death (McDougal and Sauer, 2018). The outcome of an infection, which can range from the pathogen's eradication to the emergence of invasive illnesses like sepsis and infections of the central nervous system, is determined by the interaction between bacterial virulence and the efficiency of the host immune response (Vázquez-Boland et al., 2001).

Pathology

The invasive character of listeriosis and its wide organ tropism, particularly in the reticuloendothelial system, central nervous system, and reproductive tissues, are reflected in pathological lesions (Osek and Wiczorek, 2022). The pathological characteristics of intracellular bacterial infections often exhibit a suppurative to necrotic inflammatory pattern, while they might vary according on host species, immunological condition, and infection stage (Hoelzer et al., 2012). Table 1 summarizes the main pathological features of listeriosis in humans and animals based on the organ systems involved.

Following bacteremia, the liver and spleen are frequently the first locations of systemic colonization in both humans and animals (Teixeira et al., 2026). Histopathologically, multifocal microabscesses with surrounding hepatocellular necrosis and neutrophil and macrophage ag-

Table 1. Pathological overview of listeriosis in humans and animals.

Organ system	Primary lesion location	Pathological features	Histopathological characteristics	References
Reticuloendothelial system	Liver and spleen	Early systemic colonization following bacteremia	Multifocal microabscesses, hepatocellular necrosis, neutrophil and macrophage infiltration, inflammatory changes in hepatic sinusoids and splenic pulp	Teixeira et al. (2026); Bagatella et al. (2022a); Waite et al. (2011)
Central nervous system	Meninges and brain parenchyma (predominantly brainstem)	Suppurative meningoen- cephalitis	Perivascular cuffing by mononuclear cells, brainstem microabscesses, neuronal necrosis, neutrophil infiltration	Xu and Tan (2024); Oevermann et al. (2010a); Bagatella et al. (2022b)
Reproductive system	Placenta and fetal tissues	Necrotic-suppurative placentitis and pregnancy impairment	Chorionic villous necrosis, neutrophil infiltration, intracellular bacterial accumulation, feto-maternal tissue damage	Janakiraman (2008); Ammendolia et al. (2009); Craig et al. (2022)
Neonates	Systemic organs (lungs, kidneys, heart)	Neonatal sepsis with systemic dissemination	Multisystem microabscesses, focal necrosis, diffuse inflammatory response	Amaral et al. (2025)
Severe systemic infection	Multiple organs	Extensive organ damage associated with bacteremia	Widespread tissue necrosis, systemic inflammatory response, signs of multiorgan dysfunction	Osek and Wiczorek (2022)

gregations were discovered (Bagatella *et al.*, 2022a). Inflammatory cell infiltration in the splenic pulp and hepatic sinusoids frequently coexist with these diseases, indicating innate immune system activation against intracellular bacterial reproduction (Waite *et al.*, 2011). Figure 2 illustrates the pathological spectrum of listeriosis, highlighting the characteristic lesions associated with its invasive nature and broad organ tropism.

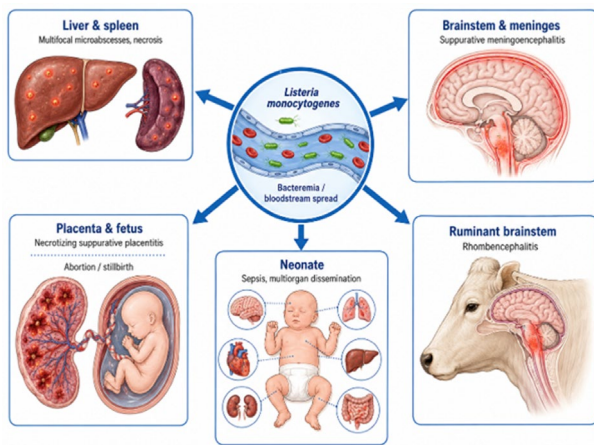


Figure 2. Organ tropism and pathological lesions of listeriosis in humans and animals.

Meningoencephalitis, which is characterized by suppurative inflammation of the meninges and brain parenchyma, can result from invasive listeriosis in the central nervous system (Xu and Tan, 2024). Perivascular cuffing by mononuclear cells, brainstem microabscesses, and neuronal necrosis with neutrophil infiltration were observed under a microscope (Oevermann *et al.*, 2010a). In neurological situations, particularly in ruminants, brainstem lesions are frequently the predominant finding (Baga-

tella *et al.*, 2022b).

Necrotic and suppurative placentitis are signs of infection of reproductive tissue, particularly in pregnant humans and animals (Janakiraman, 2008). Necrosis occurs in chorionic villi along with neutrophil infiltration and intracellular bacterial buildup (Ammendolia *et al.*, 2009). Feto-maternal insufficiency, which results in abortion, stillbirth, or premature birth, is exacerbated by this placental injury (Craig *et al.*, 2022).

Microabscesses in the kidneys, heart, lungs, and other organs can accompany systemic diseases in the form of sepsis in infected infants (Amaral *et al.*, 2025). Severe bacterial spread results in multiorgan dysfunction with diffuse inflammation and localized necrosis (Osek and Wiecek, 2022).

Clinical manifestations

Depending on the infectious dosage, strain pathogenicity, and host immunological status, listeriosis can present with a wide range of clinical symptoms, from asymptomatic infection to severe invasive disease (Manyi-Loh and Lues, 2025). In vulnerable populations, the illness can develop into a systemic infection with a dire prognosis, although in healthy persons, it is frequently moderate or restricted to nonspecific gastrointestinal symptoms (Vázquez-Boland *et al.*, 2001).

Diarrhea, nausea, vomiting, cramping in the abdomen, and occasionally a low-grade fever are the typical symptoms of acute gastroenteritis (Graves, 2013). These symptoms are self-limiting and typically manifest after consuming significant quantities of tainted food (Matle *et al.*, 2020). However, germs can occasionally advance to the systemic phase of invasion, particularly in those with risk factors (Bongiovanni *et al.*, 2024).

Bacteremia, sepsis, and involvement of the central nervous system are typical features of invasive listeriosis, the most severe clinical type (Schlech, 2019). High temperature, chills, malaise, hypotension, and de-

Table 2. Diagnostic methods and approaches for listeriosis.

Diagnostic approach	Method / Technique	Clinical sample	Main characteristics / findings	Advantages / Limitations	References
Clinical evaluation	Assessment of clinical signs and patient risk factors	Clinical data from humans/animals	Nonspecific clinical manifestations including sepsis, meningitis, abortion, and encephalitis	Essential for initial assessment but not sufficient for definitive diagnosis	Xu <i>et al.</i> (2023); Schlech (2019)
Microbiological culture (gold standard)	Isolation on blood agar and biochemical testing	Blood, cerebrospinal fluid (CSF), placenta, abortion tissues, lesion swabs	Small colonies showing weak β -hemolysis; characteristic tumbling motility at room temperature	Highly accurate but relatively time-consuming	Dincer (2024); Sharma <i>et al.</i> (2026a); Kawacka <i>et al.</i> (2022); Colagiorgi <i>et al.</i> (2016)
Conventional identification	Motility and biochemical assays	Culture isolates	Characteristic motility at 20–25°C supporting species-level identification	Supports confirmatory species identification following culture	Colagiorgi <i>et al.</i> (2016)
MALDI-TOF MS	Matrix-assisted laser desorption/ionization time-of-flight mass spectrometry	Bacterial isolates	Species identification based on characteristic protein profiles of <i>Listeria monocytogenes</i>	Rapid, accurate, and time-efficient compared with conventional culture	Thouvenot <i>et al.</i> (2018); Kluz <i>et al.</i> (2025)
Conventional PCR and real-time PCR	Detection of virulence-associated genes (<i>hly</i> , <i>inlA</i> , <i>prfA</i>)	Blood, CSF, tissue samples	Detection of bacterial DNA and quantification of bacterial burden	Highly sensitive and useful in cases with low bacterial load or prior antibiotic treatment	Niederhauser <i>et al.</i> (1992); Chen <i>et al.</i> (2025); Torresi <i>et al.</i> (2020)
Histopathology	Microscopic tissue examination	Placenta, abortion tissues, systemic organs	Suppurative necrosis and intracellular bacterial localization	Useful as supportive evidence but lacks specificity and requires molecular or microbiological confirmation	Wareth <i>et al.</i> (2026); Alharbi <i>et al.</i> (2025); Salih and Mohammed (2025)
Serology	Antibody detection	Serum	Variable antibody response and delayed seroconversion	Limited value for acute diagnosis; more applicable for epidemiological investigations	Vafai <i>et al.</i> (2024); Sharma <i>et al.</i> (2026b)
Integrated clinical diagnosis	Combination of clinical assessment and laboratory confirmation	Clinical findings and laboratory results	Integration of symptoms, risk factors, and confirmatory test outcomes	Considered the most practical approach in routine clinical settings	Schlech (2019)
Differential diagnosis	Evaluation of alternative diseases	Clinical and laboratory data	Includes other bacterial meningitis, viral encephalitis, sepsis, and zoonotic infections	Important to minimize the risk of misdiagnosis	Xu <i>et al.</i> (2023); Schlech (2019)

creased awareness are signs of sepsis (Yildiz *et al.*, 2007). Meningitis or meningoencephalitis, which can cause severe headache, neck stiffness, photophobia, focal neurological abnormalities, ataxia, and even diminished consciousness, are examples of neurological involvement (Xu and Tan, 2024). Brainstem encephalitis, which is marked by neurological symptoms such as facial paralysis, dysphagia, and incoordination, can occasionally occur, especially in ruminants (Oevermann *et al.*, 2010a).

Listeriosis is frequently asymptomatic or only produces moderate fever and influenza-like symptoms in susceptible groups, such as pregnant women (Moran *et al.*, 2018). However, there are serious pregnancy-related repercussions from this infection, such as spontaneous abortion, stillbirth, premature birth, and neonatal infection (Wang *et al.*, 2021). Early symptoms of neonatal sepsis, such as respiratory distress, lethargy, poor feeding, and hypothermia, can be seen in infected newborns (Simonsen *et al.*, 2014).

Reduced appetite, sadness, ataxia, head tilt, and decreased production are common clinical indicators in animals, especially ruminants (Končurat and Sukalić, 2024). The most prevalent type is a central nervous system infection, which has increasing neurological symptoms that, if untreated, can be fatal (Horta-Baas *et al.*, 2013). Animals in the septicemic variety may die suddenly without exhibiting any overt neurological symptoms (Hoelzer *et al.*, 2012).

Diagnosis

Because listeriosis's clinical symptoms are frequently nonspecific and resemble those of other bacterial infections, particularly in the early stages of the disease, a comprehensive approach combining clinical evaluation, laboratory examination, and microbiological or molecular confirmation is necessary for the diagnosis (Xu *et al.*, 2023). Table 2 presents diagnostic approaches for listeriosis, including clinical, microbiological, molecular, and histopathological methods.

Bacterial isolation via culture is still the main diagnostic technique (Dincer, 2024). Blood, placenta, cerebrospinal fluid (CSF), abortion tissue, and swabs from target organ lesions are often used clinical samples (Sharma *et al.*, 2026a). On common culture media like blood agar, *L. monocytogenes* can thrive and exhibit tiny colonies with poor β -hemolysis (Kawacka *et al.*, 2022). Biochemical assays, such as the distinctive "tumbling motility" at room temperature, are used for additional identification (Colagiorgi *et al.*, 2016).

Modern mass spectrometry-based techniques like MALDI-TOF MS, which enable quick and precise species identification based on bacte-

rial protein patterns, frequently supplement traditional microbiological approaches (Thouvenot *et al.*, 2018). Because it saves time compared to conventional culture procedures, this technology is becoming more and more popular in clinical diagnostic labs (Kluz *et al.*, 2025).

Polymerase chain reaction (PCR)-based molecular techniques are essential for early identification, particularly in situations with low bacterial burdens or when antibiotic therapy has begun prior to sampling (Niederhauser *et al.*, 1992). To improve detection specificity, targeted virulence genes like *hly*, *inlA*, and *prfA* are frequently employed (Chen *et al.*, 2025). Additionally, real-time PCR makes it possible to quickly quantify the bacterial load, which is helpful in determining the degree of infection (Torresi *et al.*, 2020).

The diagnosis may also be supported by a histopathological study, particularly in cases of severe systemic infections or animal abortions (Wareth *et al.*, 2026). The presence of intracellular bacteria in the tissue and typical lesions of suppurative necrosis can increase the likelihood of a *Listeria* infection (Alharbi *et al.*, 2025). Nevertheless, this approach lacks specificity and needs to be verified using molecular detection or isolation (Salih and Mohammed, 2025).

Due to variable antibody responses and delayed seroconversion, serology is limited in its ability to diagnose acute listeriosis (Vafai *et al.*, 2024). Therefore, while it can be utilized in epidemiological research, this approach is not advised as a main diagnostic tool (Sharma *et al.*, 2026b).

Clinical symptoms, patient risk factors, and test confirmation are frequently used in clinical practice to diagnose listeriosis (Schlech, 2019). Other diseases affecting the central nervous system or sepsis, such as viral encephalitis, meningitis brought on by other bacteria, and other zoonotic illnesses, should be included in the differential diagnosis.

Differential diagnosis

Due to the wide and frequently nonspecific clinical range of listeriosis, especially in invasive forms involving the central nervous system and sepsis, the differential diagnosis is essential (Xu *et al.*, 2019). This illness frequently resembles other infectious disorders, necessitating a cautious clinical and analytical approach to prevent misdiagnosis (Vázquez-Boland *et al.*, 2001). Table 3 summarizes the main differential diagnoses of listeriosis based on common clinical manifestations in humans and animals.

Listeriosis must be differentiated from other bacterial diseases, such as meningitis brought on by *Streptococcus pneumoniae*, *Neisseria meningitidis*, and *Haemophilus influenzae*, in cases of meningitis and meningoencephalitis (Pino and Delgado, 2025). Listeriosis has unique features,

Table 3. Differential diagnosis of listeriosis in humans and animals based on clinical manifestations.

Clinical manifestation	Listeriosis (distinguishing features)	Differential diagnosis	Key distinguishing features	References
Meningitis and meningoencephalitis	Predominant brainstem involvement, subacute onset, mixed CSF pleocytosis with mononuclear predominance	<i>Streptococcus pneumoniae</i> , <i>Neisseria meningitidis</i> , <i>Haemophilus influenzae</i>	Other bacterial meningitis commonly presents with acute neutrophilic pleocytosis and a more fulminant clinical course	Pino and Delgado (2025); Rovas <i>et al.</i> (2023); Li <i>et al.</i> (2026)
Encephalitis	Brainstem involvement (rhombencephalitis) with progressive neurological manifestations	Herpes simplex virus (HSV), West Nile virus, and other neurotropic viruses	Differentiation is mainly based on bacterial versus viral etiology; in ruminants, brainstem involvement is more characteristic of <i>Listeria</i> infection	Cunha <i>et al.</i> (2004); Cunha <i>et al.</i> (2007); de Sousa <i>et al.</i> (2025); Oevermann <i>et al.</i> (2010b)
Sepsis	Systemic dissemination with potential involvement of the central nervous system and placenta	<i>Escherichia coli</i> , <i>Salmonella</i> spp., <i>Staphylococcus aureus</i>	Listeriosis more frequently involves the central nervous system and reproductive tissues, particularly in susceptible populations	Marwasyifa <i>et al.</i> (2025); Ahmed <i>et al.</i> (2024)
Pregnancy-associated infection (abortion)	Suppurative-necrotic placentitis and transplacental infection, frequently without overt maternal symptoms	<i>Toxoplasma gondii</i> , <i>Brucella</i> spp., Cytomegalovirus (CMV)	Characteristic placental lesions with suppurative-necrotic inflammation and fetal involvement are suggestive of listeriosis	Kumar <i>et al.</i> (2022); Vázquez-Boland <i>et al.</i> (2017)
Encephalitis in ruminants	Rhombencephalitis with unilateral or asymmetric brainstem lesions	Rabies, polioencephalomalacia, parasitic encephalitis, and viral encephalitis	Characteristic brainstem lesion distribution and unilateral/asymmetric localization strongly support listeriosis	Hoelzer <i>et al.</i> (2012); Disson and Lecuit (2012)

such as prominent brainstem involvement, a more subacute onset, and a preference for immunocompromised people, pregnant women, and newborns, even though clinical signs can be comparable (Rovas *et al.*, 2023). Additionally, in contrast to the typical neutrophilic pattern of other acute bacterial meningitis, cerebrospinal fluid testing may show mixed pleocytosis with a mononuclear predominance (Li *et al.*, 2026).

Listeriosis must be distinguished from viral encephalitis in the context of encephalitis, such as that brought on by the West Nile virus, herpes simplex virus (HSV), or other neurotropic viruses (Cunha *et al.*, 2004; Cunha *et al.*, 2007). Although neurological symptoms such as diminished consciousness, ataxia, and seizures can coexist, the main difference is the bacterial vs viral origin (de Sousa *et al.*, 2025). *Listeria*-induced encephalitis in ruminants frequently affects the brainstem (rhombencephalitis), which might help distinguish it from other etiologies based on the pattern of neurological symptoms (Oevermann *et al.*, 2010b).

Other systemic bacterial infections like *Escherichia coli*, *Salmonella* spp., and *Staphylococcus aureus* are included in the differential diagnosis when sepsis manifests (Marwasyifa *et al.*, 2025). Particularly among susceptible groups, listeriosis has a propensity to extend to the placenta and central nervous system, resulting in more extensive organ involvement (Ahmed *et al.*, 2024).

It is important to distinguish listeriosis from other infectious abortion causes during pregnancy, such as CMV infection, brucellosis (*Brucella* spp.), and toxoplasmosis (*Toxoplasma gondii*) (Kumar *et al.*, 2022). Placental involvement with suppurative-necrotic placentitis and the potential to produce transplacental infection—often without overt maternal symptoms—are the hallmarks of listeriosis (Vázquez-Boland *et al.*, 2017).

The neurological symptoms of listeriosis in animals, particularly ruminants, must be differentiated from those of other neurological conditions such as polioencephalomalacia, rabies, and other viral or parasite infections that damage the central nervous system (Hoelzer *et al.*, 2012). When diagnosing listeriosis, unilateral or asymmetric brainstem lesions are frequently crucial indicators (Disson and Lecuit, 2012).

Transmission

Foodborne transmission is the main way that listeriosis spreads, making it a serious zoonosis that is directly linked to food safety (de Sousa *et al.*, 2025). Ready-to-eat foods like unpasteurized dairy products, processed meats, shellfish, and items kept in the refrigerator for long periods of time might harbor this bacteria (EFSA Panel on Biological Hazards (BIOHAZ) *et al.*, 2018). One of the main causes of *L. monocytogenes*' persistence and cross-contamination in the food supply chain is its psychrotrophic capacity to grow at low temperatures (Osek and Wiczorek, 2022).

From basic cultivation to slaughter, processing, distribution, and storage, food contamination can happen at any point (Manyi-Loh and Lues, 2025). Environments used in the food business, such as wet production spaces, drainage channels, and equipment surfaces, can act as persistent reservoirs for the bacteria, enabling re-contamination even after thorough cleaning (Dzieciol *et al.*, 2016). When *L. monocytogenes* forms biofilms on abiotic surfaces, it becomes more resistant to disinfectants and continues to be a source of infection (Mazaheri *et al.*, 2021).

Apart from foodborne transmission, vertical pathways can also result in transmission, especially in humans and pregnant animals (Lamont *et al.*, 2011). After the bacteria cause systemic bacteremia, which can result in intrauterine infection with implications like abortion, stillbirth, or neonatal infection, the infection can be passed from mother to fetus through the placenta (Wang *et al.*, 2021). In sensitive populations, this pathway plays a significant role in the epidemiology of listeriosis (Kumar *et al.*, 2022).

The source of infection in animal settings, especially ruminants, is frequently linked to contaminated feed, such as subpar silage with a high pH that encourages bacterial growth (López-Almela *et al.*, 2025). Although

bacterial discharge in feces is typically minimal and not always a significant route of direct transmission between persons, infected animals can serve as reservoirs (Gezali *et al.*, 2016).

Although direct human-to-human transmission is exceedingly uncommon, it can occasionally happen in specific situations, such as nosocomial infections in newborns or mother-to-child transmission during pregnancy or childbirth (Lamont *et al.*, 2011). Therefore, rather than being spread through interpersonal contact, most human cases of listeriosis are sporadic and linked to exposure to contaminated food (Conly and Johnston, 2008).

Risk factors

Food contamination, environmental exposure, and host factors interact to affect the risk of listeriosis (Manyi-Loh and Lues, 2025). Individual and population vulnerability to infection, especially invasive forms with high rates of morbidity and mortality, is determined by these factors (Huang *et al.*, 2023).

In humans, immunological condition is the primary risk factor (Cong *et al.*, 2024). Invasive infections are more common in people with weakened immune systems, such as HIV/AIDS patients, cancer patients receiving chemotherapy, organ transplant recipients, and those using immunosuppressive medication (Schlech, 2019). The cellular immunological response, which is essential for getting rid of *L. monocytogenes*, is greatly less in these populations, which permits unchecked intracellular replication (Zenewicz and Shen, 2007).

Pregnant women, newborns, and the elderly are additional sensitive categories (Kraus *et al.*, 2024). Although maternal symptoms are frequently mild or vague, physiological changes in the immune system during pregnancy enhance susceptibility to infection (Janakiraman, 2008). However, there may be serious repercussions for the fetus, such as neonatal infection, stillbirth, and abortion (Rovas *et al.*, 2023). Immunological system immaturity raises the risk of sepsis and meningitis in newborns, while immunosenescence, an age-related loss in immunological function, increases susceptibility in the elderly (Zou *et al.*, 2020).

A significant risk factor associated with food handling and consumption behaviors is foodborne exposure (Chen *et al.*, 2018). Bacterial exposure is increased when unpasteurized dairy products, processed meats kept at cold temperatures, and improperly reheated ready-to-eat foods are consumed (Lamont *et al.*, 2011). Additionally, the risk of illness might be raised by cross-contamination in homes or the food business (Sharma *et al.*, 2025).

Feed quality is the primary risk factor for animals, particularly ruminants (Nightingale *et al.*, 2004). *L. monocytogenes* can thrive in suboptimally fermented silage, which has an unstable anaerobic environment and a moderately high pH (Pauly and Tham, 2003). The danger of infection, especially neurological and abortive forms, is increased when this contaminated feed is consumed (Allerberger and Wagner, 2010).

Environmental variables are also important, especially the microorganisms found in soil, water, cattle, and food industry facilities (Shimojima *et al.*, 2016). Long-term survival in food production contexts is made possible by *L. monocytogenes*' capacity to form biofilms on abiotic surfaces, which makes it a source of repeated contamination (Finn *et al.*, 2023).

Public health importance

Despite having a relatively low prevalence in comparison to other enteric diseases, listeriosis is a foodborne disease with enormous invasive and lethal potential, making it extremely relevant to public health (Manyi-Loh and Lues, 2025). Given its disproportionate influence on the number of reported cases, these features make it a priority in the worldwide food safety system (D'Ambrosio *et al.*, 2026).

Clinically speaking, listeriosis is a major cause of sepsis, meningitis, and difficulties during pregnancy and childbirth (Maddaloni *et al.*, 2026).

Pregnant women, newborns, the elderly, and people with impaired immune systems are among the vulnerable demographics most at risk of contracting invasive forms of the illness (Anupama et al., 2025). The load on healthcare services is increased in these people because diseases can spread quickly and necessitate intensive medical care (de Sousa et al., 2025).

According to epidemiology, listeriosis frequently manifests as isolated cases and outbreaks linked to tainted food items (Schlech, 2019). Because processed foods are distributed all over the world, there is a greater chance that a single source of contamination will affect populations in different parts of the world (Yangchen et al., 2025). Eliminating sources of infection is made more difficult by *L. monocytogenes*' capacity to withstand low temperatures and build biofilms in food processing facilities (Santos et al., 2019).

The existence of this bacterium necessitates careful observation throughout the food production chain from the standpoint of food safety (Elbehiry et al., 2026). In order to prevent listeriosis, strict microbiological laws, food inspection systems, and the use of international standards like Codex Alimentarius are essential (d'Ovidio et al., 2026). Food distribution chain disruptions and widespread product recalls may result from failing to manage these risks (Belias et al., 2022).

Listeriosis has wide-ranging social and economic ramifications in addition to its direct health effects (Farber et al., 2021). These include decreased productivity as a result of morbidity and mortality, higher medical expenses, and losses to the food sector as a result of diminished consumer confidence (Shamloo et al., 2019). These effects support the idea that listeriosis has a substantial indirect economic cost (Ivanek et al., 2004).

Listeriosis is a complicated interplay between people, animals, and the environment in the context of One Health (Ramatla et al., 2026). The environment used for food production acts as a medium for bacterial persistence, and livestock can act as reservoirs (Poutou-Piñales et al., 2026). Therefore, cross-sectoral collaboration involving environmental monitoring, animal health, and human health is necessary to control this disease (Ryzhova et al., 2025).

Economic impact

Public health, the food business, and cattle are among the many industries that are significantly impacted economically by listeriosis (Yangchen et al., 2025). Despite having a lower prevalence than other foodborne illnesses, it has a disproportionately high cost burden in relation to the number of cases due to its severe clinical character, the requirement for intensive care, and the possibility of outbreaks (Nadeem et al., 2026).

Laboratory diagnostics, hospital stays, long-term antibiotic medication, and the treatment of neurological and obstetric issues are examples of direct costs in the healthcare industry (Gunarathna et al., 2025). Meningitis and sepsis are examples of invasive illnesses that frequently necessitate critical care in the intensive care unit (ICU), greatly raising the cost of healthcare per patient (Villa et al., 2025). Additionally, severe obstetric and neonatal procedures, such as the treatment of premature infants or neonates with sepsis, may be necessary when listeriosis occurs during pregnancy (Wu et al., 2022).

Significant indirect economic effects include lost production as a result of sickness and mortality, especially in those of working age who have systemic issues (Shamloo et al., 2019). Reduced job capacity and increased financial burden on families are two consequences of premature mortality and long-term disability, especially when the central nervous system is involved (Osek and Wiecezorek, 2022).

Because contamination necessitates product recalls, listeriosis has significant economic ramifications for the food business (Boatema et al., 2019). Source identification, product recalls, brief production halts, and improved quality control are all part of this procedure (Gupta and Adhikari, 2022). Stricter food safety control systems, improved sanitation

requirements, and microbiological testing all result in additional expenses (Yates and Wiedmann, 2026).

Additionally, listeriosis outbreaks can cause long-term sales losses and reputational harm by undermining consumer confidence in a specific brand or product category (Viazis et al., 2025). Due to their frequent association with sources of *L. monocytogenes* contamination, the fast food and dairy-based food industries are especially susceptible to these effects (Jordan et al., 2018).

Abortions, animal mortality, decreased milk production, and reproductive abnormalities in infected animals all result in financial losses for the cattle industry (Herlina et al., 2025). Long-term productivity can be directly impacted by infection in pregnant animals, which might result in the loss of a generation (Vázquez-Boland et al., 2001).

Treatment

Because listeriosis is a facultative intracellular infection, treatment of the disease depends on the use of antibiotics that successfully enter host cells (Hoelzer et al., 2012). To lower the risk of problems, therapy should be started right once upon clinical suspicion, particularly in invasive cases like sepsis, meningitis, or infections during pregnancy, without waiting for laboratory confirmation (Janakiraman, 2008).

Because of its synergistic bactericidal effect, ampicillin is the most prescribed first-line regimen, either alone or in combination with gentamicin (Park et al., 2022). Immunocompromised patients with severe conditions including meningitis or systemic infections are the main uses for this combination (Castellazzi et al., 2018). By boosting penetration and bactericidal activities against intracellular bacteria, gentamicin is sometimes added to improve antibacterial activity (Drevets et al., 1994).

Alternative treatments for β -lactam allergies include trimethoprim-sulfamethoxazole (TMP-SMX), which has shown good effectiveness against *L. monocytogenes* (Manyi-Loh et al., 2023). Although they are not recommended as the first option in standard guidelines, other antibiotics like meropenem may also be used in certain situations (Winslow and Pankey, 1982).

The location and intensity of the infection determine how long therapy will last (Mo et al., 2025). Therapy is typically administered for 10–14 days in cases of uncomplicated bacteremia, but it may be prolonged to 3 weeks or longer in cases of meningitis or encephalitis in order to completely eradicate the germs from the central nervous system (Pino and Delgado, 2025). Antibiotic medication should be started as soon as possible for infections during pregnancy in order to lower the risk of transplacental transfer and fetal problems (Frias et al., 2024). The regimen should be modified according to the mother's and fetus's clinical conditions (Janakiraman, 2008).

Given the significant danger of newborn sepsis and meningitis, treatment for neonates must be vigorous and involve a combination of intravenous antibiotics (Zhang et al., 2023). In this population, careful observation of organ function and therapy response is essential (Wu et al., 2022).

Supportive care is essential for treating severe listeriosis in addition to antibiotic therapy (Temple and Nahata, 2000). This covers the therapy of neurologic problems, hemodynamic stabilization in sepsis, and critical care for patients with organ failure or reduced consciousness (Hof et al., 1997).

Control

A comprehensive strategy that addresses the whole epidemiological chain—from primary production and food processing to distribution and final consumption—is necessary to reduce listeriosis (Byun and Kim, 2023). By putting in place a strict food safety system, the main control method aims to stop food contamination and break the chain of transmission (Shamloo et al., 2019).

A key element in reducing *L. monocytogenes* infection at the food

industry level is the application of the Hazard Analysis and Critical Control Points (HACCP) system (Byun *et al.*, 2024). This approach places a strong emphasis on identifying crucial stages in the production process, such as cross-contamination avoidance, storage temperature management, and equipment sanitation (Adebesin *et al.*, 2024). An efficient cleaning and disinfection program is essential to getting rid of persistent environmental reservoirs since this bacterium can build biofilms on abiotic surfaces (Fagerlund *et al.*, 2017).

Although *L. monocytogenes* can withstand refrigerated temperatures, temperature control is crucial for inhibiting bacterial development (Kroft *et al.*, 2022). Therefore, to reduce the risk of bacterial proliferation in ready-to-eat food products, a combination of temperature control, restricted shelf life, and hygienic production techniques are required (D'Ambrosio *et al.*, 2026).

The management of animal feed, especially silage, is the main focus of listeriosis control at the farm level (d'Ovidio *et al.*, 2026). To attain a low pH that inhibits bacterial development, the quality of fermented silage must be preserved (Pauly and Tham, 2003). In order to minimize exposure to animals, particularly ruminants, who are vulnerable to neurological and abortive forms, it is also essential to monitor environmental contamination of barns and feeding equipment (Končurat and Sukalić, 2024).

The early identification and management of listeriosis depend heavily on epidemiological surveillance (Swaminathan and Gerner-Smidt, 2007). Contamination sources can be identified more quickly when food products, industrial settings, and human and animal disease cases are routinely monitored (EFSA Panel on Biological Hazards (BIOHAZ) *et al.*, 2018). Additionally, strain tracking is supported by molecular laboratory-based methods using genotyping techniques to find patterns of transmission (Zhu *et al.*, 2023).

Another element of control efforts is public health education, especially for high-risk populations like the elderly, immunocompromised people, and pregnant women (Liu *et al.*, 2025). The risk of infection can be considerably decreased by following dietary guidelines, such as avoiding unpasteurized dairy products, unreheated processed meats, and ready-to-eat items with a high risk of contamination (EFSA Panel on Biological Hazards (BIOHAZ) *et al.*, 2018). An integrated diagnostic and One Health-based control pathway for listeriosis is presented in Figure 3.

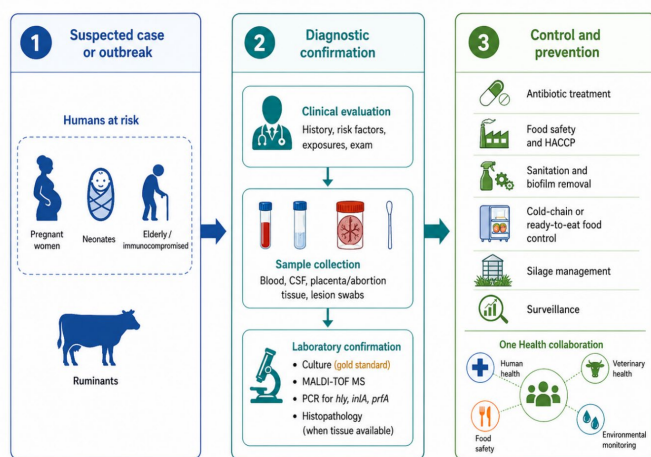


Figure 3. Integrated diagnostic and One Health control roadmap for listeriosis.

Given the intimate connections between people, animals, and the environment, the One Health approach provides a pertinent framework for controlling listeriosis (Ryzhova *et al.*, 2025). To guarantee efficient and long-lasting management, policies from the fields of food safety, veterinary health, and human health must be integrated (Badge *et al.*, 2025).

Conclusion

Foodborne zoonosis caused by *L. monocytogenes* is known for its

invasiveness, great environmental adaptation, and serious clinical effects in both people and animals. This infection causes a wide range of symptoms, including gastroenteritis, sepsis, meningitis, and reproductive issues such as abortion and newborn infection. It is mainly linked to the ingestion of contaminated food.

The bacteria can avoid the immune system and spread systemically thanks to pathogenesis driven by intracellular processes, which raises the risk of serious illness in susceptible populations like pregnant women, newborns, the elderly, and immunocompromised people. Listeriosis is a neurological and abortive disease that has economic and epidemiological ramifications in animals, especially ruminants.

Because of its extensive distribution, connection to the contemporary food chain, and propensity for erratic irregular outbreaks, listeriosis continues to be a global public health concern. Thus, improving food safety, surveillance, and a One Health approach are crucial tactics for avoiding and managing this illness.

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Conflict of interest

The authors declare that there is no conflict of interest.

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