

# Health Insights: The Efficacy of Current Prenatal Education on *Listeria Monocytogenes*

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**Abstract--** Every year, at least one major *Listeria monocytogenes* (*Listeria*) outbreak occurs within the United States. If pregnant women are uninformed of possible ramifications of contracting *Listeria*, the mother and child are at risk for health complications. One possibly effective communication approach to this population regarding prevention and risk is through *Listeria* Educational Materials (LEM). In order to ascertain the status and effectiveness of currently available LEM for pregnant women, a systematic literature review was conducted. Literature searches were conducted using widely accepted public/private databases. The mesh terms used included “*Listeria* pregnancy”, “*listeria* education”, “*Listeriosis*”, “*Listeria* pregnancy prevalence” “*Listeria monocytogenes*”. Articles published within the past 10 years pertaining to educational materials for pregnant women were evaluated. Articles relating to general information of *Listeria*, were also narrowed to specific characteristics, traits, and origin for exposure. References to *Listeria* in elderly and immunocompromised individuals were excluded. Four studies involving *Listeria* interventions including LEM for pregnant women were identified. These studies all concluded a majority of pregnant women were still not provided with sufficient information on infection prevention of *Listeria*. Most educational materials provided to the women were in the form of pamphlets, and the majority of pregnant women who had heard of *Listeria* gathered the information through their own research efforts. The current evaluation of the available studies concludes there is inadequate emphasis placed on educational interventions for pregnant women regarding *Listeria* risk. These interventions concluded more must be done to inform these pregnant women of the dangers of *Listeria* as well as on the high-risk foods they consume on a daily basis.

**Keywords-** *Listeriosis*, *Listeria monocytogenes*, *Listeria* education, education, pregnancy

## I. INTRODUCTION

Many pregnant women may not be confronted about the issue of *Listeriosis* through their primary physician, but rather through ‘drips and drabs’ of information provided by the Department of Health [1]. If these women are not obtaining the reality of possible ramifications of contracting the *Listeriosis* bacterium, they may be placing both themselves and their unborn child at risk for illness and even death. Many public health based programs have tried to account for this

insufficiency but have also fallen short of their ultimate goals of prevention. More care should be seen between the public health officials and other levels of intervention including nutrition, environmental health, and primary care. This review will present all current information as well as programs for *listeriosis* prevention, and provide detail as to the strengths and weakness of the programs as well as alternative interventions, which may provide improved effects.

## II. BACKGROUND

### A. Overview of Organism

Many individuals within the United States become infected with foodborne illnesses at some point in their lifetime. Coincidentally, the rate of occurrence is quite alarming, and the CDC statistics indicate one of six individuals will become infected with a pathogen related to food products and groceries each year [2]. These foodborne pathogens include *Salmonella* Heidelberg, *Esherichia coli*, *Norovirus caliciviradae*, *Clostridium botulinum*, *Campylobacter jejuni*, and *Listeria monocytogenes*.

The Centers for Disease Control research indicates that *Listeria monocytogenes* is of particular concern for pregnant women due to a general lack of awareness regarding the bacteria. The focus of concern lies in the ‘hidden dangers’ surrounding *Listeria monocytogenes*. *Listeria monocytogenes* can be better known as the foodborne illness *Listeriosis*, and is a very resistant, resilient organism. The *Listeria* bacterium survives in anaerobic conditions and can affect the digestive tract of susceptible individuals. These individuals include pregnant women, elderly, and immunocompromised individuals. Others such as children and adults can become infected, though these cases comprise less than ten percent of the infections [3]. It has remained strong through its ability to endure a broad range of temperatures. *Listeria* can survive up to approximately 67 degrees Celsius, and even below refrigeration temperatures [4]. These ‘low’ temperatures were discovered through a recent student dissertation from Louisiana State University. According to this experimentation, there is still viability of *Listeria monocytogenes* when placed under conditions of -20 degrees

Celsius [5]. These temperature ranges help describe the bacteria's ability to conform to its surroundings, and survive under drastic conditions. *Listeria monocytogenes* also has the ability to exist in high pH and has halophilic-like properties. The adaptation of this organism in extreme environments has given Listeriosis its ability to appear and remain viable in food products such as refrigerated cheeses and deli meats.

### B. Origin of Exposure

*Listeria monocytogenes* has the capability of surviving in the environment such as soil, water, and the intestinal tract of many animals. One Norwegian study stated that this bacterium could even survive years in the environment [6]. In this study it was made clear the environment can become contaminated through animal fertilizer or through the shedding of the bacteria from the animals directly onto their surroundings. Furthermore, researchers stated that animals can also be carriers and up to 50 percent of the samples taken from healthy animals are infected with the bacteria [7]. Nightingale discusses that infected animals and contaminated agricultural environments are seldom linked to communicable disease. However, manufactured animal products untreated prior to consumption (e.g., raw milk) and raw plant foods contaminated by animal fertilizer from infected animals or carriers, represent 'direct' correlations between contagious factors among individuals and *Listeria monocytogenes* within the agricultural settings [7]. Subsequently, dairy products from raw milk that include soft cheeses (such as Mexican-style cheese, feta, Camembert, Brie, Stilton, and blue cheeses), yogurt, and soft-serve ice cream have a higher likelihood of contamination [8]. Other routes of exposure include hot dogs, various deli meats and pates, and even some seafood products such as smoked salmon. A major hazard when dining resides in 'ready-to-eat food' products, since they are processed to maintain a "medium-to-long shelf-life—a highly sought-after quality by today's consumer" [9]. This includes many at risk fish products such as cold smoked fish, raw carpaccio, and marinated fish.

### C. Transmission

From the origination, Listeriosis then can be transmitted due to improper handling of food products and lack of sanitation. Many high-risk foods such as unpasteurized milk products have more of a tendency to be infected with the *Listeria monocytogene* pathogens since they are not subjected to the same high temperatures pasteurized milk is subject to. The cause of an outbreak is usually due to improper handling at numerous stations when manufacturing of food products is taking place. A circuit can also take place once food products become infected with bacteria. New issues can arise, including not cooking food to proper temperatures and letting the product sit out for lengthy durations at hazardous temperatures. This can result in wide spread foodborne disease [10]. Unpasteurized products are at a higher risk for *Listeria monocytogenes* and are linked to disease outbreaks due to improper handling through the processing of the dairy products.

Also, the lack of properly rinsing fresh produce, and not washing hands after handling raw products can lead to infection of Listeriosis. Due to usage of animal manure based products for the growth of farm crops, rinsing is essential to ensure the *Listeria monocytogenes* pathogens are sloughed off the produce before ingesting the product. Other ways in which *Listeria monocytogenes* can integrate with food products is through inadequate reheating of refrigerated food products. All foods should be reheated to a temperature of 160 degrees in order to ensure the *Listeria monocytogenes* pathogen is completely eradicated. Gambarin et al., discusses the "psychrotolerant" characteristics allowing "*Listeria monocytogenes* to adapt to acidic conditions and to low water activity environments" [9]. Smoked fish commodities are a major contribution to overall infections. Additionally, throughout Europe, smoked salmon is the most commonly reported product to exceed maximal allowable limits for contamination of *L. monocytogenes*. The cooking process of smoking is conducted at a "low temp" environment (200 °F to 300 °F) (93 °C to 149 °C) and *Listeria monocytogenes* is able to survive these temperatures, creating a high-risk environment.

### D. Incubation and Health Issues

The incubation period of *Listeria monocytogenes* can range anywhere from 3 to 70 days. There is a broad range of symptoms, which may be present at the time of infection. Unfortunately, these symptoms can be easily confused with other illnesses and can include various flu-like indicators such as fever, chills, muscle aches, malaise, intestinal disruption and diarrhea; other symptoms include septicemia, meningitis, and encephalitis [8]. In addition, more severe symptoms can also occur simultaneously for pregnant women. Listeriosis may cause harm to fetal development triggering premature birth, miscarriage, as well as stillbirth [12]. Listeriosis infection occurs through the intrauterine lining, which can then infect the fetus. A model was devised that *Listeria monocytogenes* could cross the placental barrier through initiation of "very low numbers or even a single organism" [13]. Infants born to infected mothers are at risk for further infection and even septicemia.

### E. Prevalence

Due to the resilient properties of *Listeria monocytogenes*, and combined with improper food handling, prevalence of *Listeria monocytogenes* among pregnant populations is a concern. Many outbreaks of Listeriosis have occurred over the years in the United States, as well as throughout the world. In Canada, for example, the incidence of Listeriosis is approximately .15 to .35 per 100,000 people [14]. In the United States, the incidence of contracting the bacterium is .31 of 100,000 individuals [15]. There have been an increasing number of outbreaks involving food vehicles between 1998 and 2008 and have been correlated to an increase in multi-state outbreaks. Research shows that multi-state Listeriosis outbreaks have gone up since 1998, and are the highest they have ever been.

### F. Issue at Hand

According to the CDC, pregnant women are “ten times more likely than the general population to get *Listeria* infection” [3]. According to Kirkham and Berowitz, if pregnant women are infected with *Listeria monocytogenes*, there is a 20 percent chance of that individual to have a miscarriage. Also, if the infants do survive, they may be premature and have over a 60 percent chance of them contracting the infection after birth [14]. Since the risk of spontaneous abortion and infection of infants is high, efforts have been taken to discover the origin and route of entry of *Listeria monocytogenes*. Various food products throughout the world have also been researched to discover their prevalence of *Listeria* in the food industry. For example, in the Vilar study of 2007, samples of dairy farm equipment and milk supplies in Spain were tested, and contamination of *Listeria monocytogenes* was present. These researchers discovered the prevalence of *Listeria monocytogenes* was over 16 percent within the milk storage vats [16]. The prevalence of *Listeria monocytogenes* in Spain milk vats was found to be higher than that of Finland (4.1%), Ireland (8.3%), United States (10.4%), and Canada (12.4%) [16]. A 2005 study researched farmed rainbow trout from Finland as another area of concern for pregnant women. The prevalence of *Listeria monocytogenes* was found to be approximately 33 percent of all trout sampled [17,18].

Not only are the statistics alarming for pregnant women around the world, there have been many outbreaks within the United States as well. One major outbreak occurred in 2001. Researchers from the CDC believed the cause of the Listeriosis outbreak was Mexican-style cheese. The source was cheese that had been contaminated subsequently, causing *Listeria monocytogenes* to enter the milk and reproduce [19]. It caused 12 individuals to become ill. 10 of these cases were expectant mothers, who ended up losing their children to this deadly disease. Another outbreak occurred in San Antonio, Texas in October of 2010. Ten cases of *Listeria monocytogenes* were reported by the Texas Department of Health. Of these ten reported cases, half of the individuals infected ended as fatalities. The source of the *Listeria monocytogenes* was discovered in bags of freshly cut celery. Analysis of the celery pieces produced findings that a combination of flaws took place to generate this bacterial contamination. There were soil remnants discovered within the packaging facility, as well as hand washing and sanitation violations, and even a water leakage occurring relatively close to the packaging vicinity. Not only was there a lack of sanitation in the facility and direct contamination of the celery, but there could have also been cross contamination to other food products handled by the company.

Not only have there been large outbreaks of *Listeria monocytogenes* where devastating effects in pregnant women have been seen, this trend continues almost every year. This raises concern for many researchers and physicians in that the risk of pregnant women becoming infected is not on the decline. In 2011, there was a multistate outbreak when contaminated cantaloupes from Jensen Farms in Colorado made their way to

other states within the U.S. This led to a total of 33 deaths, and a total 147 infected individuals from 28 of the states. Also, a total of eight of these illnesses involved pregnant women, and one of these ended in a miscarriage. Consequently, the *Listeria* bacterium was isolated from the equipment within the Colorado packing facility [20]. Shortly, after the discovery of *Listeria* related illnesses, the cantaloupes were recalled.

Another outbreak involving infection of pregnant women occurred in September of 2012. In this case, the product in question happened to be imported Frescolina Marte Brand Ricotta Salata Cheese. This particular cheese was imported from Italy and produced a total of 22 infected individuals, including two deaths and a miscarriage. Researchers within the CDC discovered it was difficult to isolate the origin of the infection. Through thorough investigation they discovered the imported cheese, along with “other types of soft cheese that had already been and repackaged” were to blame for the outbreak [21].

The most recent *Listeria monocytogenes* outbreak occurred on July 3, 2013. This occurrence was due to processed soft cheese known as Les Freres, distributed by Crave Brothers. One person succumbed to the infection and passed away, while a few others were hospitalized. One pregnant mother ended up having a miscarriage. The CDC is still unable to pinpoint the exact cause of the contamination; however, further investigation is taking place. The issue of pregnancy miscarriages due to *Listeria monocytogenes*, continues to perplex the public health field.

### III. METHODS

When searching through relevant articles for the *Listeria* literature review, various databases were utilized including Academic Search Premier, Ebsco Host, and PubMed. The time frame that this search took place was between June 2013 and August 2013. In order to narrow down the search, a range of mesh terms were used including “*Listeria* pregnancy”, “*listeria* education”, “*Listeriosis*”, “environmental sources *Listeria*”, “prevalence of *Listeria* during pregnancy and United States”, “*Listeria* pregnancy prevalence” “*Listeria monocytogenes*”. Over 5,000 results were formulated; however, approximately 30 of them were relevant for the particular review at hand. To narrow the list down from 5,000, first, only articles pertaining to educational materials for pregnant women were taken from within the past 10 years. Articles relating to general information specifically of *Listeria monocytogenes* were also narrowed down to specific characteristics, traits, and environmental origin for exposure. These articles had to have been published within the past 20 years. Lastly, so as no bias toward cases of *Listeria monocytogenes* for miscarriages was prevalent, the statistics provided within this document were obtained from reputable sites such as the CDC. Of the included approximately 30 reviews, those that pertained to education, relevance, and recently published material on *Listeria monocytogenes* were chosen. Articles that were only discussing

*Listeria monocytogenes* in elderly and immunocompromised individuals were excluded.

#### IV. RESULTS

These cases provide evidence that it is still of great importance to provide information to pregnant women regarding contamination of *Listeria monocytogenes* in food products. The incidence, prevalence, and case studies show relevance in support for educational opportunities that can be provided to physicians and their patients. Currently, there are only a few educational models, which have been researched and described in detail.

The first of these research plans was researched in 2004. This research model began by collecting data on what women were looking for in terms of educational knowledge regarding pregnancy and foodborne illnesses. So as to discover the needs of these pregnant women, the research team decided to offer focus groups in various states. The subjects were divided into two focus groups per city, and there were a total of four states including New Hampshire, Iowa, North Carolina, and Utah [22]. The total number of participants was comprised of 63 pregnant women, who were at least three months pregnant. Two, well-versed focus leaders, at 'local market research facilities', directed these focus groups. It was found that many of these women were, in fact, anxious about issues regarding food pathogens and wanted to know what they could do to prevent the spread of contamination. It was stated that the majority of these women had acknowledged the existence of salmonella and *E. coli*, but did not know much, if at all, about *Listeria monocytogenes*. The subjects were each provided with the U.S. Department of Agriculture's Food Safety and Inspection Service Listeriosis brochure, and asked what they thought about the information contained within. Many of the subjects stated they would prefer a brochure for each separate at-risk group, more in depth information on *Listeria monocytogenes*, statistics regarding 'morbidity and mortality,' and the risk for pregnant women to develop the infection [22]. The women also stated they would have liked to have known about the pathogen ahead of time, and that it would have been beneficial to hear more from their health care practitioners. Various types of media, including news sites, public service announcements, and even magazines and books, would have also been helpful.

The second analysis accomplished on pregnancy knowledge of Listeriosis was achieved in 2006. The goal of the analysis was to discover if a program designed through a partnership of AWHONN (Association of Women's Health, Obstetric and Neonatal Nurses), the U.S. Department of Agriculture, the U.S. Department of Health and Human Services, and the International Food Information Council was beneficial. The joint team effort created what they called "tear sheets" that provided Listeriosis information to pregnant women regarding food products they should and should not consume [23]. This effort, however, contained many issues, for which the team had not planned. First, many individuals did not understand

the information provided on the sheet, and that health care providers did not promote the prevention system. When surveying of the nation's pregnant women took place, a mere 18 percent had "indicated they had ever read, heard, or seen any information about Listeriosis" [23]. What is more, a majority of them did not even know *Listeria monocytogenes* was a food pathogen. Many thought it could be an allergy, that it could be contracted from swimming in infected water, or even contracted from tick bites. Only 31 percent surveyed stated that it could come from 'germs in raw food.' This study provided clear information on what was lacking in educational material provided to pregnant women.

A third study done in South Eastern Sydney, in March of 2007, developed a critical analysis at what was provided in terms of educational materials (specifically regarding Listeriosis) to pregnant women. The research team wanted to know what the awareness of Listeriosis among pregnant women was, throughout the South Eastern community. Pregnant women were provided questionnaires in the major clinics of the area, and were asked about their knowledge of Listeria. Some, however, were unable to speak much English and declined the opportunity to take the survey. The response rate was 92 percent for those who took the survey. It was found that only 42 percent had actually obtained knowledge regarding *Listeria monocytogenes* from their practitioners, and that those who did know about *Listeria monocytogenes* received the information from a 'women's social network' [24]. Also, the survey showed only 29 percent thought they knew enough about the pathogen. The amount of those who answered all questions correctly regarding high-risk foods was only 13 percent, over 50 percent did not choose coleslaw as a potential intermediate, and 36 percent did not know deli meats could be a potential contaminant [24]. What is interesting is that over 38 percent of the women did not understand that Listeriosis could, in fact, harm their infant's fetal development. The analysis showed that even in other countries, physicians and other health care workers are not providing the essential materials needed to educate pregnant women on prevention of Listeriosis, and that other systems of delivery need to be utilized.

In a 2012 study by Taylor et al., the objective was to discover if pregnant women had obtained knowledge regarding *Listeria monocytogenes* through their pregnancy. Another goal of these researchers was to discern where the pregnant women were obtaining the information they did gather regarding infection of *Listeria monocytogenes*. This study took place in British Columbia, and the women chosen for the study had to have recently given birth, and were from many different backgrounds. Once the women were chosen, they were given a questionnaire during a focus group meeting, containing material relating to basic knowledge of the *Listeria monocytogenes*, as well as 'food safety' concerns [25]. A total of 25 women took part in these group discussions. Also, another questionnaire was provided to women who had recently become pregnant within the Vancouver region. The women included had to be able to read the English language, and the questionnaire was similar to the one provided in the British Columbia focus groups. The total

number of women who took part in this written questionnaire was much greater, for a total of 107 completed documents.

The results of these questionnaires showed that only approximately 50 percent of the women had a concrete idea of what *Listeria monocytogenes* was, and less than 40 percent knew that smoked fish was a 'high-risk' food product [25]. It was also discovered through the questionnaire that not only did the women have a poor understanding of 'high-risk' foods, over 16 percent of them were regularly ingesting these products on a weekly basis. Pregnant women also seemed to fully trust in their health care practitioners for guidance; however, the findings of the questionnaire demonstrated only 58 percent of the women received all the necessary information regarding high-risk foods. The majority who did followed through with their own research [25]. The data in this study revealed current health care practitioner counseling to pregnant women throughout North America is not as effective as previously thought. The delivery of high-risk foods could become more effective if each woman was provided with improved delivery methods, and if these methods and foods could be catered to the individual.

## V. CONCLUSIONS

All of these analyses indicate a different form of intervention is needed to successfully reduce the risk of pregnant women becoming infected with *Listeria monocytogenes*. A major shortfall within all of these interventions seems to be within the delivery of the high-risk foods pertaining to *Listeria monocytogenes*. These delivery methods as stated above, should cater to each individual. To begin to develop optimized delivery methods, researchers need to utilize more detailed food frequency questionnaires. Most of the interventions involved a list of only high-risk foods. This is a great starting point; however, it needs to be developed further to each culture. Once the high-risk foods have been identified, researchers should then pinpoint each of the main high-risk foods consumed in the specific area of interest.

Within the studies examined it was apparent that no validation of the questionnaires utilized had taken place. If a food frequency questionnaire is followed through with in future interventions, validation will be key to knowing if the questionnaire is successful in answering the questions it set out to solve. This validation can be done through either multiple 24-hour recalls, or through biochemical analyses. Within the intervention studies, there will also need to be thorough evidence for the type of study chosen, and statistical procedures for processing justifiable results. Within most of these interventions, statistical methods were not present, or viewed as important. It would be beneficial to even provide simple data such as inclusion of a chi-square test. That way, even the dichotomous variables could be analyzed effectively.

Once the main high-risk foods are discovered, another list can be developed for use by medical personnel. This list can then provide the foods pregnant women should avoid consuming

for fear of *Listeria monocytogenes*, and also foods they can easily replace them with. That way the list provides a wide array of options rather than only 'no' foods. This list also needs to contain enough foods high in calcium, so the pregnant women are consuming the appropriate amounts. This is due to the fact that many of the high-risk foods are high in calcium, and they would be avoiding them for the health of the child. Urine samples should be taken to discover if products consumed contained enough calcium.

After a variety of options for a foods list is established, it seems as though in all of these situations, a multilevel intervention approach would be the most superlative method for an educational intervention. Not only does the physician need to be on board with the preventative measures, but also the patient, government, and health care plans should be a part of the process. The multilevel system provides various levels of influence, to the individual affected [26]. It begins with the individual, and then the influence branches out to the interpersonal level, organizational level, community level, and finally the policy level. As one can see, through the multilevel approach there is more opportunity for change and to help make a difference in individuals' lives. If this approach is utilized for the educational process of pregnant women, more awareness of *Listeria monocytogenes* can be spread not just from physician to patient, but also through the community and food industry as well.

In the case of the 2006 partnership between AWHONN, the U.S. Department of Agriculture, the U.S. Department of Health and Human Services, and the International Food Information Council, it seems as though, if the physicians and the health plans had been held accountable to provide the information on Listeriosis to the pregnant women, there may have been a much better response level and understanding from the patients. When a pamphlet is made, it can provide very pertinent information to the patient. If there is no support behind the material, however, it can fall between the cracks and be left untouched. In order to begin a successful multilevel intervention, researchers need to follow through with several pilot studies to ensure the intervention will, in fact, be an accomplishment. Once these pilot studies have ended, there should also be an evaluation presented on the efficacy of the multilevel intervention. Lastly, another advantage in providing a multilevel approach will help with sustainability of the intended Listeriosis education among pregnant women.

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