Public health and food safety experts estimate that millions of episodes of illnesses annually can be traced to contaminated food and water. Food and water safety is extremely important to persons infected with the human immunodeficiency virus (HIV) or with acquired immunodeficiency syndrome (AIDS). A compromised immune system causes people with HIV or AIDS to be more susceptible to foodborne illness from eating foods that are unsafely handled and poorly prepared and from using water from unsafe sources. Food- and waterborne illnesses can cause diarrhea, nausea, and vomiting that can lead to weight loss. These illnesses can be minimized or prevented if proper precautions are taken.

Because of their weakened immune system, immuno-compromised persons are more susceptible to serious foodborne and waterborne illnesses than are persons with stronger immune systems. These secondary infections, transmitted through food and water, contribute significantly to the morbidity and mortality of HIV-infected persons. Food plays an active role in disease transmission by supporting growth of the etiologic agent or toxin production, or a passive role where the food does not support growth but serves as a means of transmission. Food- and waterborne diseases cause nausea, vomiting, and/or diarrhea with or without additional symptoms of fever, chills, headache, and fatigue. Chronic diseases that may result from foodborne diseases include arthropathies, chronic gastroenteritis, organ compromise, and nutritional and other malabsorptive disorders, and death may occur [1]. The major pathogens seen in AIDS-related diarrhea are Cryptosporidium, Microsporidium, Salmonella, and cytomegalovirus [2–4].

Diarrhea is usually the most significant manifestation of such an infection and is a possible life-threatening complication. Diarrhea in immunocompromised patients is a challenge for the treatment and prevention of wasting. Fifty percent to 90% of persons with AIDS have serious episodes of diarrhea that can be life-threatening [2]. In one New York study of patients with AIDS, two-thirds had diarrheal disease, and in two-thirds of these, enteric pathogens could be identified [3]. Many microorganisms (Giardia lamblia, Entamoeba histolytica, Cryptosporidium, Salmonella, Shigella, Listeria, Yersinia, and Campylobacter sp.) identified as the cause of enteric infections in HIV-infected patients have also been recognized as etiologic agents in food- and waterborne diseases. Diarrhea is a common clinical feature of symptomatic HIV infection.

**ETIOLOGY**

Salmonellosis is estimated to be nearly 20 times more common and 5 times more often bacteremic in AIDS patients than in patients without AIDS [4]. In persons with AIDS, nontyphoidal salmonellosis is often life-threatening and relapsing [5–7]. Similarly, campylo-
bacteriosi can also cause bacteremia and can be difficult to cure in AIDS patients [8, 9]. Mycobacterium sp., including antimicrobial-resistant M. avium complex and M. tuberculosis, also cause enteric infections and disseminated infections in patients with AIDS [2]. An epidemiological study of persons with HIV infection also found an association between consumption of raw or partially cooked fish and M. avium complex [10, 11].

Greenson et al. [12] studied 22 patients with advanced HIV infection by analysis of endoscopic samples taken during biopsy. Eleven of 22 patients with chronic diarrhea showed occult enteric pathogens, specifically Mycobacterium avium-intracellular and microsporidia. Patients with diarrhea and occult enteric infections experienced more weight loss and died sooner than those with diarrhea but no identified pathogens.

In a San Francisco study, Celum et al. [4] found the average annual incidence of salmonellosis in men 15–60 years old with AIDS was 384 per 100,000, whereas the average annual incidence for men the same age without AIDS was only 20 per 100,000. Salmonella bacteremia was more common in persons with AIDS (45%) than in those without the disease (9%). This report and related reports identified the following microorganisms in 55%–86% of cases of patients with AIDS: cytomegalovirus and herpes simplex virus; Salmonella sp., Campylobacter sp., Clostridium difficile toxin, Mycobacterium spp., Shigella sp., Vibrio parahaemolyticus, Cryptosporidium, Entamoeba histolytica, Giardia lamblia, Isospora belli, microsporidia, and Strongyloides stercoralis [4, 13–16].

Listeriosis, shigellosis, cholera, and Vibrio vulnificus enteritis are other bacterial foodborne diseases for which people with HIV/AIDS are at increased risk [17]. Soft cheeses, contaminated milk, ice cream, lettuce, undercooked poultry, hot dogs not thoroughly reheated, and delicatessen food are associated with sporadic listeriosis outbreaks in the United States. The organism that causes listeriosis, Listeria monocytogenes, is an unusual pathogen that grows and multiplies at refrigeration temperatures. According to a report in Emerging Infectious Diseases [17], the estimated annual incidence of foodborne listeriosis in the United States is 2518 cases and 499 deaths, a case fatality rate of ~20%. These data confirmed that although foodborne listeriosis is rare, the associated mortality rate is high among those who are most at risk, including individuals with HIV/AIDS.

Vibrio vulnificus is usually associated with consumption of raw shellfish, especially oysters. It can also be transmitted directly to wounds from seawater. The organism causes a rapidly developing septicemia in those at risk (persons with cirrhosis, diabetes, or immunodeficiency caused by AIDS or other sources) and has a 50% mortality rate. The disease is so severe, with extensive lesions, that it may require surgical debridement or amputation of affected limbs. Cryptosporidium parvum, a protozoal parasite, was hardly recognized as a human pathogen until it appeared in AIDS patients, with life-threatening diarrhea [18]. Usually waterborne, Cryptosporidium also can cause limited diarrhea of short duration in immunocompetent patients [19, 20]. Cryptosporidiosis has also been traced to consumption of raw milk, unpasteurized apple cider, and chicken salad [21–23]. There is no known effective drug for the treatment of cryptosporidiosis. Immunodeficient individuals, especially persons with AIDS, may have the disease for life, with severe diarrhea and invasion of the pulmonary system contributing to death [17].

Beginning in 1985, and similar to the emergence of Cryptosporidium, 4 microsporidian protozoan parasites have been found almost exclusively in AIDS patients. Two microsporidians implicated in chronic diarrhea are Enterocytozoon bieneusi and Encephalitozoon intestinalis [24]. However, the sources and modes of transmission are uncertain. Environmental waterborne transmission is possible, as are ingestion of the spores, inhalation of aerosolized spores, and sexual transmission [25]. Effective therapies for Enterocytozoon bieneusi have not been established [26, 27]. Another protozoan parasite causing diarrhea and malabsorption, Isospora belli, may require repeated antimicrobial therapy in patients with AIDS [28–30].

### FOOD AND WATER SAFETY PRECAUTIONS

The following precautions for preventing or minimizing food- or waterborne diseases are recommended in the fifth edition of Nutrition and Your Health: Dietary Guidelines for Americans [31]:

- Do not eat raw or undercooked meat, poultry, fish, or shellfish (clams, oysters, scallops, and mussels). Whole poultry should be cooked to 180°F, poultry breast and well-done meats to 170°F, and medium-rare beefsteaks, roasts, veal, and lamb to 140°F.
- Reheat sauces, soups, marinades, and gravies to a boil. Reheat leftovers thoroughly to at least 165°F. Use a food thermometer to determine temperature. If a microwave oven is used, cover the container and turn or stir the food to make sure it is heated evenly throughout.
- Do not eat raw or partially cooked eggs, or foods containing raw eggs, raw (unpasteurized) milk, or cheeses made with raw milk. Cook eggs until whites and yolks are firm.
- The risk of contamination is high from undercooked hamburger and from raw fish (including sushi), clams, and oysters. Cook fish and shellfish until it is opaque; fish should flake easily with a fork. When eating out, order foods that have been thoroughly cooked and make sure they are served piping hot.
- When cooking, keep hot foods hot (140°F or above) and cold foods cold (40°F or below.) Harmful bacteria can...
grow rapidly in the danger zone between these temperatures. Whether raw or cooked, never leave meat, poultry, eggs, fish, or shellfish out at room temperature for >2 h (1 h in weather 90°F or above). Chill leftovers as soon as possible. Use refrigerated leftovers within 3–4 days.

- Freeze fresh meat, poultry, fish, and shellfish that cannot be used in a few days. Thaw frozen meat, poultry, fish, and shellfish in the refrigerator, microwave, or cold water changed every 30 min. Cook foods immediately after thawing.

- Avoid cross-contamination of foods. Uncooked meats should not come in contact with other foods. Hands, cutting boards, counters, knives, and other cooking utensils should be washed thoroughly after contact with uncooked foods.

- Listeriosis is a serious disease that occurs frequently among HIV-infected persons who are severely immuno-suppressed. Some soft cheeses and some ready-to-eat foods (e.g., hot dogs and cold cuts from delicatessen counters) have been known to cause listeriosis. Reheating these foods until they are steaming before eating them can prevent listeriosis.

- HIV-infected persons should not drink water directly from lakes or rivers because of the risk for cryptosporidiosis and giardiasis. They should avoid swimming in water that may be contaminated with human or animal waste, and they should avoid swallowing water during swimming.

- Boiling water for 1 min will eliminate the risk of acquiring cryptosporidiosis infection. The use of submicron, personal-use water filters or the drinking of bottled water might also reduce the risk for acquiring cryptosporidiosis. Current data are inadequate to support a recommendation that all HIV-infected persons boil or otherwise avoid drinking tap water in nonoutbreak settings. Persons choosing to use a personal-use filter or bottled water should be aware of the complexities involved in selecting the appropriate products, the lack of enforceable standards for destruction or removal of oocysts, the cost of the products, and the difficulty of using these products consistently.

- Nationally distributed brands of bottled or canned carbonated soft drinks are safe to drink. Commercially packaged noncarbonated soft drinks and fruit juices that do not require refrigeration until after they are opened are also safe. Nationally distributed brands of frozen fruit juice concentrate are safe if they are reconstituted with water from a safe source. Only juices labeled as pasteurized should be considered free of Cryptosporidium risk. Other pasteurized beverages and beers are considered safe to drink. No data are available concerning survival of Cryptosporidium oocysts in wine.

**CONCLUSION**

Knowledge of safe food- and water-handling techniques is essential for persons living with HIV and AIDS, their caretakers, and for health care providers to prevent the potentially life-threatening nature of such infections. The prevention of foodborne and waterborne illnesses as a component of an overall strategy for defensive living is critical. To decrease the risk of infection from enteric pathogens, emphasis should be placed on proper storage of perishable foods, adequate cooking of animal foods, avoiding cross-contamination of raw and cooked foods, ensuring appropriate sanitation in the kitchen, ensuring proper personal hygiene, and using water from safe sources.

**References**


