OVERVIEW 0F *LISTERIA MONOCYTOGENS* AND ITS EPIDEMIOLOGY: A POTENTIAL THREAT FOR PREGNANT WOMEN

A thesis submitted to the Department of Mathematics and Natural Sciences in partial fulfillment of the requirements for the degree of Bachelor of Science in Microbiology

By

Shaba Binte Hafiz Neha

17326014

Department of Mathematics and Natural Sciences

BRAC University

December, 2021

Declaration

It is hereby declared that

1. The thesis submitted is my/our own original work while completing degree at Brac University.
2. The thesis does not contain material previously published or written by a third party, except where this is appropriately cited through full and accurate referencing.
3. The thesis does not contain material which has been accepted, or submitted, for any other degree or diploma at a university or other institution.
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Student's Full Name & Signature:

Shaba Binte Hafiz Neha
17326014

Approval

The thesis/project titled "Overview of *Listeria monocytogens* and its Epidemiology : A Potential Threat for Pregnant Women" submitted by Shaba Binte Hafiz Neha - 17326014 of Fall Semester, 2021 has been accepted as satisfactory in partial fulfillment of the requirement for the degree of B.Sc. in Microbiology on December,2021.

Examining Committee:

Supervisor: _____

(Member) Akash Ahmed

Lecturer, Department of Mathematics and Natural Sciences

BRAC University

Program Coordinator: _____

(Member) Dr. Mahbubul Hasan Siddique

Senior Lecturer , Department of Mathematics and Natural Sciences, BRAC University

Departmental Head: _____

(Chair) A F M Yusuf Haider

Professor and Chairperson, Department of Mathematics and Natural Sciences, BRAC University

Abstract

Listeria monocytogenes is a Gram-positive intracellular, aerobic, and facultative anaerobic bacteria that is mostly transferred to humans through food. Thousands of people have died as a result of listeriosis outbreaks. Although LM can occur in asymptomatic pregnant women, fetal infection is a dangerous illness that can result in early birth, abortion, sepsis, CNS involvement, or even death. If a pregnant woman experiences symptoms like fever, headache, diarrhea, myalgia, or other digestive-related symptoms, it's nearly like she has influenza. Positive cultures from maternal or neonatal blood, neonatal cerebrospinal fluid (CSF), amniotic fluid, intrauterine mucosa, or the placenta can be used to diagnose listeriosis. For LM pregnant women without allergies, two weeks of high-dose intravenous amoxicillin (more than 6 g/day) is advised. If maternal and fetal problems worsen, it may be necessary to terminate the pregnancy to save the mother's life. Listeria infection in newborns is primarily transmitted through the placenta, and it is a serious sickness with a high fatality rate. Dietary recommendations for pregnant women can help to minimize the rate of pregnancy-related listeriosis.

Keywords: *Listeria monocytogenes*, listeriosis, outbreaks, pregnancy, neonatal listeriosis, amoxicillin

Dedication

Dedicated to my loving family

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List of Acronyms

ACOG	American College of Obstetricians and Gynecologists
BAM	Bacteriological Analytical Manual
BLEB	Buffered Listeria enrichment broth
BNP	Brain natriuretic peptide
CDC	Centers for Disease Control and Prevention
CNS	Central nervous system
DNA	Deoxyribonucleic acid
ECDC	European Centre for Disease Prevention and Control
EFSA	European Food Safety Authority
EOD	Early onset disease
FDA	Food and Drug Administration
HACCP	Hazard analysis at critical control points
HIV	Human immunodeficiency virus
LOD	Late onset disease
RID	Relative infant dosage
RNA	Ribonucleic acid
RTE	Ready-to-eat
USDA	US Department of Agriculture
UVM	University of Vermont Medium
WBC	White blood cell
WHO	World Health Organization

Glossary

CSF: A cerebrospinal fluid culture is a laboratory test that examines the fluid that circulates around the spinal cord for bacteria, fungi, and viruses.

FDA-BAM: The Bacteriological Analytical Manual is a collection of procedures used by analysts at the US Food and Drug Administration to detect pathogens (bacterial, viral, parasitic, yeast, and mold) and microbial toxins in food and cosmetic products.

LAMP: LAMP is a fast molecular method for amplification of DNA in isothermal conditions.

mPCR: Multiplex polymerase chain reaction is when a polymerase chain reaction is used to amplify multiple DNA sequences at the same time.

NASBA: NASBA stands for nucleic acid sequence-based amplification, and it is a molecular biology technique for producing multiple copies of single-stranded RNA.

NGS: Next-generation sequencing is a DNA sequencing technique that determines sequence by sequencing several tiny segments of DNA in parallel.

PCR: PCR is a technique for making many copies of a given portion of DNA (amplifying).

Polony: Polony is a contraction of "polymerase colony," a small colony of DNA.

Chapter 1
Introduction

1.1. Introduction

Listeria monocytogenes, a foodborne bacteria that can infect the placenta and cause difficulties during pregnancy. Although listeriosis is mainly an uncommon condition, major outbreaks have been documented. According to the WHO, over 43% of all Listeria cases occurred during pregnancy, with 14% occurring in late pregnancies.(Wadhwa Desai & Smith, 2017) According to newly released data, 11% of all listeriosis cases caused by pregnancy accounts in Italy, (Mammina et al., 2013) 16% of all listeriosis cases in Spain, (Nolla-Salas et al., 1998) and 17.7% of all listeriosis cases in France. (Goulet et al., 2012) In France, during 1984 to 2011 the evidence fell from 60 to 5 occurrences per 100,000 live births, a reduction of more than 12 times. Between 1998 and 2007, the number of incidences per 100,000 live births in Israel grew from 5.5 to 25.2. (Elinav et al., 2014) Furthermore, in China, 41.1–52% of listeriosis cases were linked to pregnancies, showing the disease's widespread impact. (Fan et al., 2019) In many countries, including France, Belgium, and the United States, the incidence rate of pregnancy-related listeriosis has recently decreased. (Bertrand et al., 2016) More stringent food production regulations, more preventive measures, and better health care for pregnant women are all thought to have contributed to the decrease.(Bertrand et al., 2016) Females with *Listeria monocytogenes* may not have usual symptoms or may have symptoms that are similar to influenza, such as a throbbing headache, fever, or myalgia. Listeria, on the other hand, could pass through the placenta and infect the fetus. (Lamont et al., 2011) Furthermore, eating amniotic fluid can cause fetal infection. (Li et al., 2020) Fetal infection, unlike infection in moms, is a dangerous illness that can result in premature birth, abortion, sepsis, CNS involvement, or eve death. (de Noordhout et al., 2014) Because *Listeria monocytogenes* is so dangerous, anti-infection medication should be initiated as soon as a diagnosis of maternal-fetal *Listeria monocytogenes* is made

1.2. *Listeria monocytogenes* :

Human listeriosis is caused by the bacteria *Listeria monocytogenes*, which is found in food. Although listeriosis has a low prevalence compared to other foodborne infections, it has a high fatality rate of up to 30%. (Morganti et al., 2016) It's a serious foodborne disease that causes stillbirths or miscarriages, septicemia, and meningitis or encephalitis, among other things. At-risk populations, such as pregnant women and their fetuses, neonates, the elderly, and those who are immunocompromised, have a high death rate.(Lamont et al., 2011) Due to its capacity to thrive and reproduce at low temperatures or in gas or in items stored and kept chilled, multiply at refrigeration temperatures, and build biofilm *Listeria monocytogeness*. *Listeria monocytogenes* is considered a dangerous agent in the food business. (Mead et al., 1999) *Listeria monocytogenes*

may also survive in a variety of ph and salt concentrations and acquire resistance to heavy metals and food sanitizers. Unlike other bacteria *Listeria monocytogenes* has not evolved into a highly resistant organism to routinely used antibiotics to treat infectious disorders. (Mullapudi et al., 2008) It has been found in North America(Sauders et al., 2012; Stea et al., 2015), South America (Montero et al., 2015), Europe (Linke et al., 2014), Asia (Huang et al., 2015) , Africa, and Oceania (McAuley et al., 2014).

Listeria monocytogenes is a gram positive, facultative anaerobe, motile that can be found in a wide variety of environments. (Linke et al., 2014) Using the selective medium, it may be easily isolated from vegetation, soil, and water, including natural goods intended for human use, without any more processing. In terms of detecting tainted samples, newer chromogenic medium may offer certain advantages.(Law et al., 2015b) Meat and vegetables are frequently contaminated on the surface, with up to 15% of these meals containing the bacterium. Furthermore, the organism is a temporary resident in the gastrointestinal tracts of both animals and humans. (Gahan & Hill, 2014) Intermittent carriage denotes a high level of exposure. When invasive listeriosis occurs, the bacterium is transmitted through the gut, and the virulence component ActA may enhance carriage. (Travier et al., 2013)

Chapter 2

Origin of *Listeria monocytogens*

Listeria monocytogen is one of the species of the listeria genus. Including that, there are more 16 recognized species in the listeria genus. They are *Listeria booriae , Listeria seeligeri, Listeria fleischmannii, Listeria innocua, Listeria cornellensis, Listeria newyorkensis, Listeria rocourtiae, Listeria ivanovii, Listeria marthii, Listeria floridensis, Listeria grandness, Listeria grayi, Listeria Riparia, Listeria Aquatica, Listeria welshimeri,* and *Listeria weihenstephanensis* (Orsi & Wiedmann, 2016). The species of genus Listeria is divided into two groups. One is *Listeria sensu strictu*, and another one is *Listeria sensu lato*. First group involves *L.seeligeri, L.monocytogenes, L.ivanovii, L.innocua, L.marthii* and *L.welshimer*. (Chiara et al., 2015) The other group involves the rest 11 Listeria species. The distinction between these two categories is based on category resemblance to *Listeria monocytogenes*, the first Listeria species to be identified and classified, as well as the most important in terms of public health and economic impact. All *Listeria sensu strictu* species have phenotypic features in common, such with the capacity to thrive at temperatures as low as 4°Celsius, motility at least 30 °C, the ability to generate acetoin from glucose fermentation via the butane pathway is indicated by a positive catalase reaction, failure to convert nitrate to nitrite, and a positive reaction in the Voges-Proskauer test.(Orsi & Wiedmann, 2016). On the other hand, only *L. floridensis* can reduce nitrate. *L. grayi* is the only motile species among all *Listeria sensu lato* strains (Chiara et al., 2015). None of the *sensu lato* species appear pathogenic; however, *L. monocytogenes* and *L. innocua* are pathogenic within their group (Orsi & Wiedmann, 2016).

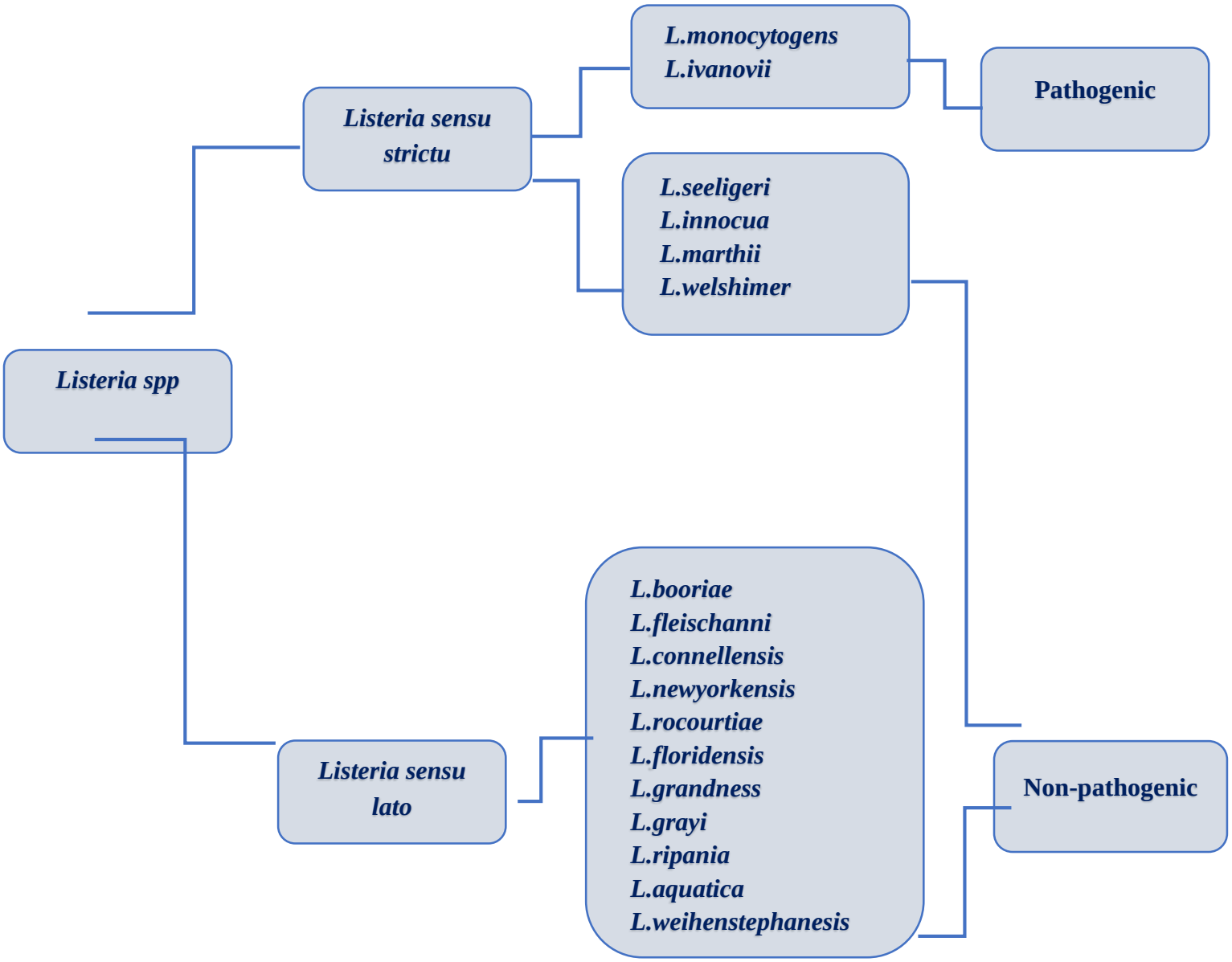

Figure: Origin of *Listeria monocytogens*

Chapter 3

Epidemiology

3.1. Outbreaks of listeriosis

Several strong human listeriosis outbreaks show similarities to epidemic listeriosis in animals. The first known foodborne incident in Canada occurred in 1980-1981, when tainted coleslaw was consumed. (Schlech, n.d.) Following that, a number of other foods have been connected to pasteurized milk, unpasteurized and pasteurized cheeses, a variety of fruits and vegetables, butter, and a number of animal products have all been linked to small and large outbreaks. In 2017-2018, a significant outbreak of listeriosis was reported in South Africa, with over 900 cases and 200 deaths. A tainted processed beef known as "polony" was the source (WHO | Listeriosis – South Africa 2021). Hospitalized patients, according to recent research, are also at risk of getting invasive listeriosis.(Carrique-Mas et al., 2003)

A rate of 5 to 9 exposures per person-year was estimated in one prospective investigation.(Grif et al., 2003). Overgrowth of *Listeria monocytogenes* is possible when the organism is amplified in biofilm *Listeria monocytogenes* or on food products that are processed but not pasteurized and maintained at cold temperatures. The innate host defense mechanisms in the gastrointestinal tract, liver, and spleen may be overwhelmed after ingestion of large amounts of the organism, resulting in the development of invasive illness. In Europe (Koopmans et al., 2017) and North America, the annual rate of sporadic listeriosis is typically 1/100,000 population, and the disease is costly in both human (de Noordhout et al., 2014) and economic terms. (Thomas et al., 2015)

Several host-specific risk indicators for invasive listeriosis were discovered indirectly using demographic data from surveillance investigations. Infection is more likely in those under the age of 60 or in the first 30 days of life. During maternal sepsis or from the mother's perivaginal and perianal colonization through the birth canal, the fetus becomes infected with *Listeria monocytogenes*. In newborns with poor macrophage and cell-mediated immune function, the host defense against listeriosis is impaired, and invasive listeriosis is more likely if the liver, respiratory system, or gastrointestinal tract have been colonized.(Dalton et al., 2011; Pouillot et al., 2012)

The growth in immunosuppressive disorders in this age range, such as solid tumors and hematologic malignancy, has raised the incidence of invasive listeriosis in older people. Effective macrophage function in the liver, spleen, and peritoneum is crucial for managing acute infection in people and animal models after bacterial translocation from the gastrointestinal system. Both of these defense mechanisms can be affected by the original disease, as well as chemotherapy or radiation-induced damage. Furthermore, cancer treatment and the use of immunosuppressive medications such as corticosteroids or cyclosporin A, which have a specific effect on cell-mediated immune activity, (Schlech, n.d.), reduce *Listeria monocytogenes* specific host responses that occur after the initial phase of infection to predispose to invasive infection. The recent discovery of biologic medicines incorporating immune modulators such as tumor necrosis factor alpha

inhibitors has also been linked to an increase in invasive listeriosis.(Abreu et al., 2013; Bodro & Paterson, 2013)

Pregnant women's cell-mediated immune responses to *Listeria monocytogenes* are reduced (Schlech, n.d.) and, Invasive listeriosis and subsequent infant transplacental infection may be predisposed to by the decreased gastrointestinal motility occurring during pregnancy. As a result, "early-onset" listeriosis develops, defined by the delivery of a frequently premature and critically unwell infant. The mother's spontaneous recovery from Listeria sepsis usually happens after the baby is born, but if the infection is detected before the baby is born, antibiotic therapy can rescue the baby. (Wald et al., 1982)

Several big outbreaks of a febrile gastrointestinal sickness have highlighted the importance of *Listeria monocytogenes* as a foodborne pathogen. These epidemics had far greater attack rates (up to 72%) than invasive listeriosis outbreaks, which had an average incubation time of roughly 24 hours. Shrimp (Mammina et al., 2013) , rice salad (Frye et al., 2002) , chocolate milk (Dalton et al., 2011), corn salad (Aureli et al., 2000), ready-to-eat meats(Frye et al., 2002), jellied pork (Pichler et al., 2009), and fresh cheese (Carrique-Mas et al., 2003) have all been described as vehicles for these more common foodborne diseases. The items implicated were typically substantially contaminated (>10^9 CFU/ml of *Listeria monocytogenes*), and the amount of food consumed seemed to correspond with infection, implying that the high attack rates aren't due to increased inherent virulence of the infecting *Listeria monocytogenes* strain. A hospital-acquired gastroenteritis outbreak has also been reported as a result of tainted beef jelly.(Jacks et al., 2016)

While individuals with cancer or who have had an organ transplant are at a higher risk of invasive listeriosis, HIV infection is also a substantial risk factor for sporadic listeriosis.(Jurado et al., 1993) In previous studies, invasive listeriosis attack rates in HIV positive patients were shown to be 500- to 1,000-fold greater than in the general population. However, widespread dietary advice to reduce foodborne disease and the use of Pneumocystis jiroveci pneumonia prophylaxis, notably trimethoprim-sulfamethoxazole, which *Listeria monocytogenes* is sensitive to, have resulted in a reduction in invasive listeriosis cases in HIV infection. Antiretroviral treatment that is better and more widely available may help to reduce HIV-related cases even further.(Jurado et al., 1993) Dietary recommendations to populations at risk, such as pregnant women, cancer patients, and organ transplant recipients, may also be responsible for lower overall rates of listeriosis in non-HIV positive people.(Bennion et al., 2008). More crucially, the decreasing incidence of listeriosis may be attributable to the food-processing industry's implementation of hazard analysis at critical control points, which has promoted recommendations to enhance public awareness of the disease.(HACCP) (Buchanan & Whiting, 1998) and microbiological risk assessment strategies to prevent *Listeria monocytogenes* and other foodborne pathogens like Salmonella contamination. These enterprises have enhanced protection in the face of rising public demand for fresh, unprocessed foods that haven't been cooked or pasteurized and, as a result, pose a higher risk of foodborne illness.(McLauchlin et al., 2004)

Regulatory agencies have worked hard to control *Listeria monocytogenes* contamination in food, in addition to hazard analysis at critical control point programs. In its industry sampling programs, the US Food and Drug Administration maintains a zero tolerance policy for *Listeria*

monocytogenes. Other countries' restrictions are less stringent, allowing for a tiny level of contamination (102 CFU/g) to strike a compromise between public health protection and unjustified condemnation of perfectly healthy foods. While invasive listeriosis appears to be more common in some European countries than in the US, it's unclear whether this is due to laxer European rules that allow more *Listeria monocytogenes* to enter the food supply. Proponents of zero tolerance and those who want a risk-based strategy continue to argue Listeria contamination in food. However, throughout the industrialized world, these treatments have had no effect on the incidence of *Listeria monocytogenes* infections.(Lomonaco et al., 2015).

3.2. Source

Food tainted with the bacterium, such as raw milk and milk products, is the most common source of human illness. Unpasteurized milk and its products have become more popular as a result of a current desire to buy fresh, raw items from local producers.(Skowron et al., 2019).Such items could be a source of dangerous microorganisms, resulting in serious diseases.(Gould et al., 2014). All tested milk samples in the RTE product category satisfied Food Safety Criteria, according to a 2017 study from the EFSA. In the category "Raw cow's milk for direct consumption" in the retail sector, one of 85 samples (1.2 %) from two member nations tested positive for *Listeria monocytogenes* (European Food Safety Authority and European Centre for Disease Prevention and Control (EFSA and ECDC), 2018). The frequency of diseases caused by this bacteria is steadily increasing in Poland and other European countries. In 2017, there were 2480 cases of listeriosis reported in EU countries, compared to only 1763 cases in 2013. In 2017, and 2016, the incidence rate per 100 000 people was 0.32 and 0.26, respectively. (European Food Safety Authority and European Centre for Disease Prevention and Control (EFSA and ECDC), 2018).In Poland, 124 instances of listeriosis documented in 2018, representing a 20% rise over 2015.In 2014, two people from California and Florida were diagnosed with listeriosis after consuming raw milk. In the northeast of Iran, 4% of the population was contaminated, 2% in the south (Noor Abad city), and 1.6 percent in the west (Shahr-e-Kord city). The rate of *Listeria monocytogenes* infection in raw sheep milk and traditional cheeses was 6 and 15%, respectively, in a 2010 study in Isfahan, Iran's largest city. Different studies in various countries have found that less than 5% of raw milk contains *Listeria monocytogenes.* Raw chocolate milk was the most common source of Listeria spp. (CDC 2016). From November 2015 to June 2016, pasteurized chocolate milk was determined to be the source of a listeriosis outbreak in Ontario, Canada. This outbreak lasted seven months and resulted in 34 listeriosis cases being confirmed.(Hanson et al., 2019) During an outbreak linked to the ingestion of tainted cheese in Los Angeles County (California), 48 out of 142 patients died. Another listeriosis incident connected to contaminated cheese occurred in Germany in 2006–2007 and Spain in 2008–2009, resulting in 189 and 8 cases, respectively. (Koch et al., 2010).*L. monocytogenes, L. seeligeri L. innocua, and L. ivanovii seeligeri* were detected in 6%, 0.66% 0.66%, and 1%of Iranian sea-food samples, respectively, according to one study in Iran. According to Rahimi et al., In frozen and fresh sea-food samples, *L. monocytogenes* and *L. innocua* were found in 1.9 percent and 5.7 percent, respectively.(Rahimi et al., 2012) Zarei et al. discovered a

low prevalence of *L. monocytogenes* in Iranian seafood samples. (1.4 %). (Zarei et al., n.d.) Akhondzadeh Basti et al. also found that *Listeria monocytogenes* was found in 2.6% of smoked fish samples. According to a study conducted in Urumia, Iran, 12.37 % of collected fish samples tested positive for Listeria. They discovered that *L. monocytogenes* and *L. ivonoi* were found in 21% and 29% of isolates, respectively. The results of investigation, as well as other Iranian publications, revealed that *Listeria spp.* were found in low numbers in Iranian sea foods. (Rojan Modaresi, 2011). *Listeria monocytogenes* was shown to be present in 3% of European fish, however Miettinen and Wirtanen found that Listeria spp. and *Listeria monocytogenes* were present in 35% and 14.6 % of pooled unprocessed fresh rainbow trout, respectively. (Miettinen & Wirtanen, 2005). Listeria spp. was found in 30 % of freshwater samples and 10.4 % of marine fish samples in Turkey. In addition, *L. monocytogenes* and *L. murrayi* accounted for 44.5 % and 83.5 % of all isolates, respectively (Yücel & Balci, 2010).

In a recent study, Meloni discovered that *Listeria monocytogenes* infection rates in the meat processing environment ranged from 17 percent to 50 percent in food contact surfaces and 11 percent to 25 percent in non-food contact surfaces, respectively.(Meloni, 2015) A survey of 34 zones of stuffing machines, tables, grinders, ,knives,, mixers and cold rooms revealed 11.7 percent positives, according to Gounadaki.(Gounadaki et al., 2008) In another study, *Listeria monocytogenes* was shown to be less common, with only one positive sample in a stuffing machine out of 20 in a cured sausage production facility. During a listeriosis outbreak in France, For a collection of 220 environmental swab samples from delicatessen companies, Salvat found that 68.0 percent of raw product samples and 33.0 percent of finished product samples tested positive for *Listeria monocytogenes*.(Gómez et al., 2015) According to Lundén, *Listeria monocytogenes* is commonly found in food processing gear such as packaging machines, slicers, conveyor belts and spiral freezers.(Lundén et al., 2003) *Listeria monocytogenes* was found on slicing equipment used at the retail level in Ireland to slice cooked RTE meat products. Swabs taken from tabletops in a butcher's shop in Nigeria revealed the highest incidence of Listeria spp. (100%) in another study. 16.3% of 141 swab samples taken in a restaurant in Belgrade (Serbia) tested positive for Listeria spp., according to Lakievi. The areas with the most contamination were the floors and drains.(Lakićević et al., n.d.)

Despite improvements in manufacturing hygiene, *Listeria monocytogenes* continues to be a severe concern in food processing operations, particularly dairies. Biofilm formation and bacterial survival are favored in such an environment. (Latorre et al., 2010) Because *Listeria monocytogenes* multiplies efficiently and quickly on poorly cleaned dairy appliances, biofilm formation occurs within 20 minutes of bacterial contact with the surface. (Weiler et al., 2013). *Listeria monocytogenes* colonizes difficult-to-clean floors, niches, surfaces, and equipment (e.g. hard-to-reach cavities) in dairy plants, becoming a potential cause of milk and milk product contamination.(Latorre et al., 2010).

Chapter 4

Listeria in Pregnancy

Asymptomatic listeria infection in mothers is possible. Symptoms in a pregnant woman are frequently non-specific, resembling flu symptoms such as headache, myalgia, fever, diarrhea, or other gastrointestinal symptoms.(K. A. Jackson et al., 2010) According to studies, a fever is present in 65–81% of pregnant women, and it is the most prevalent clinical presentation. (Sisó et al., 2012) The temperatures of most infected pregnant women would be above 38°C, but usually below 39°C. Most importantly, some people may not have feverish symptoms, making professional diagnosis challenging.(Charlier et al., 2017) If *Listeria monocytogenes* gains access to the circulatory system, the patient may develop sepsis, which manifests as a high fever, shivering, and breathing difficulties. When cardiac function is implicated, the brain natriuretic peptide (BNP) may rise. Multiple organ failure or post-septic shock can occur as a result of sepsis. These two circumstances, on the other hand, are uncommon. Furthermore, *Listeria monocytogenes* has the potential to cause chorioamnionitis. Meanwhile, the germs could hide in the placenta and produce recurrent infections, making treatment more difficult. (Bakardjiev et al., 2006) Despite the fact that *Listeria monocytogenes* infection rarely results in maternal death, it is linked to maternal main illnesses. (Yücel, N., & Balci, S., 2010) Pregnancy does not increase the risk of maternal neurolisteriosis.

CSF culture, on the other hand, is crucial for pregnant women with *Listeria monocytogenes* infection who have immune deficiencies. Meningitis or other neurological illnesses can cause headaches in pregnant women in particular. Meningitis in pregnant women can cause loss of consciousness and other neurological symptoms. *Listeria monocytogenes* has a substantially longer incubation period than other foodborne illnesses. According to statistics, the incubation period for maternal-neonatal listeriosis is 19 to 27.5 days (range: 7–67 days), which is larger than the incubation period for neurolisteriosis (9 days; range: 1–14 days) or bacteremia (2 days; range: 1–12 days).(K. A. (CDC/OID/NCEZID) Jackson, n.d.) Bacteremia, placental involvement, and signs of impending preterm labor, such as abdominal pain, vaginal bleeding, or premature rupture of membranes, may take longer to manifest. The fetal heart rate was over 160 beats per minute at rest, with no significant or small changes, according to the non-stress test. During birth, chorioamnionitis or meconium-like amniotic fluid infection in the mother could produce chorioamnionitis or meconium-like amniotic fluid. Apart from the aforementioned symptoms, the literature says that ultrasound can reveal abnormalities of the fetal digestive tract, such as gallbladder enlargement, small intestine widening, fetal ascites, intestinal echo enhancement, and signaling the likelihood of a fetal intrauterine infection. In this instance, the child was born with mild jaundice and dyspnea.(Hasbún et al., 2013)

The gestational age of the newborn has a significant impact on the newborn's prognosis.(Girard et al., 2014) When a fetal infection is detected early in pregnancy, 65% of pregnant women will have

an abortion. (Yücel, N., & Balci, S., 2010) Stillbirths, uterine fetal loss, and abortion are all possible complications if the infection occurs during the second or third trimester of pregnancy. (Yücel, N., & Balci, S., 2010) Late in pregnancy, *Listeria monocytogenes* is more common. There were, however, proven incidences in the early stages of pregnancy. (Gray et al., 1993) It's possible that the lower frequency of *Listeria monocytogenes* in early pregnancy is due to the fact that embryo or maternal blood cultures are rarely performed after a pregnancy loss.(Lamont et al., 2011) As a result, it's critical to follow up on a patient's medical history and test results after an early spontaneous abortion.

Only 5% of pregnancies with maternal listeriosis have a positive pregnancy outcome. (Charlier et al., 2017) According to the MONALISA group, 82 percent of pregnant women (88/107) experienced serious consequences, such as fetal loss (25 percent, 27/107), premature birth before 32 weeks (19 percent in the maternal group and 42 percent in all premature neonates), and some newborns with early-onset or late-onset listeriosis.(Charlier et al., 2017) Moreover, despite accepting ideas for preventive ampicillin treatment for maternal fever, the rate of fetal loss linked to *Listeria monocytogenes* has not decreased in recent years. (Mateus et al., 2013) According to reports, in the study includes 166 cases of fetal listeriosis. The newborn survival rate was 0%, 29.2% during the first year, and 95.3% during the second year. Pregnancies at their early, middle, and late stages, respectively. (Elinav et al., 2014) Between 1967 and 1985, the rate of net perinatal mortality was In the United Kingdom, there were 722 cases of listeriosis, with a 50% mortality rate. (McLauchlin, 1990) Listeria infections have been monitored at ten sites since 2004. In the United States, 760 Listeria infection cases were connected to pregnancies, with a 29 percent likelihood of fetal loss and neonatal mortality.(Silk et al., 2012) Antibiotic development may be connected to better perinatal outcomes. A better understanding of listeriosis in pregnancy, as well as treatment competence in neonatology.

With the emergence of maternal clinical symptoms, the importance of the fetus's effect shifted. According to a study conducted in England and Wales between 1990 and 2010, pregnant women who experience symptoms are more likely to suffer a stillbirth or spontaneous miscarriage.(Awofisayo et al., 2015) It could be because the majority of pregnant women who show symptoms are in the first or second trimester of pregnancy, or because the body has an abnormal amount of Listeria. The commencement to the demise of the fetus takes nine days, according to empirical guinea pig investigations. (Williams et al., 2007) Because the germs must colonize the placenta before infecting the fetus, the intermediate delay interval implies that they must do so. In silent parturient cases, *Listeria monocytogenes* may infiltrate the placenta and induce intrauterine infection, even if it is undetected.

In a Chinese hospital since 2013, 12 cases of pregnancy-related *Listeria monocytogenes* infection have been documented, including 10 singletons and two twins.(Li et al., 2020) The rate of Listeria infection during pregnancy was 13.7 per 100,000 newborns.(Li et al., 2020) All of the mothers were cured. Sadly, there were two spontaneous miscarriages and four fetal losses. Six of the eight neonates delivered were healthy, while the other two died within 48 hours. After postnatal examination, no neurological abnormalities were identified in the surviving babies. (Li et al., 2020)

Chapter 5

Neonatal Listeriosis

Listeriosis in newborns is a serious infection with a high fatality rate. (Pucci et al., 2018) Neonatal listeriosis can be split into two categories based on clinical manifestations: early onset disease (EOD) and late onset disease (LOD). (McLauchlin, 1990) EOD usually occurs within 6 days after delivery, and pregnant women frequently experience only minor clinical manifestations, whereas newborns may experience dyspnea, pneumonia, septicemia, or cephalomeningitis. (Sapuan et al., 2017) EOD has a 20% fatality rate, and follow-up studies found that 40% of survivors experienced neurological problems. (Scallan et al., 2011) LOD is most usually detected in full-term babies with asymptomatic mothers 7–28 days after birth.(Mateus et al., 2013) With a mortality rate of 10%, LOD neonates may develop sepsis or meningitis.(Mateus et al., 2013) Even after they were treated, LOD patients could experience serious sequelae such as stunted physical development or nervous system abnormalities.(Sapuan et al., 2017) According to reports, Listeria infection has a 68% chance of causing newborn sepsis.(Lamont et al., 2011) As a result, infants born to infected moms must undergo follow-up tests for the next 2–3 months following birth.

Nervous system symptoms, such as infant Listeria meningitis, are rather prevalent. Younger gestational weeks at delivery were discovered by researchers, rather than the presence of *Listeria monocytogenes* in neonatal CSF, are the leading cause of newborn death, signaling that other factors, such as preterm delivery, have a role in mortality.(Awofisayo et al., 2015; Girard et al., 2014) Furthermore, as the newborn grows older, the risk of dying from Listeria meningitis decreases. The mortality of neonates aged 15–30 days was much lower than that of newborns within 15 days after birth. (Yücel, N., & Balci, S., 2010) In the United Kingdom, 81.4% of babies with neurological problems survived. (Awofisayo et al., 2015) In France, EOD was detected in 94% of neonates, whereas LOD was diagnosed in 5%. The EOD instances had an 8% death rate, but there were no fatalities in the LOD cases. Surprisingly, all newborn CSF samples from LOD patients tested positive for *Listeria monocytogenes*.(Girard et al., 2014) These studies revealed that the age of a newborn with Listeria infection is a major determinant of survival.

Chapter 6

Listeria monocytogenes detection and identification

6.1. Enrichment Media and Selectivity

Several selective enrichment and plating media have been developed and used to isolate and identify *Listeria monocytogenes* in food and environmental samples. One Listeria bacteria must be detectable by isolation procedures per 25 g of food. The bulk of regulatory authorities demand it. Enrichment procedures are needed to achieve this level of sensitivity, as they allow the organism to grow to a detectable level of 104–105 CFU 1ml before plating onto selective media and culture confirmation. Because Listeria cells are slow-growing and easily overwhelmed by competition, antimicrobial compounds are used in enrichment and plating media to reduce competing microflora. Acriflavine, nalidixic acid, and cycloheximide are the most prevalent selective agents. Acriflavine inhibits the growth of Gram-positive bacteria and is widely used in conjunction with other selective agents such as polymyxin B-sulfate, cycloheximide, potassium thiocyanate, and nalidixic acid. Gram-negative bacteria are inhibited by nalidixic acid, while Gram-positive bacteria are inhibited by cycloheximide..(Beumer & Hazeleger, 2003).

Esculin is also a carbohydrate that is frequently utilized in Listeria enrichment and plating media. Esculin hydrolysis is a process that all Listeria species are capable of, and it causes the media to turn a dark black color. In the presence of esculin and ferric iron in the medium, ferric iron forms a combination with 6, 7-dihidroxycoumarin, a product of esculin cleavage by β-D-glucosidase, resulting in a black residue. As a result, Listeria is more likely to be found in cultures that turn a deep black color..(Law et al., 2015b).

Regulatory agencies have suggested BLEB, Fraser broth, and UVM Listeria enrichment broth as selective enrichment media for *Listeria monocytogenes*. For the isolation and identification of *L. monocytogenes*, the US Food and Drug Administration (FDA) recommends BLEB as a bacteriological and analytical technique (BAM). BLEB is a recipe that increases the buffering capacity of the medium by adding disodium phosphate, resulting in enhanced enrichment properties. After a 4-hour non-selective pre-enrichment period, selective agents such as nalidixic acid, acriflavine, and cycloheximide are added to the medium. (Magalhães et al., 2014).

PALCAM and Oxford are often suggested selective differential plating media for the isolation of Listeria sp. by FDA-BAM, ISO, and USD. Both PALCAM and Oxford effectively isolate Listeria sp. from food samples containing wounded Listeria cells and a high concentration of competitive microflora. (Marrakchi et al., 2004)

The main problem with PALCAM and Oxford is that they can't differentiate between pathogenic *Listeria monocytogenes* and nonpathogenic Listeria sp. As a result, these plating media are incapable of quickly detecting *L. monocytogenes* in meals. This led to the development of

chromogenic medium, which can be used to isolate *L. monocytogenes* and pathogenic Listeria sp. from non-pathogenic Listeria sp. The majority of chromogenic media are available commercially as ready-to-use plates for identifying essential pathogenicity indicators of Listeria sp.(Zunabovic et al., 2011). Furthermore, presumptive *L. monocytogenes* can be identified after 24 hours using chromogenic media. (Vlaemynck et al., 2000). Non-chromogenic media, such as PALCAM and Oxford, are more sensitive, specific, quick, and cost-effective in detecting *Listeria monocytogenes* than chromogenic media, such as Agar Listeria according to ALOA) and CHROMagar™ Listeria. (Vlaemynck et al., 2000) . However, the sensitivity and specificity of the culture medium may be affected by the types of food matrices used.(Andritsos et al., 2013).

6.2. *Listeria monocytogenes* Culture Detection and Enumeration

Detecting and identifying pathogens in foods has traditionally relied on culture methods, with phenotypic confirmation via conventional culture (e.g., hemolysis and phospholipase C), biochemical, and immunological identification following.(Gasanov et al., 2005). Conventional procedures are straightforward, sensitive, and affordable when bacterial culture is required due to positive samples(Law et al., 2015b) . A two-stage enrichment process is followed by plating on selected differential agar in the most typical culture methods.(Jantzen et al., 2006). Depending on the number of cells expected in a sample and/or the official culture reference methods utilized, the protocols may change. A variety of elements influence the success of cultural initiatives. The amount and condition of bacteria in the sample, media selectivity (balance between competitor and target bacteria inhibition), isolation medium selectivity (difference between target bacteria and competitive micro flora), and incubation conditions (temperature, time, and oxygen) are all things to think about.(Beumer & Hazeleger, 2003).

Prior to the two-stage enrichment process, which is separated into pre-enrichment and selective enrichment stages, the food samples are homogenized and incubated for 24–72 hours at 30–37°C.(Churchill et al., 2006). To resuscitate and increase the number of the damaged target pathogen, pre-enrichment in a non- or half-selective enrichment medium is used. Pre-enrichment also permits the dilution of food inhibitors such as preservatives, as well as the rehydration of microorganisms collected from dried or processed food matrices.(Jadhav et al., 2012). The target pathogen can be isolated and detected using a selective medium that increases the quantity of target pathogens while limits the growth of competing background micro flora. (Dwivedi & Jaykus, 2011) The two-stage enrichment method is used for selective and differential plating. When no separate colonies can be seen on the selected differential agar, the analysis is complete, and the results are reported as negative. If presumptive positive colonies are isolated, additional tests to confirm the pathogen are required, as shown below.(Välimaa et al., 2015).

For the isolation and detection of *Listeria monocytogenes* in foods, the FDA-BAM, ISO 11290, and USDA-FSIS procedures are all widely used culture reference methods. These approaches are indicated for detecting *Listeria monocytogenes* in a variety of food matrices, and they make use of various enrichment and plating media. Furthermore, each culture reference method's incubation time and temperature are slightly different.(Churchill et al., 2006).These culture reference methods

have been used by several researchers to investigate *Listeria monocytogenes* in foods.(Osman et al., 2014).

Table 1: summarizes the culture reference approaches.

Method	**Food matrices**	**Summary of method**	**detection limit**	**Reference**
FDA-BAM	Seafood, fruits, vegetables, and dairy products.	(1) A 25 g food sample was stomached in 225 mL BLEB, then incubated at 30°C for 4 hours. (2) Add selective agents including cycloheximide, acriflavine, and nalidixic acid to enrichment broth after 4 hours of incubation, then incubate at 30°C for 48 hours. (3) After 24 and 48 hours, streak enrichment culture onto one of the selective differential agar plates (PALCAM, Oxford, or MOX). (4) Incubate the agar plate at 35°C for 24–48 hours. (5) Before confirming Listeria sp. and *L. monocytogenes*, determine the putative colonies.	<1 CFU/mL	(Välimaa et al., 2015)
ISO 11290-1		(1) Add X g or X mL of food sample to 9X mL of half Fraser broth for initial enrichment, then incubate for 24±2 hours at 30°C.		

	All types of foods	(2) Incubate for 24±2 hours at 37°C after streaking primary enrichment culture onto ALOA and second selective media (Oxford or PALCAM). If necessary, extend the time by an additional 242 hours. (3) Incubate 0.1 mL primary enrichment culture in 10 mL Fraser broth for 48±2 hours at 35 or 37 ° C for secondary enrichment. (4) After streaking secondary enrichment culture onto ALOA plate and second selective media, incubate at 37°C for 24±2 hours (Oxford or PALCAM). Extend the time by another 24±2 hours if necessary. (5) Confirm Listeria sp. and *L.monocytogenes* before going on to Listeria sp. and *L.monocytogenes*.	<1 CFU/g in 25 g	(Zunabovic et al., 2011)
		(1) Incubate a 25 g food sample for 20–26 hours at 302oC in 225 mL UVM broth. (2) After spreading primary enrichment culture onto MOX plate, incubate at 352oC for 26±2 hours. Identify the putative colonies using the MOX plate. It is necessary to confirm the presence of Listeria sp. and *Listeria monocytogenes.*		(Välimaa et al., 2015)

USDA-FSIS	Red meat, poultry products, and egg products	(3) For secondary enrichment, mix 0.1 mL of primary enrichment culture with 10 mL Fraser broth or MOPS-BLEB. (4) Incubate Fraser broth for 26±2 hours at 352oC. Examine the broth for *L. monocytogenes* after it has been incubated (medium will darken due to esculin hydrolysis). (I) Streak 0.1 mL Fraser broth onto the MOX plate if the test is positive. Incubate the MOX plate at 352°C for 26±2 hours. Determine the presumed colonies on the MOX plate. Check for Listeria sp. and *Listeria monocytogenes*. (ii) If the findings are negative, continue to incubate Fraser broth for another 24 hours. Examine the Fraser broth once again for any indications of discoloration. If there is no darkening of Fraser broth and no suspicious colonies on MOX, the sample is deemed negative for *L. monocytogenes.* (5) Incubate MOPS-BLEB for 18–24 hours at 352°C. (I) After incubation, smear 0.1 mL of MOPS-BLEB onto a MOX plate. Incubate the MOX plate for 26±2 hours at 352°C.	<1 CFU/g	

		(ii) Identify the alleged colonies on the MOX plate and check that Listeria sp. and *L. monocytogenes* are present.		

6.3. Molecular detection of *Listeria monocytogenes*

When compared to molecular approaches, conventional methods for detecting *Listeria monocytogenes* in food samples are straightforward, sensitive, and inexpensive (Law et al., 2015a). Traditional procedures, on the other hand, are arduous and time consuming, taking more than a week to discover and confirm a virus (Dwivedi & Jaykus, 2011). Molecular methodologies have been employed as an alternative to culture and serological methods for food testing due to recent advances in molecular technology. (Gasanov et al., 2005).

There is evidence of the existence of a pathogen. The detection of particular DNA or RNA sequences in the target pathogen using nucleic-acid based molecular approaches in food is based on the detection of specific DNA or RNA sequences in the target pathogen. As a result, these genetic approaches can produce more precise and consistent results when compared to phenotypic methods. On the other hand, molecular techniques demand specialized equipment and highly trained personnel(Jadhav et al., 2012). For the detection and identification of *Listeria monocytogenes*, molecular approaches such as PCR, mPCR, real-time PCR, NASBA, LAMP, DNA microarray, and next-generation sequencing

Table 02: The use of molecular technologies to detect and identify *L.monocytogenes* in a variety of dietary samples.

Detection method	Food matrix	References
Simple PCR	Fish samples that were naturally contaminated; raw meat samples that were naturally contaminated; milk, pork, and water that had been artificially contaminated.	(Khan et al., 2013)
Multiplex PCR	Milk that has been artificially contaminated; deli meat samples that have been naturally tainted: pig and chicken goods	(Rawool et al., 2007)
	Pork meat that has been infected artificially; Soft cheese that has	

Real-time PCR	been artificially contaminated, fermented sausage, cured ham, and salad that is ready to eat	(Gattuso et al., 2014; Rantsiou et al., 2008)
LAMP	Milk that has been tainted artificially; poultry, pig, ground beef, and milk powder that has been tainted artificially; Raw milk that has been polluted both artificially and naturally	(Wan et al., 2012)
DNA microarray	Milk that has been tainted artificially	(Bang et al., 2013)
NGS	Quargel cheese, deli turkey meat, ready-to-eat meat	(Gilmour et al., 2010)

6.4 Listeriosis Pregnancy Diagnosis

Because sensitive treatments improve the prognosis of babies, early detection and diagnosis of pregnancy-associated listeriosis is critical.(Charlier et al., 2014; Lamont et al., 2011) If a pregnant woman has an unexplained fever, doctors are more likely to suspect listeriosis. (Charlier et al., 2017; Elinav et al., 2014) In particular, when females had consumed potentially contaminated items in the previous month (Mateus et al., 2013) or when detailed information on a variety of important issues, such as smoking or alcohol intake, is available. (Pereboom et al., 2013) Positive cultures from sterile samples can be used to diagnose listeriosis. In most cases, amniotic fluid, maternal or newborn blood, the placenta neonatal CSF or intrauterine mucosa are used for isolation. (Lamont et al., 2011) Blood culture is the most common way to diagnose listeria infection. If the blood culture is negative and the required antibiotics are given, infectious disease specialists, high-risk obstetricians, and neonatal doctors should be consulted before continuing to administer antibiotics. Furthermore, *Listeria monocytogenes* takes 36 hours to produce. In the meantime, only 36–55% of symptomatic females had positive blood cultures. (Charlier et al., 2014, 2017; Mateus et al., 2013) Additional test results, such as a higher WBC, a vaginal smear, or a Gram stain, may be helpful. (Posfay-Barbe & Wald, 2004)

The most sensitive approach for diagnosing maternal-neonatal listeriosis is bacterial culture of placental tissues. It must be done in conjunction with a maternal blood culture. The two tests have a positive rate of 80% and 55%, respectively. It's also useful to culture neonatal stomach aspirates to see whether there's a neonatal infection. (Charlier et al., 2017) Cultures of the placenta should be obtained during delivery. Retrospective placental detection aids in the diagnosis of subsequent Listeria infections; however, only half of newborn illnesses were subjected to this pathological biopsy. (Bubonja-Sonje et al., 2013) Specific alterations in placental tissues, such as large abscesses or necrosis in small blood veins, may occur after Listeria infection. (Barikbin et al., 2016) Aside from the placental inspection, amniocentesis can be used to retrieve amniotic fluid. If gram-positive rods are seen in amniotic fluid, this could be a sign of Listeria infection, which can be diagnosed quickly. (Mazor et al., 1992) The amniotic fluid result can potentially be used as an auxiliary diagnostic tool to help guide treatment. (Craig et al., 1996) In circumstances when there is no definitive evidence of maternal-fetal listeriosis, a listeriosis culture obtained from non-invasive cervical/vaginal smears may help to diagnose fetal listeriosis. (Disson et al., 2008; Janakiraman, n.d.) According to recent research, the positive percentage of culture for cervical or vaginal smears in maternal-neonatal listeriosis patients was 26%.(Charlier et al., 2017) In normal pregnant Iranian women, 5.5 percent (22/400) of vaginal smear samples were found to be *Listeria monocytogenes* culture positive.(Heidarzadeh, S et al., 2018) As a result, vaginal smear culture may be considered as part of a routine prenatal examination for pregnant women with high-risk factors, as this test is non-invasive, simple to do, and can improve the detection rate of *Listeria monocytogenes*, reducing the chance of miscarriage.

Due to the abundance of Listeria-containing chemicals in the environment, stool culture is not currently advised for detecting Listeria. As a result, there is a considerable risk of ingestion of *Listeria monocytogenes* and the presence of listeriosis in feces. Thus, sporadic bacteria carrying or shedding in feces (approximately 5% of the population, but a significant variation exists) is rarely indicative of infection. (Lamont et al., 2011) Furthermore, a *Listeria monocytogenes* fecal culture is less sensitive, and most laboratories lack the necessary equipment to conduct tests.

Chapter 7

Treatment of Liseriosis

7.1. In general

With the exception of cephalosporins, which the bacterium is frequently resistant to, most -lactam antibiotics are still effective against *Listeria monocytogenes* (Morvan et al., 2010). Some patients' listeriosis treatment may be delayed because newer cephalosporins are widely used to treat nonspecific sepsis symptoms or as an empiric treatment for bacterial meningitis. Empiric ampicillin therapy for bacterial meningitis is recommended for older individuals, however it may not be necessary for infants past the neonatal period. When listeriosis is suspected, ampicillin or, in penicillin-allergic patients, vancomycin is given to provide empiric coverage for *Listeria monocytogenes* until a culture is done to confirm the diagnosis.(Okike et al., 2015)

The current therapy of choice for all types of listeriosis is an ampicillin-gentamicin combination. (Temple & Nahata MC, 2000). However, some evidence suggests that this combination is ineffective and even dangerous. (Mitja et al., 2009) Penicillin resistance has been on the rise in recent years (Morvan et al., 2010). Ampicillin is not bactericidal against *Listeria monocytogenes*, although findings from in vitro and in vivo studies suggest that combining it with gentamicin may enhance the outcome. (MacGowan et al., 1998) However, there have been no randomized, controlled clinical trials of treatment in persons.

An alternative therapeutic regimen that has been recommended is trimethoprim-sulfamethoxazole with or without rifampin. Several examples of early "step-down" to oral trimethoprim-sulfamethoxazole have been successful.(Grant et al., 2010). Amoxicillin and cotrimoxazole were found to be more efficacious than ampicillin and gentamicin in one retrospective investigation.(Merle-Melet et al., 1996) Trimethoprim resistance has been found in large numbers(Bertsch et al., 2014). New quinolones may also be effective, albeit the evidence is limited to in vitro studies(Marco et al., 2000). Despite its effectiveness against Listeria, Rifampin has been found to be resistant in cases of prosthetic joint infection(Chenal-Francisque et al., 2014). Pelegrn advised dexamethasone and phenytoin as appropriate treatment adjuncts for central nervous system infection.(Pelegrín et al., 2014).

In HIV patients and those undergoing chemotherapy for leukemia or lymphoma, trimethoprim-sulfamethoxazole has also been used as a preventative drug against a variety of bacteria, including P. jiroveci. This drug could help people from getting infected with *Listeria monocytogenes*. When used in conjunction with dietary instructions provided for these patients in recent years, prophylaxis has been related to a reduction in the incidence of listeriosis in these weakened hosts (Ewert et al, 1995). There has been no research done on the duration of invasive listeriosis treatment. Relapses appear to be rare, and most types of listeriosis can be treated with ampicillin and gentamicin for two to three weeks. If rhombencephalitis is accompanied by abscess formation in the central nervous system, a longer treatment period may be required, but there is little evidence to support treatment beyond four weeks. (Temple & Nahata, 2000).

7.2 Listeria Treatment during Pregnancy

Patients with *Listeria monocytogenes* without allergies should get two weeks of high-dose intravenous amoxicillin (more than 6 g/day). The safety of amoxicillin for a fetus has been proven beyond a shadow of a doubt.(Shaw et al., 1998) If the remedy lasts through the puerperium or begins after birth, it's also acceptable. The relative infant dosage (RID) of amoxicillin (the ratio of the drug concentration in newborn blood to that in maternal blood) is only 0.2–0.5 percent, owing to its safety for neonates when breastfeeding.(Ito et al., 1993) Because studies have shown that gentamicin has a synergistic effect with amoxicillin, it can typically be added to the prescription scheme (Temple ME et al., 2000) However, some experts have raised concerns about this practice, especially because of gentamicin's toxicity to the fetus. (Janakiraman, n.d.) Gentamicin in combination with ampicillin/amoxicillin may enhance invasive *Listeria monocytogenes* survival rates, but it has little effect on intracellular Listeria in macrophages. (Charlier et al., 2017) Cephalosporin is routinely given to pregnant women to prevent or treat infectious illnesses, and it has a strong effect on group *B Streptococcus* and *E. coli. Listeria monocytogenes*, on the other hand, is unaffected. (Bubonja-Sonje et al., 2013; Elinav et al., 2014)

Clinical treatment will be difficult if the pregnant woman is allergic to penicillin or amoxicillin. Trimethoprim with sulfamethoxazole is an additional therapy option in such circumstances.(Janakiraman, n.d.) Trimethoprim, on the other hand, has the potential to impair the developing heart and nervous system of the fetus. (Hernández-Díaz S et al., 2001) Because it is safe for the fetus in this situation, erythromycin is an excellent choice for persons who are allergic to penicillin(Lin et al., 2013; Romøren et al., 2012) The only disadvantage of erythromycin is that it loses potency after passing through the placenta. As a result, it is necessary to raise the dosage. When nursing, erythromycin can also be used.(Welekidan et al., 2019) 2–3 weeks of treatment is usually enough for different Listeria serotypes. However, if the maternal nervous system is involved, four weeks of treatment is required.(Janakiraman, n.d.)

There is very little research on drug resistance in the treatment of *Listeria monocytogenes* in pregnant women. Drug resistance was shown to be exceptionally high for clindamycin (66.7%), penicillin G (66.7%), amoxicillin (50%), and vancomycin (50%) in one investigation (50%). (Welekidan et al., 2019) As a result, increasing drug resistance to medications used to treat listeriosis puts the clinical outcome of listeriosis-related pregnancies at risk. *Listeria monocytogenes* isolated from patients who had a spontaneous miscarriage in Iran, on the other hand, was completely resistant to trimethoprim and erythromycin and had a higher susceptibility to chloramphenicol (88%) and ciprofloxacin (66.67%). (Pourkaveh, B., et al., 2015) Furthermore, listeria discovered in all instant consumable meals tested positive for ciprofloxacin, chloramphenicol, and trimethoprim/sulfamethoxazole in Poland. (Sosnowski et al., 2019) Furthermore, ciprofloxacin and trimethoprim/sulfamethoxazole sensitivity was high in Chinese food samples (90.5%) and trimethoprim/sulfamethoxazole sensitivity was very high (57.1%). (Zhang et al., 2019)

The idea of a Listeria infection vaccination during pregnancy has sparked debate. Fetal loss or maternal-fetal listeriosis cannot be prevented by prenatal vaccination with attenuated *Listeria monocytogenes* strains before or during pregnancy. (Clark et al., 2014) Nano vaccines, on the

other hand, appear to have some promise, according to some reports. (Calderón-Gonzalez et al., 2016)

Given that prompt and adequate antibiotic therapy can greatly improve the prognosis of mothers and infants, some clinicians have advised that preventive antibiotic use for pregnant women with fever and/or gastrointestinal symptoms be investigated. (Elinav et al., 2015) Oral amoxicillin or trimethoprim-sulfamethoxazole for one week during the second or third trimester has been recommended for high-risk pregnant women suspected of Listeria infection.(Madjunkov et al., 2017) In 2011, the Centers for Disease Control and Prevention (CDC) developed a recommended treatment regimen for people who are at risk of developing invasive listeriosis after consuming *Listeria monocytogenes*-contaminated meals. (Imanishi et al., 2015) Experts say there's no medical reason to detect and treat suspected *Listeria monocytogenes* infections because the risk of it turning into invasive Listeria is so low.(Imanishi et al., 2015) As a result, the American College of Obstetricians and Gynecologists (ACOG) has advised against performing blood cultures, stool cultures, or treatments for women who are pregnant but have no obvious symptoms, regardless of whether their food was recalled or they were engaged in a lawsuit(&Na;, 2014) These viewpoints were also presented. Researchers came to a consensus in later investigations after Listeria outbreaks in a variety of places.(Imanishi et al., 2015)

If the mother's and fetal conditions deteriorate, the pregnancy may need to be terminated to save the mother's life. In addition, if the pregnant woman gets systemic infections, such as cardiovascular system involvement or liver and kidney failure, the pregnancy must be terminated to save the mother's life. If the placental function has worsened or non-stress testing have showed repeated variant deceleration or late deceleration, the pregnancy should be terminated.(Mateus et al., 2013) In light of the aforementioned conditions, obstetricians should raise awareness about Listeria in pregnancy, and early and timely antibiotic therapy is critical for illness prevention. Patients should be tested for the same thing at the same time.

Chapter 8

Listeriosis Prevention during Pregnancy

Most pregnant women who had been infected with *Listeria monocytogenes* had eaten anything that could have harmed their pregnancy. It emphasizes the significance of delivering prenatal health education to pregnant mothers in places where *Listeria monocytogenes* is prevalent. Pregnant women should avoid ready-to-eat foods and dairy products that have not been disinfected at high temperatures. Cross-infection should also be avoided by keeping dinnerware clean and tidy and ensuring that the surface used for food preparation is free of *Listeria monocytogenes* contamination. There is a temporal lag between the seasonal peak of pregnancy-related listeriosis and the seasonal peak of other listeriosis. Additionally, clinicians should advise all pregnant women about listeriosis symptoms so that they can seek medical treatment as soon as clinical manifestations occur. Fortunately, the French government has taken steps to prevent Listeria contamination throughout the food processing process, and the risk of Listeria infection has fallen dramatically between 1984 and 2006. Dietary recommendations for pregnant women can help to minimize the rate of pregnancy-related listeriosis. Importantly, by raising mother awareness of Listeria infection, the risk of fetal death can be minimized. (Girard et al., 2014)

Chapter 9

Conclusion

Listeria monocytogenes has been found in a range of processed foods as an opportunistic intracellular pathogen that can live under high pH, osmolarity, and temperature. The current reference methods for detecting *Listeria monocytogenes* make it relatively simple to recover this pathogen from a variety of foods. The use of chromogenic medium has significantly enhanced *Listeria monocytogenes* isolation. Because they are highly sensitive, precise, and rapid, molecular diagnostic techniques have also aided in the detection and identification of this infection. Although there are numerous subtyping approaches for tracking *Listeria monocytogenes* strains, using two or more of them together is often more discriminatory and powerful than using each procedure separately. There have been reports of both small and big listeriosis epidemics. *Listeria monocytogenes* can cause a variety of clinical symptoms in immunocompromised patients, the most common of which are sepsis, meningitis, and rhombencephalitis. Although the most common treatment for listeriosis is a combination of ampicillin and an aminoglycoside, various regimens have been utilized in the past. A combination of an immunocompromised host and a usually delayed diagnosis contributes to the high fatality rate.

Listeria is difficult to diagnose and treat clinically since it is an intracellular bacterium. Obstetricians should look into the possibility of pregnancy-related *Listeria monocytogenes* in pregnant women who have flu-like symptoms and a history of high-risk eating. Pregnant women with typical indications or additional symptoms that raise suspicion of listeriosis should be tested for the bacteria and given prophylactic medicine to minimize adverse maternal and fetal outcomes. To minimize the rate of listeriosis, governments may need to improve surveillance. More research on the costs and benefits of routinely monitoring pregnant women for *Listeria monocytogenes* in order to lower illness burden and enhance prognosis by prophylactic therapy is needed.

References

Abreu, C., Magro, F., Vilas-Boas, F., Lopes, S., Macedo, G., & Sarmento, A. (2013). Listeria infection in patients on anti-TNF treatment: Report of two cases and review of the literature. *Journal of Crohn's and Colitis*, *7*(2), 175–182. https://doi.org/10.1016/j.crohns.2012.04.018

Andritsos, N. D., Mataragas, M., Paramithiotis, S., & Drosinos, E. H. (2013). Quantifying Listeria monocytogenes prevalence and concentration in minced pork meat and estimating performance of three culture media from presence/absence microbiological testing using a deterministic and stochastic approach. *Food Microbiology*, *36*(2), 395–405. https://doi.org/10.1016/j.fm.2013.06.020

Aureli, P., Fiorucci, G. C., Caroli, D., Marchiaro, G., Novara, O., Leone, L., & Salmaso, S. (2000). An Outbreak of Febrile Gastroenteritis Associated with Corn Contaminated by *Listeria monocytogenes*. *New England Journal of Medicine*, *342*(17), 1236–1241. https://doi.org/10.1056/NEJM200004273421702

Awofisayo, A., Amar, C., Ruggles, R., Elson, R., Adak, G. K., Mook, P., & Grant, K. A. (2015). Pregnancy-associated listeriosis in England and Wales. *Epidemiology and Infection*, *143*(2), 249–256. https://doi.org/10.1017/S0950268814000594

Bakardjiev, A. I., Theriot, J. A., & Portnoy, D. A. (2006). Listeria monocytogenes Traffics from Maternal Organs to the Placenta and Back. *PLoS Pathogens*, *2*(6), e66. https://doi.org/10.1371/journal.ppat.0020066

Bang, J., Beuchat, L. R., Song, H., Gu, M. B., Chang, H.-I., Kim, H. S., & Ryu, J.-H. (2013). Development of a random genomic DNA microarray for the detection and identification of Listeria monocytogenes in milk. *International Journal of Food Microbiology*, *161*(2), 134–141. https://doi.org/10.1016/j.ijfoodmicro.2012.11.023

Barikbin, P., Sallmon, H., Hüseman, D., Sarioglu, N., Weichert, A., von Weizsäcker, K., Bührer, C., & Koehne, P. (2016). Clinical, Laboratory, and Placental Findings in Perinatal Listeriosis. *Fetal and Pediatric Pathology*, *35*(5), 307–314. https://doi.org/10.1080/15513815.2016.1179822

Bennion, J. R., Sorvillo, F., Wise, M. E., Krishna, S., & Mascola, L. (2008). Decreasing Listeriosis Mortality in the United States, 1990–2005. *Clinical Infectious Diseases*, *47*(7), 867–874. https://doi.org/10.1086/591131

Bertrand, S., Ceyssens, P. J., Yde, M., Dierick, K., Boyen, F., Vanderpas, J., Vanhoof, R., & Mattheus, W. (2016). Diversity of Listeria monocytogenes Strains of Clinical and Food Chain Origins in Belgium between 1985 and 2014. *PLOS ONE*, *11*(10), e0164283. https://doi.org/10.1371/journal.pone.0164283

Bertsch, D., Muelli, M., Weller, M., Uruty, A., Lacroix, C., & Meile, L. (2014). Antimicrobial susceptibility and antibiotic resistance gene transfer analysis of foodborne, clinical, and

environmental *Listeria* spp. Isolates including *Listeria monocytogenes*. *MicrobiologyOpen*, *3*(1), 118–127. https://doi.org/10.1002/mbo3.155

Beumer, R. R., & Hazeleger, W. C. (2003). *Listeria monocytogenes*: Diagnostic problems. *FEMS Immunology & Medical Microbiology*, *35*(3), 191–197. https://doi.org/10.1016/S0928-8244(02)00444-3

Bodro, M., & Paterson, D. L. (2013). Listeriosis in patients receiving biologic therapies. *European Journal of Clinical Microbiology & Infectious Diseases*, *32*(9), 1225–1230. https://doi.org/10.1007/s10096-013-1873-1

Bubonja-Sonje, M., Mustac, E., Brunn, A., Deckert, M., & Abram, M. (2013). Listeriosis in pregnancy: Case report and retrospective study. *The Journal of Maternal-Fetal & Neonatal Medicine*, *26*(3), 321–323. https://doi.org/10.3109/14767058.2012.733780

Buchanan, R. L., & Whiting, R. C. (1998). Risk Assessment: A Means for Linking HACCP Plans and Public Health. *Journal of Food Protection*, *61*(11), 1531–1534. https://doi.org/10.4315/0362-028X-61.11.1531

Calderón-Gonzalez, R., Terán-Navarro, H., Frande-Cabanes, E., Ferrández-Fernández, E., Freire, J., Penadés, S., Marradi, M., García, I., Gomez-Román, J., Yañez-Díaz, S., & Álvarez-Domínguez, C. (2016). Pregnancy Vaccination with Gold Glyco-Nanoparticles Carrying Listeria monocytogenes Peptides Protects against Listeriosis and Brain- and Cutaneous-Associated Morbidities. *Nanomaterials*, *6*(8), 151. https://doi.org/10.3390/nano6080151

Carrique-Mas, J. J., Hökeberg, I., Andersson, Y., Arneborn, M., Tham, W., Danielsson-Tham, M.-L., Osterman, B., Leffler, M., Steen, M., Eriksson, E., Hedin, G., & Giesecke, J. (2003). Febrile gastroenteritis after eating on-farm manufactured fresh cheese – an outbreak of listeriosis? *Epidemiology and Infection*, *130*(1), 79–86. https://doi.org/10.1017/S0950268802008014

Charlier, C., Disson, O., & Lecuit, M. (2020). Maternal-neonatal listeriosis. *Virulence*, *11*(1), 391–397. https://doi.org/10.1080/21505594.2020.1759287

Charlier, C., Goffinet, F., Azria, E., Leclercq, A., & Lecuit, M. (2014). Inadequate management of pregnancy-associated listeriosis: Lessons from four case reports. *Clinical Microbiology and Infection*, *20*(3), 246–249. https://doi.org/10.1111/1469-0691.12281

Charlier, C., Perrodeau, É., Leclercq, A., Cazenave, B., Pilmis, B., Henry, B., Lopes, A., Maury, M. M., Moura, A., Goffinet, F., Dieye, H. B., Thouvenot, P., Ungeheuer, M.-N., Tourdjman, M., Goulet, V., de Valk, H., Lortholary, O., Ravaud, P., Lecuit, M., … Zumbo, C. (2017). Clinical features and prognostic factors of listeriosis: The MONALISA national prospective cohort study. *The Lancet Infectious Diseases*, *17*(5), 510–519. https://doi.org/10.1016/S1473-3099(16)30521-7

Chenal-Francisque, V., Charlier, C., Mehvish, S., Dieye, H., Leclercq, A., Courvalin, P., & Lecuit, M. (2014). Highly Rifampin-Resistant Listeria monocytogenes Isolated from a Patient with Prosthetic Bone Infection. *Antimicrobial Agents and Chemotherapy*, *58*(3), 1829–1830. https://doi.org/10.1128/AAC.02449-13

Chiara, M., Caruso, M., D'Erchia, A. M., Manzari, C., Fraccalvieri, R., Goffredo, E., Latorre, L., Miccolupo, A., Padalino, I., Santagada, G., Chiocco, D., Pesole, G., Horner, D. S., & Parisi, A. (2015). Comparative Genomics of *Listeria* Sensu Lato: Genus-Wide Differences in Evolutionary Dynamics and the Progressive Gain of Complex, Potentially Pathogenicity-Related Traits through Lateral Gene Transfer. *Genome Biology and Evolution*, *7*(8), 2154–2172. https://doi.org/10.1093/gbe/evv131

Churchill, R. L. T., Lee, H., & Hall, J. C. (2006). Detection of Listeria monocytogenes and the toxin listeriolysin O in food. *Journal of Microbiological Methods*, *64*(2), 141–170. https://doi.org/10.1016/j.mimet.2005.10.007

Clark, D. R., Chaturvedi, V., Kinder, J. M., Jiang, T. T., Xin, L., Ertelt, J. M., & Way, S. S. (2014). Perinatal Listeria monocytogenes susceptibility despite preconceptual priming and maintenance of pathogen-specific CD8+ T cells during pregnancy. *Cellular & Molecular Immunology*, *11*(6), 595–605. https://doi.org/10.1038/cmi.2014.84

Craig, S., Permezel, M., Doyle, L., Mildenhall, L., & Garland, S. (1996). Perinatal Infection with listeria Monocytogenes. *The Australian and New Zealand Journal of Obstetrics and Gynaecology*, *36*(3), 286–290. https://doi.org/10.1111/j.1479-828X.1996.tb02712.x

Dalton, C. B., Merritt, T. D., Unicomb, L. E., Kirk, M. D., Stafford, R. J., Lalor, K., & the OzFoodNet Working Group. (2011). A national case-control study of risk factors for listeriosis in Australia. *Epidemiology and Infection*, *139*(3), 437–445. https://doi.org/10.1017/S0950268810000944

de Noordhout, C. M., Devleesschauwer, B., Angulo, F. J., Verbeke, G., Haagsma, J., Kirk, M., Havelaar, A., & Speybroeck, N. (2014). The global burden of listeriosis: A systematic review and meta-analysis. *The Lancet Infectious Diseases*, *14*(11), 1073–1082. https://doi.org/10.1016/S1473-3099(14)70870-9

Disson, O., Grayo, S., Huillet, E., Nikitas, G., Langa-Vives, F., Dussurget, O., Ragon, M., Le Monnier, A., Babinet, C., Cossart, P., & Lecuit, M. (2008). Conjugated action of two species-specific invasion proteins for fetoplacental listeriosis. *Nature*, *455*(7216), 1114–1118. https://doi.org/10.1038/nature07303

Dwivedi, H. P., & Jaykus, L.-A. (2011). Detection of pathogens in foods: The current state-of-the-art and future directions. *Critical Reviews in Microbiology*, *37*(1), 40–63. https://doi.org/10.3109/1040841X.2010.506430

Elinav, H., Hershko-Klement, A., Solt, I., Glikman, D., & Nir-Paz, R. (2015). Pregnancy-associated listeriosis: Many beliefs, few facts. *The Lancet Infectious Diseases*, *15*(10), 1128–1130. https://doi.org/10.1016/S1473-3099(15)00302-3

Elinav, H., Hershko-Klement, A., Valinsky, L., Jaffe, J., Wiseman, A., Shimon, H., Braun, E., Paitan, Y., Block, C., Sorek, R., Nir-Paz, R., Miron, D., Glikman, D., Soboh, S., Nseir, W., Paz, A., Cohen, E., Mendelson, B., Paz, E., … Japeth, R. (2014). Pregnancy-Associated Listeriosis:

Clinical Characteristics and Geospatial Analysis of a 10-Year Period in Israel. *Clinical Infectious Diseases*, *59*(7), 953–961. https://doi.org/10.1093/cid/ciu504

European Food Safety Authority and European Centre for Disease Prevention and Control (EFSA and ECDC). (2018). The European Union summary report on trends and sources of zoonoses, zoonotic agents and food-borne outbreaks in 2017. *EFSA Journal*, *16*(12). https://doi.org/10.2903/j.efsa.2018.5500

Fan, Z., Xie, J., Li, Y., & Wang, H. (2019). Listeriosis in mainland China: A systematic review. *International Journal of Infectious Diseases*, *81*, 17–24. https://doi.org/10.1016/j.ijid.2019.01.007

Frye, D. M., Zweig, R., Sturgeon, J., Tormey, M., LeCavalier, M., Lee, I., Lawani, L., & Mascola, L. (2002). An Outbreak of Febrile Gastroenteritis Associated with Delicatessen Meat Contaminated with *Listeria monocytogenes*. *Clinical Infectious Diseases*, *35*(8), 943–949. https://doi.org/10.1086/342582

Gahan, C. G. M., & Hill, C. (2014). Listeria monocytogenes: Survival and adaptation in the gastrointestinal tract. *Frontiers in Cellular and Infection Microbiology*, *4*. https://doi.org/10.3389/fcimb.2014.00009

Gasanov, U., Hughes, D., & Hansbro, P. M. (2005). Methods for the isolation and identification of *Listeria* spp. and *Listeria monocytogenes*: A review. *FEMS Microbiology Reviews*, *29*(5), 851–875. https://doi.org/10.1016/j.femsre.2004.12.002

Gattuso, A., Gianfranceschi, M. V., Sonnessa, M., Delibato, E., Marchesan, M., Hernandez, M., De Medici, D., & Rodriguez-Lazaro, D. (2014). Optimization of a Real Time PCR based method for the detection of Listeria monocytogenes in pork meat. *International Journal of Food Microbiology*, *184*, 106–108. https://doi.org/10.1016/j.ijfoodmicro.2014.04.015

Gilmour, M. W., Graham, M., Van Domselaar, G., Tyler, S., Kent, H., Trout-Yakel, K. M., Larios, O., Allen, V., Lee, B., & Nadon, C. (2010). High-throughput genome sequencing of two Listeria monocytogenes clinical isolates during a large foodborne outbreak. *BMC Genomics*, *11*(1), 120. https://doi.org/10.1186/1471-2164-11-120

Girard, D., Leclercq, A., Laurent, E., Lecuit, M., de Valk, H., & Goulet, V. (2014). Pregnancy-related listeriosis in France, 1984 to 2011, with a focus on 606 cases from 1999 to 2011. *Eurosurveillance*, *19*(38). https://doi.org/10.2807/1560-7917.ES2014.19.38.20909

Gómez, D., Iguácel, L., Rota, M., Carramiñana, J., Ariño, A., & Yangüela, J. (2015). Occurrence of Listeria monocytogenes in Ready-to-Eat Meat Products and Meat Processing Plants in Spain. *Foods*, *4*(4), 271–282. https://doi.org/10.3390/foods4030271

Gould, L. H., Mungai, E., & Barton Behravesh, C. (2014). Outbreaks Attributed to Cheese: Differences Between Outbreaks Caused by Unpasteurized and Pasteurized Dairy Products, United States, 1998–2011. *Foodborne Pathogens and Disease*, *11*(7), 545–551. https://doi.org/10.1089/fpd.2013.1650

Goulet, V., Hebert, M., Hedberg, C., Laurent, E., Vaillant, V., De Valk, H., & Desenclos, J.-C. (2012). Incidence of Listeriosis and Related Mortality Among Groups at Risk of Acquiring Listeriosis. *Clinical Infectious Diseases*, *54*(5), 652–660. https://doi.org/10.1093/cid/cir902

Gounadaki, A. S., Skandamis, P. N., Drosinos, E. H., & Nychas, G.-J. E. (2008). Microbial ecology of food contact surfaces and products of small-scale facilities producing traditional sausages. *Food Microbiology*, *25*(2), 313–323. https://doi.org/10.1016/j.fm.2007.10.001

Grant, M. H., Ravreby, H., & Lorber, B. (2010). Cure of *Listeria monocytogenes* Meningitis after Early Transition to Oral Therapy. *Antimicrobial Agents and Chemotherapy*, *54*(5), 2276–2277. https://doi.org/10.1128/AAC.01815-09

Gray, J. W., Barrett, J. F. R., Pedler, S. J., & Lind, T. (1993). Faecal carriage of listeria during pregnancy. *BJOG: An International Journal of Obstetrics and Gynaecology*, *100*(9), 873–874. https://doi.org/10.1111/j.1471-0528.1993.tb14324.x

Grif, K., Patscheider, G., Dierich, M. P., & Allerberger, F. (2003). Incidence of Fecal Carriage of Listeria monocytogenes in Three Healthy Volunteers: A One-Year Prospective Stool Survey. *European Journal of Clinical Microbiology and Infectious Diseases*, *22*(1), 16–20. https://doi.org/10.1007/s10096-002-0835-9

Hanson, H., Whitfield, Y., Lee, C., Badiani, T., Minielly, C., Fenik, J., Makrostergios, T., Kopko, C., Majury, A., Hillyer, E., Fortuna, L., Maki, A., Murphy, A., Lombos, M., Zittermann, S., Yu, Y., Hill, K., Kong, A., Sharma, D., & Warshawsky, B. (2019). *Listeria monocytogenes* Associated with Pasteurized Chocolate Milk, Ontario, Canada. *Emerging Infectious Diseases*, *25*(3), 581–584. https://doi.org/10.3201/eid2503.180742

Hasbún, J., Sepúlveda-Martínez, A., Haye, M. T., Astudillo, J., & Parra-Cordero, M. (2013). Chorioamnionitis Caused by *Listeria monocytogenes* : A Case Report of Ultrasound Features of Fetal Infection. *Fetal Diagnosis and Therapy*, *33*(4), 268–271. https://doi.org/10.1159/000345091

Huang, Y.-T., Ko, W.-C., Chan, Y.-J., Lu, J.-J., Tsai, H.-Y., Liao, C.-H., Sheng, W.-H., Teng, L.-J., & Hsueh, P.-R. (2015). Disease Burden of Invasive Listeriosis and Molecular Characterization of Clinical Isolates in Taiwan, 2000-2013. *PLOS ONE*, *10*(11), e0141241. https://doi.org/10.1371/journal.pone.0141241

Imanishi, M., Routh, J. A., Klaber, M., Gu, W., Vanselow, M. S., Jackson, K. A., Sullivan-Chang, L., Heinrichs, G., Jain, N., Albanese, B., Callaghan, W. M., Mahon, B. E., & Silk, B. J. (2015). Estimating the Attack Rate of Pregnancy-Associated Listeriosis during a Large Outbreak. *Infectious Diseases in Obstetrics and Gynecology*, *2015*, 1–5. https://doi.org/10.1155/2015/201479

Ito, S., Blajchman, A., Stephenson, M., Eliopoulos, C., & Koren, G. (1993). Prospective follow-up of adverse reactions in breast-fed infants exposed to maternal medication. *American Journal of Obstetrics and Gynecology*, *168*(5), 1393–1399. https://doi.org/10.1016/S0002-9378(11)90771-6

Jacks, A., Pihlajasaari, A., Vahe, M., Myntti, A., Kaukoranta, S.-S., Elomaa, N., Salmenlinna, S., Rantala, L., Lahti, K., Huusko, S., Kuusi, M., Siitonen, A., & Rimhanen-Finne, R. (2016).

Outbreak of hospital-acquired gastroenteritis and invasive infection caused by *Listeria monocytogenes* , Finland, 2012. *Epidemiology and Infection*, *144*(13), 2732–2742. https://doi.org/10.1017/S0950268815002563

Jackson, K. A. (CDC/OID/NCEZID). (n.d.). *Assessment of the Incubation Period for Invasive Listeriosis*. 10.

Jackson, K. A., Iwamoto, M., & Swerdlow, D. (2010). Pregnancy-associated listeriosis. *Epidemiology and Infection*, *138*(10), 1503–1509. https://doi.org/10.1017/S0950268810000294

Jadhav, S., Bhave, M., & Palombo, E. A. (2012). Methods used for the detection and subtyping of Listeria monocytogenes. *Journal of Microbiological Methods*, *88*(3), 327–341. https://doi.org/10.1016/j.mimet.2012.01.002

Janakiraman, V. (n.d.). *Listeriosis in Pregnancy: Diagnosis, Treatment, and Prevention*. 7.

Jantzen, M. M., Navas, J., Corujo, A., Moreno, R., López, V., & Martínez-Suárez, J. V. (2006). Review. Specific detection of Listeria monocytogenes in foods using commercial methods: From chromogenic media to real-time PCR. *Spanish Journal of Agricultural Research*, *4*(3), 235. https://doi.org/10.5424/sjar/2006043-198

Jurado, R. L., Farley, M. M., Pereira, E., Harvey, R. C., Schuchat, A., Wenger, J. D., & Stephens, D. S. (1993). Increased Risk of Meningitis and Bacteremia Due to Listeria monocytogenes in Patients with Human Immunodeficiency Virus Infection. *Clinical Infectious Diseases*, *17*(2), 224–227. https://doi.org/10.1093/clinids/17.2.224

Khan, J. A., Rathore, R. S., Khan, S., & Ahmad, I. (2013). In vitro detection of pathogenic Listeria monocytogenes from food sources by conventional, molecular and cell culture method. *Brazilian Journal of Microbiology*, *44*(3), 751–758. https://doi.org/10.1590/S1517-83822013000300013

Koch, J., Dworak, R., Prager, R., Becker, B., Brockmann, S., Wicke, A., Wichmann-Schauer, H., Hof, H., Werber, D., & Stark, K. (2010). Large Listeriosis Outbreak Linked to Cheese Made from Pasteurized Milk, Germany, 2006–2007. *Foodborne Pathogens and Disease*, *7*(12), 1581–1584. https://doi.org/10.1089/fpd.2010.0631

Koopmans, M. M., Bijlsma, M. W., Brouwer, M. C., van de Beek, D., & van der Ende, A. (2017). Listeria monocytogenes meningitis in the Netherlands, 1985–2014: A nationwide surveillance study. *Journal of Infection*, *75*(1), 12–19. https://doi.org/10.1016/j.jinf.2017.04.004

Lakićević, B., Stjepanović, A., Milijašević, M., Terzić, A., Golić, N., & Topisirović, L. (n.d.). *THE PRESENCE OF LISTERIA SPP. AND LISTERIA MONOCYTOGENES IN A CHOSEN FOOD PROCESSING ESTABLISHMENT IN SERBIA*. 8.

Lamont, R. F., Sobel, J., Mazaki-Tovi, S., Kusanovic, J. P., Vaisbuch, E., Kim, S. K., Uldbjerg, N., & Romero, R. (2011). Listeriosis in human pregnancy: A systematic review. *Journal of Perinatal Medicine*, *39*(3). https://doi.org/10.1515/jpm.2011.035

Latorre, A. A., Van Kessel, J. S., Karns, J. S., Zurakowski, M. J., Pradhan, A. K., Boor, K. J., Jayarao, B. M., Houser, B. A., Daugherty, C. S., & Schukken, Y. H. (2010). Biofilm in milking

equipment on a dairy farm as a potential source of bulk tank milk contamination with Listeria monocytogenes. *Journal of Dairy Science*, *93*(6), 2792–2802. https://doi.org/10.3168/jds.2009-2717

Law, J. W.-F., Ab Mutalib, N.-S., Chan, K.-G., & Lee, L.-H. (2015a). Rapid methods for the detection of foodborne bacterial pathogens: Principles, applications, advantages and limitations. *Frontiers in Microbiology*, *5*. https://doi.org/10.3389/fmicb.2014.00770

Law, J. W.-F., Ab Mutalib, N.-S., Chan, K.-G., & Lee, L.-H. (2015b). An insight into the isolation, enumeration, and molecular detection of Listeria monocytogenes in food. *Frontiers in Microbiology*, *6*. https://doi.org/10.3389/fmicb.2015.01227

Li, C., Zeng, H., Ding, X., Chen, Y., Liu, X., Zhou, L., Wang, X., Cheng, Y., Hu, S., Cao, Z., Liu, R., & Yin, C. (2020). Perinatal listeriosis patients treated at a maternity hospital in Beijing, China, from 2013–2018. *BMC Infectious Diseases*, *20*(1), 601. https://doi.org/10.1186/s12879-020-05327-6

Lin, K. J., Mitchell, A. A., Yau, W.-P., Louik, C., & Hernández-Díaz, S. (2013). Safety of macrolides during pregnancy. *American Journal of Obstetrics and Gynecology*, *208*(3), 221.e1-221.e8. https://doi.org/10.1016/j.ajog.2012.12.023

Linke, K., Rückerl, I., Brugger, K., Karpiskova, R., Walland, J., Muri-Klinger, S., Tichy, A., Wagner, M., & Stessl, B. (2014). Reservoirs of Listeria Species in Three Environmental Ecosystems. *Applied and Environmental Microbiology*, *80*(18), 5583–5592. https://doi.org/10.1128/AEM.01018-14

Lomonaco, S., Nucera, D., & Filipello, V. (2015). The evolution and epidemiology of Listeria monocytogenes in Europe and the United States. *Infection, Genetics and Evolution*, *35*, 172–183. https://doi.org/10.1016/j.meegid.2015.08.008

Lundén, J. M., Autio, T. J., Sjöberg, A.-M., & Korkeala, H. J. (2003). Persistent and Nonpersistent Listeria monocytogenes Contamination in Meat and Poultry Processing Plants. *Journal of Food Protection*, *66*(11), 2062–2069. https://doi.org/10.4315/0362-028X-66.11.2062

MacGowan, A., Wootton, M., Bowker, K., Holt, H. A., & Reeves, D. (1998). Ampicillin-aminoglycoside interaction studies using Listeria monocytogenes. *Journal of Antimicrobial Chemotherapy*, *41*(3), 417–418. https://doi.org/10.1093/jac/41.3.417

Madjunkov, M., Chaudhry, S., & Ito, S. (2017). Listeriosis during pregnancy. *Archives of Gynecology and Obstetrics*, *296*(2), 143–152. https://doi.org/10.1007/s00404-017-4401-1

Magalhães, R., Mena, C., Ferreira, V., Almeida, G., Silva, J., & Teixeira, P. (2014). Traditional Methods for Isolation of Listeria monocytogenes. In K. Jordan, E. M. Fox, & M. Wagner (Eds.), *Listeria monocytogenes* (Vol. 1157, pp. 15–30). Springer New York. https://doi.org/10.1007/978-1-4939-0703-8_2

Mammina, C., Parisi, A., Guaita, A., Aleo, A., Bonura, C., Nastasi, A., & Pontello, M. (2013). Enhanced surveillance of invasive listeriosis in the Lombardy region, Italy, in the years 2006-2010

reveals major clones and an increase in serotype 1/2a. *BMC Infectious Diseases*, *13*(1), 152. https://doi.org/10.1186/1471-2334-13-152

Marco, F., Almela, M., Nolla-Salas, J., Coll, P., Gasser, I., Ferrer, M. D., & de Simon, M. (2000). In vitro activities of 22 antimicrobial agents against Listeria monocytogenes strains isolated in Barcelona, Spain. *Diagnostic Microbiology and Infectious Disease*, *38*(4), 259–261. https://doi.org/10.1016/S0732-8893(00)00208-X

Marrakchi, A. E., Boum'handi, N., & Hamama, A. (2004). Performance of a new chromogenic plating medium for the isolation of Listeria monocytogenes from marine environments. *Letters in Applied Microbiology*, 5.

Mateus, T., Silva, J., Maia, R. L., & Teixeira, P. (2013). Listeriosis during Pregnancy: A Public Health Concern. *ISRN Obstetrics and Gynecology*, *2013*, 1–6. https://doi.org/10.1155/2013/851712

Mazor, M., Froimovich, M., Lazer, S., Maymon, E., & Glezerman, M. (1992). Listeria Monocytogenes: The role of transabdominal amniocentesis in febrile patients with preterm labor. *Archives of Gynecology and Obstetrics*, *252*(2), 109–112. https://doi.org/10.1007/BF02389637

McAuley, C. M., McMillan, K., Moore, S. C., Fegan, N., & Fox, E. M. (2014). Prevalence and characterization of foodborne pathogens from Australian dairy farm environments. *Journal of Dairy Science*, *97*(12), 7402–7412. https://doi.org/10.3168/jds.2014-8735

McLauchlin, J. (1990). Human listeriosis in Britain, 1967–85, a summary of 722 cases: 1. Listeriosis during pregnancy and in the newborn. *Epidemiology and Infection*, *104*(2), 181–189. https://doi.org/10.1017/S0950268800059343

McLauchlin, J., Mitchell, R. T., Smerdon, W. J., & Jewell, K. (2004). Listeria monocytogenes and listeriosis: A review of hazard characterisation for use in microbiological risk assessment of foods. *International Journal of Food Microbiology*, *92*(1), 15–33. https://doi.org/10.1016/S0168-1605(03)00326-X

Mead, P. S., Slutsker, L., Dietz, V., McCaig, L. F., Bresee, J. S., Shapiro, C., Griffin, P. M., & Tauxe, R. V. (1999). Food-Related Illness and Death in the United States. *Emerging Infectious Diseases*, *5*(5), 19.

Meloni, D. (2015). Presence of Listeria monocytogenes in Mediterranean-Style Dry Fermented Sausages. *Foods*, *4*(4), 34–50. https://doi.org/10.3390/foods4010034

Merle-Melet, M., Dossou-Gbete, L., Maurer, P., Meyer, Ph., Lozniewski, A., Kuntzburger, O., Wéber, M., & Gérard, A. (1996). Is amoxicillin-cotrimoxazole the most appropriate antibiotic regimen for listeria meningoencephalitis? Review of 22 cases and the literature. *Journal of Infection*, *33*(2), 79–85. https://doi.org/10.1016/S0163-4453(96)92929-1

Miettinen, H., & Wirtanen, G. (2005). Prevalence and location of Listeria monocytogenes in farmed rainbow trout. *International Journal of Food Microbiology*, *104*(2), 135–143. https://doi.org/10.1016/j.ijfoodmicro.2005.01.013

Mitja, O., Pigrau, C., Ruiz, I., Vidal, X., Almirante, B., Planes, A.-M., Molina, I., Rodriguez, D., & Pahissa, A. (2009). Predictors of mortality and impact of aminoglycosides on outcome in listeriosis in a retrospective cohort study. *Journal of Antimicrobial Chemotherapy*, *64*(2), 416–423. https://doi.org/10.1093/jac/dkp180

Montero, D., Bodero, M., Riveros, G., Lapierre, L., Gaggero, A., Vidal, R. M., & Vidal, M. (2015). Molecular epidemiology and genetic diversity of Listeria monocytogenes isolates from a wide variety of ready-to-eat foods and their relationship to clinical strains from listeriosis outbreaks in Chile. *Frontiers in Microbiology*, *6*. https://doi.org/10.3389/fmicb.2015.00384

Moosavy, M.-H., Esmaeili, S., Mostafavi, E., & Amiri, F. B. (n.d.). *Isolation of Listeria monocytogenes from milks used for Iranian traditional cheese_in Lighvan cheese factories*. 2.

Morganti, M., Scaltriti, E., Cozzolino, P., Bolzoni, L., Casadei, G., Pierantoni, M., Foni, E., & Pongolini, S. (2016). Processing-Dependent and Clonal Contamination Patterns of Listeria monocytogenes in the Cured Ham Food Chain Revealed by Genetic Analysis. *Applied and Environmental Microbiology*, *82*(3), 822–831. https://doi.org/10.1128/AEM.03103-15

Morvan, A., Moubareck, C., Leclercq, A., Hervé-Bazin, M., Bremont, S., Lecuit, M., Courvalin, P., & Le Monnier, A. (2010). Antimicrobial Resistance of *Listeria monocytogenes* Strains Isolated from Humans in France. *Antimicrobial Agents and Chemotherapy*, *54*(6), 2728–2731. https://doi.org/10.1128/AAC.01557-09

Mullapudi, S., Siletzky, R. M., & Kathariou, S. (2008). Heavy-Metal and Benzalkonium Chloride Resistance of *Listeria monocytogenes* Isolates from the Environment of Turkey-Processing Plants. *Applied and Environmental Microbiology*, *74*(5), 1464–1468. https://doi.org/10.1128/AEM.02426-07

&Na; (2014). Management of Pregnant Women With Presumptive Exposure to Listeria monocytogenes: *Obstetrics & Gynecology*, 1. https://doi.org/10.1097/01.AOG.0000453542.64048.92

Nolla-Salas, J., Vinas, L., & Latorre, C. (1998). PERINATAL LISTERIOSIS: A POPULATION-BASED MULTICENTER STUDY IN BARCELONA, SPAIN (1990-1996). *AMERICAN JOURNAL OF PERINATOLOGY*, *15*(8), 7.

Okike, I. O., Awofisayo, A., Adak, B., & Heath, P. T. (2015). Empirical antibiotic cover for *Listeria monocytogenes* infection beyond the neonatal period: A time for change? *Archives of Disease in Childhood*, *100*(5), 423–425. https://doi.org/10.1136/archdischild-2014-307059

Orsi, R. H., & Wiedmann, M. (2016). Characteristics and distribution of Listeria spp., including Listeria species newly described since 2009. *Applied Microbiology and Biotechnology*, *100*(12), 5273–5287. https://doi.org/10.1007/s00253-016-7552-2

Osman, K. M., Samir, A., Orabi, A., & Zolnikov, T. R. (2014). Confirmed low prevalence of Listeria mastitis in she-camel milk delivers a safe, alternative milk for human consumption. *Acta Tropica*, *130*, 1–6. https://doi.org/10.1016/j.actatropica.2013.10.001

Pelegrín, I., Moragas, M., Suárez, C., Ribera, A., Verdaguer, R., Martínez-Yelamos, S., Rubio-Borrego, F., Ariza, J., Viladrich, P. F., & Cabellos, C. (2014). Listeria monocytogenes meningoencephalitis in adults: Analysis of factors related to unfavourable outcome. *Infection*, *42*(5), 817–827. https://doi.org/10.1007/s15010-014-0636-y

Pereboom, M. T. R., Manniën, J., Spelten, E. R., Schellevis, F. G., & Hutton, E. K. (2013). Observational study to assess pregnant women's knowledge and behaviour to prevent toxoplasmosis, listeriosis and cytomegalovirus. *BMC Pregnancy and Childbirth*, *13*(1), 98. https://doi.org/10.1186/1471-2393-13-98

Pichler, J., Much, P., Kasper, S., Fretz, R., Auer, B., Kathan, J., Mann, M., Huhulescu, S., Ruppitsch, W., Pietzka, A., Silberbauer, K., Neumann, C., Gschiel, E., de Martin, A., Schuetz, A., Gindl, J., Neugschwandtner, E., & Allerberger, F. (2009). An outbreak of febrile gastroenteritis associated with jellied pork contaminated with Listeria monocytogenes. *Wiener Klinische Wochenschrift*, *121*(3–4), 149–156. https://doi.org/10.1007/s00508-009-1137-3

Posfay-Barbe, K. M., & Wald, E. R. (2004). Listeriosis. *Pediatrics in Review*, *25*(5), 151–159. https://doi.org/10.1542/pir.25-5-151

Pouillot, R., Hoelzer, K., Jackson, K. A., Henao, O. L., & Silk, B. J. (2012). Relative Risk of Listeriosis in Foodborne Diseases Active Surveillance Network (FoodNet) Sites According to Age, Pregnancy, and Ethnicity. *Clinical Infectious Diseases*, *54*(suppl_5), S405–S410. https://doi.org/10.1093/cid/cis269

Pucci, L., Massacesi, M., & Liuzzi, G. (2018). Clinical management of women with listeriosis risk during pregnancy: A review of national guidelines. *Expert Review of Anti-Infective Therapy*, *16*(1), 13–21. https://doi.org/10.1080/14787210.2018.1417837

Rahimi, E., Shakerian, A., & Raissy, M. (2012). Prevalence of Listeria species in fresh and frozen fish and shrimp in Iran. *Annals of Microbiology*, *62*(1), 37–40. https://doi.org/10.1007/s13213-011-0222-9

Rantsiou, K., Alessandria, V., Urso, R., Dolci, P., & Cocolin, L. (2008). Detection, quantification and vitality of Listeria monocytogenes in food as determined by quantitative PCR. *International Journal of Food Microbiology*, *121*(1), 99–105. https://doi.org/10.1016/j.ijfoodmicro.2007.11.006

Rawool, D. B., Malik, S. V. S., Shakuntala, I., Sahare, A. M., & Barbuddhe, S. B. (2007). Detection of multiple virulence-associated genes in Listeria monocytogenes isolated from bovine mastitis cases. *International Journal of Food Microbiology*, *113*(2), 201–207. https://doi.org/10.1016/j.ijfoodmicro.2006.06.029

Rojan Modaresi. (2011). Prevalence of Listeria spp. In fish obtained from Urmia fish markets. *African Journal of Microbiology Research*, *5*(30). https://doi.org/10.5897/AJMR11.888

Romøren, M., Lindbaek, M., & Nordeng, H. (2012). Pregnancy outcome after gestational exposure to erythromycin - a population-based register study from Norway: Erythromycin in pregnancy. *British Journal of Clinical Pharmacology*, *74*(6), 1053–1062. https://doi.org/10.1111/j.1365-2125.2012.04286.x

Sapuan, S., Kortsalioudaki, C., Anthony, M., Chang, J., Embleton, N. D., Geethanath, R. M., Gray, J., Greenough, A., Lal, M. K., Luck, S., Pattnayak, S., Reynolds, P., Russell, A. B., Scorrer, T., Turner, M., Heath, P. T., & Vergnano, S. (2017). Neonatal listeriosis in the UK 2004–2014. *Journal of Infection*, *74*(3), 236–242. https://doi.org/10.1016/j.jinf.2016.11.007

Sauders, B. D., Overdevest, J., Fortes, E., Windham, K., Schukken, Y., Lembo, A., & Wiedmann, M. (2012). Diversity of Listeria Species in Urban and Natural Environments. *Applied and Environmental Microbiology*, *78*(12), 4420–4433. https://doi.org/10.1128/AEM.00282-12

Scallan, E., Hoekstra, R. M., Angulo, F. J., Tauxe, R. V., Widdowson, M.-A., Roy, S. L., Jones, J. L., & Griffin, P. M. (2011). Foodborne Illness Acquired in the United States—Major Pathogens. *Emerging Infectious Diseases*, *17*(1), 7–15. https://doi.org/10.3201/eid1701.P11101

Schlech, W. F. (n.d.). *Epidemiology and Clinical Manifestations of Listeria monocytogenes Infection*. 12.

Shaw, G. M., Todoroff, K., Velie, E. M., & Lammer, E. J. (1998). Maternal illness, including fever, and medication use as risk factors for neural tube defects. *Teratology*, *57*(1), 1–7. https://doi.org/10.1002/(SICI)1096-9926(199801)57:1<1::AID-TERA1>3.0.CO;2-6

Silk, B. J., Date, K. A., Jackson, K. A., Pouillot, R., Holt, K. G., Graves, L. M., Ong, K. L., Hurd, S., Meyer, R., Marcus, R., Shiferaw, B., Norton, D. M., Medus, C., Zansky, S. M., Cronquist, A. B., Henao, O. L., Jones, T. F., Vugia, D. J., Farley, M. M., & Mahon, B. E. (2012). Invasive Listeriosis in the Foodborne Diseases Active Surveillance Network (FoodNet), 2004–2009: Further Targeted Prevention Needed for Higher-Risk Groups. *Clinical Infectious Diseases*, *54*(suppl_5), S396–S404. https://doi.org/10.1093/cid/cis268

Sisó, C., Goncé, A., Bosch, J., Salvia, M. D., Hernández, S., & Figueras, F. (2012). Listeriosis in pregnancy: A secular trend in a tertiary referral hospital in Barcelona. *European Journal of Clinical Microbiology & Infectious Diseases*, *31*(9), 2125–2132. https://doi.org/10.1007/s10096-012-1545-6

Skowron, K., Wałecka-Zacharksa, E., Grudlewska, K., Wiktorczyk, N., Kaczmarek, A., Gryń, G., Kwiecińska-Piróg, J., Juszczuk, K., Paluszak, Z., Kosek-Paszkowska, K., & Gospodarek-Komkowska, E. (2019). Characteristics of Listeria monocytogenes Strains Isolated from Milk and Humans and the Possibility of Milk-Borne Strains Transmission. *Polish Journal of Microbiology*, *68*(3), 353–369. https://doi.org/10.33073/pjm-2019-038

Sosnowski, M., Lachtara, B., Wieczorek, K., & Osek, J. (2019). Antimicrobial resistance and genotypic characteristics of Listeria monocytogenes isolated from food in Poland. *International Journal of Food Microbiology*, *289*, 1–6. https://doi.org/10.1016/j.ijfoodmicro.2018.08.029

Stea, E. C., Purdue, L. M., Jamieson, R. C., Yost, C. K., & Truelstrup Hansen, L. (2015). Comparison of the Prevalences and Diversities of Listeria Species and Listeria monocytogenes in an Urban and a Rural Agricultural Watershed. *Applied and Environmental Microbiology*, *81*(11), 3812–3822. https://doi.org/10.1128/AEM.00416-15

Thomas, M. K., Vriezen, R., Farber, J. M., Currie, A., Schlech, W., & Fazil, A. (2015). Economic Cost of a *Listeria monocytogenes* Outbreak in Canada, 2008. *Foodborne Pathogens and Disease*, *12*(12), 966–971. https://doi.org/10.1089/fpd.2015.1965

Travier, L., Guadagnini, S., Gouin, E., Dufour, A., Chenal-Francisque, V., Cossart, P., Olivo-Marin, J.-C., Ghigo, J.-M., Disson, O., & Lecuit, M. (2013). ActA Promotes Listeria monocytogenes Aggregation, Intestinal Colonization and Carriage. *PLoS Pathogens*, *9*(1), e1003131. https://doi.org/10.1371/journal.ppat.1003131

Välimaa, A.-L., Tilsala-Timisjärvi, A., & Virtanen, E. (2015). Rapid detection and identification methods for Listeria monocytogenes in the food chain – A review. *Food Control*, *55*, 103–114. https://doi.org/10.1016/j.foodcont.2015.02.037

Vlaemynck, G., Lafarge, V., & Scotter, S. (2000). Improvement of the detection of Listeria monocytogenes by the application of ALOA, a diagnostic, chromogenic isolation medium. *Journal of Applied Microbiology*, *88*(3), 430–441. https://doi.org/10.1046/j.1365-2672.2000.00978.x

Wadhwa Desai, R., & Smith, M. A. (2017). Pregnancy-related listeriosis: Pregnancy-Related Listeriosis. *Birth Defects Research*, *109*(5), 324–335. https://doi.org/10.1002/bdr2.1012

Wald, A., Van Thiel, D. H., Hoechstetter, L., Gavaler, J. S., Egler, K. M., Verm, R., Scott, L., & Lester, R. (1982). Effect of pregnancy on gastrointestinal transit. *Digestive Diseases and Sciences*, *27*(11), 1015–1018. https://doi.org/10.1007/BF01391748

Wan, C., Yang, Y., Xu, H., Aguilar, Z. P., Liu, C., Lai, W., Xiong, Y., Xu, F., & Wei, H. (2012). Development of a propidium monoazide treatment combined with loop-mediated isothermal amplification (PMA-LAMP) assay for rapid detection of viable *Listeria monocytogenes*. *International Journal of Food Science & Technology*, *47*(11), 2460–2467. https://doi.org/10.1111/j.1365-2621.2012.03123.x

Weiler, C., Ifland, A., Naumann, A., Kleta, S., & Noll, M. (2013). Incorporation of Listeria monocytogenes strains in raw milk biofilms. *International Journal of Food Microbiology*, *161*(2), 61–68. https://doi.org/10.1016/j.ijfoodmicro.2012.11.027

Welekidan, L. N., Bahta, Y. W., Teklehaimanot, M. G., Abay, G. K., Wasihun, A. G., Dejene, T. A., Muthupandian, S., Mezgebo, T. A., & Hagos, A. K. (2019). Prevalence and drug resistance pattern of Listeria monocytogenes among pregnant women in Tigray region, Northern Ethiopia: A cross-sectional study. *BMC Research Notes*, *12*(1), 538. https://doi.org/10.1186/s13104-019-4566-8

Williams, D., Irvin, E. A., Chmielewski, R. A., Frank, J. F., & Smith, M. A. (2007). Dose-Response of Listeria monocytogenes after Oral Exposure in Pregnant Guinea Pigs. *Journal of Food Protection*, *70*(5), 1122–1128. https://doi.org/10.4315/0362-028X-70.5.1122

Yücel, N., & Balci, Ş. (2010). Prevalence of Listeria, Aeromonas, and Vibrio Species in Fish Used for Human Consumption in Turkey. *Journal of Food Protection*, *73*(2), 380–384. https://doi.org/10.4315/0362-028X-73.2.380

Zarei, M., Maktabi, S., & Ghorbanpour, M. (n.d.). *Prevalence of Listeria monocytogenes, Vibrio parahaemolyticus, Staphylococcus aureus, and Salmonella spp. In Seafood Products Using Multiplex Polymerase Chain Reaction*. 6.

Zhang, X., Niu, Y., Liu, Y., Lu, Z., Wang, D., Cui, X., Chen, Q., & Ma, X. (2019). Isolation and Characterization of Clinical Listeria monocytogenes in Beijing, China, 2014–2016. *Frontiers in Microbiology*, *10*, 981. https://doi.org/10.3389/fmicb.2019.00981

Zunabovic, M., Domig, K. J., & Kneifel, W. (2011). Practical relevance of methodologies for detecting and tracing of Listeria monocytogenes in ready-to-eat foods and manufacture environments – A review. *LWT - Food Science and Technology*, *44*(2), 351–362. https://doi.org/10.1016/j.lwt.2010.08.005