Position of the American Dietetic Association: Food and water safety

ABSTRACT

It is the position of the American Dietetic Association that the public has the right to a safe food and water supply. The Association supports collaboration among dietetics professionals, academics, representatives of the agriculture and food industries, and appropriate government agencies to ensure the safety of the food and water supply by providing education to the public and industry, promoting technologic innovation and applications, and supporting further research. Numerous bacterial, viral, and chemical food and water threats exist with certain populations such as the elderly, children, pregnant women, those in institutionalized settings, and the immune compromised being at high risk. Recent outbreaks of food and waterborne disease and threats of bioterrorism have focused attention on the safety of US food and water systems. The US government and other entities have developed programs to address challenges associated with maintaining food and water safety. Safety initiatives such as the Pathogen Reduction/Hazard Analysis Critical Point (HACCP), revisions to the Food Code, and the National Primary Drinking Water Regulations provide a framework to evaluate current and future challenges to the safety of food and water systems. Dietetics professionals should take a proactive role in ensuring that appropriate food and water safety practices are followed and can also assume major roles in food and water safety education and research. *J Am Diet Assoc. 2003;103:1203-1218.*

POSITION STATEMENT

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GENERAL OVERVIEW AND RATIONALE: FOOD AND WATER SAFETY ISSUES

Scope of the Problem

It is estimated that, on an annual basis, there are 76 million cases of foodborne illness in the United States (1,2). Each year, 5,000 people die from foodborne illnesses (1,2), and there are 325,000 food-related hospitalizations (1,2). In 2000, there were 1,417 foodborne disease outbreaks reported to the Centers for Disease Control and Prevention (CDC), with bacterial diseases accounting for the majority of these outbreaks (3). Viral etiology (176 outbreaks) was the next most common, with chemical etiology confirmed in 37 outbreaks and parasitic etiology in six (3). In 1999-2000, there were 39 outbreaks of disease reported in association with US drinking water, and 20 of these were related to bacterial, parasitic, or viral pathogens (4).

Foodborne illness carries a significant economic cost for the United States. Hospitalization is estimated to cost $3 billion annually, with lost productivity costs estimated to range between $20 and $40 billion dollars per year (1). The economic impact of foodborne illnesses encompasses numerous factors, which include the following: costs associated with investigation of foodborne outbreaks, treatment costs, employer costs related to lost worker productivity, and food industry losses because of low sales and lower stock prices (5). Additional economic and social costs arise from secondary illnesses and complications estimated to occur in conjunction with one to three percent of foodborne illnesses (6).

The US government recently reported that incidence of several bacterial foodborne illnesses has declined substantially since 1996 (7-9). These declines were attributed to increased

0002-8223/03/10309-0015$30.00/0
doi: 10.1053/jada.2003.50593

government commitment to food safety (7,9). Specifically noted as factors were the implementation of the Pathogen Reduction/ Hazard Analysis and Critical Control Points (HACCP) regulations, egg quality assurance programs, greater emphasis on fresh produce safety, technologic advances designed to reduce contamination, greater emphasis on food safety education, and greater regulation to increase the safety of imported foods (9). Factors cited as potentially contributing to foodborne illness incidence in the 21st century include globalization of the food supply, new methods of food production and distribution, and increased reliance on commercial food sources (10).

In addition to concern about food safety, there is also societal concern about water safety. There are 54,000 community water systems (systems providing water for a permanent population year round) producing water for all purposes including drinking, bathing, and food preparation, resulting in an average per person consumption of 100 gallons per day (11,12). In recent years, public concern about the safety of water has grown because of chemical and biologic contaminants. The 1993 outbreak of cryptosporidiosis in Milwaukee brought the importance of water safety to the forefront (13). According to a survey conducted by the Water Quality Association, 60% of US adults believe the quality of their drinking water affects their health, and 75% have some concerns about the quality of their household water supply (14).

Media Coverage of Food and Water Safety

Several major outbreaks of foodborne illness such as bovine spongioform encephalopathy or Mad Cow Disease (15,16) and *E. coli* 0157:H7 infection (17) have continued to keep food and water safety issues in the eye of the United States public. The media's coverage of foodborne illness tied to restaurants has decreased consumer confidence in food safety when eating outside of the home (18). Water safety problems such as drinking water contaminated with lead, arsenic, pesticides, mercury, chlorine compounds, herbicides, and *E. coli* have also been highlighted in the media (19,20). In addition, the media have focused attention on the potential for bioterrorist attacks using food and water as vehicles for biologic or chemical agents (21).

Consumer Views of Food and Water Safety

In addition to being concerned about foodborne and waterborne disease risk, sparked by media stories or personal experience, some US consumers also believe that selected practices of modern agriculture may pose health risks. Examples of food safety issues that interest consumers include use of pesticides, large-scale meat production and processing, inappropriate use of antibiotics in agriculture, genetic engineering, and irradiation (22-26). Recent research has indicated that consumers have a broad view of food risk perception and that consumer education, rather than being focused narrowly on one type of food safety issue, may be more effective if it addresses the broad spectrum of the public's concerns in this area (27). It has been reported that 80% of all food safety problems arise from lack of education or lack of awareness (28).

In December of 2001, the Research Triangle Institute (RTI) published a report for the US Department of Agriculture (USDA) that focused on consumer knowledge and behaviors related to food safety in the time period from 1996-1997 to 2001 (29,30). This report indicated that, whereas consumers' knowledge about food safety has increased, they do not always behave in a way consistent with that knowledge when observed (29). The report also indicated that consumers think that they are at low risk for acquiring foodborne illness when eating at home and at high risk when eating at restaurants or eating processed foods (29). This is despite the fact that foodborne illness is a major concern when foods are eaten at home as well as outside the home (26). In fact, home preparation has been associated with 20% of reported cases of foodborne illness (26). This figure may even be conservative because it is believed that foodborne illness associated with home preparation may be underreported (26).

The RTI report also highlighted the need for more consumer education related to proper defrosting and reheating techniques as well as use of food thermometers (29). The report found that consumers have little awareness of foodborne illnesses such as listeriosis and *Campylobacter* infection (29). It was observed in the report and by others that consumers need more education regarding hand washing, use of plates before and after grilling, and cleaning cutting boards (29,31). Consumers also need to know about the major factors contributing to foodborne illness such as food stored at improper temperatures, inadequately cooked foods, contaminated food preparation and serving equipment, inadequate personal hygiene, and food acquired from unsafe sources (31).

Government Focus on Food and Water Safety

The federal government's focus on food and water safety is evidenced by its inclusion of this topic as an integral component of *Healthy People 2010* (1,31), which outlines national goals for public health. This document highlights the need for the following: reduce disease related to foodborne pathogens as well as pesticide and allergen exposure; promote food-handling practices that support food safety; reduce disease incidence associated with water; and reduce food and water-related exposure to environmental pollutants (1,31,32).

Eight agencies in the federal government bear the primary responsibility for food and water safety. These are the following: (a) the Food and Drug Administration (FDA); (b) the USDA; (c) the Environmental Protection Agency (EPA); (d) the CDC; (e) the National Marine Fisheries Service of the Commerce Department; (f) the Federal Trade Commission (FTC); (g) the US Customs Service; and (h) the Bureau of Alcohol, Tobacco, and Firearms (26,31). In addition, the National Institutes of Health sponsor research on foodborne disease (26). Other federal agencies, as well as state and local governments, also bear responsibility for ensuring food safety; however, a review of these programs and regulations is beyond the scope of this Position Paper (33).

In the past, responses to foodborne and waterborne disease outbreaks were frequently complicated and uncoordinated because of overlapping responsibilities of federal and state agencies. In 1997, President Clinton's Food Safety Initiative (FSI) coordinated the research agendas and public health activities of the government agencies responsible for the regulation of foods into one common plan to improve the safety of the nation's food supply (34,35). The following programs for improvement of the food supply are coordinated under FSI:

- FoodNet, a collaboration between the CDC, USDA, FDA, and selected health departments representing 6% of the US population, conducts active surveillance for seven bacterial and two parasitic foodborne diseases. Its purpose is to improve understanding and response times to foodborne disease (36-37).
- PulseNet is a network of government and public health labo-

ratories using DNA fingerprinting to detect foodborne illness (34,35).

■ HACCP is a seven-step process to identify and control hazards in foods. HACCP guidelines have been in effect since 1997 by the FDA for fish and fishery products. Meat and poultry processing plants have had HACCP guidelines in effect by the FSIS since 1998, the date of implementation dependent on size of operation (38,39). The FSIS also is currently evaluating pilot HACCP programs for dairy, bakery, breakfast cereals, and low-acid canned products (40). The FDA also has endorsed HACCP for foodservice operations (41,42).

■ Food Code, published every 2 years, is a reference document for regulatory agencies that oversee food safety in commercial and noncommercial foodservice operations. The Food Code covers topics such as water, equipment, personnel, food, and physical facility (43).

■ Fight BAC! (Partnership for Food Safety Education) is a consumer education program developed by industry and government agencies. The program promotes four messages: (a) wash hands and surfaces, (b) don't cross contaminate, (c) cook to proper temperature, and (d) refrigerate promptly (44).

HACCP principles can be adapted to foodservice and home settings. Because foodservice operations prepare many types of food products simultaneously, using a variety of ingredients and production techniques, the FDA recommends using a "process approach" when conducting a hazard analysis (45). Qualified dietetics professionals in all practice areas can contribute to the implementation of HACCP by becoming part of the team that initiates and develops HACCP systems, including training and educating staff and consumers. However, a completely risk-free food supply is not possible even with surveillance, inspections, and education programs. The presence of enteric pathogens on raw agricultural commodities creates hazards that cannot be completely addressed by present systems and technology. A necessary component of food safety is risk analysis. Risk analysis uses scientific data to determine the probability of an adverse health effect and the severity of that effect. Food Safety Objectives (FSOs) have been proposed as a means of assessing the maximum frequency and/or concentration of a microbiologic hazard in a food at the time of consumption that provides the appropriate level of protection. FSOs, including HACCP, can be integrated into the current farm-to-table approach (42).

Dietetics professionals can help implement risk assessment into the food system by becoming knowledgeable about emerging and microbiologic hazards and process criteria as they complement the HACCP system (46). Concerns about the safety and security of the food supply have led the Center for Food Safety and Applied Nutrition (CFSAN) to prioritize funding for its programs. Priority is updated each fiscal year, based on the question "where do we do the most good for consumers?" A prioritized work plan is developed annually. Projects designated priority level "A" indicates that CFSAN plans to complete 90% of those projects within the fiscal year. Current A-level projects include counter terrorism and safety of imported foods, *Vibrio vulnificus*, HACCP program for juice, and pesticide and dioxin monitoring. Projects having a B-level priority may not be completed in a single fiscal year but are expected to make progress and may be moved to A-level status in the next fiscal year. The harvest of scrombroid fish is a current B-level project (47).

Protection of water safety is also an important function for government. Disinfection of drinking water was one of the significant public health initiatives of the 20th century. Typhoid and cholera epidemics, once common in urban areas, were reduced by the disinfection of public water supplies, initiated by the US Public Health Service in 1914 (48,49). By the mid-20th century, the presence of man-made chemicals in drinking water and their impact on human health led to the passage of the Safe Drinking Water Act (SDWA) (50). The goal of the SDWA is to protect consumers from contaminants that present health risks and are known to, or are likely to, occur in public drinking water supplies. Water pollutants can include soil sediments, pesticides, manufacturing byproducts, animal wastes, and nutrients from fertilizer and sewage (51). Maximum contaminant levels (MCLs) are regulated by the EPA for public water systems (49). All community water systems must distribute annual reports about the system's water, including information on detected contaminants, potential health effects, and source of the water (49,52).

Maintaining a safe and adequate water supply will present a challenge to local and state governments. The infrastructure of many public water systems, which includes underground networks of pipes, aqueducts, and treatment plants, were built using early 20th century technology. The USEPA Drinking Water Infrastructure Needs Survey, released in 1997, estimated that public water systems will need to invest $138.4 billion over a 20-year period to ensure the continued source development, storage, treatment, and distribution of safe drinking water (53). The EPA is currently evaluating risks from several health concerns such as microbial contaminants, byproducts of drinking water disinfection, radon, arsenic, and water systems that do not currently disinfect their water but get it from a potentially vulnerable groundwater source (52).

Disinfection of drinking water from public water systems may not decrease health risks from its consumption. Disinfectants such as chlorine, chloramines, and chlorine dioxide may react with naturally occurring organic and inorganic matter to create disinfection byproducts (DBPs), such as trihalomethanes. These DBPs have been demonstrated to cause cancer and reproductive and developmental effects in laboratory animals. Specific microbial pathogens such as *Cryptosporidium parvum* and *Giardia lamblia* are resistant to traditional disinfection agents (54,55). Because over 200 million people consume disinfected water, the EPA has been mandated by the SDWA to promulgate a Disinfectants and Disinfection Byproducts Rule that establishes maximum contaminant levels for DBPs and maximum residual disinfectant levels for chlorine, chloramines, and chlorine dioxide (54).

FOOD SAFETY ISSUES

Changing Demographics and Lifestyles

Food and water safety initiatives are particularly critical given current trends in populations, diseases, and lifestyles. Groups considered to be at high risk for developing foodborne illness are shown in Figure 1. One group considered at high risk is the elderly population (31,56). In 2000, the US population aged 65 years and older numbered 35 million, and, by 2030, it is estimated that this number will increase to 70 million with the elderly population representing 20% of the US population (57). There are some physiologic factors that contribute to the assignment of the elderly population as a high-risk group. These include diminishing immune functioning and lower stomach acid content (56). A recent study of seniors who frequently prepare meals at home indicates that many do not use appro-

Young children
Pregnant women
Elderly adults
Immunocompromised persons (AIDS/HIV, steroids, chemotherapy, diabetes mellitus, cancer)
Alcoholics
Persons with liver disease
Persons with decreased stomach acidity (due to gastric surgery or antacid use)
Persons with autoimmune disorders
Persons taking antibiotics
Persons who are malnourished
Persons in institutionalized settings (nursing homes, hospitals, day care centers)

FIG 1. Groups at high risk for foodborne illness (1,26,31,56,60-62).

priate safety procedures related to food preparation (58). A study of elderly Meals on Wheels participants reported food safety concerns existed for 26% of clients surveyed (59). For many foodborne infections monitored by FoodNet, however, older adults have lower rates of infection compared with many age categories (56). The elderly population does appear to be at greater risk of serious complications when they experience foodborne illness (56). One example is the greater tendency of elderly people to develop Guillan-Barré syndrome associated with *Campylobacter* infection and more frequent fatalities among the elderly population with *E. Coli* 0157:H7 infection (56).

In addition to the elderly population, children and pregnant women may be considered high-risk groups (60-62). Statistics indicate that approximately one third of all foodborne illness in the United States occurs in children less than 10 years of age (60). A less than fully developed immune system and lower weight are two factors that place children at high risk (61). Pregnant women may be more susceptible to certain viruses and may also be considered high risk because their infections with viruses, bacteria, or parasites may represent a risk to the fetus (62).

Another high-risk population is those with HIV infection and/or AIDS (26). At the present time, there are estimated to be 800,000 to 900,000 people infected with HIV living in the United States (63). It has been noted that salmonellosis, listeriosis, and infection with *Campylobacter jejuni* are particular concerns for this group (64). Comparing AIDS patients to otherwise healthy adults, *Salmonella* infection is 100 times more common in AIDS patients, and *Campylobacter* infection is 35 times more common (64). Other persons who are immunocompromised for reasons other than HIV/AIDS are also believed to be at higher risk for foodborne illness (31).

Persons in institutional settings such as hospitals, assisted living facilities, nursing homes, schools, correctional facilities, day-care centers, and shelters are also considered at high risk for foodborne illness (31,65,66). One study of nursing home residents found that case fatality rates were 100 times higher for rotavirus and 10 times higher for *Campylobacter* than for the general US population (56,62). *E. coli* 0157:H7 case fatality rates in nursing home patients were also much higher than for the general US population (62).

Americans consume foods through numerous venues. According to government figures, 80% of the US population consumes food prepared outside the home at least once a week (67). Case control studies using FoodNet data indicate that this pattern of consumption is associated with increased risk of foodborne illness (67). Various initiatives and educational programs seek to address the "outside home" eating patterns of Americans. Examples include the following: National Food Safety Education Month (68), issuance of guidelines and educational material for mail order food safety (69), ServSafe training (70), educational information about the safety of "take out foods" (71), guidelines and materials for volunteers cooking for large community groups (72), and safe eating outdoors (73-75). Numerous resources for retail foodservice food safety are available at the Gateway to Government Food Safety Web site (76).

Racial and ethnic differences exist with regard to patterns of foodborne illness in the US population (77). Ethnic food preferences linked to outbreaks of foodborne illness (*Listeria monocytogenes* and *Yersinia enterocolitica*) are consumption of soft pasteurized cheeses by Hispanics and consumption of chitterlings by African Americans (77,78). One study noted that Hispanics consume several food types such as undercooked eggs, fruits, vegetables, and unpasteurized fruit juices, which have also been linked to a higher incidence of *Campylobacter* infection as well as listeriosis and salmonellosis in this population (79). An analysis of 2000 FoodNet data indicated that compared with non-Hispanic whites, Hispanics had a higher incidence of *Shigella* and *S. typhi*. In making a comparison with whites, African Americans have a high incidence of *Shigella* and *Yersinia* and Asians a higher incidence of *Yersinia*, *Vibrio*, and *S. typhi* when compared with whites (77). As these differences are further studied, it may be possible to construct food safety measures that are more relevant to specific racial and ethnic groups.

Globalization of the food supply is introducing foods and food pathogens into the United States (10). Seafood and fresh fruits lead the list of imported commodities, and both can be vehicles for illness (80). The FDA, as authorized by the 1997 FDA Modernization Act, works with other countries and international agencies to prevent foodborne illness (80). The FDA establishes and promulgates procedures and rules to prevent contaminated foods from being marketed in the United States (81). In the year 2000, FDA programming and initiatives related to food safety involved over 30 nations (82).

An example of foodborne illness related to globalization was the 1996 outbreak of cyclosporiasis linked to the consumption of raspberries imported from Guatemala (83). This outbreak involved 1,465 cases of disease in North America, with US cases reported in 20 states and the District of Columbia (83). Previously, this disease was primarily reported in North America as being linked to travel to endemic areas (83). Another example of globalization related to foodborne illness was *Salmonella typhi* infection (typhoid fever) in Florida linked to consumption of frozen mamey produced in Guatemala and Honduras (84).

Bacterial and Viral Food Safety Hazards

Commonly recognized bacterial microbes associated with foodborne illness in the United States include the following: *Campylobacter jejuni, Bacillus cereus, Clostridium perfringens, Escherichia coli* 0157:H7, *Listeria monocytogenes, Salmonella, Shigella, Staphylococcus aureus*, and *Vibrio parahaemolyticus* (85). *Vibrio vulnificus* is also receiving attention as a foodborne pathogen of importance (86). *Vibrio vulnificus* is a bacteria naturally found in warm saltwa-

ter (87). It usually causes foodborne illness related to raw oyster consumption (86,87). Other contaminated crustaceans, mollusks, and reef fish when eaten raw or if undercooked can also be sources of *Vibrio vulnificus* infection (31,87). In addition to the above bacterial foodborne diseases, there usually are a small number of botulism cases reported in the United States each year (88). Some of these cases are associated with low-acid-content, home-canned foods but may also arise from unusual sources such as chopped garlic in oil or aluminum foil-covered baked potatoes (88). Honey is also a potential source of botulism spores that are associated with botulism in infants (89-91). The *Bad Bug Book* or the *Foodborne Pathogenic Microorganisms and Natural Toxins Handbook* (92) provides an extensive listing of and information about bacteria associated with foodborne illness in the United States.

Some foodborne bacteria cause clinical problems related to infection and others related to intoxication (93). For example, *Salmonella* is an infection because it is the bacteria that causes illness (93). Toxins that are produced by *Clostridium botulinum, Staphyloccus aureus*, and *Bacillus cereus* bacteria cause illness by intoxication (93,94).

Most of these bacterial foodborne illnesses are characterized clinically by symptoms of gastrointestinal distress such as vomiting, diarrhea, and/or abdominal cramps, but some also are associated with other pathologies (93,94). For example, paralytic shellfish poisoning can be associated with breathing problems and/or paresthesias because of pathology induced in the nervous system (94).

Of particular interest are those bacterial foodborne illnesses that may be associated with death. Bloodstream *Vibrio vulnificus* infection has a high case fatality rate (about 50%) in immunocompromised persons, including those with liver disease (87). According to Mead and colleagues (2), bacterial foodborne illnesses most often linked to death include *Salmonella, Listeria, Campylobacter,* and *E. coli* 0157:H7.

Listeriosis is often a severe disease and, of the 2,500 cases in the US each year, 500 are fatal (95). Listeriosis may cause septicemia or infection of the brain and nervous systems as well as having gastrointestinal manifestations (31,95). *Listeria monocytogenes* infection in pregnancy can result in spontaneous abortion or stillbirth because *Listeria* organisms can cross the placenta to infect the fetus (31). This is particularly alarming because about one third of listeriosis cases are reported to occur in pregnant women (31). To prevent listeriosis, the CDC recommends that pregnant women avoid soft cheese and cold cuts and make sure that leftover or ready-to-eat foods are consumed hot (96).

E. coli 0157:H7 infection has also been linked to deaths when hemolytic uremic syndrome (HUS) has developed (97). *E. coli* 0104:21 (another Shiga-like strain) has also been linked with the development of hemorrhagic colitis, which may develop into hemolytic uremic syndrome (31). HUS is characterized by kidney failure and, potentially, by complications such as seizures and stroke (97). The CDC estimates that there are approximately 61 fatalities each year associated with HUS representing a case fatality rate for HUS of 3% to 5% (97). All persons who are infected with *E. coli* O157:H7 are considered at risk for complications such as HUS, but children less than five years of age and the elderly usually become most seriously ill (97).

A wide variety of foods can act to transmit bacterial foodborne illnesses. Some of these foods are locations where the bacteria are found naturally and multiply and other foods serve as vehicles for bacterial or bacterial toxin contamination (93). Figure 2 gives some examples of foods linked to bacterial foodborne illness (85-87,98). Viruses are also causative of foodborne illness (99,100). Notable in this regard are noroviruses as well as hepatitis A and rotavirus (2,31,99,100).

Bacteria	**Food**
Bacillus cereus	Taco, salmon, fried rice
Campylobacter jejuni	Unpasteurized milk and cheese, lettuce salad
Clastridium perfringens	Beef taco, chicken salad, beef lasagna
E. coli 0157:H7	Ground beef, salad, raw sprouts (alfalfa, mung bean)
Listeria monocytogenes	Deli meat, cheese
Salmonella	Chicken, eggs, raw sprouts (alfalfa, mung bean)
Shigella	Bean dip, meat pizza, fruit
Staphylococcus aureus	Mashed potato, ham, chicken salad
Vibrio parahaemolyticus	Crab cakes, raw oysters
Vibrio vulnificus	Raw oysters
Virus	**Food**
Norovirus	Potato salad, vegetable dips, raw oysters, meat pizza, ham, pasta salad, lettuce salad
Hepatitis A	Strawberries, crab, scallions, guacamole
Rotavirus	Appetizers, salads, fruit

FIG 2. Examples of foods associated with bacterial (85,86,87,98) and viral (100,107) foodborne illnesses.

Noroviruses usually cause illness for few days with the following signs and symptoms: nonbloody diarrhea, nausea, vomiting, headache, low-grade fever, and/or abdominal cramping (31,101). Norovirus is the illness that is commonly misclassified as "stomach flu" (101). Norovirus infection is sudden in onset and usually has a short duration of one to two days (101). Noroviruses are very contagious and can be spread through feces and vomitus (101). Noroviruses are relatively hardy and can survive freezing and relatively high temperatures (102). They also can survive despite chlorination up to 10 ppm (102). Norovirus may be acquired through consumption of contaminated food or water, touching contaminated fomites, or by having direct contact with an infected person (101-104). Noroviruses can enter food through contaminated hands or surfaces or by vomit droplets in the air landing on the food (103). Hand washing is helpful in norovirus prevention as is having a person with norovirus refrain from handling or preparing food during their illness and until signs and symptoms are absent for two to three days (103). Norovirus-contaminated items should be discarded or cleaned using hot temperatures (103). The CDC also recommends obtaining oysters from known sources and thoroughly washing fruits and vegetables to help decrease norovirus risk (101,103). The CDC has prepared a special information sheet to educate food handlers about noroviruses because this disease is so common (103).

Hepatitis A enters food via fecal contamination during the growing, processing, or preparation processes (105). Frequent dietary sources of infection are water, shellfish, and salads (105). Hepatitis A infection is associated with nausea, diarrhea, abdominal pain, fever, fatigue, appetite loss, and jaundice (106). There is now a vaccine for hepatitis A, and the CDC recommends its use for persons traveling to geographic areas where the disease is common, men who have sex with men, persons with chronic liver disease, injecting and noninjecting

drug users, persons with hemophilia, and children who live in locations where there are high rates of hepatitis A infection (106). Approximately one third of Americans appear to have immunity to hepatitis A as the result of prior infection (106).

Rotavirus, with its associated diarrhea, vomiting, and low-grade fever, can also be foodborne, although it is most often spread through fecally contaminated hands (107,108). Children most commonly acquire this infection, which can in some instances be fatal (31). In developing countries, rotavirus infection is associated with 20% to 25% of deaths linked to diarrhea (108). A rotavirus vaccine was licensed for use in the United States in 1998 (108); however, the Advisory Committee on Immunization Practices (ACIP) is not recommending the use of rotavirus vaccine for US infants because of the potential complication of bowel obstruction (109). Foods associated with rotavirus spread include the following: salads, fruits, and appetizers (107). Usually, the virus is introduced by an infected worker into a food type such as one of the previously mentioned because these foods are not usually cooked after handling (107).

As with foodborne illness related to bacteria, a variety of foods can be involved in transmitting viral diseases (100). In viral illness, however, food and water serve as vehicles for person-to-person spread via the fecal-oral route (99). Hand washing after toileting; before eating; and before, during, and after food preparation is critical in the prevention of viral foodborne illnesses (31,102,106,107). Figure 2 also gives some examples of foods linked to viral foodborne illnesses (100).

Parasitic Food Safety Hazards

Relatively speaking, parasites are a problem of lesser magnitude in the United States (110). Vigilance is needed, however, because these problems may become more widespread. *Cryptosporidium parvum*, a protozoal parasite, for example, is now considered an emerging pathogen (111).

In 2000, there were six US outbreaks related to parasites (110). Parasitic agents implicated were *Crytosporidium parvum*, *Cyclospora cayatenensis*, *Giardia lamblia*, and *Trichinella spiralis* (110). *Cryptosporidium parvum* is a single-celled protozoa that may infect food via feces (112). Infection is characterized by watery diarrhea and possibly a low-grade fever (112). Coughing may occur if there is pulmonary involvement (112). *Cyclospora cayetanensis* is a one-celled parasite that is found in fecally contaminated water and fecally contaminated foods such as fresh basil and raspberries (31,113). The disease may be asymptomatic but is usually associated with symptoms such as watery and sometimes explosive diarrhea, weight loss, bloating, fever, muscle aches, nausea, and vomiting (113). *Giardia lamblia* is another one-celled parasite that is transmitted through feces of animals or humans in food or water (114). This infection is usually characterized by stomach cramps, diarrhea, weight loss, and potentially dehydration (114). There are some asymptomatic individuals (114). *Trichinella spiralis* is a worm that may contaminate raw or undercooked wild game or pork (115). This infection, in its severest form, can be fatal (115). Initial symptoms are gastrointestinal (nausea, diarrhea, vomiting, abdominal pain), with fever and fatigue (115). Later in the course of the disease, other symptoms such as muscle pain, itching, headache, fever, chills, eye swelling, and diarrhea or constipation may be present (115). Cardiovascular and respiratory complications may occur in severe cases (115). Foods implicated in 2000 parasitic outbreaks in the United States were the following: coleslaw (*Cryptosporidium parvum*), raspberries and blackberries (*Cyclospora cayatenesis*), multiple foods (*Giardia lamblia*), and bear meat (*Trichinella spiralis*) (110).

New or Emerging Food Pathogens

In addition to the agents described above, there are new or emerging pathogens. This term is used to signify a variety of conditions such as initially linking a pathogen to disease, increasing disease frequency or severity, or increasing pathogen prominence because of more new cases in a population (116). *Listeria monocytogenes*, known as a foodborne pathogen for many years, is sometimes put in this category because it is being implicated more often in outbreaks (116). This may be because of greater ease of laboratory identification (116). Other new or emerging pathogens include the following: *Anisakis simplex, Cryptosporidium parvum*, and a multidrug resistant *Salmonella typhimurium* DT 104 (111). *Healthy People 2010* (1) also highlights *Toxoplasma gondii* as a threat that has been underreported. *Toxoplasma gondii* has been linked in Europe to consumption of raw or undercooked meat and/or raw vegetables (1).

Bovine spongioform encephalogy (BSE), which is believed to be related to a prion agent, has currently not emerged in the US food supply (117,118). BSE, commonly known as Mad Cow Disease, has been linked to variant Creutzfeldt-Jakob disease (vCJD) in humans (118-120). Variant Creutzfeldt-Jakob disease has been seen primarily in young adults and is characterized by psychiatric and sensory problems initially, followed by ataxia, dementia, and myoclonus (119). The disease is considered to be a fatal brain disorder (120). In April 2002, a case of suspected vCJD in the United States was investigated (121). The Florida Department of Health and the CDC reported potential vCJD in an individual thought to have contracted the disease in the United Kingdom (121). A major priority of the FDA is to keep both BSE and vCJD outside of the United States (117). The CDC reports that, as of July 2002, cattle were the only known food animal linked to BSE, although sheep have been experimentally infected (120). Several countries other than the United Kingdom have confirmed BSE, and, therefore, US citizens who travel outside the country should consult the updated list of confirmed countries with BSE available on the Office International Des Epizooties website (120,122). In addition, the CDC recommends that travelers to areas where BSE has been found consider avoiding beef entirely or just eat solid beef muscle, which is believed to be a lower risk food part of the cow compared with brains or ground beef (120). At present, it is reported that milk and milk products do not appear to be related to BSE transmission (120).

Chemical Food Safety Hazards

Chemical agents can be those naturally contained in food or those added to food either intentionally or accidentally (123). Consumers may focus on chemical risks because these usually receive more media attention than bacterial or viral problems (124). Examples of identified chemical agents associated with 2000 US foodborne outbreaks were ciguatoxin, scombroid toxin, and paralytic shellfish poisoning (125).

Ciguatoxin and scombroid toxins are both associated with fish consumption (125,126). Specific fish types associated with ciguatoxin poisoning include finfish such as grouper, snapper, and mackerel (123,127). Scrombroid poisoning is commonly associated with consumption of tuna, mackerel, anchovies,

mahi mahi, amberjack, and sardines (31,123,128). Ciguatera toxin originates in dinoflagellates and accumulates in fish such as the finfish types mentioned previously (123,127). Ciguatoxin illness is characterized by numerous gastrointestinal, cardiovascular, and neurologic problems (127). Scrombroid poisoning is associated with consuming fish in which bacteria are present to convert histidine and other amino acids to histamine (128). Symptoms of scrombroid poisoning may include the following: mouth tingling, upper body rash, low blood pressure, headache, itching, and/or gastrointestinal problems (128).

Paralytic shellfish poisoning is related to consumption of shellfish (mussels, clams, scallops, or cockles) or other fish, such as the pufferfish, which contains saxitoxin (129,130). Saxitoxin is produced by algae, on which the shellfish or fish feed (129). Associated symptoms are usually neurologic problems such as abnormal sensations of burning, tingling, and numbness (129). Persons suffering from paralytic shellfish poisoning may also experience difficulties with speech and, potentially, respiratory paralysis (129).

Other chemicals naturally present in foods can also cause illness. One example is aflatoxin, which is a type of mycotoxin (31,131). Mycotoxins are harmful chemicals produced by fungi growing on foods such as nuts, grains, and milk (123). There are several types of aflatoxins that can cause health problems. These include B1, B2, G1, and G2, of which B1 is considered the most toxic (131). Aflatoxins may be present in corn, tree nuts, peanuts, cottenseed, and milk (131). Acute disease is associated with eating higher amounts and is characterized by abnormalities in digestion and absorption, hemorrhage, liver damage, and edema (131). This form may result in death (131). Chronic disease may impair nutritional status and impede growth (131). Other examples of naturally occurring food toxins include the following: tetrodotoxin in puffer fish, phytohaemagglutinin in undercooked red kidney beans, and grayanotoxin present in honey made from rhododendron nectar (132-134). Certain types of mushrooms or toadstools also contain natural toxins (135).

Some foods may cause health problems related to allergenicity (136,137). Allergenicity involves an abnormal response to a food protein, glycoprotein, or polypeptide in a food (137). Ig-E mediated food allergy is the most common type of food allergy, but there can also be non–Ig-E-mediated immune responses associated with food allergy as well (136). Common food allergies include allergies to milk, wheat, egg, and peanut (136,137). Heiner's syndrome related to milk consumption and celiac disease related to consumption of grains such as oats, barley, wheat, and rye (136) are examples of non–Ig-E-mediated abnormal responses to food. Intolerance to food may occur because of enzyme abnormalities, an abnormal pharmacologic reaction, or unknown mechanism (136).

In addition to chemicals present in food as described above, a potentially hazardous chemical change that results from processing a national constituent of food has recently been identified (138). In April 2002, researchers in Sweden noted acrylamide formation in carbohydrate foods such as french fries, processed cereals/breads, and potato chips that are heated to high temperatures (138). Acrylamide has carcinogenic potential and may also cause nerve damage (138). Scientists consulting the World Health Organization (WHO) and the Food and Agricultural Organization (FAO) have recommended further study of the potential of acrylamide formation to harm human health (138). The FDA has presented a draft action plan related to acrylamide (139,140). The FDA and the Center for Food Safety and Applied Nutrition published information on a variety of US food samples in December 2002 (141). Wide variations in acrylamide levels were found even among the same food types such as french fries (141). Acrylamide levels are low to nonexistent in boiled foods, and it appears to mainly be formed during frying and baking when the cooking process produces a temperature in excess of 250°F (139,140). Once more is known about acrylamide, the FDA has plans to develop an educational program for consumers and advises against overreaction at this point (140).

There are also chemical food safety concerns that result from chemicals intentionally used in agriculture such as pesticides, antibiotics, and hormones. All of these chemical types are used to exert positive effects on the food supply. Pesticides are used to reduce crop damage caused by insects and pests such as rodents (142). Antibiotics are given to food-producing animals for the following reasons: disease treatment, disease prevention, and growth promotion (143). Hormones such as steroids are given to cattle to promote growth (144), and recombinant bovine somatotropin has been used to accelerate milk production in cattle (145,146).

According to the EPA, laboratory studies have linked pesticides to problems such as cancer, nerve damage, and birth defects (147). The health effects of pesticides are dependent on toxicity and dose (142,147). *Healthy People 2010* (1) has indicated the need to reduce consumption of organophosphate pesticides, which may be found on fruits and vegetables. Organophosphate pesticides are the first group of pesticides being reviewed by the EPA under the Food Quality Protection Act (148). These pesticides are being reviewed not only because residues may be found on food crops but there is also exposure related to use in buildings and on lawns and gardens (149). Organophosphates can be toxic because they act as cholinesterase inhibitors (149). A lack of acetylcholinesterase can cause symptoms such as weakness and paralysis (149). Metabolites of organophosphates are monitored through measurements taken as a part of the National Health and Nutrition Examination Survey (NHANES) (150). There was a recent report from Taiwan highlighting three case studies of individuals who were poisoned though consuming vegetables contaminated by an organophosphate pesticide (151). Clinical signs of poisoning in these cases included gastrointestinal symptoms (nausea, vomiting, diarrhea, abdominal pain), sweating, miosis, muscle weakness, and hypertension (151).

The EPA establishes pesticide residue limits, and information about these limits is available from the EPA Web site, which allows one to either search by crop or by chemical (152). The EPA monitors pesticide health risks using a four-step process involving hazard identification, dose response assessment, exposure assessment, and risk characterization (153). According to the EPA, children and infants may be particularly vulnerable to the health risks posed by pesticides (154). The reasons for this increased vulnerability are thought to be related to the fact that children eat and drink more in relation to their body weight than do adults (154). Children also have immature and growing body organs (154). The play patterns of children both in the home and outdoors may also increase their overall exposure to pesticides (154). The EPA has a publication entitled *Citizen's Guide to Pest Control and Pesticide Safety* (155) that provides suggestions to reduce pesticide exposure through food and water.

The National Institute of Occupational Health and Safety (NIOSH) is active in monitoring occupational exposures to pes-

ticides (156). There are a number of federal and state agencies that track acute pesticide toxicity (156). Another way that the government monitors pesticide exposure is through the FDA Total Diet or Market Basket Survey, which has been conducted since the 1960s to determine levels of pesticide residues and contaminants in diets representative of US population subgroups (157,158). Of the 14,000 analytical findings of the Total Diet Study each year, about 36% indicate toxic elements and chemical contaminants, including pesticides (157). Most of these, however, are at low levels (157).

There is also a question as to how antibiotics used in agriculture may affect human health. In 1997, the WHO published a report indicating that antibiotic use in food animals might lead to problems with antibiotic resistance and treatment failures (159). The FDA Center for Veterinary Medicine has been concerned particularly about fluoroquinolone resistance (160-162). The FDA has the authority to regulate the use of antibiotics in food animals and act to withdraw animal antibiotics that might pose a threat to human health (161).

Concern has been expressed about the safety of bovine somatotropin (BST), which is produced in laboratories and used to stimulate milk production in cows (26). BST was approved by the Food and Drug Administration in 1993 for commercial use (26). Those who question BST safety are concerned about health effects of not only the hormone itself but about the relationship of BST to insulin-like growth factor (26). It is acknowledged that milk from cows that receive BST have higher levels of IG F 1 (26). The FDA has noted that the small increase in IG F 1 levels associated with BST are within normal levels of variation and therefore do not pose a human health risk (146). Many health organizations, including the American Dietetic Association, have concluded that the use of BST to increase bovine milk production does not pose any human health risks (163).

Food additives represent chemicals added intentionally to food during the production process for specific beneficial purposes such as adding color, enhancing flavor, and improving texture (164). Food additive safety is regulated by the Food and Drug Administration, and additives that have gone through appropriate government approvals appear to be safe for the majority of people (164). There are some additives that may cause adverse reactions in a select number of individuals (131). One example is tartrazine (FD & C Yellow No. 5), which may cause hives in susceptible individuals (31,165). Other examples of food additives to which small subsets of the population may react adversely include monosodium glutamate and sulfites (26,31,166).

Chemicals can also be introduced into foods unintentionally (131,123). Prevention of inadvertent chemical pesticide contamination has recently been addressed by the food industry (167). A recent article reported illness in Thai restaurant patrons who ate salt that had been contaminated with a carbamate pesticide (168). Other examples of chemicals that may inadvertently contaminate food during the preparation or serving processes include those in cleaning supplies or metals from food containers or kitchen and/or dining surfaces (31,123).

Environmental contaminants may also be problematic in the food supply (1). Mercury is one example that can be consumed by humans as a constituent of contaminated water or fish (169). Because mercury can damage the fetal nervous system, the FDA has issued a consumer alert for pregnant women and women of childbearing age to not eat these large fish types in which mercury may accumulate: shark, swordfish, king mackerel, and tilefish (170). The EPA has calculated fish consumption limits for the typical consumer related to mercury exposure (171). The American Dietetic Association has recently provided its membership with information to give pregnant women and women of childbearing age, concerning safety issues regarding fish and shellfish consumption (172). Polychlorinated biphenyls (PCBs) are another example of an environmental contaminant of concern in the food supply (157,158,173). PCBs were chemicals used for their insulating properties in a wide variety of applications (174). PCB production was stopped in the United States in 1977 (173,174). PCBs can cause cancer, and the US public is now exposed through small amounts that may occur in food animal fats (173). PCB levels in food are monitored through the FDA's Total Diet Study (157,158). Levels of PCB are also measured by NHANES (32).

Food Safety and Biotechnology

Development and distribution of genetically modified foods have been associated with concerns about health effects (175). Foods have been genetically modified for a variety of reasons, which include the following: increasing resistance to pests and disease, enhancing production capacity, extending the period of freshness and marketability, and increasing the nutrient content (175,176).

Health effects that have been advanced as potential problems with genetically modified foods include allergenicity and expressions of either toxicity or antinutritient effects (176). A decision-tree algorithm to assess potential allergenicity of genetically altered food crops has been developed by the International Food Biotechnology Council (IFBC) and the Allergy and Immunology Institute of the International Life Sciences Institute (176,177). It has been noted that potential allergenicity of proteins introduced into a food, if evaluated appropriately, can serve to limit the potential for allergy induction (178). The Institute of Food Technologists cited a national Research Council Committee report, which indicated that risk assessment of genetically modified foods should focus on a food's properties, such as protein content and content of other substances, rather than on the genetic alteration process itself (176,179). The US government is active in regulating the safety of bioengineered food (180). Readers are also referred to the ADA position paper on biotechnology for further background on this issue (181). ADA also has a Biotechnology Resource Kit providing continuing education opportunity available for member purchase (182).

Food Safety and Food Irradiation

Food irradiation involves exposing food to ionizing radiation to kill foodborne pathogens (183). The CDC has indicated that irradiation could be used to (a) treat raw meat and poultry to destroy *E.coli* 0157: H7, *Salmonella*, and *Campylobacter*; (b) treat ready-to-eat meats to destroy *Listeria monocytogenes*; and (c) treat produce to eliminate *Cyclospora* as well as *Shigella* and *Salmonella* (184). This technology has been tested for safety and efficacy for decades, and its use is endorsed by numerous health organizations (183). Wheat flour was approved for irradiation in the United States as early as 1963 for the purpose of controlling mold (183,184). Three methods for food irradiation currently exist (184). These methods are x-ray, gamma ray, and electron beam technologies (184). The American Dietetic Association in 2000 supported the use of food irradiation to help those populations most at risk of food-

borne illness and to aid foodservice operations in implementing the HACCP system (183). The International Food Information Council has supported irradiation as an important tool to increase food safety (185). The FDA and USDA regulate food irradiation (183-186). It is required that irradiated foods sold in the United States be appropriately labeled (183-186). The CDC indicates that nutrients in food are not substantially changed by irradiation except for a slight reduction in thiamin content (184).

Food and Bioterrorism

Food has been previously targeted to inflict harm and influence politics (187) and could be used again by bioterrorists. The CDC has particularly highlighted the following foodborne pathogens as having this potential: tularemia; brucellosis; *Clostridium botulinum* toxin; the epsilon toxin of *Clostridium perfringens*; and infection with *Salmonella, E. Coli,* and *Shigella* (188). This agency also has indicated that the centralized nature of food production and processing and the wide distribution of foods, both domestic and imported, may make the food sector vulnerable to attack (189). Various governmental agencies are preparing to recognize and contain any incidents that occur (189). The Gateway to Government Food Safety information Web site provides information about local, state, federal, and international websites related to countering bioterrorism, especially potential attacks on the food supply (190). In January 2003, the FDA announced that it would propose regulations related to the Public Health Security and Bioterrorism Preparedness and Response Act of 2002 (191). The food industry has also recognized the potential for bioterrorism and has promulgated guidelines for practices designed to thwart attack (192). The role of the consumer will also be critical because illness related to bioterroism will likely first occur among the general public (193). Dietetics professionals have been recognized for being an important educational link to consumers and as being critical to the monitoring of any unusual foodborne outbreaks (193,194). The critical role of the dietetics professionals in food security and combating bioterrorism has been recently discussed by Bruemmer (194). Dietitians are noted to have roles in surveillance and in planning for and responding to emergency situations involving food and water security (194).

FOOD SAFETY INITIATIVES

Meeting the challenge of food safety in the 21st century will require the application of new methods to identify, monitor, and assess foodborne hazards. These methods would include surveillance networks, food safety control systems, public health laboratories, and risk assessment to establish food safety standards (195). In addition to governmental initiatives designed to foster food safety, other organizations also promote food safety as well. These include the following: the Joint Commission on Accreditation of Healthcare Organizations (JCAHO), the Partnership for Food Safety Education (a public/private group), the International Food Safety Council, the International Association of Food Protection, the Institute of Food Technologists, the National Environmental Health Association, and the American Dietetic Association (26,31).

Education about food and water safety is needed for health and hospitality professionals, food industry personnel, farmers, and consumers (26,196). Recent studies have indicated that food safety in the home may be especially critical as an educational topic (195). Antibioterrorism efforts will also extend the need for information about food and water safety to law enforcement officials and emergency responders (197). Healthcare professionals and others as outlined above need to have knowledge of foodborne and waterborne illnesses, which encompasses causative agents; incubation periods; clinical symptoms; duration of illness; common and probable food and/or water sources; factors affecting transmission, infectivity, pathogenicity, and virulence; ways to identify and investigate study of foodborne illness in populations; and modes of diagnosis, prevention, and treatment (94).

WATER SAFETY ISSUES

Emerging Contaminants in the Water Supply

National Primary Drinking Water Regulations as determined by EPA currently set standards for microorganisms, organic and inorganic chemicals, radionuclides, disinfectants, and disinfectant byproducts in public water systems. Changes in detection methodology and increased incidents of the following contaminants have led the EPA to issue health advisories for the following:

- Mycobacteria have been found in both surface and piped water. These microorganisms have been demonstrated to cause skin infections. They can multiply in water devoid of nutrients and are resistant to chlorine. The CDC estimates that 25% to 50% of the population infected with AIDS will develop Non-Tuburculor Mycobacterial disease. UV radiation is the most effective disinfection treatment for mycobacteria (198).
- *Legionella* is considered to be ubiquitous in natural and manmade water bodies; it is resistant to standard disinfection procedures. *Legionella* can survive in water up to 60°C, colonizing water distribution systems, cooling towers, and whirlpools. It is directly transmitted to humans by aerosolization or aspiration, resulting in either Pontiac fever or Legionnaire's disease. Vulnerable populations include neonates, HIV-infected individuals, renal patients, and patients with intubation or ventilation assistance. Two-stage disinfection is recommended: at the source with UV sterilization or ozonation, and systemic with hyperchlorination or copper-silver ionization (199).
- *Giardia* cysts are ubiquitous in all surface waters. It has a low infectious dose, which causes gastrointestinal disease. Children and immunocompromised adults are particularly susceptible to infection, although all segments of the population have the potential to become infected. *Giardia* cysts can be removed by filtration but are resistant to disinfectants. The most effective disinfectants are ozone and chlorine dioxide (200).
- Viruses, enteroviruses, hepatitis A: The EPA is in the process of monitoring these microorganisms and will submit a health advisory by 2006 (201).
- Arsenic maximum contaminant level (MCL) has been changed from 50 ppb to 10 ppb, effective February 22, 2002. All public water systems must comply by January 23, 2006 (202).
- Lead and copper MCL has not changed, but the EPA has ruled that all public water systems must operate and maintain corrosion control within the treatment and distribution system (203).
- Methyl butyl ether (MTBE) is a fuel oxygenate added to decrease carbon monoxide and ozone emissions; it enters ground water by leaking from underground storage tanks. There are no adverse health effects if MTBE levels are less than 20 to 40 ppb (204).
- Uranium enters water from erosion of natural deposits. The

potential health effects are increased risk of cancer and renal toxicity. The MCL will be 30 μg/L as of December 8, 2003 (205).
■ Radon enters indoor air and the water supply from soil. Radon may increase risk for lung and stomach cancer. EPA has proposed the MCL be changed to 4,000 pico Curies (pCi)/liter by 2006 (206).

The Unregulated Contaminant Rule was established by the EPA as a method to evaluate and prioritize contaminants, which may be considered for revised drinking water standards. There are 36 contaminants being evaluated, depending on evidence of occurrence and availability of testing methods. The list is assessed every five years; an updated list will be published in 2004. Examples of contaminants on the list are *cyanobacteria, echoviruses, heliobacter pylori, human calciviruses*, *adenoviruses*, sulfates, and perchlorate (207).

Water Safety Policies for Facility Disaster Planning

The purpose of a disaster plan is to minimize disruption during a natural or man-made disaster situation and to allow for the resumption of normal activities as quickly as possible (208). Dietetics professionals must consider loss of power as a complicating factor in delivery of potable water. Alternative power sources in multiple locations may be necessary to keep distributed networks functioning within the facility. Consideration also must be given to operation of the water-treatment systems, including drains, sewage, and solid waste outlets (209,210). Water safety factors in a disaster plan should include the following:

- identification of water supply and alternate source;
- amount of water required to operate the facility;
- determination of water quality after a disaster;
- disinfection of water distribution system after a disaster;
- mechanics of implementing a "boil water" advisory;
- length of downtime before recovery phase; and
- sanitizing ice-making and ice-handling machines (211).

Dietetics professionals must increase consumer awareness of the ways in which the safety of a community water supply can be jeopardized and prepare them to take appropriate measures when a water emergency is declared, such as "boil water" advisories (197).

Bottled Water

Consumers may try to avoid the perceived risks from community drinking water supplies by consuming bottled water (212). Over half of Americans drink bottled water, spending 240 to 10,000 times more per gallon for bottled water than they do for tap water (213). Total US sales for bottled water are now 13% of all bottled beverage purchases (214). Concerns have been raised about the safety of bottled water. It has been reported that up to 25% of all bottled water originates from community water systems. Bottled water may exceed the MCL for some substances or may have chemical migration from the plastic container (212,214). Bottled water is regulated by the FDA as a food product and is required to meet standards equivalent to those used by EPA for tap water. When EPA issues a National Primary Drinking Water Regulation for a contaminant, FDA must issue a standard of quality regulation for the same contaminant in bottled water or make a finding that such a regulation is not necessary to protect public health (215,216). FDA has established standard of identity regulations for bottled artesian, mineral, sparkling, spring, and purified water in Title 21 of the Code of Federal Regulations (213). Qualified dietetics professionals must be familiar with the types of bottled water and the techniques used by processors to ensure the safety of these waters.

ROLE OF DIETETICS AND FOODSERVICE PROFESSIONALS

Dietetics professionals need to maintain a current knowledge base regarding food and water safety issues. Knowledge related to this topic has been included in the current educational standards of the profession (217). Case studies can be used as an educational tool on this topic (218). A 1998-1999 survey of program directors of didactic dietetics programs indicated that many programs included food safety information in multiple courses (219). Approximately, 29% of responding dietetics educators indicated plans to increase food safety education content in the curriculum (219). At the time of the survey, it was noted that slightly over one third of the responding didactic dietetics programs either required or had the option of food safety certification (219).

Dietetics professionals should be a major source of information concerning food and water safety. To be such a source, dietetics professionals need to have a commitment to ongoing continuing education related to this topic. Cody and Kunkel (31) and Puckett and Norton (197) are excellent resources in this regard. Practitioners need to maintain a database of resource agencies and organizations that provide current information. Examples of these are shown in Figure 3.

Dietetics professionals will be involved in identifying continuing and new foodborne and waterborne threats to high-risk groups, and, perhaps, there will be identification of new high-risk groups as well (193,194). Dietetics professionals can help translate food safety information into educational programs for both consumers and professionals (31,193,196). Dietetics professionals also have the ability to transmit personally relevant food and water safety information through one-on-one counseling (31). Dietetics professionals are at the forefront of ensuring food and water safety through their work in institutionalized settings such as hospitals, long-term-care facilities, schools, and correctional facilities through training of employees and professional staff (31,220). Dietetics professionals are and will be involved in food and water safety concerns associated with emergencies and disasters. The American Dietetic Association has recently published a disaster preparedness guide for professionals (197).

Working to ensure food and water safety will mean that dietetics professionals need to collaborate with the food-processing and foodservice industries as well as with other professionals in fields such as epidemiology, environmental health, public health, agriculture, medicine, medical anthropology, media, and law enforcement. Collaborations of this type will be cost-effective and will ensure that issues are examined and addressed from a variety of disciplinary perspectives. Collaboration with food and nutrition professionals throughout the world is also desirable. Discussion of food and safety issues, which transcend national boundaries, can be very productive. Collaboration with consumers is also needed to ensure that efforts of dietetics professionals and others really do influence the behaviors and health of the target audience. Dietetics professionals also can move beyond their work setting and help to ensure food and water safety at local and/or regional, community, and/or faith-based events.

Dietetics professionals should be involved in developing educational strategies relevant to food and water safety that are relevant, accessible, engaging, and effective (220,221). The

Gateway to Government Food Safety Information	www.foodsafety.gov
US Food and Drug Administration	www.fda.gov
US Department of Agriculture	www.usda.gov
US Department of Agriculture Food Safety and Inspection Service	www.fsis.usda.gov
US Department of Education	www.ed.gov
US Department of Health and Human Services	www.os.dhhs.gov
US Environmental Protection Agency Office of Ground and Drinking Water	www.epa.gov/safewater
National Institutes of Health	www.nih.gov
Center for Food Safety and Applied Nutrition	www.cfsan.fda.gov
Centers for Disease Control and Prevention	www.cdc.gov
The Partnership for Food Safety Education	www.fightbac.org.main.cfm
Food Chemical News	http://www.foodchemicalnews.com/home.asp
International Food Information Council	http://ific.org/food/
National Food Safety Database	http://www.agen.ufl.edu/foodsaf/foodsaf.html
National Restaurant Association Educational Foundation	www.edfound.org
American Egg Board	www.aeb.org
American Meat Institute	www.meatami.com
Food Marketing Institute	www.fmi.org
Grocery Manufacturers of America	www.gmabrands.org
National Broiler Council	www.eatchicken.com/
National Cattlemen's Beef Association	www.ncanet.org
Produce Marketing Association	www.pma.com
The Soap and Detergent Association	www.sdahq.org
US Poultry and Egg Association	www.poultryegg.org
Food Preservation and Safety, Iowa State University	www.foodpres.com
Foundation for Food Irradiation Education	www.Food-Irradiation.com

FIG 3. Examples of Web site resources.

media and new methods of communication such as the Internet will be key elements to consider as new educational approaches are planned. Skills and knowledge related to social marketing may be helpful in supporting these initiatives. The use of health education models related to behavior change may also be of help to dietetics professionals when designing, implementing, and evaluating food and water safety education programs (196).

Dietetics professionals need to display and encourage appropriate behavior related to food and water safety. For example, dietetics professionals can model and facilitate appropriate procedures such as temperature control, hand washing, and home/facility sanitation. The ServSafe food safety training course developed by the Educational Foundation of the National Restaurant Association is available to dietetics professionals as one method to update their food safety knowledge (222). Dietetics professionals also can be involved in research related to food and water safety and in determining practical and effective means to implement findings from this research (221).

Advocacy for food and water safety legislation and policies is another critical role for the dietitian (220,221). Advocacy efforts are needed, related to all levels of government.

Dietetics professionals should take a more proactive role in food and water safety research as it relates to identification of food and water safety issues as well as research involving education and communication to effectively prevent foodborne and waterborne health problems. Collaboration with other disciplines may be helpful to research efforts. The ADA strongly supports research involving the following:

- development of rapid, reliable, and economic methods of detecting foodborne and waterborne hazards;
- identification of the causes of and factors facilitating the development of foodborne and waterborne disease;
- improvement of epidemiologic surveillance systems related to detection and reporting of foodborne and waterborne illnesses;
- development of better food-related preparation, handling, and distribution practices to reduce incidence of disease or contamination;
- identification of the most effective role of dietetics professionals in prevention of foodborne and waterborne diseases linked to bioterrorism; and
- development and evaluation of educational materials for high-risk populations and the general public related to food and water safety issues (221).

SUMMARY

Access to safe food and water is critical to the health of a population. Dietetics professionals must work collaboratively with other health professionals; law enforcement officials; and persons in the food, water, and hospitality industries to help ensure food and water safety. Dietetics professionals must also help the media communicate accurate, comprehensive, and timely information about food and water safety issues. Dietetics professionals should also use opportunities afforded by direct contact with foodservice workers, clients, and patients to promote awareness of and positive behaviors related to prevention of foodborne and waterborne diseases (221).

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ADA Position adopted by the House of Delegates on October 20, 1996 and was reaffirmed on June 15, 2001. This position is in effect until December 31, 2007.

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