THESIS

LISTERIA CONTROL AND SAFE FOOD TRAINING FOR DIETARY MANAGERS

Submitted by

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WE HEREBY RECOMMEND THAT THE THESIS PREPARED UNDER OUR SUPERVISION BY HANAA THIGEEL ENTITLED *LISTERIA* CONTROL AND SAFE FOOD TRAINING FOR DIETARY MANAGERS, BE ACCEPTED AS FULFULLING IN PART REQUIREMENTS FOR THE DEGREE OF MASTER OF SCIENCE.

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ABSTRACT OF THESIS

LISTERIA CONTROL AND SAFE FOOD TRAINING FOR DIETARY MANAGERS

Elderly individuals are a growing sector in the U.S. population. With that increase, the need for long-term care facilities (LTCF) is growing as well. It is estimated that 5% of individuals age 65 or older and 20% of individuals age 85 or older live in long-term care facilities. Due to aging, the immune system of the elderly becomes weak, which increases the vulnerability to foodborne illnesses. Other factors associated with aging like chronic disease, dementia, lack of physical activity and entering nursing homes, can also contribute to the increased susceptibility to foodborne diseases. For these reasons, caregivers of the elderly, including dietary managers who serve food to the elderly, should be aware of factors that can increase the likelihood of contracting infection. *Listeria monocytogenes* is a particularly important foodborne pathogen that can cause severe illnesses or even deaths in populations at higher risk for foodborne illness, including the elderly. "*Listeria* Control and Safe Food Training for Dietary Manager" was an on-line course developed to provide important information about this pathogen and suggested control measures. The training module targeted Dietary Managers and Registered Dietitians who work in LTCF. The module consisted of three segments and was 47 minutes long. The module included PowerPoint® slides, recorded audio, written scripts and reference links. Pre and post questionnaires were used to measure the course outcomes along with course evaluation items. Multiple-choice knowledge questions were developed and evaluated for reliability, content validity and difficulty by module developers. Of 20 questions initially developed from the course content and tested for reliability, 13 questions were selected as final questions. Participant recruitment for the module pilot testing was conducted through winter 2010. Participants were recruited via state Dietary Manager Associations and state associations for Registered Dietitians and Dietetic Technicians. Emails and advertisement fliers were used for recruiting efforts. Of 211 participants who showed interest in the module, 143 participants were able to complete both the pre and post knowledge questionnaires. Participants who completed the course received one continuing education credit from their professional organization. The module knowledge scores achieved significant increase ($P<0.0001$) from pre to post-questionnaire. The knowledge score overall increased from 65.7% correct pre to 88.7% post. The course evaluation showed that more than 90% agreed or strongly agreed that they gained new and useful information from the course and planned to use the information in training others. They also found the web module a convenient way to earn continuing education credits. Feedback gained from course pilot test and evaluation will be considered as a helpful tool in making improvements to future on-line courses.

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INTRODUCTION

Foodborne diseases are a substantial public health concern in the United States and worldwide. Both developed and developing world suffer severe foodborne illness consequences, but to a variable extent (King et al., 2000). The U.S. Centers for Disease Control and Prevention (CDC) estimate foodborne outbreaks cause 76 million illnesses and about 5000 deaths annually in the United States (Mead et al., 1999). Scharff (2010) provided recent estimates that the cost of foodborne illness in the U.S. accounted for $152 billion each year.

Foodborne infections can cause severe illnesses in the general population including healthy adults. However, older adults (those who are over 60 years old) tend to have more severe complications to these infections. Also, research has shown that elderly persons are more susceptible to foodborne illness infections and deaths (Buzby, 2002). According to Smith (1998), older adults are more likely to experience severe illness and deaths from gastroenteritis than younger adults. The elderly population is very heterogeneous, i.e. it varies in physiological function, health and vulnerability to infection (Smith, 1998); however, as a population, the elderly exhibit increased vulnerability to gastroenteritis and foodborne infections due to changes in immune response (McGlauchlen & Vogel, 2003; Nikolich-Zugich, 2008), gastrointestinal physiology (Slotwiner-Nie, 2001), use of medications that induce suppression of gastric acid or the immune system (Gavazzi, 2002; Swaminathan & Gerner-Smidt, 2007), and comorbid conditions such as arthritis and heart diseases occurring at the same time (Gavazzi, 2002).

The U.S. population is aging and the older adults segment of population is growing rapidly (U.S. Census Bureau, 2005). This indicates that the need for long-term care settings is continuing to grow, which is creating a significant challenge to healthcare providers (U.S. Department of Health/U.S. Department of Labor, 2003). According to Buzby (2002), approximately 5% of individuals age 65 or older and 20% of individuals age 85 or older live in nursing homes.

Older adults who live at long-term care facilities (LTCF) are at increased risk of developing foodborne diseases (Djuretic et al., 1996; Garibaldi, 1999). It was reported in the United States during the period of 1994-1998 that residents in LTCFs were more likely to die from gastroenteritis than the general population living in the community (Frenzen, 2004). According to Frenzen (2004), about 17.5% of deaths involving gastroenteritis occurred in LTCF. Gerba et al. (1996) estimated the case fatality rates from specific foodborne pathogens and found that these rates were 10-100 times higher in nursing homes residents than in the general U.S. population.

There are several factors that contribute to the vulnerability of LTCF residents. These people tend to have a poor health status (Garibaldi, 1999; Strausbaugh et al., 2003) and a high prevalence of chronic diseases (Kinsella & He, 2009), which compromise the immune systems. Additionally, LTCF residents tend to have a greater use of antibiotics and other medications (Garibaldi, 1999). Another factor that contributes to the increased susceptibility to foodborne illnesses among LTCF residents is the close living arrangements and contact with visitors and staff which provides a unique environment for spreading infectious agents (Garibaldi, 1999; Strausbaugh et al., 2003; Garibaldi et al., 1981). In addition, food preparation and serving protocols that are centralized can facilitate the transmission of foodborne pathogens among LTCF residents (Levine et al., 1991; Nelson et al., 2008).

Although outbreaks in LTCF are frequent, few studies have assessed measures to prevent foodborne diseases or gastroenteritis. An evaluation of 75 published outbreaks involving LTCF reported that data was insufficient to provide an assessment and general recommendations were only made (Greig & Lee, 2009).

One problem that can be addressed is the low awareness of foodservice managers about food safety related issues (Sneed et al., 2004). Improperly preparing and serving food to the elderly can greatly impact food safety. Sneed et al. (2004) conducted research in assisted living facilities and found several food-handling practices that required improvement, including hand washing, ware washing, and cleaning and sanitizing procedures. Kendall et al. (2008) conducted a web-based survey with dietary managers to evaluate their understanding of populations at high risk for foodborne pathogens like *Listeria monocytogenes*. Even though 95% had received training on food safety, only 21% said they have had received training about *Listeria*. Therefore, enhanced training to foodservice managers is needed to address food safety issues associated with certain foodborne pathogens that can cause severe illness or deaths to the elderly with focus on *Listeria monocytogenes.*

An attempt was initiated by researchers at Colorado State University to develop an on-line training module for dietary managers and other similar professions. The *Listeria* Control and Safe Food Training for Dietary Managers module was designed to provide a convenient way for gaining knowledge and earning continuing education credits. The module focuses on *Listeria monocytogenes* and why this bacterium can cause severe illness or death in the elderly and other susceptible populations. Additionally, the training module addresses methods to prevent listeriosis or reduce the infection in long-term care settings through implementing a HACCP plan. Moreover, the module highlights proper cleaning and sanitizing protocols to prevent listeriosis, and other foodborne pathogens of special importance to the elderly.

REVIEW OF LITERATURE

I. Foodborne Illness: an overview

Foodborne diseases have a major impact on health; therefore, food safety is a worldwide health objective (Velusamy et al., 2010). The World Health Organization defines foodborne illnesses as diseases, usually either infectious or toxic in nature, caused by agents that enter the body through the ingestion of food (WHO, 2007). The current surveillance system of foodborne and waterborne diseases began in 1966 (CDC, 2006). The Centers for Disease Control and Prevention (CDC) have maintained a collaborative surveillance program for periodic data reporting of foodborne-related outbreaks in the United States since 1973. The CDC foodborne outbreak investigations are based on collecting reports on the number of illnesses, hospitalizations and deaths, the etiologic agents for illnesses, implicated food vehicles, and other outbreak-associated factors (Ryser & Marth, 2007). According to the World Health Organization (2007), the percentage of the population suffering from foodborne diseases in developed countries has been reported to more than 30% each year.

It has been estimated that around 76 million cases of foodborne diseases, resulting in 325,000 hospitalizations and 5000 deaths occur each year in the United States (Mead et al., 1999). Although deaths due to acute foodborne illnesses are relatively rare less than 0.1% of all deaths, these deaths are most likely to occur in very young persons, elderly persons, or persons with compromised immune systems (Gerba et al., 1996). Currently, officials in all states report foodborne outbreaks by using a surveillance system called the electronic Foodborne Outbreak Reporting System (eFORS). This system was developed to ensure complete and accurate reports of foodborne illness (Ryser & Marth, 2007).

The population in the United States and internationally is aging. It was estimated in 2000 that about 35 million individuals, accounting for 12.4% of the population, were 65 years or older in the United States. It is anticipated that by 2030, 71 million Americans (U.S. Census Bureau, 2005) and more than one billion individuals worldwide (Gavazzi et al., 2004) will be 65 years or older. While many Americans over age 65 enjoy sufficient health for full physical function, older adults, specifically, those who are 85 years or older, are at increased risk for both infections and death from infections including foodborne illnesses (Smith, 1998; Strausbaugh, 2001; Gerba et al., 1996). Thus, preventing foodborne illness and death among the elderly presents a significant challenge (Buzby, 2002).

There are several factors that contribute to the increased susceptibility to and severity of foodborne pathogens among older adults. The relationship between the diminished febrile response and increased mortality has been considered a contributing factor to the increased susceptibility to foodborne illness (Kreger et al., 1980; Weinstein et al., 1983). One important contributing factor to the increased susceptibility of foodborne illness in the elderly is the aging immune system. As persons age, they lose adaptive immune function naturally (Castle, 2000). The defective constitutive functioning of macrophages and granulocytes and the natural shift to memory T cells with aging reduces older adults' ability to mount a cell-mediated response to an infection (Castle, 2000; Khanna & Markham, 1999). In addition, cytokine production decreases with natural aging and the IL-2 and IL-8 function is further affected. Therefore, susceptibility to foodborne infections can increase for elderly persons, especially when they are exposed to new or genetically-mutated pathogens (Kendall et al., 2006).

Another factor that contributes to increased susceptibility and severity of foodborne illness among the elderly is chronic disease. Immune suppression associated with aging, chronic disease (Gerba et al., 1996) and therapeutic regimens used to treat diseases (Bow, 1998) increase one's vulnerability to opportunistic infection. Examples of chronic diseases in the elderly that increase susceptibility to foodborne illness include: diabetes mellitus (Samra et al., 1984), cancer (Louria et al., 1967; Hantel et al., 1989; Khardori et al., 1989; Jensen et al., 1994; Mora et al., 1998) and acquired immunodeficiency syndrome (AIDS) (Decker et al., 1991).

Nutritional deficiency, dementia, and lack of physical activity can also contribute to increased susceptibility and severity of foodborne illness among the elderly. For example, there is a potential of increased susceptibility to infection due to malnutrition (High, 1999). A deficiency of protein, minerals or vitamins can lead to impaired immune function (Chandra, 1995; Lesourd, 1997). The affect of dementia on malnutrition is not well recognized. However, some studies reinforce the necessity of protecting cognitively impaired individuals from foodborne infections (Kendall, et al., 2006). In addition, loss of mobility in older adults can impair immune function (Kendall, et al., 2006). Kohut and

Senchina (2004) concluded that long-term exercise interventions may improve immune function in older adults.

II. *Listeria monocytogenes*

Listeria monocytogenes was originally named *Bacterium monocytogenes*. It is a Gram-positive pathogen first described in 1926 in Cambridge, United Kingdom, as a source of infection with monocytosis in laboratory rodents (Murray et al., 1926). In the following year, Pirie also isolated a Gram-positive bacterium, in this instance from infected wild gerbils in South Africa, and proposed the name *Listerella* for the genus in honor of the surgeon Lord Lister (Pirie, 1927). Murray and Pirie realized that they were dealing with the same species of bacteria and thus combined the name to form *Listerella monocytogenes*, which was later, changed to the current name "*Listeria monocytogenes"* due to taxonomic reasons (Pirie, 1940).

Listeria monocytogenes causes listeriosis, a rare disease, but it is potentially serious (Allerberger & Wagner, 2010). This disease occurs in various animals, including humans. Organs that may be affected by listeriosis include the uterus during pregnancy, the central nervous system, and the blood stream. Infection with *Listeria* is life-threatening and most often recognized in immunocompromized individuals, the elderly, pregnant women and neonates (Liu, 2008). The average case fatality rate of human listeriosis is from 20% to 30% (Swaminathan & Gerner-Smidt, 2007).

Listeria monocytogenes causes two forms of listeriosis: non-invasive gastrointestinal listeriosis and invasive listeriosis. In immune-competent individuals, non-invasive listeriosis develops as a typical febrile gastroenteritis. The incubation period, which is the time between the consumption of the contaminated food and the first recognition of clinical signs, varies between individuals, and may range from one to 90 days (Liu, 2008). For example, the median incubation period in noninvasive listeriosis is one day with a range of 6 hours to 10 days. The most commonly reported symptoms are fever and non-bloody stools. In immune-compromised individuals such as the elderly and patients receiving immunosuppressive agents, listeriosis can manifest as septicemia or meningoencephalitis. Fever is generally present in patients with bacteremia. Other nonspecific symptoms such as malaise, fatigue and abdominal pain may also occur. Invasive listeriosis can also be acquired by the fetus from its infected mother via the placenta (Allerberger & Wagner, 2010).

The incidence of infection increases with advanced age (Liu, 2008), primarily because older adults are more prone to be infected by *Listeria* due to their weakened immune system. Immune suppression is an important risk factor for both epidemic outbreaks and sporadic cases. In recent years, the incidence of listeriosis has been 3.1 cases/million persons/year (Anonymous, 2007). Among 2,168 foodborne outbreaks with identified etiology reported to eFORS for the period of 1998 to 2002, 11 were due to the pathogen *Listeria monocytogenes* (Ryser & Marth, 2007).

The major route of infection is the consumption of food contaminated with *Listeria monocytogenes.* However, infection can also be transmitted by direct contact with the environment, infected animals or cross-infection between patients during the neonatal period (McLauchlin & Low, 1994; McLauchlin, 1996). In contrast to the relatively low incidence of listeriosis, more than 60% of all recall actions in the United States between

1996 and 2000 were launched as a result of detecting *Listeria monocytogenes* contamination (Wong et al., 2000).

Listeria monocytogenes is a ubiquitous microorganism. It can be found everywhere in the environment in soil, water, sewage, silage and fecal materials. Soil is commonly known as a harborage of the bacterium, particularly in silage (Bourry & Poutrel, 1996). Also, it has been reported that a wide variety of healthy animal species shed *Listeria* in their feces. The stressful factors that animals encounter during transportation to slaughter plants has been reported to increase the shedding of *Listeria*. In addition, symptomatic and asymptomatic humans do excrete the bacterium in their feces (Ryser & Marth, 1999).

III. Growth Characteristics of *Listeria monocytogenes*

Listeria sp., in general, are fairly undemanding bacteria in terms of nutrition. For optimal growth, these bacteria require vitamins, amino acids, and carbohydrates as well as non-selective microbiological media that support microbial growth. *Listeria* sp. can grow well on several artificial media such as tryptone soy broth, or brain-heart infusion broth under both aerobic and anaerobic conditions (Liu, 2008). At the optimum temperature, microorganisms exhibit short initial lag periods, short generation times during the exponential growth and high cell counts or densities at the stationary phase. *Listeria monocytogenes* is commonly a psychrotrophic and mesophilic bacterium. This bacterium is capable of growing at temperatures below 0˚C (32˚F) in laboratory media broth (Walker et al., 1990; Bajard et al., 1996). The minimal growth temperature for *Listeria* varies between -2 and 4˚C (28.4 and 39.2˚F), whereas the maximum growth temperature is 45˚C (113˚F) (Ryser & Marth, 1991; ICMSF, 1996). *Listeria* *monocytogenes* is destroyed when exposed to temperatures of more than 50˚C (122˚F) (Ryser & Marth, 2007). Significant growth variation among different strains of *Listeria*, especially at refrigeration temperatures, was observed by Barbosa et al. (1994). In fact, *Listeria* becomes more virulent at low rather than high temperatures. Freezing temperatures -18˚C (0˚F) inhibit the growth, but the pathogen is still able to survive. It was observed by El-Kest et al. (1991) that slow freezing at -18˚C was more lethal and injurious to this pathogen than rapid freezing at -198˚C (-324˚F). *Listeria* exhibits sensitivity to both lysozyme and lipase, which are naturally present in some foods, and freezing increases *Listeria*'s sensitivity to these enzymes. In contrast, the ability of *Listeria* to adapt to stressors, such as low pH, ethanol, NaCl, heat shock or starvation increases *Listeria*'s survival during freezing, frozen storage, and freeze/thaw cycles (Lou, 1997).

Growth temperatures can influence the thermotolerance of *Listeria monocytogenes.* Also, heat shock conditions have been shown to increase the thermotolerance of the pathogen and possibly increase its virulence. In food processing there are several conditions that are similar to heat shock. Examples include slow heating, preheating, cooking, hot water washing, mild thermal processes and holding foods in warm trays (Ryser & Marth, 1999).

Like many other bacteria, *Listeria monocytogenes* grows best at a pH close to neutrality (Ryser & Marth, 2007). Early literature indicated that *Listeria* can only grow at pH values from 5.6 to 9.6 (Seeliger & Jones, 1986). However, due to *Listeria* outbreaks linked to consumption of fermented dairy products, the minimum pH requirement has been reassessed (Ryser & Marth, 1999). Growth of *Listeria* at pH values ranging from 4.0 to 9.6 have been reported (Petran & Zottola, 1989; Phan-Thanh, 1998). Studies also have shown that *Listeria* can grow and multiply in laboratory adjusted media to pH values lower than those mentioned above. According to George et al. (1988), all 16 strains of *Listeria monocytogenes* tested positive when inoculated into Trypticase Soy Broth acidified with hydrochloric acid to pH values between 4.39 to 4.63 and incubated at 20-30˚C. Thus, the minimum pH at which *Listeria* can grow is well below pH 5 (Ryser & Marth, 1999). In fact, growth of *Listeria monocytogenes* in acid or acidified foods confirms the findings in laboratory media. Conner et al. (1990) conducted a study prompted by the listeriosis outbreak in Canada linked to consumption of contaminated coleslaw. The study showed that the pathogen could tolerate and grow in cabbage juice at pH values less than 5.6. Koutsoumanis et al. (2004) examined the pH limits of *Listeria monocytogenes* growth in broth and agar with the effect of temperature and water activity by using the growth/no growth model. The researchers observed that the minimum pH and water activity that allowed the pathogen to grow were 4.45 and 0.90 respectively at temperature ranged from 15 to 30˚C (59 to 86˚F). It has not been documented yet that *Listeria monocytogenes* can grow at pH values less than 4.0 (Ryser & Marth, 2007).

The moisture requirement for microbial growth is best expressed by water activity (a_w) (Ryser & Marth, 2007). *Listeria monocytogenes* grows optimally at a_w 0.97 or higher (Petran & Zottola, 1989). However, when compared to other foodborne pathogens, *Listeria* has a unique ability to multiply at a_w values as low as 0.90. It was observed that *Listeria monocytogenes* can survive in environments of $a_w < 0.90$, particularly under refrigeration for extended periods (Ryser & Marth, 2007). Moreover, it was observed that

Listeria monocytogenes was able to survive for 84 days at 4˚C (39.2˚F) in fermented hard salami which had a_w between 0.79 and 0.86 (Johnson et al., 1988). *Listeria monocytogenes* was detectable in commercial cheese brine (with salt concentration of 23.8% and pH value of 4.9) inoculated with the pathogen and stored at 4˚C for up to 259 days. Low a_w (<0.90) is listeriostatic, but rapid growth may resume as a_w increases. Thus, cheese brines should be considered as potential sources for cross-contamination (Larson et al., 1999). This also indicates that the bacterium tolerates the extremely high salt concentrations of commercial cheese brines (Larson et al., 1999).

Listeria monocytogenes grows well under aerobic and anaerobic conditions and at refrigeration temperatures. This property makes *Listeria* a potential threat to the safety of foods packaged under vacuum or modified atmospheres (Church & Parsons, 1995) and the growth of this pathogen is not inhibited in vacuum packaged food items (Hudson et al., 1994).

Listeria monocytogenes can attach to numerous surfaces such as stainless steel, glass, wood, porcelain, iron, plastic, polyester, propylene, rubber, waxed cardboard, and paper (Stanfield et al., 1987; Mafu et al., 1990; Krysinski et al., 1992; Mosteller & Bishop 1993). Attachment of a bacterium to a solid substrate is usually followed by microcolony formation that may surround itself with extracellular polysaccharide which is called glycocalyx or a biofilm. *Listeria* biofilms can serve as a physical barrier and can protect the microcolony within them (Jeyasekaran et al., 2000). As a consequence, equipment surfaces, conveyer belts, floor sealants, and drains may become potential reservoirs for *Listeria*, and then may cross-contaminate food products (Spurlock & Zottola, 1991). Due to *Listeria*'s ability to attach to different surfaces, packaging material could be considered a potential source of contamination with this pathogen (Midelet & Carpentier, 2002). *Listeria* in a biofilm is harder to remove and inactivate than when it is present as freely suspended planktonic cells (Ryser & Marth, 2007). Planktonic *Listeria* is less resistant to harsh treatments than is adherent *Listeria*. This bacterium has been found to be more resistant to antimicrobial agents at higher inoculum levels (Leriche et al., 1999), in older biofilms (Oh & Marshall, 1996) and at lower environmental temperatures (Palumbo & Williams, 1991).

The discussion above states that *Listeria monocytogenes* is a hardy bacterium which has several unique virulence characteristics compared to other foodborne pathogens. Factors that increase *Listeria*'s virulence are its ability to grow at very low temperatures and grow at relatively low pHs. This bacterium can tolerate low moisture environments, anaerobic conditions and extremely high salt concentrations. *Listeria* can also be found in a wide variety of foods which makes it a very important foodborne pathogen.

IV. *Listeria* Contamination of Foods

Within the last 25 years, food has been recognized as a potential mode of transmission of *Listeria monocytogenes* in humans (Ryser & Marth, 2007). Murray et al. (1926) described the potential transmission of *Listeria monocytogenes* to humans through foods when he conducted an experiment in rabbits for a disease caused by a bacterium subsequently identified as *Listeria monocytogenes*.

In good hygiene slaughter houses, the incidence of *Listeria* contamination on red meat carcasses is fairly low. This intermittent low level direct contamination could be mainly from feces. However, this level of contamination is sufficient enough for the bacterium to colonize in meat processing environments. Thus, contaminated equipment in this environment can act as a potential indirect contamination source for further processed foods. The contamination of *Listeria* to the environment is usually minimal and sporadic; however, poor hygiene practices on the farm level lead to potential contamination of *Listeria* in food processing environments (Ryser & Marth, 1999).

After harvest, food and food ingredients can become contaminated at any stage of food processing, during retailing, and in consumers' home environment. Also, *Listeria* outbreaks point to the importance of contamination from sites within food processing environments. *Listeria monocytogenes* can be introduced into the environment of a food processing plant, especially when sanitation is insufficient. Loss of control in specific plant areas where *Listeria* contamination must be avoided can lead to contamination with the pathogen (Figure 1). Food production systems are now diverse so they can produce different types of food and often integrate a high degree of food handling (Liu, 2008). This increases the risk of *Listeria* contamination of foods. For instance, studies have shown that more highly processed meats are more likely to be contaminated with *Listeria* than unprocessed meats (Fenlon et al., 1994; Ryser et al., 1996). Interestingly, contamination with a single strain of *Listeria* can affect a single environment for several years. This is due to *Listeria*'s ability to survive in niches within plants where sanitization is not effective, persist and remain undetectable for a long period of time (Wagner et al., 1996). Studies conducted in fish and dairy plants suggested that the level of contamination increases at later processing steps (e.g. after brining or during ripening). In fact, contamination of food and food contact surfaces in the processing area from sites and machinery within the food plant is of greater importance than contamination of the raw food components that enter the plant (Liu, 2008).

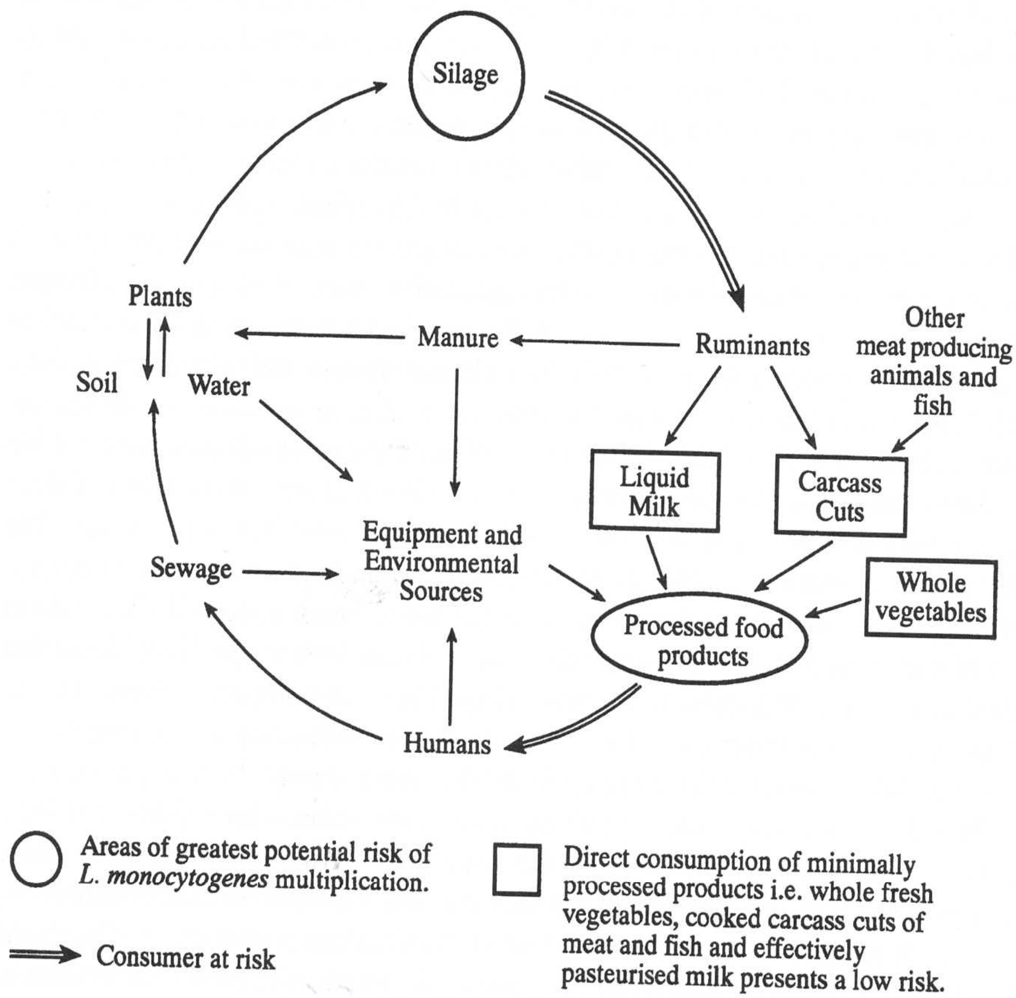

Figure 1: Spread of *L. monocytogenes* to the food chain from the natural environment (Ryser & Marth, 1999).

Since the recognition of food as the primary mode of transmission, a wide variety of food types have been implicated in outbreaks of *Listeria monocytogenes*. These foods are capable of supporting the growth and multiplication of *Listeria*. In fact, many of these foods are cured, pasteurized or cooked in the production process and then exposed to post-processing contamination from the environment. A common characteristic of many implicated foods is that they are refrigerated Ready-to-Eat (RTE). This means they are eaten by consumers without cooking or reheating (Ryser & Marth, 2007). Processed refrigerated RTE foods often have a longer shelf life (Liu, 2008) compared to fresh foods, which provides ample time for *Listeria*, a psychotropic bacterium, to grow. *Listeria* grows well in cold environments to levels posing a high risk for human infection and disease, particularly in susceptible individuals (Ryser & Marth, 2007).

According to the FDA Food Code definition, foods associated with listeriosis are commonly considered Potentially Hazardous Foods (PHF). The Food Code defines PHF as natural or synthetic foods that are capable of supporting the growth of pathogenic and toxin producing bacteria. Therefore, these foods require temperature control (FDA, 2001). Recently, the term potentially hazardous foods was changed to Temperature Control for Safety (TCS), which is used for any food that requires time and temperature control to reduce the growth of pathogenic and toxin forming microorganisms (FDA, 2005).

Examples of these foods can include dairy products such as soft unripened cheeses, raw (fluid) milk, ready-to-eat meat and poultry products like turkey franks and pâté. Also, fish and seafood products such as cold smoked fish and crab meat can be implicated with *Listeria*. Vegetables like coleslaw have also been associated with *Listeria* outbreaks

(Schlech et al., 1983).

In 2001, the FDA/Center for Food Safety and Applied Nutrition, USDA/Food Safety and Inspection Service and Centers for Disease Control and Prevention jointly published an assessment report for a variety of ready-to-eat foods commonly associated with *Listeria* (FDA/USDA/CDC, 2003). Pasteurized fluid milk was categorized in the moderate risk category for potentially causing listeriosis (FDA/USDA/CDC, 2003). Although the pathogen is inactivated during pasteurization, there is a potential for post processing contamination of fluid milk which can result in outbreaks that are associated with pasteurized milk (FDA/USDA/CDC, 2003). In 1985, health officials linked an outbreak of serotype 4b infections in Massachusetts to consumption of a specific brand of 2% and whole pasteurized milk (Fleming et al., 1985). Also, there was one outbreak of listeriosis linked to consumption of contaminated pasteurized milk (Dalton et al., 1997). Another outbreak of listeriosis linked to pasteurized milk resulted in five cases identified and three deaths (CDC, 2008). The report identified unpasteurized milk as being a low predictive relative risk of causing listeriosis. This is mainly due to the low rate of consumption of raw milk in the United States where the Federal law requires pasteurization of milk sold through interstate commerce. Still, some states in the U.S. allow the purchase of unpasteurized milk. According to a 1995 FDA/CDC survey conducted in all 50 states, Puerto Rico and the District of Columbia, 28 states (54%) allowed the sale of raw (unpasteurized) milk (FDA/USDA/CDC, 2003). More recently, Behravesh (2010) has reported that while the interstate sale of unpasteurized milk is prohibited by the FDA, about 25 states permitted the sale of unpasteurized milk during the period of 1993-2006.

In 1985, listeriosis was brought to attention and became a major public health concern when a large epidemic occurred in Los Angeles County (Linnan et al., 1988). The number of cases recognized was 142 cases. The predominance of perinatal listeriosis was striking, about 65%, of which 87% occurred among Hispanic women. In addition, 29% of cases were among non-pregnant Hispanic adults. The outbreak caused by *Listeria* was due to the consumption of soft, unripened Mexican-Style cheese (Linnan et al., 1988).

Unlike hard or aged cheeses, heat-treated natural and processed cheeses that had a low predicted relative risk of causing listeriosis, fresh soft cheeses (or Mexican-Style cheeses made with raw (unpasteurized) milk like queso fresco were identified as foods with high predicted relative risk of causing foodborne listeriosis (FDA/USDA/CDC, 2003). This type of cheese has relatively high moisture content and pH of 5.6 or higher (Ryser, 1999) and usually consumed without additional aging, which perfectly supports the growth and replication of *Listeria*. In 2003, an outbreak of listeriosis was linked to the consumption of queso fresco occurred in southern Texas. Among six cases of pregnant women and a neonate, one resulted in fetal death and one in the neonate death. Investigation conducted by Texas health officials revealed that five of six women consumed queso fresco during the month before illness. Further investigations indicated that the cheese was made in Mexico from unpasteurized milk and sold illegally in the state flea markets and by unlicensed street vendors (Anonymous, 2003).

Frankfurters were found to be in the relative high risk food category for causing listeriosis in the U.S. (FDA/USDA/CDC, 2003). In 1988, a case of invasive listeriosis was linked to consumption of contaminated turkey frankfurters. This case was the first laboratory-confirmed association of meat and poultry products with invasive listeriosis

(Anonymous, 1989). During the period of 1998-1999, the largest listeriosis outbreak in the United States occurred due to the consumption of contaminated frankfurters and deli meats (Mead et al., 2006).

Smoked seafood also had a high predicted relative risk for causing listeriosis. Cold smoking of these food products can result in contamination of foods with *Listeria* as this process have no significant inactivation of the pathogen (FDA/USDA/CDC, 2003). Smoked fish and seafood have been linked to several outbreaks in Europe. For instance, smoked mussels have been linked to *Listeria* outbreaks in Australia and New Zealand (Brett et al. 1998), cold smoked rainbow trout have been linked to an outbreak in Sweden (Ericsson et al., 1997), smoked salmon has been linked to sporadic cases in Australia, and smoked cod roe has been linked to sporadic cases in Denmark (Ryser, 1999). In contrast, raw seafood has a low predicted relative risk of causing listeriosis in the U.S. (FDA/USDA/CDC, 2003).

Vegetables category is difficult to be categorized because it contains a wide variety of products, but according to the FDA/USDA/CDC (2003) risk assessment, vegetables had low predicted relative risk of causing listeriosis in the United States on per serving basis. The FAO/WHO (2004) risk assessment classified vegetables under moderate risk category for listeriosis. This classification is mainly based on the high number of annual servings and moderate frequency of contamination by *Listeria monocytogenes*. In spite of this assessment, vegetables remain infrequently associated with outbreaks of listeriosis (Ryser & Marth, 2007). In 1983 *Listeria monocytogenes* was implicated with a large coleslaw outbreak that occurred in the Canadian Maritime Provinces (Schlech et al., 1983).

Unreheated deli meats such as meat spreads and pâté were categorized with foods of high predicted relative risk of causing listeriosis. Deli meats can be contaminated with *Listeria* at retail level and during long period of refrigeration storage. In 2002, a case-control study was conducted to identify contaminated food source that caused multistate listeriosis outbreak. 188 patients with *Listeria monocytogenes* infection were identified in nine states during the period of July to November, 2002 linked to the consumption of RTE turkey deli meat. Of these patients, 54 were infected with the outbreak strain that caused 8 deaths and 3 fetal deaths (Gottlieb et al., 2006).

Deli salads such as meat, seafood, egg and pasta salads may contain components that inhibit the growth of *Listeria* like acidic components. However, PHF/TCS ingredients including meat, poultry, and seafood in the salad would allow the growth of pathogen. According to the FDA/USDA/CDC (2003) report, the meat, seafood, eggs and pasta salads from this category have not been yet linked to outbreaks of listeriosis.

V. Use of HACCP in the Control of *Listeria*

According to Puckett (1998), one way to minimize or reduce the risk of foodborne illnesses is to implement HACCP (Hazard Analysis Critical Control Points). The term HACCP is an acronym for Hazard Analysis Critical Control Points. This system is a management tool designed to control biological, chemical and physical hazards that may occur at any point in the flow of food. Use of the tool is mandatory for meat and poultry industries monitored by the United States Department of Agriculture (USDA), and for seafood and juice industries monitored by the U.S. Food and Drug Administration (NACMCF, 1998). HACCP programs can be very important in providing food safety in foodservice operations that serve food to the elderly. However, Strohbehn and colleagues

(2004) found no published research regarding the implementation of HACCP plans in long-term care facilities.

In general, the HACCP system for controlling potential hazards in foods is based on seven principles: conducting a hazard analysis, determining the critical control points (CCPs), establishing critical limits (CLs), establishing monitoring procedures, establishing corrective actions, establishing verification procedures, and establishing record keeping and documentation procedures (NACMCF, 1998). The purpose of conducting hazard analysis and determining critical control points is mainly to assist in identifying and evaluating potential hazards. Establishing critical limits, monitoring, and corrective actions are used to establish ways of controlling those hazards, whereas verification and record keeping procedures are used to help maintain the HACCP plan and verify its effectiveness (National Restaurant Association Educational Foundation, 2008).

Hazard analysis is one of the essential principles in developing an effective HACCP plan, but this principle is often inadequately developed in many HACCP plans. The principle is mainly used to determine the potential hazards that are associated with a food or food processing step that most likely introduces a risk to consumers. Hazard analysis includes two steps. The first step is called hazard identification, which mainly focuses on determining any potentially hazards food in the menu and the hazards associated with each process. The second step is hazard evaluation which means evaluating each potential hazard based on its severity and its likelihood of occurrence (Ryser & Marth, 2007). For example, the *Listeria* Control and Safe Food Training module for dietary mangers emphasized avoiding TCS foods that are usually associated with *Listeria monocytogenes* and may pose a high risk to the elderly, such as soft cheeses made with raw unpasteurized milk, cold hot dogs and lunch meats, pâtés, cold smoked fish and raw milk.

Control can be applied through determining the critical control points to prevent or eliminate a food safety hazard or reduce it to an acceptable level. This determination should be complete and accurate in order to control food safety hazards. Examples of critical control points include cooking or cooling of a product (Ryser & Marth, 2007).

Each CCP has one or more critical or safety limits and the developed CCPs must be documented. A critical limit (CL) is defined as the specific criterion that determines between safe and unsafe products. For instance, cooking is the CCP that makes a raw hamburger patty safe to eat. The critical limit that is associated with this CCP is cooking that patty to a minimum internal temperature of 160˚F for 15 seconds (National Restaurant Association Educational Foundation, 2008).

To determine whether a CCP is under control and the CLs are met, a planned sequence of observations or measurements must be conducted which is called monitoring procedure. Monitoring also provides an accurate record for future use in verification (Ryser & Marth, 2007). For instance, monitoring of fruit salad may include taking and recording the internal temperature of the salad, which should be 41˚F or below, every three hours (National Restaurant Association Educational Foundation, 2008).

The fifth principle in a HACCP system is to establish corrective actions when a loss of control occurs at any critical step. This means when a critical limit is not met and a deviation occurs (National Restaurant Association Educational Foundation, 2008). The purpose of establishing corrective actions is to prevent hazardous foods from being consumed. Corrective actions are needed to determine and correct the cause of noncompliance, determine the discard of suspect product and record any corrective actions that are taken (Ryser & Marth, 2007). For instance, if dirt is found on the surface of washed melons, they need to be washed again to remove the dirt before slicing them (National Restaurant Association Educational Foundation, 2008).

Any HACCP plan needs to be verified on a regular basis to determine if it is working. Verification is an important principle that determines the validity of the HACCP plan. This means establishing validation that the primary HACCP plan is sound whether scientifically or technically and that this plan can be implemented effectively to control all potential hazards (Ryser & Marth, 2007).

The last principle in a HACCP system is establishing record-keeping and documentation procedures which are considered an essential part of HACCP system. Without an effective record-keeping plan, there is no proof that HACCP principles were followed and there is no trace back of the production history of a finished product. Examples of records that may be used in food service establishments could include temperature logs, corrective actions records, equipment validation, shelf life studies, invoices, and specifications that are related to working with suppliers (National Restaurant Association Educational Foundation, 2008).

VI. Cleaning and Sanitizing in the Control of *Listeria*

Enhanced cleaning and sanitizing protocols can be another way to control pathogenic bacteria, including *Listeria*. Cleaning is the physical removal of grease and dirt or any extraneous matter (termed as soil) that may be found on a surface. Such soil may entrap and provide nutrients to microbes. Cleaning approaches can be applied to dry and wet areas. Dry approaches to cleaning include vacuum removal of residues, brushing, scraping, and damp mopping, whereas cleaning wet processing areas can be accomplished by appropriate brushing, sweeping and hot water application (Ryser & Marth, 2007).

Sanitizing reduces any pathogens on the surface to a safe level and is usually performed in sequence with cleaning by using liquid sanitizing agents. The code of Federal Regulations specifies concentrations of sanitizers that may be used in food processing facilities (FDA, 2004). Literature has shown that *Listeria monocytogenes* is sensitive to commonly used sanitizers in food industry. Studies have shown that chlorine-based, iodine-based, acid anionic and quaternary ammonium-type sanitizers were effective against *Listeria monocytogenes* when used at concentrations of 100 ppm, 25-45 ppm, 200 ppm, and 100-200 ppm, respectively (Lopes, 1986; Orth & Mrozek, 1989). A recent study conducted at Colorado State University showed that a chlorine bleach solution at a concentration of 300 parts per million reduced *Listeria, Escherichia coli* O157:H7 and *Salmonella typhimurium* by approximately 5 log CFU/ml after one minute of exposure at 77˚F (Yang et al., 2009).

VII. Other Pathogens of Concern to the Elderly

In addition to *Listeria*, other foodborne pathogens of particular importance to the elderly include *Salmonella* spp., *Escherichia coli* O157:H7 and norovirus.

Salmonella species are bacterial agents causative of acute gastroenteritis. Majowicz et al. (2010) used Monte Carlo simulation to estimate the global health impact of nontyphoidal salmonellosis. The scientists found that 93.8 million cases of gastroenteritis due to *Salmonella* sp. occur globally each year with 155,000 deaths. Of all gastroenteritis cases, 80.3 million cases were foodborne (Majowicz et al., 2010).

Since aging is associated with a decline in immune function, elderly persons are at high risk of *Salmonella* infections (Ren et al., 2009). Several studies have addressed *Salmonella* infections in nursing home residents (Levine et al., 1991; Mishu et al., 1994; Ryan et al., 1997). The mortality attributed to gastrointestinal infections can be 400-fold higher in older adults compared to younger adults (Schmucker et al., 1996). Data collected from foodborne outbreaks associated with nursing homes indicated that the mortality rate due to diseases caused by *Campylobacter, Clostridium perfringens, Escherichia coli* O157:H7, *Salmonella*, and *Staphylococcus aureus* is higher in older adults compared to the general population. In fact, infections caused by *Salmonella* spp., specifically *Salmonella* Enteritidis, are the most common cause of morbidity and mortality among nursing home residents (Smith, 1998). Buzby (2002) pointed out the higher rate of *Salmonella* sp. incidence among the elderly compared to other foodborne pathogens because they are more likely to frequently consume undercooked eggs.

Another pathogen that may cause severe illness in susceptible individuals, including the elderly, is *Escherichia coli* O157:H7. Typical symptoms of this disease include severe abdominal pain and diarrhea, which is primarily watery and becomes visibly bloody afterwards. Vomiting may occasionally occur with low grade or absent fever. Hemorrhagic Uremic Syndrome can develop in older adults with neurologic symptoms including Thrombotic Thrombocytopenic Purpura (TTP). The mortality rate in the elderly due to this disease can be as high as 50% (FDA, 2009).

Norovirus is one of the important identified viruses that cause acute foodborne gastroenteritis (Dreyfuss, 2009) and cases associated with norovirus gastroenteritis exceeded those caused by bacteria (Mead et al., 1999). This virus is highly contagious and difficult to eradicate once it spreads (Barker et al., 2004; Isakbaeva et al., 2005). The mode of transmission for noroviruses is commonly considered to be through the oral-fecal route (Dreyfuss, 2009). Other routes of transmission can be direct through person to person, or indirect through contaminated food, water, fomites, infected fecal matter, or vomitus (Kroneman et al., 2008). Norovirus infections are common within closed environments such as hospitals and nursing homes (Koopmans & Duizer, 2004).
The disease causes long-term diarrhea and dehydration in the elderly, especially individuals aged >65; therefore, patients should be hospitalized and monitored frequently (Mattner et al., 2006).

VIII. Food Safety Education

Improper food handling and preparation is one of the important factors that can lead to significant foodborne illness, especially in individuals with weakened immune systems (Kendall, et al., 2006). Nonetheless, foodborne infections can be avoided with proper education methods and safety measures (Archer & Young, 1988).

Due to the aging of the baby-boom generation in the United States, the need for long-term care settings will continue to grow. Assisted living, for example, is part of the health care options available to fairly independent elderly who need assistance that may not be available at home (Strohbehn et al., 2004). State officials conduct inspections at least once per year. Many state officials have employed recommendations with FDA food code standards. These recommendations are reviewed every two years to reflect the scientific knowledge and identify food safety related issues such as food handling and preparation, equipment cleaning and sanitizing, as well as personnel hygiene practices (Strohbehn et al., 2004). Because most residents of long-term care facilities are at high risk for foodborne illness, state officials perform inspections at least once per year. However, food safety is still a concern in these facilities. Levine et al. (1991) found that between 1970 and 1984, foodborne illness outbreaks occurring in nursing homes accounted for only 2% of all reported outbreaks, but resulted in 17% of all reported deaths from foodborne illness. Therefore, more attention regarding food safety is needed in these types of facilities.

Dietary managers at long-term care facilities are primarily responsible for providing optimum nutritional care for patients (Dietary Managers Association, 2009). In addition, a dietary manager may be responsible for food safety, budget management and compliance with government regulations (Mayne, 2003). Because dietary mangers are responsible for serving food to older adults, they should be well trained on foodborne pathogens of particular importance to the elderly that can cause severe illnesses or even death. A survey conducted in 2008 by scientists from Ohio State University and Colorado State University revealed gaps in food safety knowledge among dietary managers serving food to the elderly (Kendall et al., 2008). The survey objective was to estimate the knowledge level of dietary managers about certain foodborne pathogens, particularly *Listeria monocytogenes.* Of the 267 dietary managers that participated in the survey, 62% reported that they had heard little or nothing about *Listeria.* Up to forty percent of them ranked their understanding about *Listeria* as low or very low and 37% of the respondents did not know that elderly adults are at high risk of this bacterium (Kendall et al., 2008). Thus, dietary managers are in need of convenient learning opportunities about current food safety related issues to avoid foodborne diseases in their facilities and better serve their residents.

Continuing education is one of the enduring options available for dietary managers who are seeking continuing education units to maintain their career. Online continuing education is now emerging as a practical option among professionals for gaining knowledge (Brug et al., 2003; Garrison et al., 2000a; Kolasa et al., 2001). Wallner et al. (2007) found an online continuing education course to be convenient, timely and effective in meeting the professional and personal needs of professionals, including dietary managers.

By considering these characteristics, *Listeria* Control and Safe Food Training for Dietary Managers module was developed to provide training for dietary managers who work at long-term care facilities on foodborne pathogens that are especially important to the elderly.

METHODS

I. Course Development:

Listeria Control and Safe Food Training for Dietary Managers course was designed as an online distance-based continuing education course for Certified Dietary Managers (CDM) and Registered Dietitians (RD). Initially, the course objectives were listed as instructor outline statements to provide a summary of important concepts in the module.

Course content was divided into three online modules. Each module was approximately 16 minutes long, with a total of 47 minutes for the entire course, excluding pre and post exams. The first module focused on *Listeria monocytogenes* and its health impact on the elderly with weakened immune systems. The second module addressed ways to control *Listeria* through implementing a HACCP system. The last module discussed proper cleaning and sanitizing protocols, worker training, and food irradiation technology. All three modules were developed at Colorado State University.

The participants were given instruction on how to access the course modules after accepting the human subject statement (Appendix A). Course content was presented as PowerPoint® slides with taped audio designed to be played simultaneously with each slide. A ‘pause’ and ‘play’ button allowed the navigation from one slide to the other by using Soundslides Plus software. At the end of each module, a navigation button was provided to allow the participant to move to the next module. Upon finishing module three, the participant was instructed to navigate to the course post survey, and then have access to the printable course certificate of completion. The course audio script was reviewed carefully by the advisor; changes and adjustments were made by the course developer. Audio was taped at the CSU Extension office. Audio recordings were edited and final revisions were added to each module. Two resource pages were provided in addition to the three modules. The first resource page included pdf files of a HACCP booklet developed by the author (Appendix B), course script and slides, references page, and the module developers' biosketches. The second resource page included a printable certificate of completion, survey test answers in pdf and the same pdf files listed in the first resource page. The second resource page was obtainable only upon a participant's completion of the post-questionnaire. The Colorado State University technology staff helped in the process of publishing the course on-line on the home page of the Department of Food Science and Human Nutrition.

During module development, the project coordinator submitted the course materials to the Certifying Board of Dietary Managers (CBDM) and the Colorado Dietetic Association (CDA) for approval of Continuing Education Units (Appendices C & D). The course was granted one hour of continuing education through August 1st, 2010 by the two organizations. Since this training course is a research project, the course was reviewed and received Human Subjects approval by the Research Integrity and Compliance Review Office (RICRO) at Colorado State University (Appendix E).

The course was beta-tested by the development team to ensure a quality product. Initially, Visual Communicator software was used, but the final slide quality was not good. Thus, we used the Soundslides Plus software instead which was much better and more user friendly.

II. Participant Recruitment

The course pilot test recruiting was conducted throughout winter 2010. The initial participant recruitment attempts involved searching the National Dietary Manager Association (DMA) website to obtain contact information for each affiliated state-wide DMA chapter. Contacts by emails accompanied by one-page recruitment fliers were made to DMA chapters in 44 states and one territory. Agreement was received from 26 states and one territory to advertise the continuing education opportunity through a combination of sending the module advertisement via listserv distribution, and/or posting the recruitment fliers to their chapter website or electronic newsletter. In addition, 14 states chapters distributed printed fliers at their annual spring association meetings held between March and May, 2010. The project coordinator mailed over 1,000 fliers to chapter presidents with large memberships to assist in the distribution effort.

In addition to the Dietary Managers Association, efforts were taken to broaden the target audience to include registered dietitians and dietetic technicians who were employed as dietary managers or food service directors in long term care. All 50 state affiliations of the American Dietetic Association were contacted by email. Return emails were received from 21 state chapter presidents. Among these states, the module advertisement was distributed via listserv (15 states), posted to chapter website (4 states), or distributed via electronic newsletter (2 states).

In addition, contact was made to the Dietetic Practice Groups (DPGs) that work in long term care including Dietitians in Health Care Communities (DHHC-DPG), Healthy Aging DPG, Food and Nutrition Systems DPG, and the Dietetic Technician DPG. Of these, only the Dietitians in Health Care Communities DPG posted the module on their website.

III. Knowledge Questionnaire Development

Knowledge questionnaires were used as a tool to evaluate the course. Twenty questions were initially developed directly from the content of the modules to measure the knowledge gained about the most important issues discussed in the course (Appendix F). Three to six answer choices were written for each question including "not sure" as a last choice for each question to discourage random guessing. The same questions were used for both the pre- and post-questionnaire. The pre- and post-questionnaires were approved by the Human Subjects Committee at Colorado State University.

The test-retest method was used to test the reliability of the knowledge questionnaire. Thirty students (n=30) were recruited from the Department of Food Science and Nutrition to take the test. Tests were distributed in hard copies given to the instructor and the survey was conducted in class. The test was retaken by the same students in seven days without any training on the topics covered. The percentage of agreement between test and retest answers for each question was assessed. The mean score for each item in the test was also considered as a measure of difficulty according to Parmenter and Wardle (2000) recommendations. As a result, seven questions were subjected for removal and the remaining 13 questions were edited to improve clarity (Appendix G) and demographic questions were also added to the pre-questionnaire (Appendix H)

IV. Course Evaluation Instrument

The course evaluation instrument was developed at Colorado State University and approved by the advisor. The purpose of designing this piece was to gain attitude assessment and feedback from pilot test participants about specific areas of the course. The attitude assessment included six attitude statements with response choices in a 5-point Likert scale format: strongly agree, agree, neutral, disagree, and strongly disagree. These individual attitude statements were designed to focus on the module usefulness, efficacy, level of difficulty and plan to use the information in the module to train others (Appendix I). Also, the course evaluation was patterned after an assessment used by Wallner et al. (2007).

V. Statistical Analysis

The SAS of Windows software (release 9.2) was used for analysis of pilot testing results. Significance level of $P<0.05$ was used for all statistical tests. The grades included the pre and post questionnaire scores report and the participant responses to the course evaluation items report. The FREQ procedure for the SAS system was used to run cumulative frequency and percent for each item in the pre and post test. Mean scores and standard deviations were also computed. The type of profession was also evaluated through comparing Certified Dietary Managers with Registered Dietary Technicians and

Registered Dietitians. The FREQ procedure and McNemar's test were used to compare the least square means of both the pre and the post test.

The GLM procedure ran analysis of variance (ANOVA) to compare pre and post knowledge scores across six demographic factors: years of employment in dietary services for elderly (0-5, 6-15, 16-25, 25+); type of facility (skilled nursing, senior living, senior center, hospital, other); profession (CDM, DTR & RD); ServSafe certification (Yes, No); job responsibility including supervisory or managerial role (Yes, No); and education (HS &GED or less, 1-2 yr college, 4 yr college). The same six demographic factors design was run for an analysis of covariance for post knowledge using pre knowledge as the covariate.

RESULTS AND DISCUSSION

I. Reliability Testing

The sample size (n=30) for the test-retest included participants who were able to complete both tests. Participants were coded as 101 through 130 for the test and 201 through 230 for the retest. Correct answers were computed for the test only and were coded as “1” and incorrect answers were coded as “0”. The change in the answers of the test and retest was determined and coded as “0” for no change and "1” for change. Table 1 presents the primary test-retest question results. The project team decided to eliminate questions that were too easy and showed unreliable responses from test to retest based on Parmenter and Wardle (2000) guidelines. These guidelines suggested that questions should not be too easy or too difficult. If a question is too easy or too difficult, it will not differentiate among respondents’ answers (Parmenter & Wardle, 2000). Generally, if 20% or less answered the question correctly on the first try, it was considered too difficult and if 80% or higher got it right, it was considered too easy. By reviewing the difficulty index, questions 1, 5, 10, 18 and 19 were eliminated because they were too easy. The primary test –retest questions did not include questions that were considered too difficult.

The no change scores were also considered to determine the reliability or lack of change from test to retest based on Parmenter and Wardle (2000) guidelines. The test-retest reliability includes submitting the same measure to the same respondents under same circumstances. If the no change percent is ≥70%, a question will be considered reliable and if the no change score is <70% then a question will be considered non-reliable (Parmenter & Wardle, 2000). Question 12 was eliminated using this criterion. Questions 6, 7, 11 and parts of 13 also fell below the change score criterion. These questions were reworded to improve clarity and left in because they covered important information presented in the module. Question 16 was also reworded to better reflect the information covered in the module.

Table 1. Test-retest questions evaluation (n=30).

Question Topic	% Correct (Test)	% No change (test to retest)	% Change (test to retest)
1. At high risk populations of foodborne illness	93	87	13
2. *Listeria* growth at refrigeration temperature	63	70	30
3. *Listeria* biofilms	47	73	27
4. *Listeria* harborage sites	47	70	30
5. Cleaning and sanitizing of mixers, slicers and food processors	83	90	10
6. Why refrigerated RTE food products are implicated with *Listeria*	47	50	50
7. Facts about *Listeria*	33	50	50
8. The recommended safe storage time for refrigerated RTE foods	40	80	20
9. Factors contribute to *Listeria* contamination	87	90	10
10. The first principle of HACCP	87	100	0
11. The highest acceptable receiving temperature for fluid milk	60	63	37
12. The warmest acceptable receiving temperature for fresh cut tomatoes and cut melons	37	50	50
13. Factors increase a food safety hazard in the menu:			
a. Food is cooked then cooled before serving	63	73	27
b. Food is handled by several workers	83	83	17
c. Food is purchased RTE and does not require refrigeration	57	67	33
d. Food is purchased as RTE item	60	80	20
e. Food that requires multi-preparation steps	73	63	37
f. Not sure	97	100	0
14. Temperature of reheating cold hot dogs	63	70	30
15. *Listeria* can be prevented through	73	80	20
16. Cleaning and sanitizing equipment in constant use	73	77	23
17. *Listeria* can grow on spills in the refrigerator	80	83	17
18. Proper handwashing time	80	93	7
19. Other foodborne pathogens of particular importance to the elderly	87	87	13
20. Facts about food irradiation	77	77	23

II. Participant Demographics

The project team was able to publish the module on-line late in January 2010. The date of the module closure was May 2010. Of 211 participants that initiated attempts to complete the pre-questionnaire, 143 participants were able to complete both the pre and post questionnaires. Therefore, the sample size that was subjected to the statistical analysis was n=143. Table 2 shows the demographic distribution of participants by years in profession, type of facility, job responsibilities, and education with an option "I choose not to answer this question." As shown in Table 2, participants were well represented across the years in profession. More participants worked at a skilled nursing/rehab facility (38.5%) or a hospital (29.4%) respectively, than any other types of facilities. In terms of job responsibility that includes a supervisory or managerial role for supervising the daily operation of dietary services, most participants (75.5%) had supervisory roles and only (24.5%) did not have supervisory roles. Also, the majority of participants had finished either 1-2 years (41.9%) or 4 years (37.8%) of college.

Table 2. Demographic distribution for pilot test participants (n=143)

Category	Frequency	(%)
Yrs. in Prof.		
0-5	40	28.0
6-15	46	32.1
16-25	31	21.7
25+	23	16.1
No answer	3	2.1
Type of Facility		
Skilled Nursing or Rehab facility	55	38.5
Senior Living	15	10.5
Senior Center	2	1.4
Hospital	42	29.4
Other	24	16.8
No answer	5	3.5
Job Responsibilities include Supervisory or Managerial Role		
No	35	24.5
Yes	108	75.5
No answer	0	0
Education		
Some HS	2	1.4
HS/GED	24	16.8
1-2 Yrs. College	60	41.9
4 Yrs. College	54	37.8
Other	3	2.1
No answer	0	0

Participants were grouped by their profession into three categories: Board Certified Dietary Manager (CDM), Registered Dietary Technician (DTR), and Registered Dietitians (RD). A few participants had multiple certifications (Table 3). Because the initial recruitment attempts targeted members of the National Dietary Manager Association, the majority of participants (66%) were Board Certified Dietary Managers.

The second major category was the Registered Dietitians (28%), who were recruited later to broaden the target audience of the module.

Table 3. Demographic distribution of pilot test participants by profession (n=143).

Profession	**CDM**	**DTR**	**RD**	**CDM/DTR**	**CDM/RD**	**DTR/RD**	**Other**
Frequencies	83	2	34	11	1	5	8
(%)	58.0	1.4	23.8	7.7	0.07	4.0	5.6

Demographic information also included lists of certificates that a participant may have completed. Sixty seven participants had completed any of listed certifications. Certifications included: ServSafe® Food Protection Manager Certification-National Restaurant Association, Certified Professional-Food Safety (CP-FS) sponsored by National Environmental Health Association (NEHA), Professional Food Manager Certification-National Registry of Food Safety Professionals®, ServSafe® Starters Employee Training-National Restaurant Association, and other safe food handler training as shown in Table 4.

Table 4. Demographic distribution of pilot test participants by certification completion (n=143).

Certification	Frequency	(%)
ServSafe® Food Protection Manager Certification-National Restaurant Association	52	36.4
Certified Professional-Food Safety (CP-FS) sponsored by National Environmental Health Association (NEHA)	0	0
Professional Food Manager Certification-National Registry of Food Safety Professionals®	3	2.0
ServSafe® Starters Employee Training	8	5.6
Other Safe Food Handler	4	2.8

Of these listed certifications, the most common certifications were the ServSafe® Food Protection Manager Certification (36.4%) and ServSafe ® Starters Employee Training (5.6%). Table 5 shows the demographic distribution of these two certifications by profession. As shown in Table 5, nearly 40% of both the Board Certified Dietary Managers and Registered Dietitians had completed the ServSafe® Food Protection Manager Certification. Persons in the "Other" category in Table 5 also were likely to have completed the ServSafe ® or the ServSafe ® Starters Employee Training Certifications.

Table 5. Demographic distribution of pilot test participants by ServSafe® and ServSafe Starters® completion (n=143).

Profession	Certification			
	ServSafe®		ServSafe® Starters	
	Frequency	(%)	Frequency	(%)
CDM (n=83)	33	39.8	2	2.4
DTR (n=2)	0	0	0	0
RD (n=34)	13	38.2	3	8.8
CDM/DTR (n=11)	1	9.1	0	0
CDM/RD (n=1)	1	100	0	0
DTR/RD (n=5)	0	0	0	0
Other (n=8)	4	50.0	3	37.5

III. Knowledge Scores

Upon completing the post survey, participants were able to download the certificate of completion. No passing score was required. Overall, mean score increased significantly (P<0.0001) from pre (65.7%) to post (88.7%) questionnaire (Table 6). Also, there were significant increases (P<0.0001) in knowledge scores from pre to post for each individual question except for two questions (No. 9 and 11) as shown in Table 6. Participants did well post training for all questions except for question nine, indicating that the question may have not been well covered in the module. The question listed multiple factors that could possibly increase the risk of *Listeria* and ask which factor did. Obviously, most participants were not able to differentiate between the factors that would increase the risk and the ones that would not. According to Parmenter and Wardle (2000) guidelines on evaluation and designing knowledge measures, common problems that cause inaccurate assessment of knowledge are ambiguous wording and unclear format. There was no significant difference observed in question 11 from pre 94% to post 98%, as this question did not leave sufficient space for improvement, indicating that the question obviously was too easy. The question listed several ways that can be employed to prevent *Listeria* contamination. This question was tested for reliability and the score of 0.73 indicated that the question was relatively easy according to the difficulty index criteria (Parmenter & Wardle, 2000). The largest change in score (0.5) occurred for question 5 indicating that the content in the module regarding this part was adequately presented. The overall, significant increase in knowledge score ($P<0.0001$) is an indication that the training course was effective and knowledge about the topics presented was gained.

Table 6. Comparison of pre and post knowledge scores with (± SD) and score changes by each question for all participants (n=143).

Question Topic	Pre (Mean ± SD)	Post (Mean ± SD)	Score Change	P-value (pre to post)
1. *Listeria* growth at refrigeration temperature	0.734 (±0.443)	0.951 (±0.216)	0.216	<0.0001
2. *Listeria* biofilms	0.559 (±0.498)	0.895 (±0.307)	0.335	<0.0001
3. *Listeria* harborage sites	0.685 (±0.466)	0.923 (±0.267)	0.237	<0.0001
4. Why refrigerated RTE food products are implicated with *Listeria*	0.580 (±0.495)	0.797 (±0.403)	0.216	<0.0001
5. Facts about *Listeria*	0.258 (±0.439)	0.755 (±0.431)	0.496	<0.0001
6. *Listeria* can grow on spills in the refrigerator	0.867 (±0.340)	1.000 (±0.000)	0.132	<0.0001
7. The recommended safe storage time for refrigerated RTE foods	0.706 (±0.457)	0.986 (±0.117)	0.279	<0.0001
8. The warmest acceptable receiving temperature for fluid milk	0.769 (±0.422)	0.944 (±0.230)	0.174	<0.0001
9. Factors that increase a food safety hazard in the menu	0.538 (±0.500)	0.608 (±0.489)	0.069	0.17
10. Temperature of reheating cold hot dogs	0.692 (±0.463)	0.902 (±0.298)	0.209	<0.0001
11. *Listeria* can be prevented through	0.937 (±0.243)	0.979 (±0.143)	0.041	0.06
12. Factors impact the effectiveness of sanitizers	0.566 (±0.497)	0.874 (±0.332)	0.307	<0.0001
13. Facts about food irradiation	0.601	0.895	0.293	<0.0001

	(±0.491)	(±0.307)		
Overall	0.653	0.885	0.230	<0.0001

125 observations were used to run the ANOVA test with the Least Squares Means (LSM). This procedure was used to determine differences in post scores within each of the six main demographic factors listed in Table 7, using pre scores as a covariate. The first factor evaluated was number of years employed in dietary services serving an elderly population. Table 7 shows that participant scores did not differ (p=0.16) by years of employment. The second factor used was type of facility in which participants were employed. As shown in Table 7, the lowest pre score was observed among people who work at the hospital (59.5%), which may not be surprising because of their lower exposure to food safety issues compared to participants in other types of facilities. However, the post score for hospital workers (88.5%) was similar to those achieved by other groups, indicating that knowledge was gained for hospital group about topics covered in the module. As a result, post scores across type of facility were not significant (p=0.99).

The third factor used showed the categories of profession for participants. As shown in Table 7, although the Certified Dietary Mangers (CDM) (n=93) did somewhat better than the Registered Dietitians on the pre test, both groups achieved high post scores so that no difference in post score was seen, even with adjustment for pre score (p=0.54). This indicates that both groups had improvement in their knowledge in food safety issues. Difference in post test score by completion of ServSafe® certification was the fourth demographic factor assessed. A comparison between participants who completed the

ServSafe® certification and those who did not is shown in Table 7. There was greater increase in scores for ServSafe® group compared with no ServSafe®, the difference was significant (P=0.048). This indicates that completing the ServSafe® certification had an impact on the performance of groups that have completed it. The fifth factor used was whether or not a participant had job responsibilities that included a supervisory or managerial role in dietary services. Interestingly, the LSM procedure revealed no significant difference (P>0.05) in change scores for those who had supervisory or managerial roles in their job and those who did not. No interactions between the two groups were seen. The last factor analyzed was the level of education for participants. As shown in Table 7, participants who had a 4 year college degree or higher had the highest scores in both the pre (71%) and post knowledge (91%) tests. However, there was no significant difference (p=0.37) in post scores across the education level. This indicates comparable knowledge gain across all educational levels.

Table 7. Comparison of pre and post scores by demographic factors (n=125).

Category	n	Pre score	Post score	P-Value*
Yrs. in Profession				0.16
0-5	40	64.0	88.6	
6-15	46	66.5	88.5	
16-25	31	62.6	92.6	
25+	23	65.7	84.7	
Type of Facility				0.99
Skilled Nursing	55	64.4	88.3	
Senior Living/Senior Center	17	68.2	88.5	
Hospital	42	59.5	88.5	
Other	24	66.8	89.0	
Profession				0.54
CDM	93	68.5	87.7	
DTR/RD	57	61.0	89.5	
Certification				0.048
No ServSafe®	89	65.8	86.4	
ServSafe®	52	63.6	90.8	
Job Responsibility includes Supervisory or Managerial Role				0.76
No	35	65.7	88.2	
Yes	108	63.8	88.9	
Education				0.37
HS/GED	24	60.7	85.2	
1-2 Yr College	60	62.5	89.4	
4 Yr College	54	71.0	91.0	

*P-value = difference in post scores within a demographic factor with pre scores as a covariate

IV. Course Evaluation

The Likert scale format with five responses ranging from strongly agree to strongly disagree was used to evaluate participants' opinions of the usefulness, value and clarity of the module. As shown in Table 8, the majority of participants either strongly agreed (SA) or agreed (A) with the evaluation statements. The value factor received the highest positive responses. For example, 70.6% strongly agreed with the value statement that "Participating in this web module was a convenient way to earn continuing education credits." In addition, 60% of participants chose to strongly agree with the following statement "I would recommend this training module to others." Wallner et al. (2007) showed similar findings where the course evaluation items for usefulness and value received the higher scores. In her study, none of the participants strongly disagreed about the usefulness and value of the modules which indicates that participants were satisfied with the content and convenience of the training module for their professional needs (Wallner et al., 2007). In the current study, there was only one strongly disagree response on the course clarity, but this is a marginal percentage (0.7%). Generally, responses to the course evaluation items were considered positive and suggest that participating in this course was worthwhile and the effort was reasonable for earning one continuing education credit.

Table 8. Responses to course evaluation questions (n=143).

Scale-Based Item	**Frequency**	**(%)**			
Usefulness	SA[1]	A	N	D	SD
I gained new and useful information from taking this course.	71 (49.7%)	66 (46.2%)	5 (3.5%)	1 (0.7%)	0 (0%)
As a result of viewing this web module, I am better able to recognize food safety risks affecting the frail elderly.	66 (46.2%)	64 (44.8%)	10 (7.0%)	3 (2.1%)	0 (0%)
I plan to use this information in training others.	74 (51.8%)	60 (42.0%)	5 (3.5%)	4 (2.8%)	0 (0%)
Value					
Participating in this web module was a convenient way to earn continuing education credits.	101 (70.6%)	39 (27.3%)	2 (1.4%)	1 (0.7%)	0 (0%)
I would recommend this training module to others.	86 (60.1%)	55 (38.5%)	1 (0.7%)	1 (0.7%)	0 (0%)
Clarity					
The level of difficulty was appropriate for a professional continuing education course.	71 (49.7%)	61 (42.7%)	9 (6.3%)	1 (0.7%)	1 (0.7%)

SA[1] Rated on a five point scale of strongly agree to strongly disagree.

There are several tools that should be considered when developing on-line training courses. For a training course to be successful, professional needs of the targeted audience should be evaluated before designing any on-line courses (Gabriel & Longman, 2004). Parmenter and Wardle (2000) stress the importance of testing the evaluation instrument for reliability, clarity, content validity and difficulty. In addition, a study conducted by Jurczyk et al. (2004) to examine the perceptions of students participating in a distance learning program revealed that pilot testing of on-line courses helps in developing future distance learning tools.

With the rapid change that is happening in the world, it seems there is an emerging need to acquire knowledge in a more effective way (Gabriel & Longman, 2004). The use of the Internet to deliver education has been employed since 1997 (Sandon, 2007). It was suggested that E-learning is an example of using technology to deliver, interact or facilitate information (Gabriel & Longman, 2004). Gabriel & Longman (2004) define E-learning as a new venue in designing and delivering education to fulfill professional needs for different organizations including health care organizations. Wallner et al. (2007) found that online continuing education can be a useful tool for providing the required profession development. Sandon (2007) recommended web-based learning for health care professionals as a way to enhance cognitive skills and knowledge. These researchers concluded that on-line continuing education is an effective use of technology to provide convenience where learner can receive education at the time it needs it and is ready to learn as well as individual or self-paced type of learning (Sandon, 2007; Wallner et al., 2007). However, the E-learning can be very challenging. Sandon (2007) listed issues related to on-line education such as variable technological tools and cost effectiveness of applying these tools.

Several characteristics have been identified for adult learners to be good candidates for an on-line learning. These characteristics include participant's preference for problem-centered learning and managing their own learning. Also, a participant should have a desire in different learning styles that can be manageable for their area of interest. In addition, it is preferred that a participant be a lifelong learner with real-life experience (Sandon, 2007). All obstacles associated with an on-line education programs must be listed and resolved to ensure the efficacy of training programs (Gabriel & Longman, 2004). Overall, due to the increased popularity of the Internet, on-line courses appear to be a convenient way to earn continuing education units (Garrison et al., 2000b; Beffa-Negrini et al., 2002; Santerre, 2005; Brug et al., 2003; Schmitt, 2004). Santerre (2005) concluded that features of on-line education represented by convenience, efficiency and affordability are appealing factors to attract educators.

Our findings in this study showed a positive attitude of participants to the course usefulness, value and clarity which are an obvious indication that the on-line training module was effective. However, the negative feedback represented by disagree and strongly disagree responses should also be considered to provide better strategies for delivering effective and flaw-free on-line training programs in the future.

CONCLUSION

Recently, distance education and on-line training courses have become a popular and convenient way to obtain continuing education units for many professional needs. The "*Listeria* Control and Safe Food Training for Dietary Managers" pilot testing helps in the process of evaluating on-line continuing education for dietary managers and similar professions. The improvement of overall scores from pre to post-questionnaire attempts was noticeable which reflects that knowledge was gained and the course was successfully capable of delivering the information about certain issues related to food safety. It appears that participants were self-motivated about finishing the course and earning the continuing education units. Participants were interested in the course material and fully understood the content as indicated by the improvement in the post survey scores. In addition, the course evaluation part provided useful information about the course usefulness, value and clarity which can help in improving future on-line courses. Participants satisfaction was clearly understood by the responses received for the scale-based items which were mostly strongly agree or agree responses.

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APPENDIX A
Online Consent Form

Listeria Control and Safe Food Training

Welcome Dietary Managers!

Thank you for taking time to participate in pilot testing the web module ***Listeria Control and Safe Food Training for Dietary Managers***, developed by Colorado State University researchers in the Department of Food Science & Human Nutrition as part of a grant project to provide food safety training to those who work with elderly populations at increased risk of foodborne illness. This course has been approved by the Certifying Board of Dietary Managers (CBDM) and the Colorado Dietetic Association (CDA) for one unit of continuing education credit through August 1, 2010.

Because this is a research project, you are first asked to give informed consent (below) to participate. Next will be a pre-questionnaire, followed by a web page with downloadable resource materials, instructions and the three part training module (47 minutes total). Once you complete the training module, you will take a post-questionnaire, then be able to print off a certificate of completion. The total process should take approximately one hour.

To begin, please read the "Human Subject Statement" (below) and click **"agree."** Acceptance will be taken as implied consent to participate in this pilot project. Your answers and comments will be kept confidential as your privacy is very important to us. An ID number will be used in place of any names or personal identity for your responses to the questionnaires. Individual responses will not be available to anyone outside the research team. Only group data (no individual responses) will be used in any reports written as a result of this research. It is not possible to identify all potential risks in research procedures, but the researchers have taken the precautions to minimize any potential risks.

Benefits: Board Certified Dietary Managers will receive 1 CEU approved through the Certifying Board of Dietary Managers (CBDM) for completing the module. For those who are not members, we hope that you find the presentation, resource and education materials provided useful. You may withdraw your consent by exiting the module at any time. You may print a copy of this consent for your records.

If you have any questions concerning your selection or treatment as a research participant, you may contact the CSU Research Integrity and Compliance Review Office (RICRO) at 970-491-1655. For questions regarding the study, please contact Mary Schroeder, project coordinator at mary.schroeder@colostate.edu; (970) 491-7335 or Patricia Kendall, project director at patricia.kendall@colostate.edu; (970) 491-7334. We hope you find this module to be a convenient way to earn continuing education credit.

Sincerely,

Pat Kendall

Patricia Kendall, Ph.D., R.D.
Professor and Extension Specialist-food safety
Dept. Food Science & Human Nutrition
Colorado State University
Fort Collins, CO 80523-1571

HUMAN SUBJECT STATEMENT
I AM AT LEAST 18 YEARS OF AGE, AND AM VOLUNTARILY PARTICIPATING IN THE PILOT TEST OF THIS WEB MODULE BY COMPLETING THE PRE- AND POST- QUESTIONNAIRES AND VIEWING A TWO-HOUR WEB MODULE. I UNDERSTAND THAT MY ANSWERS MAY BE INCLUDED AS GROUP DATA IN RESEARCH REPORTS WRITTEN AS A RESULT OF THIS PROJECT.

AGREE   DISAGREE

APPENDIX B
HACCP Booklet

A HACCP Plan to Control *Listeria monocytogenes* and Other Foodborne Pathogens in Long-Term Care Facilities (LTCFs)

As Part of Training Course Module for Dietary Managers

2010

Colorado State University

Extension

Introduction

Listeria monocytogenes is a pathogen of particular importance to the elderly. This bacterium causes a disease called listeriosis. Listeriosis might cause mild symptoms in healthy individuals, but in the elderly or individuals with compromised immune systems, this disease can be fatal. Fatality rate reaches 10-20% in elderly over 60 years old.

Listeria monocytogenes can be found nearly everywhere in the environment, including in air, soil, water, plants and animals. It can also be found hard-to-clean places such as drains, grease traps, meat and cheese slicers, and cracks in preparation tables. *Listeria* can grow over a fairly wide temperature range, from 29˚F to 113˚F. This means the bacterium is capable of growing and multiplying at refrigeration temperatures (40˚F). It does not grow, but can survive at freezing temperatures (0˚F). Also, it tolerates acidic environments when kept at low temperatures. *Listeria* resists drying and high salt concentrations. In addition, *Listeria* can grow in vacuum packaged food products during long-term refrigerated storage.

Listeria is able to produce biofilms that make it more virulent. In fact, these biofilms can protect the bacterium from sanitizers, biocides or antibiotics by shielding it. Bacteria then can break off and be transferred to foods or food contact surfaces. Thus, *Listeria* biofilms increase the risk of contamination of food and food contact surfaces. They also are hard to remove once formed, which makes cleaning and sanitizing a hard task.

Listeria monocytogenes is often associated with refrigerated Ready-to-Eat (RTE) foods such as luncheon meats, hot dogs, cold pates and cold meat spreads. Raw (unpasteurized) milk and soft cheeses made with raw milk such as Camembert, brie, feta and Mexican-style cheeses are other common sources of *Listeria*. Raw meat and poultry have also been implicated with *Listeria.*

From the previously mentioned factors, it can be implied that *Listeria* is a hardy bacterium; however, *Listeria monocytogenes* can easily be destroyed by proper cooking of foods. In addition, *Listeria* can be prevented through proper reheating of RTE meats to 165˚F or until steaming hot. Proper cleaning and sanitizing protocols can be an efficient way to control the prevalence of the pathogen in food operation areas. Other foodborne pathogens such as *Salmonella*, *E. coli* O157:H7, *Clostridium perfringens*, *Campylobacter* species and *Bacillus cereus* can also be of particular concern to the elderly in long-term care facilities.

The HACCP System

HACCP is an abbreviation for Hazard Analysis Critical Control Points. It is a prevention-based safety approach that identifies and monitors any food safety hazard that may occur during the processing of food. This system will give you confidence that food safety is being managed effectively. Moreover, HACCP ensures that personnel are well trained and able to make necessary decisions. However, if HACCP is applied improperly, it may result in an ineffective control system. The improper application of HACCP may be due to several factors, but the most important factor is inadequate personnel training.

Why use HACCP?

The main reasons for using HACCP is to implement food safety management and prevent food safety hazards, which means that something has gone wrong with a food product. By identifying where hazards are most likely to occur in the operation it will be much easier to put in place the measures needed to prevent those hazards. In addition, food safety incidents, such as the peanut butter outbreak due to *Salmonella* and the Mexican style cheese due to *Listeria monocytogenes*, can be prevented by an effective HACCP system.

Types of Hazards

A hazard is a biological, chemical or physical property or agent of food that renders it unsafe for consumption, if uncontrolled. The purpose of HACCP is to control the factors that lead to loss of control of any of these hazards. **Biological hazards** could be bacteria and their toxins, parasites and viruses. One or more biological hazards could be introduced into food during processing. **Physical hazards** include such things as bandages, jewelry, stones, glass, bone and/or metal fragments and packaging materials that inadvertently end up in food. Physical hazards are actually the most common type of hazard. **Chemical hazards** include natural plant and animal toxins, unlabeled allergens (allergen-causing proteins), nonfood-grade lubricants, cleaning compounds, food additives, hormones and insecticides.

HACCP Principles

There are seven HACCP principles. These principles outline how to establish, implement and maintain a HACCP plan in your operation. To ensure a sound HACCP plan in any facility, these seven principles should be employed:

1. Hazard analysis
2. Critical control points (CCP)
3. Critical limits (CLs)

4. Monitoring procedures
5. Corrective actions
6. Verification procedures
7. Record keeping procedures

1. Conduct a hazard analysis:

Conducting a hazard analysis is the first step in developing a HACCP plan. This includes collecting and evaluating information on all hazards and circumstances leading to their presence in food at all steps of processing up to consumption. To do this, you may need to prepare a list of all steps in the process. Then, identify where significant hazards could occur and describe their control measures.

2. Determine critical control points (CCPs):

This determination is done after identifying all hazards and their control measures. A critical control point (CCP) is a point where loss of control will lead to a significant hazard. In other words, any control measure required to prevent the introduction of a hazard. Cooking and chilling are two examples of CCPs because these steps are intended to reduce the existence of a hazard.

3. Establish critical limits (CLs):

Critical limits are measurable parameters or safety limits that are set for each CCP. They actually describe the difference between safe and unsafe products. For example, the safe holding temperature for foods in a steam holding is 135ºF. This temperature (135ºF) is the critical limit for hot held foods.

4. Establish monitoring procedures:

You need to establish a system to monitor control of the CCPs and CLs. Monitoring is achieved by ongoing observations during the operation. For instance, monitoring can be done through regular checking of the temperature of hot held foods.

5. Identify corrective actions:

When monitoring indicates that a particular CCP is not under control, then you need to take a corrective action to bring the process back under control. For example, if food has dropped below the safe hot holding temperature of 135ºF, then the corrective action is either to discard the food or reheat it to 165ºF for 15 seconds.

6. Verification procedures:

Establish procedures in your facility to verify and confirm that the HACCP system is working correctly. All records such as hazard analysis, monitoring procedures, and any corrective actions needed should be reviewed.

7. **Record keeping procedures:**
The last component of your HACCP plan is establishing your record keeping procedures to document that you have conducted your hazard analysis, established the critical control points and critical limits, and have the monitoring procedures in place to trigger any needed corrective actions. All documentations and records created in terms of monitoring activities, taking any corrective actions, validating equipment and working with suppliers need to be maintained and reviewed on a regular basis, with adjustments made as needed to ensure a safe food system.

Terms related to HACCP

- **Control point:** Any step at which biological, chemical or physical hazards can be controlled, like refrigeration of perishable foods to slow pathogen growth. A critical control point is a control point that is essential to prevent or eliminate a food safety hazard or reduce it to an acceptable level. Cooking to a safe internal temperature is an example of a critical control point.

- **Control measure:** Any action or activity that can be used to prevent, eliminate or reduce a significant hazard. Control measures are applied at critical control points in the flow of food and determined to be essential for food safety. For example, wearing gloves during handling RTE foods will prevent cross contamination or bacteria transfer from hands to the food and this is a control measure.

- **Acceptable level:** The highest level allowed for a food safety hazard in a food product that will not cause an illness or injury. For *Listeria monocytogenes,* the U.S. Department of Agriculture Food Safety Inspection Services (USDA-FSIS) has a zero-tolerance policy in RTE meat and poultry. The zero-tolerance policy states that the organism must **not** be detectable in a 25-gram food sample. If *Listeria* is found, the food is considered adulterated.

- **Prerequisite Programs (PPs):** This term refers to steps that can be applied or put in place before or during implementing the HACCP plan. Prerequisite programs are the foundation of a successful food safety management plan. They are steps or procedures that are applied to control the environmental and operational conditions in a food service operation to produce a safe food. Examples could be purchasing requirements, product receiving and storage, pest control programs, employee training or standard operating procedures.

- **Standard Operating Procedures (SOPs):** SOPs are written practices and procedures that are carried out by foodservice employees on a routine and repetitive basis. In other words, SOPs are specific job instructions including what the job is, when, what, who, how this job should be conducted. They also include instructions about what to do if the job fails. For example, SOP can include temperature measurement or thermometer calibration. These procedures are

- essential to produce safe food. It is very essential to train foodservice staff on the importance of following these procedures. SOPs also include cleaning and sanitizing food contact surfaces, cooking and cooling potentially hazardous foods, controlling time and temperature during preparation, date marking of perishable RTE and potentially hazardous foods and reheating potentially hazardous foods.

- **Sanitation Standard Operating Procedures (SSOPs):** SSOPs are written procedures that a foodservice establishment may develop and implement to prevent direct contamination. SSOPs include maintaining the sanitary conditions of the foodservice environment or cleaning and sanitizing of food contact surfaces.

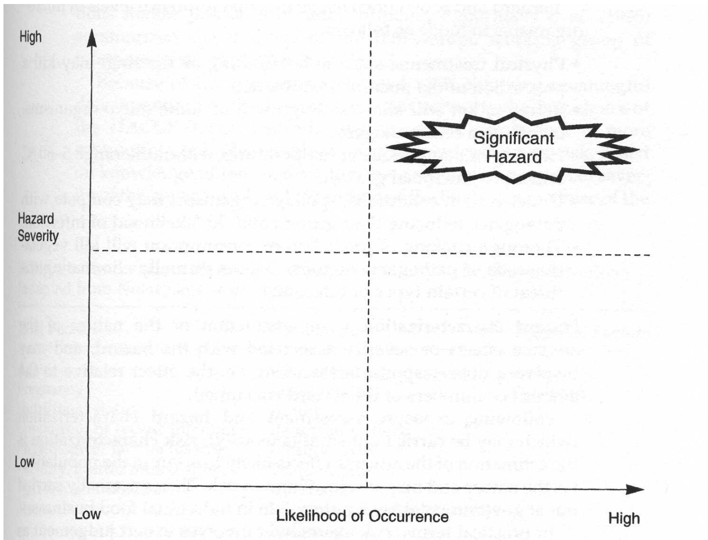
Preparing for HACCP

To implement a HACCP plan you need to select a HACCP team first, as HACCP is carried out by people. In long term care facilities, the HACCP team might be limited to a dietary manager or two, registered dietitian or two, cook and shipments or incoming goods inspectors. Implementing a HACCP plan for each food item might seem impractical because food that is served in long term care facilities varies in quality and the way it is made. But, the good news is that HACCP principles provide a common sense approach to identifying and controlling the problem. Also, due to the diversity of operations, HACCP principles can be implemented in more than one correct way. Besides, the regulatory inspection programs must be flexible enough to understand this complexity. Risk factors could be any poor conditions, procedures, or practices that result in out-of-control food safety hazards. These factors include:

- Foods from unapproved sources
- Poor personal hygiene
- Contaminated equipment
- Cross-contamination
- Inadequate cooking
- Improper holding temperature

Carrying out the Hazard Analysis

Conducting a hazard analysis is one of the most important steps in a HACCP plan, as this is where the team ensures that all potential hazards have been identified and considered. The hazard analysis involves collection and evaluation of information on hazards and circumstances that lead to their presence (brainstorm hazards and their potential sources). This helps to decide which hazards are significant and of concern to food safety and thus should be addressed in the HACCP plan. Keep in mind the meaning of the word “hazard”, which includes any condition that potentially makes food unsafe for consumption.



The figure shows that a significant hazard is one with a high likelihood of occurrence and severe outcome. In long term care facilities (LTCFs), menu reviewing is the best way to conduct the hazard analysis. Reviewing the menu helps to identify high risk foods and high risk food preparation processes as well as identify the operational steps requiring further inquiry such as receiving, preparation, cooking, and cooling. High risk or potentially hazardous foods, such as raw chicken that naturally carry a heavy load of pathogenic bacteria, are those that will most likely cause foodborne illness if uncontrolled. Here you should pay attention to practices that may or may not cause cross contamination. Also, you need to pay attention to the proper cooking temperature that can destroy pathogenic bacteria in the meat. Additionally, a dietary manager is responsible for activities that occur in the facility on a regular-basis such as receiving shipments, food preparation and handling, cooking, cooling, and/or reheating.

As mentioned earlier, conducting a hazard analysis on each individual food item is time and labor intensive and is sometimes unnecessary. Therefore, it is quite convenient to conduct a hazard analysis on each preparation process. Usually, there are three food preparing processes that are followed in foodservice operations:

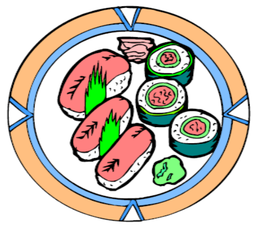
1. **Food Preparation with No Cook Step:** in this type of process food is received, stored, prepared, held and served without cooking.
2. **Preparation for Same Day Service:** in this case the food is cooked, held and then served. There is only one trip through the temperature danger zone (41-135˚F).
3. **Complex Food Preparation:** in this process, food is cooked, cooled, reheated, hot-held and served. There are two or more complete trips through the danger zone.

This classification of processes shows that the risk of contamination or recontamination can occur. Also, trips through the temperature danger zone mean that there is a potential chance for bacteria to grow and multiply in food. The key here is how to reduce these hazards to a safe level.

Practical Application of Food Preparation Steps:

Let us discuss in detail how to conduct a hazard analysis of each food preparation step:

1. Food Preparation with No Cook Step



Ready-to-Eat foods, cheeses and salads are grouped in this category. The most important thing to know about this type of process is that there is no kill step. In other words, there is no procedure, like cooking, to destroy bacteria. There are several safety measures you can take while receiving the product:

- Make sure the product is obtained from approved sources and is received in a good condition.
- Make sure the food is handled carefully to reduce or prevent further contamination.
- Make sure your employees are following good hygienic practices.
- Keep foods that are RTE separate from those that are raw to prevent cross contamination.
- Store perishable RTE foods at low refrigeration temperatures (41˚F or below) and for a short period of time (4 days maximum).

This chart helps you to determine what control measure should be taken for certain hazards in this process.

Table 1a. Process #1 – Food Preparation with No Cook Step

FOOD/MENU ITEMS:						
HAZARD(S)	CRITICAL CONTROL POINTS (List Only the Operational Steps that are CCPs)	CRITICAL LIMITS	MONITORING	CORRECTIVE ACTIONS	VERIFICATION	RECORDS
PREREQUISITE PROGRAMS						

2. Preparation for Same Day Service

Food in this process (e.g. baked chicken or meatloaf) is either cooked and served right away or held hot until served. Therefore, it passes through the temperature danger zone, but only one time. The temperature danger zone is the temperature at which bacteria grow rapidly. Control measures may involve proper cooking and holding. These control measures will ensure safety of all foods in this category even though each type of food has its individual hazards. Let's take a closer look at hazards that may be found in baked chicken and meat loaf. *Salmonella*, *Bacillus cereus* and *Clostridium*

Table 2a. Process #2 – Preparation for Same Day Service

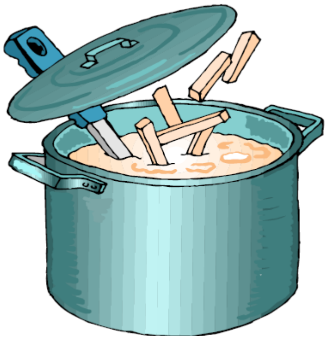
FOOD/MENU ITEMS:						
HAZARD(S)	CRITICAL CONTROL POINTS (List Only the Operational Steps that are CCPs)	CRITICAL LIMITS	MONITORING	CORRECTIVE ACTIONS	VERIFICATION	RECORDS
PREREQUISITE PROGRAMS						

perfringens are significant biological hazards in both foods. However, *Campylobacter* is mainly associated with chicken and *E. coli* O157:H7 is associated with meatloaf (see table below). But, proper cooking destroys all these pathogens.

Below is an example that shows how to fill in the above chart.

Process 2: Preparation for Same Day Service		
Example Products	**Baked Meatloaf**	**Baked Chicken**
Example Biological Hazards	*Salmonella*	*Salmonella*
	E. coli O157:H7	*Campylobacter*
	Clostridium perfringens	*Clostridium perfringens*
	Bacillus cereus	*Bacillus cereus*
	Various fecal-oral route pathogens	Various fecal-oral route pathogens
Example Control Measures (there may be others)	Refrigeration 41 °F or below	Refrigeration 41 °F or below
	Cooking at 155 °F for 15 seconds	**Cooking at 165 °F for 15 seconds**
	Hot Holding at 135 °F or above OR Time Control for 4 hours or less	Hot Holding at 135 °F or above OR Time Control for 4 hours or less
	No bare hand contact with RTE food, proper handwashing, exclusion/restriction of ill employees	No bare hand contact with RTE food, proper handwashing, exclusion/restriction of ill employees

3. **Complex Food Preparation**



This includes foods prepared in large volumes or in advance for next day service. This type of food may pass through the temperature danger zone multiple times. Food preparing in this process includes cooking, cooling, reheating, hot holding, and serving. Any loss of control in each of these processes will allow bacteria to grow and multiply.

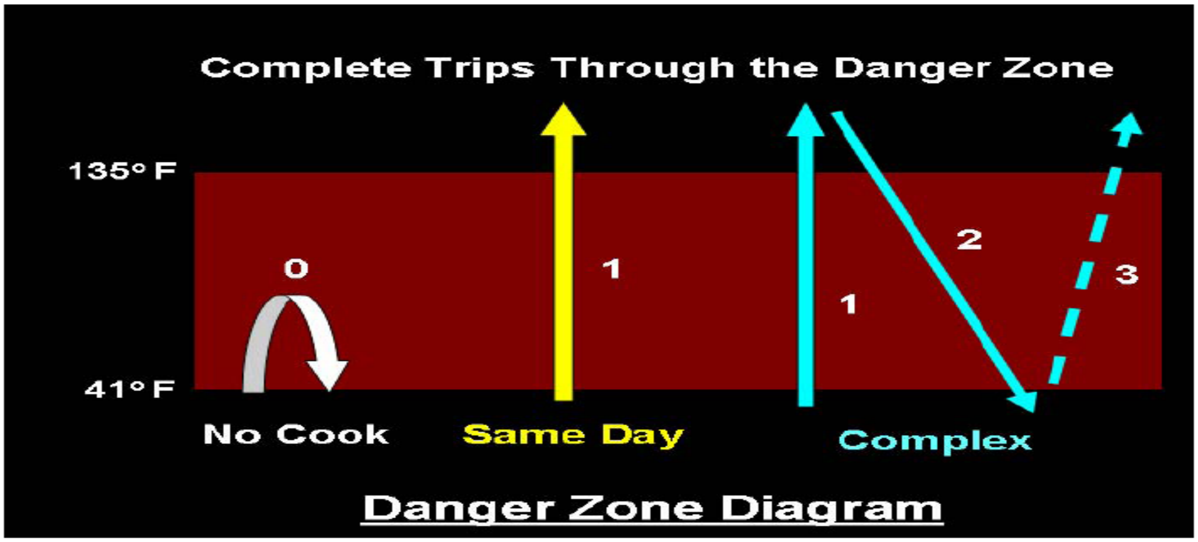
It is essential to know that these food preparation processes are not the same in every food service facility. Each food establishment may have its own food preparation process. For example, chicken salad sandwich may be created using several components that may be produced using more than one process. Despite the variation of three food preparation processes, the control measures applied based on the number of times food goes through the temperature danger zone are basically the same.

Table 3a. Process #3 – Complex Food Preparation

FOOD/MENU ITEMS:						
HAZARD(S)	CRITICAL CONTROL POINTS (List Only the Operational Steps that are CCPs)	CRITICAL LIMITS	MONITORING	CORRECTIVE ACTIONS	VERIFICATION	RECORDS
PREREQUISITE PROGRAMS						

Notice that prerequisite programs in the three above tables could also be control measures listed in page 9.

The following diagram summarizes these three processes, where 0, 1, 2 and 3 mean the number of trips to the danger zone.



Control measures must be monitored in the facility by a foodservice manager, including personal hygiene practices, cross contamination prevention, and proper cooking and holding of foods. The following are some examples of control measures:

- Not handling RTE with bare hands (use clean gloves or utensils instead)
- Proper handwashing
- Prevention of cross-contamination of RTE food or clean and sanitized food contact surfaces with soiled cutting boards, utensils, aprons, or raw animal foods.
- Restriction or exclusion of ill employees

Personnel Training

This concept is very important in terms of controlling foodborne pathogens, particularly *Listeria monocytogenes*. In fact, humans may be a source of this pathogen because it is known that humans can carry *Listeria* in their gut. Therefore, poor personal hygiene practices such as improper handwashing or dirty uniforms can lead to the contamination of food and equipment with *Listeria monocytogenes*. As a manager, it is your responsibility to ensure that employees have the knowledge and skills needed to handle food safely in your establishment. Employees should receive training on proper cleaning and sanitizing practices, safe chemical handling, and pest prevention. Also, they need to be trained periodically and be updated on new procedures for food safety practices.

In summary, the comprehensive implementation of control measures for the three food preparation processes by a dietary manager ensures that a risk of foodborne illness hazards will be prevented or reduced. It is essential to know that not all foodservice facilities apply formal HACCP plans. However, they must at least have active managerial control. This can be carried out by training programs, manager oversight, or standard operating procedures.

The food code has set critical limits (which are specific measurable criteria) to prevent, eliminate or reduce hazards in foods. For each critical control point there is one or more critical limits and vice versa. Common examples of these could be time/temperature standards or no bare hand control with RTE foods. Monitoring here is very critical step that is done by a dietary manager to make sure that these limits or criteria are met. If a deviation occurs and these criteria are not met, then you need to take a corrective action. A simple example on corrective actions would be cooking food until it reaches the proper internal temperature or throwing food that had been stored for a longer period of time (exceeded the recommended storage time) in the refrigerator.

A voluntarily implemented food safety management system using HACCP principles needs to be validated. You may use observations, measurements and evaluations taken in the establishment as well as scientific studies or food code standards when conducting the validation procedure. It is important to keep records related to validation or verification procedures as well as any records that are necessary for the HACCP plan, e.g. temperature logs, receiving logs and corrective action logs. Once you validate your HACCP or food safety plan you then need to update it regularly on a scheduled basis.

References

1. Association of Food and Drug Officials. (2009, December 16). Control of *Listeria monocytogenes* in retail establishments. Retrieved from http://www.afdo.org/training/ListeriaControl.cfm

2. Mortimore, S. & Wallace, C. (1998). *HACCP: A Practical Approach* (2nd Ed). Massachusetts: Kluwer Academic Publishers.

3. National Advisory Committee on Microbiological Criteria for Foods. (1998). Hazard Analysis and Critical Control Point Principles and Application Guidelines. *Journal of Food Protection, 61 (9*), 1246-1259.

4. National Restaurant Association Educational Foundation. (2008). *ServSafe Essentials.* Chicago: IL.

5. Ryser, E. & Marth, E. (Eds) (2007). *Listeria, Listeriosis, and Food Safety* (3rd Ed). New York: Marcel Dekker.

6. U.S. Department of Health and Human Services, Food and Drug Administration, Center for Food Safety and Applied Nutrition (2006, April). *Managing Food Safety: A manual for the use of HACCP principles for operators of food service and retail establishments*. Retrieved June 22, 2009 from http://www.fda.gov/downloads/Food/FoodSafety/RetailFoodProtection/ManagingFoodSafetyHACCPPrinciples/Operators/UCM077957.pdf

APPENDIX C
Certifying Board of Dietary Managers Approval

CBDM **PRIOR APPROVAL**
(PLEASE RETAIN A COPY FOR YOUR RECORDS)

FOR OFFICE USE ONLY		
Approval # 120477		A B C D E F G I J K
____Sanitation	____FS	____General
Date Processed: / /		By:

PLEASE READ INSTRUCTIONS ON REVERSE SIDE

A. Program Start Date 8 / 1 / 2009

Program End Date 7 / 31 / 2010

If there are additional dates/locations, please attach a list

B. Program Title Listeria Control & Safe Food Training for Dietary Managers in Long-Term Care

C. Location of Program City Fort Collins State CO

D. Program Sponsor Colorado State University

All DMA District and State meetings are exempt from fees. (Please check the appropriate box below:)

❒ DMA District Meeting ❒ DMA State Meeting

❒ Check here if the agenda includes a pre-approved "Meeting in a Box" session from DMA

List the "Meeting in a Box" title(s) & sponsoring company:________________

E. Total number of Continuing Education Hours 2

Do not count time for introductions, breaks, lunch, etc. Please indicate sanitation hours on agenda.

2 sanitation hours ______ *food show hours ______ general hours

* Food show hours will be equivalent to the amount of time designated in the printed program with a maximum of 4 hours (minimum of 1 hour). See back for details.

All DMA meetings, Colleges/Universities, Hospitals/Health Care Facilities, and Non-Profit Organizations/Associations are exempt from the fee.

A SURCHARGE IS REQUIRED FOR EACH PROGRAM PRESENTATION (Maximum of $150 for 5 or more presentations of the same program)

Submit payment with program. Make checks payable to DMA. Credit cards are accepted.	
Please check one: ❒ Visa ❒ Discover ❒ Mastercard ❒ American Express	
Name on your card	N/A
Credit Card #	Exp. Date / /
Billing Address	
Signature	
Amount	

F. Estimated # of CDM,CFPPs to attend up to 200 online participants

G. Evaluation Techniques (see back for explanation)

❒ Oral question and answer period/physical demonstration

❒ Printed evaluation (sample attached)

Other: online web-based module

H. Program Coordinator Name Mary Schroeder, MS, RD

Company Name Colorado State University

Address Dept. of Food Science & Human Nutri.

Fort Collins, CO 80523-1571

Daytime Phone (970)491-7335 Fax (970) 7252

Email mary.schroeder@colostate.edu

I. Attachments required for approval (Please staple the following to this form):

- Printed program and/or outline of program, including date, topics, time outline of sessions, lunches, breaks, etc.
- Learning objectives (see definition on reverse side)
- Speaker information (vitae, bio, resume)
- Program evaluation technique
- If applicable, sample certificate of attendance (when approved, please include DMA approval number, program title, breakdown of hours earned when certificates are issued), and a place for attendee member number.

[illegible]
406 Surrey Woods Dr
St. Charles, IL 60174
[illegible]

APPENDIX D
Colorado Dietetic Association Approval

Commission on Dietetic Registration
the credentialing agency for the American Dietetic Association

Continuing Professional Education Prior Approval Request Form

For CDR use only

Hours are requested for: ☒ Registered Dietitians ☒ Dietetic Technicians, Registered
CPE Online Database -- www.cdrnet.org/application/CPE/index.cfm

Program Number

Program Title: Listeria Control and Safe Food Training for Dietary Managers

Program Provider: Colorado State University

Program Date(s): April 2010 to April 2011

Estimated # of RDs/DTRs in Attendance 200

Program Location (City & State) Fort Collins, CO (online web-based module)

Target Audience X RDs X DTRs X Other Dietary managers working in long-term care

Check here if program is closed/by invitation only __

Program Chair Patricia Kendall, PhD, RD, project director

Contact Person- This person will recieve Certificates of Attendance & additional materials
Mary Schroeder, MS, RD, project coordinator

Address Dept. of Food Science & Human Nutrition - 1571 Campus
Colorado State University
Fort Collins, CO 80523-1571

Daytime Phone (970) 491-7335

Fax (970) 491-7252

Email mary.schroeder@colostate.edu

As a Program Provider, I verify that the content of this continuing education program is education beyond the basic preparation required for initial entry into the profession for the Registered Dietitan and/or the Dietetic Technician, Registered.

Mary H Schroeder 2/4/10

Signature of Program Provider Date

Required Documentation: The following must be provided with this form:

1. Educational objectives, describing anticipated outcomes for each session.
2. A timing outline, detailing all time spent in sessions, meals, breaks and such. This is to ensure all hours are awarded for learning time only.
3. Information regarding the target audience.
4. Qualifications of speakers/presenters. These should be resumes or CVs.

Some Affiliate Dietetic Associations share the CPE approval responsibility with CDR. Please review the Prior Approval Review Contact List at www.cdrnet.org/pdrcenter/affiliate.htm to determine where to submit your request form for review.

Please Indicate Activity Type:

☐ Journal Club ☒ Seminar/Lecture/Webinar ☐ Study Group
☐ Workshop ☐ Experiential Skills Development ☐ Poster Sessions
☐ Certificate Program ☐ Residency and Fellowship Programs ☐ Exhibits

Information on CPEUs Requested:

Number of contact hours: 1 Exhibits: ____ Posters: ____

Applicable Learning Need Code(s): (See Page 2 for LNC List) 8040

CPEU Level: 1,2

Level 1: Little or no prior knowledge of subject
Level 2: General knowledge of literature and professional practice in areas covered
Level 3: Thorough knowledge of literature and professional practice in areas covered

For Continuing Professional Education Committee Use Only

Date 2/18/10 Maximum Hours 1

Approved by Hilary Rounds RD Exhibit Hours ____

Disapproved by ____ Poster Sessions ____

Note: Approval of CPEU hours acknowledges the need for an objective look at the information being presented. Endorsement of presentations is not the function of CDR.

Send this form to CDR!
120 South Riverside Plaza, Suite 2000, Chicago, Illinois 60606-6995
You may also fax it to 312-899-4772

Questions? Call 1-800-877-1600 xt. 5500 and ask for the Prior Approval contact.

RC-3 05/09

Print Form

APPENDIX E
Research Integrity and Compliance Review Office Approval

Colorado State University
Knowledge to Go Places

Integrity & Compliance Review Office
Office of the Vice President for Research
321 General Services Building - Campus Delivery 2011
Fort Collins, CO
TEL:#(970) 491-1553
FAX:#(970) 491-2293

NOTICE OF APPROVAL FOR HUMAN RESEARCH
DATE: May 04, 2009
TO:
Swiss, Evelyn, RICRO, Sofos, John, Animal Science, Schroeder, Mary, Food Sci. & Human Nutrition, Kendall, Patricia , Food Sci. & Human Nutrition, Wailes, William , Animal Science, Geornaras, Gina, Animal Science
FROM: Janell Barker, CSU IRB 1
PROTOCOL TITLE:
Understanding and Controlling of Listeria monocytogenes transmission through ready-to-eat meat products from Processing plant to consumer
FUNDING SOURCE: USDA-CSREES
PROTOCOL NUMBER: 09-999H
APPROVAL PERIOD: Approval Date: May 04, 2009 Expiration Date: June 15, 2009
The CSU Institutional Review Board (IRB) for the protection of human subjects has reviewed the protocol entitled: Understanding and Controlling of
Listeria monocytogenes transmission through ready-to-eat meat products from processing plant to consumer. The project has been approved for the
procedures and subjects described in the protocol. This protocol must be reviewed for renewal on a yearly basis for as long as the research remains
active. Should the protocol not be renewed before expiration, all activities must cease until the protocol has been re-reviewed.
If approval did not accompany a proposal when it was submitted to a sponsor, it is the PI's responsibility to provide the sponsor with the approval notice.
This approval is issued under Colorado State University's Federal Wide Assurance 00000647 with the Office for Human Research Protections (OHRP).

If you have any questions regarding your obligations under CSU's Assurance, please do not hesitate to contact us.
Please direct any questions about the IRB's actions on this project to:
Janell Barker, Senior IRB Coordinator - (970) 491-1655 Janell.Barker@Research.Colostate.edu
Evelyn Swiss, IRB Coordinator - (970) 491-1381 Evelyn.Swiss@Research.Colostate.edu

Janell Barker

Janell Barker
Includes: Amendment is to implement Objective 3.2c & 3.2d using the new documents to recruit dietary managers & food service staff: recruitment, electronic cover letter for dietary managers, pre- and post evaluation and instructor outline.

Approval Period: May 04, 2009 through June 15, 2009
Review Type: EXPEDITED
IRB Number: 00000202
Funding: USDA-CSREES
Research Integrity & Compliance Review Office
Office of the Vice President for Research
321 General Services Building - Campus Delivery 2011
Fort Collins, CO
TEL:#(970) 491-1553
FAX:#(970) 491-2293

APPENDIX F
Test-retest Questionnaire

Thanks for participating in the evaluation of these survey questions. Please circle <u>one</u> response (except as noted).

First two letters of mother's first name ___ ___
Year of your birth ___ ___ ___ ___

1. Who is at high risk of foodborne illness?
   a. Elderly
   b. Pregnant women
   c. Cancer patients
   d. All the above
   e. Not sure
2. *Listeria monocytogenes* can grow and multiply in refrigeration temperature (40˚F).
   a. True
   b. False
   c. Not sure
3. *Listeria* biofilms:
   a. Protect the bacterium from sanitizers
   b. Cannot be seen by the naked eye
   c. Can transfer bacteria into food and food contact surfaces
   d. All the above
   e. Not sure
4. *Listeria* may be found in:
   a. Soil, air, water, plants and animals
   b. Drains, grease traps, meat slicers
   c. Refrigerated ready-to-eat (RTE) foods
   d. All the above
   e. a & b only
   f. Not sure
5. Mixers, slicers and food processors should be cleaned and sanitized:
   a. After each use or between each food item change
   b. Once a week
   c. Never
   d. Both a & b
   e. Not sure
6. Refrigerated ready-to-eat food products are most likely implicated with *Listeria monocytogenes* because:

    a. *Listeria* can contaminate these foods during post-cooking handling
    b. *Listeria* can grow and multiply in foods during refrigeration storage
    c. Some refrigerated foods may not require further heating before serving
    d. All the above
    e. Only a & c
    f. Not sure
7. Which statement is <u>incorrect</u> about *Listeria*?
    a. *Listeria* can survive but not grow at freezing temperature (0˚F)
    b. *Listeria* can tolerate acidic environments when kept at low temperatures
    c. Proper cooking destroys *Listeria*
    d. Vacuum packaging allows the growth of *Listeria*
    e. When *Listeria* produces biofilms the risk of contamination decreases
    f. Not sure
8. The recommended safe storage time for opened packages of lunch meat is:
    a. ≤ 4 days
    b. 7 days
    c. 14 days
    d. Not sure
9. Factor(s) that contribute to *Listeria* contamination is-(are):
    a. Cross-contamination
    b. Improper time and temperature control
    c. Improper cleaning and sanitizing
    d. All the above
    e. a & b above
    f. Not sure
10. The first principle of HACCP is conducting a hazard analysis.
    a. True
    b. False
    c. Not sure

11. What is the <u>highest</u> acceptable receiving temperature for fluid milk?
    a. 32˚F
    b. 55˚F
    c. 41˚F
    d. 45˚F
    e. Not sure
12. What is the <u>warmest</u> acceptable receiving temperature for fresh cut tomatoes and cut melons?
    a. 32˚F

b. 41˚F
c. 45˚F
d. 50˚F
e. Not sure

13. Which of the following factors increases the likelihood that a menu item has a food safety hazard that must be controlled? **(circle all that apply)**
    a. Food is cooked, then cooled before serving
    b. Food is handled by several workers
    c. Food is purchased ready-to-eat and does not require refrigeration
    d. Food is purchased as a refrigerated ready-to-eat item
    e. Food that requires multi-preparation steps
    f. Not sure
14. Cold hot dogs should be reheated to what temperature to be considered safe for elderly to eat?
    a. 135˚F for 15 seconds
    b. 145˚F for 15 seconds
    c. 155˚F for 15 seconds
    d. 165˚F for 15 seconds
    e. 180˚F for 15 seconds
    f. Not sure
15. *Listeria* can be prevented through:
    a. Purchasing foods from reputable suppliers
    b. Heating luncheon meat and hot dogs to 165˚F or until steaming hot
    c. Monitoring the storage time and temperature of refrigerated RTE foods
    d. Preventing cross-contamination
    e. All the above
    f. Not sure
16. Equipment and utensils that are in constant use should be cleaned and sanitized:
    a. Every 4 hours
    b. Once per shift
    c. Once per day
    d. Every 8 hours
    e. Not sure
17. *Listeria* can grow on spills in the refrigerator.
    a. True
    b. False
    c. Not sure

18. How long should foodhandlers scrub their hands to ensure proper washing?

a. 2-3 seconds
b. 5-10 seconds
c. 10-15 seconds
d. 15-20 seconds
e. Not sure

19. Other foodborne pathogen(s) of particular importance to elderly is (are):
    a. *Salmonella* spp.
    b. *E. coli* O157 :H7
    c. Noroviruses
    d. Only a & c
    e. All of the above

20. Which statement is <u>incorrect</u> about food irradiation:
    a. Irradiation makes foods radioactive
    b. Foods approved for irradiation are poultry, red meat, spinach and spices
    c. The energy source of irradiation is usually gamma rays or electron beam
    d. Irradiation kills bacteria like *Listeria*, *Salmonella* and *E. coli* O157:H7
    e. Irradiation causes a small loss in nutritional value of foods

Thank you!

APPENDIX G
Final Knowledge Questionnaire

1. **So that no personal names will be used, please create your own identification code following the instructions below. For example, if your mother's name is Emily and you were born on August 24, your ID code would be EM-08-24.**

   Enter the first two letters of your MOTHER'S first name: __ __
   Enter the month you were born: __ __
   Enter the day of your birth: __ __

2. ***Listeria monocytogenes* can grow and multiply at refrigeration temperature (<40˚F).**
   a. **True**
   b. False
   c. Not sure

3. ***Listeria* biofilms:**
   a. Protect the bacterium from sanitizers
   b. Cannot be seen by the naked eye
   c. Can break off and transfer bacteria to food and food contact surfaces
   d. **All the above**
   e. Only a & b above
   f. Not sure

4. ***Listeria* may be found in:**
   a. Soil, water, plants and animals
   b. Drains, grease traps, meat slicers
   c. Refrigerated ready-to-eat foods
   d. **All the above**
   e. Not sure

5. **Refrigerated ready-to-eat food products are most likely to be implicated with *Listeria monocytogenes* because:**
   a. *Listeria* can contaminate these foods during post-cooking handling
   b. *Listeria* can grow and multiply in foods during refrigeration storage
   c. Some refrigerated ready-to-eat foods may not require further heating before serving
   d. **All the above**
   e. Only a & c above
   f. Not sure

6. **Which statement is <u>incorrect</u> about *Listeria*?**

a. *Listeria* can survive but not grow at freezing temperature (0˚F)

b. *Listeria* can tolerate acidic environments when kept at low temperatures
c. Proper cooking destroys *Listeria*
d. Vacuum packaging allows the growth of *Listeria* in long term refrigeration storage
e. **When *Listeria* produces biofilms the risk of contamination decreases**
f. Not sure

7. *Listeria* can grow on food spills in the refrigerator, causing potential cross-contamination to other foods.
a. **True**
b. False
c. Not sure

8. The recommended safe refrigerated storage time for opened packages of hot dogs and lunch meat served to the elderly is:
a. **4 days or less**
b. 7 days
c. 14 days
d. Not sure

9. What is the <u>warmest</u> acceptable receiving temperature for fluid milk?
a. 32˚F
b. 55˚F
c. **41˚F**
d. 45˚F
e. Not sure

10. Which of the following factors does <u>not increase</u> the likelihood that a menu item has a food safety hazard that must be controlled:
a. Food is cooked, then cooled before serving
b. **Food is purchased ready-to-eat and does not require refrigeration**
c. Food is prepared in advance, then stored in the refrigerator
d. Food requires several preparation steps prior to serving
e. All the above
f. Not sure

11. Cold hot dogs should be reheated to what temperature for 15 seconds to be considered safe for the elderly to eat?

a. 135˚F
b. 145˚F
c. 155˚F
d. **165˚F**
e. 180˚F
f. Not sure

12. *Listeria* can be prevented through:

a. Purchasing foods from reputable suppliers
b. Frequent cleaning and sanitizing
c. Monitoring the storage time and temperature of refrigerated RTE foods
d. Preventing cross-contamination
e. **All the above**
f. Not sure

13. Which of the following factors impact the effectiveness of sanitizers?

a. Temperature of the solvent
b. pH of the water
c. Concentration of the sanitizing solution
d. **All the above**
e. Only a & c above
f. Not sure

14. Which statement is <u>incorrect</u> about food irradiation?

a. **Irradiation makes foods radioactive**
b. Foods approved for irradiation include poultry, red meat, spinach and spices
c. The energy source of irradiation is usually gamma rays or electron beams
d. Irradiation kills bacteria like *Listeria*, *Salmonella* and *E. coli* O157:H7
e. Irradiation causes a small loss in nutritional value of foods
f. Not sure

APPENDIX H
Demographic Questions

Now we would like you to answer a few questions to help us better understand our participants for reporting purposes.

1. **Number of years employed in dietary services serving an elderly population?**
   _____ 0-5 years
   _____ 6-15 years
   _____ 16-25 years
   _____ 25+ years
   _____ I choose not to answer this question

2. **Type of facility in which you are employed:**
   _____ Skilled Nursing or Rehab Facility
   _____ Senior Living Community (Assisted and independent living)
   _____ Senior Center/ Congregate meal site
   _____ Hospital
   _____ Other (please list) ________________________
   _____ I choose not to answer this question

3. **Please check any of the following certifications you have completed:**
   _____ Board-Certified Dietary Manager (CDM, CFPP)
   _____ Registered Dietary Technician (DTR)
   _____ Registered Dietitian (RD)
   _____ ServSafe® Food Protection Manager Certification- National Restaurant Association
   _____ Certified Professional-Food Safety (CP-FS) sponsored by National Environmental Health Association (NEHA)
   _____ Professional Food Manager Certification-National Registry of Food Safety Professionals®
   _____ ServSafe® Starters Employee Training- National Restaurant Association
   _____ Other safe food handler training: list:_____________________
   _____ I choose not to answer this question

4. **Do your job responsibilities include a supervisory or managerial role (responsible for supervising the daily operation of dietary services)?**
   ____ No
   ____ Yes
   ____ I choose not to answer this question

5. **What is the highest level of education you have received?**
   ____ Some high school

_____ High school graduate or GED
_____ 1-2 years college and/or technical school
_____ 4 year college degree (bachelor) or higher
_____ Other (please list) ________________________________
_____ I choose not to answer this question

Thank you!

APPENDIX I
Course Evaluation Instrument

Now please circle the response that best describes your opinion to the right of each question below.

	Strongly Agree	**Agree**	**Neutral**	**Disagree**	**Strongly Disagree**
15. I gained new and useful information from taking this course.	________	________	________	________	________
16. As a result of viewing this web module, I am better able to recognize food safety risks affecting the frail elderly.	________	________	________	________	________
17. Participating in this web module was a convenient way to earn continuing education credits.	________	________	________	________	________
18. The level of difficulty was appropriate for a professional continuing education course.	________	________	________	________	________
19. I plan to use this information in training others.	________	________	________	________	________
20. I would recommend this training module to others.	________	________	________	________	________

APPENDIX J
Listeria Fact Sheet

Listeriosis

by H. Thigeel, P. Kendall and M. Bunning[1]

Quick Facts...

- Listeriosis is a life-threatening disease for individuals with compromised immune systems.
- *Listeria* not only survives but can grow at refrigeration temperatures.
- Refrigerated ready-to-eat (RTE) foods are commonly linked to listeriosis outbreaks.
- Proper storage and handling of refrigerated RTE foods is one way to control *Listeria*.

What is Listeriosis?

Listeria monocytogenes causes listeriosis, a rare disease but one with serious consequences. This disease occurs in a variety of animals, including humans. Organs that may be affected by listeriosis include the uterus during pregnancy, the central nervous system, and the blood stream. Infection with *Listeria* is life-threatening and primarily affects newborn infants, pregnant women, the elderly and those with compromised immune systems. The death rate among these individuals from listeriosis is high, from 20% to 30%.

Disease Characteristics

Listeria monocytogenes causes two forms of listeriosis: non-invasive gastrointestinal listeriosis and invasive listeriosis. In immune-competent individuals, non-invasive listeriosis develops as a typical gastrointestinal illness with fever. In immune-compromised individuals such as the elderly and patients receiving immunosuppressive drugs, listeriosis can cause septicemia or meningoencephalitis. Fever is generally present in patients with bacteremia. Other nonspecific flu-like symptoms such as fatigue, abdominal pain, and nausea may also occur. Invasive listeriosis can also be acquired by the fetus from its infected mother via the placenta.

Organism Characteristics

Listeria monocytogenes is a hardy bacterium which has several unique survival characteristics compared to other microorganisms that cause foodborne disease. *Listeria* is widely distributed in nature and can be found in/on soil, stale water supplies, silage, dust, plants and animals.

Factors that increase *Listeria*'s threat to human health are its ability to:

- Grow at refrigeration temperatures, 32˚F and above.
- Grow in an acidic (as low as 4.4 pH) or basic (as high as pH 9.6) environment.
- Tolerate low moisture environments; it has been detected in hard fermented salami.
- Grow under anaerobic conditions at refrigeration temperatures. This property makes *Listeria* a potential threat to the safety of foods packaged under vacuum or modified atmospheres as the growth of this microorganism is not inhibited in vacuum packaged food items.
- Grow at extremely high salt concentrations, especially at refrigerator temperatures. It has been detected in commercial cheese brines. Thus, cheese brines should be considered as potential sources for cross-contamination.
- Attach to a wide variety of surfaces, including stainless steel, glass, wood, porcelain, iron, plastic, polyester, propylene, rubber, waxed cardboard, and paper. Attachment of *Listeria* to a solid surface may be followed by the formation of extracellular polysaccharide layers, called biofilms, which serve as physical barriers to protect the bacteria within them. *Listeria* biofilms cannot be seen with the naked eye. Once they are formed, they can be very difficult to remove. Due to *Listeria*'s ability to attach to different surfaces, packaging materials can be a potential source of contamination.

Foodborne Listeriosis

Within the last 25 years, food has been recognized as a primary mode of transmission of *Listeria monocytogenes* in humans. Several foodborne illness outbreaks associated with *Listeria monocytogenes* have been attributed to the consumption of perishable foods that require refrigeration. These foods are often referred to as *refrigerated ready-to-eat* foods because they are designed to be eaten without cooking, like deli salads, luncheon meats and hot dogs. As one example, in 1985, listeriosis was brought to public attention and became a major health concern when an outbreak of 142 cases occurred in California. The majority of cases (65%) involved pregnant women or their offspring, mostly of Hispanic descent. Among the 49 nonpregnant adults infected, nearly all had a known predisposing condition that compromised their immune system. The outbreak was caused by consumption of soft, unripened Mexican-style cheese made with unpasteurized milk.

Listeria is destroyed during the pasteurization process; however, there is potential for post-processing contamination of milk with *Listeria* through contact with unpasteurized (raw) milk or contaminated equipment. Although there is a low rate of consumption of raw milk in the United States where the Federal law requires pasteurization of milk sold through interstate commerce, some states allow the purchase of unpasteurized milk.

Uncooked or undercooked frankfurters have been the cause of many cases of listeriosis in the U.S. In 1988, invasive listeriosis was linked to consumption of contaminated turkey frankfurters. This was the first laboratory-confirmed association of meat and poultry products with invasive listeriosis. The largest listeriosis outbreak in the United States occurred in 1998-1999 due to the consumption of contaminated frankfurters and deli meats. In 2008, deli meats were again implicated in a large outbreak of listeriosis in Canada.

Smoked seafood products also have been associated with listeriosis. Cold smoking of fish and other seafood can result in contamination with *Listeria* as this process has no significant inactivation of the bacteria. Smoked fish and seafood have been linked to several outbreaks, involving such foods as smoked mussels, rainbow trout, smoked salmon, and smoked cod roe.

Vegetables have the potential for contamination with *Listeria* from their growing environment. However, there have been relatively few listeriosis outbreaks associated with vegetables. In 1983 *Listeria monocytogenes* was implicated in a large coleslaw outbreak that occurred in the Canadian Maritime Provinces.

Control and Prevention of Listeria

Since the recognition of food as the primary mode of transmission, a wide variety of food types have been implicated in outbreaks of *Listeria monocytogenes.* These foods are capable of supporting the growth and multiplication of *Listeria*. In fact, many of these foods are cured, pasteurized or cooked in the production process and then exposed to post-processing contamination from the environment. A common characteristic of many implicated foods is that they are refrigerated Ready-to-Eat. Table 1 shows types of foods that are commonly associated with *Listeria* and safety measures consumers should follow to help control *Listeria.*

When purchasing and storing foods, it is important to keep ready-to-eat items separate from uncooked meats and unwashed produce. Read and follow label instructions to "keep refrigerated" and "use by" a certain date. The temperature of your refrigerator should be between 35°F-40°F.

Washing hands well before working with food can help prevent *Listeria* as well as other diseases. Risk of exposure to *Listeria monocytogenes* from cross contamination can also be prevented by thorough cleaning and sanitizing of cutting boards and other kitchen surfaces. Chlorine bleach is a commonly used sanitizer that can be effective against *Listeria monocytogenes*. Use 1 scant teaspoon of chlorine bleach per quart of water to sanitize cleaned surfaces. Two other household products that can be effective against *Listeria* on food contact surfaces are hydrogen peroxide (available in 3% concentration) and white vinegar (available in 5% concentration).

Cooking foods thoroughly destroys *Listeria*. Pregnant women should heat lunch meats and deli meats to steaming hot before eating. This includes packaged lunch meats and those purchased at the deli. You can use a microwave, oven or grill. If you prefer lunch meats cold, they can be heated and then cooled before eating.

Table 1. Food safety tips for preventing listeriosis among high risk individuals.

Food	To reduce risk:
Meats, lunch meats and hot dogs	Heat hot dogs to 165˚F or until steaming hot At risk consumers should not eat fresh pâté or fresh meat spreads; canned pâté or meat spreads are safer. Wrap food well and date packages. Refrigerate meat products as soon as possible after purchasing. Freeze meats, lunch meats and hot dogs that you are not planning to consume within 4 days of purchase or preparation. If opened food can't be frozen or reheated before eating, discard after 4 days in the refrigerator.
Fish and seafood	Do not eat cold smoked fish or raw or undercooked seafood. Instead choose canned fish or fish heated to steaming hot.
Dairy foods	Do not drink raw milk or eat soft cheeses made with raw milk such as queso fresco, Feta, Brie, Camembert and blue-veined cheese. Cream cheese, cottage cheese, and aged cheeses, like cheddar or Swiss are safe to eat.
Deli-style salads	Salads from deli counters are considered risky if made with potentially hazardous ingredients like smoked seafood. Store-bought mayonnaise is safe to use in making salads if properly handled and refrigerated. When buying sliced meats from a deli (such as bologna, roast beef, turkey or ham), ask what the date is on the original packaging before you purchase.
Fruits & Vegetables	Wash all fresh produce well with cold running water before eating. Avoid eating raw sprouts, like alfalfa and radish sprouts. Avoid drinking unpasteurized fruit juices, like raw apple cider.
Leftovers	Refrigerate or freeze cooked leftovers in small, covered shallow containers (2 inches deep or less) within two hours after cooking.

	Use cooked leftovers within 4 days. Don't taste to determine safety. If in doubt, throw it out.

References and Resources

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