

## PART D: SCIENCE BASE

### Section 9: Food Safety

This section addresses two major questions related to food safety, which led to two conclusive statements:

1. What behaviors are most likely to prevent food safety problems? Or, in terms of how food is handled, what behavior(s) are most likely to cause food safety problems (foodborne illness)?

Subsumed under this question were more specific questions, such as “What data are there regarding the effectiveness of bacterial cleansers in preventing foodborne illness?” and “What are the data regarding cleaning fruits and vegetables to reduce the risk of foodborne illness?”

The general search strategy used to find the scientific evidence related to this broad question appears in Part C, Methodology. See the summary table in Appendix G 3 for a table summarizing the findings from a search on hand washing.

As a part of its search, the Committee also collected data related to an educational tool for conveying messages to consumers about safe food handling and preparation. In particular, the Committee obtained information on a national public education campaign called FightBAC! and addressed the following question:

2. What topics, if any, need attention even though they are not an integral part of the “FightBAC!<sup>®</sup>” campaign? (FightBAC! is a national public education campaign to promote food safety to consumers and educate them on how to handle and prepare food safely. In this campaign, pathogens are represented by a cartoon-like bacteria character named “BAC.”)

#### SCOPE OF THE PROBLEM

Foodborne diseases cause approximately 76 million illnesses, 325,000 hospitalizations, and 5,000 deaths in the United States each year (Mead et al., 1999). Known pathogens account for an estimated 14 million illnesses, 60,000 hospitalizations, and 1,800 deaths. Three pathogens—*Salmonella*, *Listeria*, and *Toxoplasma*—are responsible for more than 75 percent of these deaths. Unknown agents account for the remaining 62 million illnesses, 265,000 hospitalizations, and 3,200 deaths. The actual percentage of outbreaks of foodborne illness is likely to be much larger than described above because small outbreaks that occur in homes often are unreported or not investigated (Tauxe, 1991).

Although most foodborne infections cause mild illness, severe infections and serious complications—including death—do occur. As described by the FoodNet Working Group (Angulo et al., 1998), the public health challenges of foodborne diseases are changing rapidly as a result of newly identified pathogens and vehicles of transmission, changes in food production, and an apparent decline in food safety awareness. Americans are exposed to foodborne pathogens from distant parts of the United States and the world. Increased demand for ready-to-eat and minimally processed foods and increased consumption of food in eating establishments outside of the home also have contributed to new exposures to foodborne disease. For example, foodborne disease outbreaks of *Salmonella* and *Escherichia coli* O157:H7 infections have been associated with an increasingly wide variety of foods, including some previously thought to be safe, such as alfalfa sprouts and unpasteurized fruit juice.

## **QUESTION 1: WHAT BEHAVIORS ARE MOST LIKELY TO PREVENT FOOD SAFETY PROBLEMS?**

### **Conclusion**

The behaviors in the home that are most likely to prevent a problem with foodborne illnesses are

- Cleaning hands, contact surfaces, and fruits and vegetables (but not meat and poultry, which should not be washed)
- Separating raw, cooked and ready-to-eat foods while shopping, preparing, or storing
- Cooking foods to a safe temperature
- Chilling (refrigerate) perishable foods promptly

### **Rationale**

#### ***The Four Basic “Fight BAC!” Educational Messages***

The four main messages of the food safety guideline emphasize proper food-handling behaviors (clean, separate, cook, chill) and coincide with the FightBAC! campaign of The Partnership for Food Safety Education, created in 1997 by the U.S. Departments of Agriculture, Education, and Health and Human Services, and 10 food industry organizations ([www.fightbac.org](http://www.fightbac.org)). The FightBAC! messages were developed from a consensus of food safety experts and have been tested for consumer comprehension. Large improvements in consumer food safety practices have been seen since the campaign has been in effect, and a recent survey found that these gains have been maintained or improved for all four food-handling practices (FDA, 2002). A survey of 500 Latino consumers (Dharod et al., 2004) showed that the influence of the FightBAC! campaign is likely to improve food safety awareness and bring about changes in food safety knowledge and attitudes.

Affirmation of the usefulness of the FightBAC! messages was demonstrated by Bryan (1988) who surveyed all the pertinent literature of the time on factors that contribute to outbreaks of foodborne disease. His sources included food surveillance data on foodborne illness submitted to the Centers for Disease Control and Prevention (CDC), surveillance data from health agencies, investigations made by CDC personnel, and

articles published in public health, medical, or food science journals. He ranked the order of practices likely to contribute to foodborne illness as follows

- Improper cooling
- Colonized person handling food (improper hand washing)
- Inadequate cooking
- Failing to avoid cross-contamination

In a viewpoint paper based on data from CDC, Medeiros et al. (2001a) developed food safety consumer education messages as follows

- Primary messages
  - Hand washing
  - Adequate cooking
  - Avoiding cross-contamination
- Secondary messages
  - Keeping food safe to eat
  - Avoiding food from unsafe sources

Using a four-round Delphi technique, Hillers et al. (2003) identified and ranked food-handling and consumption behaviors associated with 13 major foodborne pathogens. They surveyed 40 nationally ranked experts: 11 in food microbiology, 9 in epidemiology, 10 in food safety education, and 10 in food safety policy. Hiller and colleagues concluded that the acts of primary importance in the prevention of foodborne illness were

- Using a thermometer to cook foods adequately
- Hand washing
- Avoiding cross-contamination
- Avoiding certain foods likely to be contaminated

The identification and ranking of the causes of food safety problems and corrective measures above is limited by shortcomings in the source data that result from incomplete and inadequate reporting of outbreaks and incomplete write-up or abstracting of contributing factors. Moreover, in the Hillers et al. (2003) study, some bias could have resulted from the use of expert opinions, processing of the opinions by a research team, and a requirement that respondents respond in fixed ways. Nonetheless, these findings are based on input from geographically dispersed experts and could lead to a clearer understanding of key concepts needed to educate consumers for safer food handling and reducing risks of foodborne illness.

Further affirmation of the FightBAC! messages was presented by Sulka et al. (2003). Contributing factors for *E. Coli* 0157:H7 and *Salmonella enteritidis* outbreaks are listed as inadequate/improper cooking, contamination, pre-harvest contamination, ill food handler, and improper storage or holding of food.

The Committee found evidence to support additional food safety guidance, as summarized below.

### ***The “Clean” Message***

***Hand Washing.*** The Committee identified five useful papers that addressed hand washing. The strongest paper was the double-blind, placebo-controlled study by White et al. (2001), which included structured hand hygiene education. The study assessed whether an alcohol-free hand sanitizer containing the surfactants allantoin and benzalkonium chloride could reduce illness and absenteeism among elementary school children and serve as an effective alternative when regular soap and water hand washing was not readily available. Although the study did not compare the sanitizer to soap and water, the importance of hand washing was evident from the results: after 5 weeks, students using the active product were 35 percent less likely to have been absent because of illness when compared with the placebo group. Although the study lacked a cross-over confirmation and it lost a large portion (55 percent) of the original study participants because of a lack of compliance in many of the study classrooms, this study demonstrated that there are simple ways to overcome obstacles of adequate hand washing, including education. The results demonstrate that there is opportunity for proper hand washing at the school level and, consequently, for improving attendance and promoting the health of students.

Charbanneau and colleagues (2000) provided direct data demonstrating the value of washing hands with a mild soap. They found that 20-second soap-and-water hand washing was more effective than using hand sanitizers containing 70 percent ethanol in eliminating viable bacteria from meat-soiled hands. The Food and Drug Administration (FDA) and the CDC (2004) recommend soap and water cleansing for food handling, noting that alcohols have very poor activity against bacterial spores, protozoan oocysts, and certain nonenveloped viruses.

Further evidence supporting soap-and-water hand washing is provided by a study conducted by Master et al. (1997). When compared with usual hand washing practices, washing the hands a minimum of four scheduled times a day in addition to usual hand washing produced a statistically significant ( $p=0.0024$ ) decrease in the number of absences due to gastrointestinal illness (18.5 days of absence in the hand washing group versus 49 days of absences in the control group). Reported overall illness-related absence was lower but not significantly different. The major limitations of the study include the use of a single institution, the use of a discrete population without socioeconomically diverse backgrounds and lack of double-blindedness.

A study in an adult day care center (Falsey et al., 1999) and another of telephone interviewees (Mead et al., 1997) provide indirect evidence supporting the value of hand washing in the prevention of infections. Although these two studies have some limitations, the authors provide a sound basis for their estimates that thorough hand washing reduces infections by about one-half and one-third, respectively.

These five studies support the inclusion of the detailed hand washing protocol developed by the CDC ([http://www.cdc.gov/ncidod/op/hand\\_washing.htm](http://www.cdc.gov/ncidod/op/hand_washing.htm)) in food safety guidance. In addition, to reduce the risk of cross-contamination, add to the protocol guidance regarding drying hands using a clean disposable or cloth towel.

Box 1. Food Safety

**Hand washing Protocol**

- First, wet your hands and apply liquid or clean bar soap. Place the bar of soap on a rack to drain.
- Next, rub your hands vigorously together and scrub all surfaces.
- Continue for 10 to 15 seconds or about the length of a little tune. It is the soap combined with the scrubbing action that helps dislodge and remove germs.
- Rinse hands well, and dry them using a clean disposable or cloth towel.

(Adapted from Centers for Disease Control and Prevention, An ounce of prevention: keeps the germs away.)

**Washing Fresh Fruits and Vegetables.** Through a systematic search of the literature, the Committee identified 10 relevant articles on washing fruits and vegetables, and experts directed them to additional useful scientific literature (See Summary Table in Appendix G-3). Recent outbreaks of foodborne illness associated with eating fresh produce have heightened concerns that these foods may be an increasing source of illness (Tauxe et al., 1997). Studies have shown that bacteria can survive and/or grow on fresh produce and that fresh produce supports the growth of pathogens such as *E coli O157:H7*, *Salmonella Montevideo*, and *Shigella flexneri* (Li-Cohen and Bruhn, 2002; Li-Cohen et al., 2002). Moreover, some consumers practice unsafe handling of fresh produce (Li-Cohen and Bruhn, 2002).

Consumer surveys demonstrate a growing public concern about food safety and the need for an explanation behind food safety guidance (Li-Cohen et al., 2002). Therefore, consumers should be given clear directions on how to remove pathogens from raw fruits and vegetables. Although washing is only partially effective at removing pathogens from fresh produce, washing is the only method that consumers have to reduce pathogen load on fresh produce (Medeiros et al., 2001b). Food safety information should be simple to read and easy to follow, such as that developed by Li-Cohen et al. (2002). Consumers may be unwilling to adopt safe practices if instructions are too time-consuming or are viewed as costly or inappropriate (Li-Cohen et al., 2002).

Box 2. Food Safety

**Protocol for Washing Fresh Fruits and Vegetables**

1. Remove and discard the outer leaves from vegetables such as lettuce and cabbage before washing
2. Wash fruits and vegetables (including organically grown, farmer's market, and homegrown produce) just before cooking or eating
3. Wash under running potable water
4. When possible, scrub fruits and vegetables with a clean scrub brush or with hands
5. Dry fruits and vegetables

(Adapted from Li-Cohen et al., 2002)

Free moisture on produce may promote survival and growth of microbial populations in an otherwise inhospitable environment (FDA, 2001). Therefore, Step 5 above is critical if the food will not be eaten or cooked right away. Additionally, consumers should read the labels of bagged produce to determine if it is ready-to-eat. Ready-to-eat, prewashed bagged produce can be used without further washing if kept refrigerated and used by the “used-by” date. If desired, prewashed, ready-to-eat produce can be washed again (FDA, 2001).

**Guidance for Safely Using Bagged Produce.**

- Read the labels of bagged produce to determine if it is ready-to-eat
- Ready-to-eat, prewashed bagged produce can be used without further washing if kept refrigerated and used by the “use-by” date
- If desired, prewashed, ready-to-eat produce can be washed again

Use-by dates should be differentiated from purchase-by dates. Products with purchase-by dates can be used after that date; however, products with use-by dates should not be used after the use-by date.

Although some studies have shown that antibacterial agents are proven effective in reducing indigenous flora on produce such as lettuce during food service preparation (Smith et al., 2003), these solutions warrant additional testing and research in household settings.

**Washing Meat and Poultry.** Washing raw poultry and meat creates the danger of cross-contamination and is not necessary because bacteria on the surface of the meat will

be destroyed by cooking. Washing these foods can allow bacteria that is present on the surface of the meat or poultry to spread to other ready-to-eat foods (FSIS, 1999). Washing raw meat and poultry is reported to be one of the most commonly observed food preparation practices that can lead to cross-contamination (presentation to the Partnership for Food Safety Education by Yankelovich Partners, Inc., June 5, 1997). Literature is not available on the effects of washing fish, but it would seem that the same risk for cross-contamination would exist.

**Cleaning Refrigerators.** Cleaning is closely linked with the problem of cross-contamination—the transfer of harmful bacteria to food from other foods, often through an intermediary. Refrigerator surfaces can become contaminated from contact with high-risk foods such as raw meats, poultry, fish, uncooked hotdogs, certain deli meats, or raw vegetables. If not cleaned, affected refrigerator surfaces can, in turn, serve as a vehicle for contaminating other foods.

Even at recommended refrigerator temperatures of 40° F. or lower, foods such as meat, poultry, fish, and cheese made from unpasteurized milk have in common the ability to support the growth of the bacterium *Listeria monocytogenes* during extended refrigerated storage (HHS/USDA, 2003). Ingesting food contaminated with this organism can be the source of very serious foodborne illness in high-risk populations (See Table E 26. In a refrigerator that is not kept clean, for example, if the liquid from uncooked hotdogs contains *Listeria monocytogenes* and it contaminates refrigerator surfaces, foods coming in contact with those surfaces may become unsafe to eat (Byers et al., 1994).

Although other pathogenic organisms grow very slowly at recommended refrigerator temperatures, cross-contamination that occurs in the refrigerator can lead to foodborne illness, especially if combined with other unsafe food practices such as allowing the food to stand at room temperature before eating or heating the food inadequately. An emphasis on cleaning refrigerators is consistent with the contribution that cross-contamination makes to foodborne illness, as reported by Sulka et al. (2003).

### ***Minimizing the Refrigerator as a Source of Cross-Contamination.***

- The refrigerator should be cleaned regularly, including the washing of shelf surfaces and drawers
- Liquids should not be allowed to drip or spill from higher refrigerator shelves onto lower shelves; wipe up spills immediately – clean surfaces thoroughly with hot, soapy water; then rinse
- Liquids from foods such as hot dogs and luncheon meats should not be allowed to come in contact with other foods or surfaces after the package is opened (USDA, 2004)

### ***The “Separate” Message***

Bacterial contamination in raw meat and poultry juices, produce, perishable ready-to-eat foods, and cooked foods can be spread to other foods, utensils, and surfaces. Its relationship with the “clean” message is discussed briefly above.

### **The “Chill” Message**

Based on discussion with food safety experts and Bryan’s analysis (Bryan, 1988), the Committee recognized the value of including more than one "chill" step in the FightBac! sequence (e.g., clean, separate, chill, cook, chill). Chilling provides substantial protection at any stage of food handling during which raw foods are not being cleaned or cooked.

### **The “Cook” Message**

Consumers make many food-handling errors during food preparation that increase their risk of foodborne illness. Furthermore, very few consumers use a food thermometer and they frequently undercook meat and poultry (Anderson et al., 2004). The best way to tell if meat, poultry, or egg dishes are cooked to a safe temperature is to use a thermometer. The U.S. Department of Agriculture (USDA) and the Food and Drug Administration (FDA) summarize the following recommendations for cooking safely:

A thermometer is used to measure the internal temperature of cooked meat and poultry and egg dishes to make sure that the meat or dish is cooked all the way through. Minimum safe internal temperatures are as follows:

- roasts and steaks—145°F
- whole poultry—180°F
- ground meat (since bacteria can spread during grinding) —160°F
- leftovers—165°F
- sauces, soups and gravy— 160°F
- egg dishes—160°F

If using a microwave oven, care is needed to be sure that all parts of the food reach the specified temperature.

Information from the CDC links eating undercooked, pink ground beef with a higher risk of illness. If a thermometer is not available, it is advisable not to eat ground beef that is still pink inside. Cook fish until it is opaque and flakes easily with a fork.

In 1996 to 1997, FoodNet, a collaborative program among the CDC, USDA, FDA, and selected State health departments, conducted a telephone survey of 7,493 adults in 5 states (California, Connecticut, Georgia, Minnesota, Oregon) to determine the prevalence of risk factors of foodborne illness. Results indicated that undercooked eggs (runny eggs) were the most commonly consumed high-risk food, eaten by 19 percent of the respondents in the 5 days before the interview. The researchers concluded that health education should emphasize the importance of cooking eggs well in order to prevent salmonellosis.

## **QUESTION 2: WHAT TOPICS, IF ANY, NEED ATTENTION EVEN THOUGH THEY ARE NOT AN INTEGRAL PART OF THE “FIGHTBAC!” CAMPAIGN?**

### **Conclusion**

Avoiding higher-risk foods is an important protective measure (e.g., deli meats and frankfurters that have not been reheated to a safe temperature may contain *Listeria*). This is especially important for high-risk groups (the very young, pregnant women, elderly and those who are immunocompromised).

## Rationale

Potentially unsafe foods fall in three categories: those having been stored in a manner or for a period of time that would allow dangerous growth of bacteria, foods at high risk for contamination by *Listeria*, and fish exposed to methylmercury.

### *Improperly Stored Foods*

Not all bacterial growth causes a food's surface to discolor or smell bad. For example, Larson and Johnson (1999) reported that botulinal toxin formation occurred before overt spoilage occurred in cubed, packaged melons. Similarly, Lubin and colleagues (1985) found that hard-cooked eggs that contained toxins did not always produce unacceptable odors or a change in appearance that was detected. When there is any doubt about the safety of fresh or leftover foods, for example, when refrigerated leftovers have been stored for 3 to 4 days, it is advisable to discard them safely, not to taste them.

### *Listeriosis, Those at High Risk, and High-Risk Foods*

A recent quantitative risk assessment documents the importance of addressing risks associated with the widely occurring bacterium *Listeria monocytogenes* (HHS/USDA, 2003). Listeriosis (the most serious illness induced by this pathogen) occurs rarely (i.e., currently approximately 3.4 cases per million people annually). When it does occur, however, it can be life threatening. Two population groups (pregnant women and their fetuses and elderly and other individuals who have a pre-existing illness that reduces the effectiveness of their immune system) are especially susceptible to potentially life-threatening human illness from listeriosis. In healthy people, the microorganism usually causes only a noninvasive gastrointestinal illness, with symptoms including fever, vomiting, and/or diarrhea (HHS/USDA, 2003).

Of the foodborne pathogens tracked by CDC, *Listeria monocytogenes* had the second highest case fatality rate (21 percent) and the highest hospitalization rate (90.5 percent). If a pregnant woman develops listeriosis, her fetus also becomes exposed. Fetal infection can lead to fetal death, premature birth, or neonatal illness and death. Other people with impaired T-cell immunity (immunocompromised patients and elderly) also are especially vulnerable to the high lethality of listeriosis (Rocourt et al., 2003).

Most prenatal cases of listeriosis are reported in the third trimester (Slutsker and Schuchat, 1999). A few days after the onset of symptoms, a pregnant woman may abort the fetus or have premature delivery (Gellin and Broome, 1989). Late in the pregnancy, listeriosis may result in stillbirth or birth of a critically ill newborn. Listeriosis in the first trimester may result in spontaneous abortion.

Foods that pose high risk for listeriosis have all the following properties: (1) relatively high rates of contamination with *L. monocytogenes*, (2) characteristics that support the growth of *L. monocytogenes* to high numbers when refrigerated, (3) ready-to-eat, and (4) commonly stored for extended periods (HHS/USDA, 2003). Two food categories—deli meats (excluding those that are very salty, such as some ham, or low in water activity, such as hard salami) and frankfurters that have not been reheated to a safe temperature—have been categorized as *very high risk* for listeriosis. According to the Quantitative

Assessment (HHS/USDA, 2003), this risk designation is consistent with the need for immediate attention for reducing the incidence of foodborne listeriosis. Addressing this risk in dietary guidance would be consistent with the position of Medeiros and colleagues (2001a; 2001b) that food safety education programs ensure that messages are aimed at reducing the risk of the most prevalent and/or serious causes of foodborne illness.

A report from the International Life Sciences Institute (ILSI) Risk Science Institute Expert Panel (2004) recommends that high-risk individuals (i.e., the elderly, pregnant women, and most immunocompromised people) should be given specific information on high-risk foods that they should avoid, and strategies to reduce their risk, such as thorough cooking, avoidance of cross-contamination and short-term refrigerated storage of cooked, perishable foods.

### ***Methylmercury in Fish***

Methylmercury is a heavy metal toxin found in varying levels in different types of fish. This toxin can cause neurological harm to fetuses and young children, whose brains are still developing. Mahaffey and colleagues (2004), using blood methylmercury data and fish intake data from the 1999–2000 *National Health and Nutrition Examination Survey*, estimated *in utero* methylmercury concentrations of newborns. They estimated that more than 300,000 U.S. newborns each year may have been exposed to methylmercury concentrations higher than those considered to be without increased risk of adverse neurodevelopmental effects. The FDA released an advisory in March 2004 (U.S Food and Drug Administration, 2004) for women and young children, developed jointly with the Environmental Protection Agency, that provides guidance on how to receive the benefits of eating fish while being confident that exposure to the harmful effects of mercury is very low. The advisory warns against eating shark, swordfish, king mackerel, or tilefish because these fish contain high levels of mercury. Instead, the advisory recommends that women eat up to 12 ounces per week of a variety of fish and shellfish that are lower in mercury (e.g., shrimp, canned light tuna, salmon, pollock, and catfish). Since albacore ("white") tuna is commonly eaten and has more mercury than canned light tuna, women are advised to limit their intake to 6 ounces of albacore tuna per week. The advisory calls for smaller portions of these fish for young children. Advice also is provided about fish from local waters.

Schober et al. (2003) found that measures of mercury exposure in women of childbearing age and in young children generally fall below levels of concern. They recommend that women who are pregnant or who intend to become pregnant follow Federal and State advisories on consumption of fish. Because of wide variations in the concentrations of mercury in different kinds of fish and shellfish, it is possible to have the nutritional benefits of moderate fish consumption and avoid fish high in mercury (Schober, 2003).

### **SUMMARY**

Taking four basic food safety measures can help consumers protect against foodborne illness. These measures include cleaning hands, contact surfaces, and fruits and vegetables; separating raw, cooked, and ready-to-eat foods while shopping, preparing, or storing; cooking foods to a safe temperature; and chilling perishable foods promptly. In addition, avoiding higher risk foods (such as frankfurters that have not been reheated to a

safe temperature) is an important protective measure, especially for high-risk groups (the very young, pregnant women, the elderly, and those who are immunocompromised).

## REFERENCES

Anderson JB, Shuster TA, Hansen KE, Levy AS, Volk A. A camera's view of consumer food-handling behaviors *Journal of the American Dietetic Association* 104:186-191, 2004.

Angulo F, Voetsch A, Vugia D, Hadler J, Farley M, Hedberg C, Cieslak P, Morse D, Dwyer D, Swerdlow D. FoodNet Working group. Determining the Burden of Human Illness from foodborne diseases: CDC's Emerging Infectious Disease Program Foodborne Disease Active Surveillance Network (FoodNet). *Veterinary Clinics of North America: Food Animal Practice* 14: 165-172, 1998.

Bryan, F.L. Risks of practices, procedures and processes that lead to outbreaks of foodborne diseases. *Journal of Food Protection* 51: 663-673, 1988.

Burnett SL, Beuchat LR. Human pathogens associated with raw produce and unpasteurized juices, and difficulties in decontamination. *Journal of Industrial Microbiology and Biotechnology* 27(2):104-110, 2001.

Byers BA, Shanklin CW, Hoover LC. 1994. *Food Service Manual for Health Care Institutions*, American Hospital Association Publishing Co.

Centers for Disease Control and Prevention, An ounce of prevention: keeps the germs away. Available at: [www.cdc.gov/ncidod/op/hand\\_washing.htm](http://www.cdc.gov/ncidod/op/hand_washing.htm). Accessed February, 09, 2004.

Charbonneau DL, Ponte JM, Kochanowshi, BA. A method of assessing the efficiency of hand sanitizers: use of real soil encountered in the food service industry. *Journal of Food Protection* 63: 495-501, 2000.

Dharod, JM, Perez-Escamilla R, Bermudez-Millan A, Segura-Perez S, Damio G. Influence of the Fight BAC! Food Safety Campaign on an urban Latino population in Connecticut. *Journal of Nutrition Education and Behavior* 36:128-134, 2004.

Falsey AR, Criddle MM, Kolassa JE, McCann RM, Brower CA, Hall WJ. Evaluation of a hand washing intervention to reduce respiratory illness rates in senior daycare centers. *Infect Control Hosp. Epidemiol* 20:200-2, 1999.

Food and Drug Administration (FDA) Center for Food Safety and Applied Nutrition. Analysis and Evaluation of Preventive Control Measures for the Control and Reduction/Elimination of Microbial Hazards on Fresh and Fresh-Cut Produce. September 30, 2001. Available at: [www.cfsan.fda.gov/~comm/ift3-toc.html](http://www.cfsan.fda.gov/~comm/ift3-toc.html). Accessed February 10, 2004.

Food and Drug Administration (FDA) and Centers for Disease Control and Prevention (CDC). 2003. Hand hygiene in retail and food service establishments, May. FDA Consumer Survey, 2001.

Food and Drug Administration (FDA). March 19, 2004. FDA and EPA announce the revised consumer advisory on methylmercury in fish. Available at [www.fda.gov/bbs/topics/news/2004/NEW01038.html](http://www.fda.gov/bbs/topics/news/2004/NEW01038.html). Accessed: March 19, 2004.

Food and Drug Administration (FDA). Food Safety Survey: Summary of Major Trends in Food Handling Practices and Consumption of Potentially Risky Foods, U.S. Food and Drug Administration, Center for Food Safety and Applied Nutrition, Consumer Studies Branch, August 27, 2002. Available at: [www.cfsan.fda.gov/~dms/fssurvey.html](http://www.cfsan.fda.gov/~dms/fssurvey.html). Accessed on July 9, 2004.

Gellin, BG, Broome, CV. Listeriosis. *Journal of the American Medical Association*. 262 (12) 1313-1320, 1989.

Health and Human Services (HHS) and US Department of Agriculture (USDA). Quantitative Assessment of the Relative Risk to Public Health From Foodborne *Listeria monocytogenes* Among Selected Categories of Ready to Eat Foods. 2003 HHS/USDA, Available at: [www.foodsafety.gov/~dms/lmr2-toc.html](http://www.foodsafety.gov/~dms/lmr2-toc.html). Accessed on January 9, 2004.

Hillers VN, Medeiros LC, Kendall P, Chen G, DiMascola S. Consumer food-handling behaviors associated with prevention of 13 foodborne illnesses. *Journal of Food Protection* 66(10):1893-1899, 2003.

ILSI Risk Science Institute. Achieving Continuous Improvement in Reductions in Foodborne Listeriosis – A Risk Based Approach. A Report from the ILSI Expert Panel on *Listeria monocytogenes* in Foods. 2004. Washington, DC. Available at: [www.ilsi.org/publications/pubslst.cfm?publicationid=541](http://www.ilsi.org/publications/pubslst.cfm?publicationid=541). Accessed June 28, 2004

Larson A, Johnson E. Evaluation of botulinal toxin production in packaged fresh-cut cantaloupe and honeydew melons. *Journal of Food Protection* 62(8):948-53, 1999.

Larson EL, Lin SX, Gomez-Pichardo C, Della-Latta P. Effect of antibacterial home cleaning and hand washing products on infectious disease symptoms. *Annals of Internal Medicine* 140(5):321-329, 2004.

Li-Cohen AE, Bruhn CM. Safety of consumer handling of fresh produce from the time of purchase to the plate: a comprehensive consumer survey. *Journal of Food Protection* 65(8):1287-1296, 2002.

Li-Cohen AE, Klenk M, Nicholson Y, Harwood J, Bruhn CM. Refining consumer safe handling educational materials through focus groups. *Dairy, Food and Environmental Sanitation* 22(7):539-551, 2002.

Lubin, LB, Morton, RD, Bernard, DT. Toxin Production in Hard-Cooked Eggs Experimentally Inoculated with *Clostridium Botulinum*. *Journal of Food Science* (50)969-984, 1985.

Master D, Hess Longe SH, Dickinson H. Scheduled hand washing in an elementary school population. *FamilyMedicine* 29(5):336-339, 1997.

Mahaffey KR, Clickner RP, Bodurow CC. Blood organic mercury and dietary mercury intake: national health and nutrition examination survey, 1999 and 2000 *Environmental Health Perspectives* 112(5):562-70, 2004.

Mead PS, Finelli L, Lambert-Fair MA, Champ D, Townes J, Hutwagner L, Barrett T, Spitalny K, Mintz E. Risk factors for sporadic infection with *Escherichia coli* O157:H7. *Archives of Internal Medicine* 157; 204-208, 1997.

Mead P, Slutsker L, Dietz A, McCaig L, Bresee J, Shapiro C, Griffin P, Tauxe R. Food-related illness and death in the United States *Emerging Infectious Diseases* 5(5):607-625, 1999.

Medeiros LC, Kendall PA, Hillers VN, Chen G, Dimascola S. Identification and classification of consumer food-handling behaviors for food safety education *Journal of the American Dietetic Association* 101(11):1326-1339, 2001.

Medeiros LC, Hillers VN, Kendall PA, Mason A. Food safety education: what should we be teaching to consumers? *Journal of Nutrition Education and Behavior* 33(2):108-113, 2001.

The Partnership for Food Safety Education. Four Steps to FightBAC! Available at: [www.fightbac.org/main.cfm](http://www.fightbac.org/main.cfm). Accessed June 22, 2004.

Rocourt J, BenEmbarek P, Toyofuku H, Schlundt J. Quantitative risk assessment of *Listeria monocytogenes* in ready-to-eat foods: the FAO/WHO approach. *FEMS Immunology and Medical Microbiology* 35(3):263-267, 2003.

Schober SE, Sinks TH, Jones RL, Bolger PM, McDowell M, Osterloh J, Garrett ES, Canady RA, Dillon CF, Sun Y, Joseph CB, Mahaffey KR. Blood mercury levels in US children and women of childbearing age, 1999-2000. *Journal of the American Medical Association* 289(13):1667-1674, 2003.

Slutsker, L, Schuchat AI. 1999. Listeriosis in humans, Pages 75-95 in E.T. Ryser and E.H. Marth, Eds. *Listeria, Listeriosis and Food Safety*. Food Science and Technology. New York, Marcel Dekker, Inc.

Smith S, Dunbar M, Tucker D, Schaffner DW. Efficacy of a commercial produce wash on bacterial contamination of lettuce in a food service setting. *Journal of Food Protection* 66(12):2359-2361, 2003.

Sulka AC, Tucker N, Fry A, Mead P. Contributing factors of foodborne disease outbreaks: lessons learned from the food borne outbreak reporting systems. *Journal of Food Protection* 66(Suppl A) 72, 2003.

Tauxe, RV. Salmonella: a postmodern pathogen. *Journal of Food Protection*. 54:563-568, 1991.

Tauxe R, Kruse H, Hedberg C, Potter M, Madden J, Wachsmuth K. Microbial hazards and emerging issues associated with produce: a preliminary report to the national advisory Committee on microbiologic criteria for foods *Journal of Food Protection* 60:1400-1408, 1997.

U.S. Department of Agriculture (USDA). Food Safety and Inspection Service, Food Safety Fact Sheet, Does washing food promote food safety? 1999. Available at: [www.fsis.usda.gov/OA/pubs/washing.htm](http://www.fsis.usda.gov/OA/pubs/washing.htm). Accessed on May 1, 2004.

U.S. Department of Agriculture (USDA). Food Safety and Inspection Service, Food Safety Fact Sheet, Keeping the Refrigerator Clean. Available at: [www.fsis.usda.gov/factsheets/refrigeration\\_&\\_food\\_safety/index.asp](http://www.fsis.usda.gov/factsheets/refrigeration_&_food_safety/index.asp). Accessed on May 1, 2004.

White C, Shinder F, Shinder A, Dyer D. Reduction of illness absenteeism in elementary schools using an alcohol-free instant hand sanitizer. *Journal of School Nursing* 17(5): 258-265, 2001.

Yankelovich Partners, Inc. Presentation—Partnership for Food Safety Education Focus Group Findings, Food Safety Awareness Campaign, June 5, 1997.