



Foodborne infections

The purpose of the present Paediatric Infectious Diseases Notes is to provide practical guidance to physicians who counsel patients on food safety (1). Food safety has become an important public health issue in North America. A sentinel system for active foodborne disease surveillance has been in place in the United States since 1996 (2), and a similar system has recently been established in Canada (3). In the United States, there has been a significant decline in the incidence of several foodborne infections in recent years, possibly attributable to implementation of safety initiatives (4-6).

BACKGROUND

The number of reported cases of enteric infections, most of which are foodborne, increased in many countries in the 1990s (7-10). New pathogens (*Cryptosporidium*, *Cyclospora*, calicivirus and norovirus) have emerged or have been recognized as foodborne (5,8,10). In addition, the population of immunocompromised patients who are highly susceptible to enteric pathogens has increased (11,12).

Foodborne pathogens have also been recognized as causes of severe extraintestinal disease (13). Infection with *Escherichia coli* O157 is an important cause of hemolytic-uremic syndrome (14,15). In the United Kingdom, variant Creutzfeldt-Jakob disease is linked to contaminated beef (16,17). Reactive arthritis after enteric bacterial pathogens, Guillain-Barré syndrome after *Campylobacter* enteritis, and disseminated *Listeria* in newborns of infected pregnant women are other examples (13,18).

Historically, vehicles for the transmission of foodborne infections have included undercooked meat, poultry or seafood, and unpasteurized milk. Uncracked eggs used to be considered safe. It is now recognized that *Salmonella* endemic in egg-laying flocks can contaminate intact eggs and, thus, inadequately cooked eggs have become a significant cause of infection. Fresh fruits and vegetables are increasingly reported as causes of foodborne outbreaks. Contaminated alfalfa sprouts, imported raspberries, tomatoes, cantaloupes, scallions and leaf lettuce, as well as unpasteurized apple juice, cider, orange juice and carrot juice have all been implicated (5,8,10,19,20). Table 1 summarizes the main food items that have been associated with foodborne illnesses and the principal microorganisms

involved. Alerts on new outbreaks of foodborne disease are posted on the Health Canada Web site (21).

THE CONSUMER AND FOOD SAFETY IN A CHANGING FOOD ENVIRONMENT

Food safety is the responsibility of the food industry, public health agencies and consumers. Issues that relate to the food industry and public health are beyond the scope of the present document. Consumers have an important responsibility in food safety. They may be increasingly concerned, but not knowledgeable about safe food preparation practices (22,23), and physicians can play a role in their education. Many consumers believe that foodborne illnesses are most often acquired outside of the home, whereas most infections actually occur in the home setting (24). Factors contributing to these infections are contaminated raw food supplies, improper food handling, and intentional consumption of raw or undercooked foods of animal origin.

Consumers are eating more fresh fruits and vegetables and grains – foods that are recommended as part of a healthier diet. These foods may travel over great distances. The demand for fresh produce all year round has resulted in increasing consumption of produce imported from countries where the methods of production are not as well controlled as in Canada and, thus, where microbial contamination is more likely to occur (8,22). It has been suggested that over 50% of fresh vegetables sold in the developed world are imported from developing countries (12).

Consumers are also using commercial meal services more often – at home or outside of the home. They frequently buy ready-to-eat take-out meals at grocery stores or restaurants. Preparation in bulk, and suboptimal storage or reheating may result in growth of pathogens in these foods (22).

Dietary choices that include rare meats or raw fish and seafood and rapid cooking methods, which do not heat food thoroughly, have become increasingly popular. Consumers need to be aware of the infection risks of these practices, and the need to ensure that the starting ingredients are safe (22).

Parents may erroneously assume that organic produce is free of risk. The risk of infection from organic produce is as high as the risk from nonorganic produce, and with some production conditions, the risk may be higher. Both types of produce must be prepared with care (25-27).

TABLE 1
Potentially contaminated food products

Food	Major organisms involved	Recommendation
Unpasteurized milk, cheese and other dairy products	<i>Salmonella</i> , <i>Campylobacter</i> , <i>Escherichia coli</i> O157, <i>Listeria</i> , <i>Mycobacterium bovis</i> , <i>Brucella</i>	Children should not drink unpasteurized milk or eat unpasteurized soft cheeses
Unpasteurized fruit or vegetable juices	<i>E coli</i> O157, <i>Salmonella</i> , <i>Clostridium botulinum</i>	Children should drink only pasteurized juice products, unless the fruit or vegetable is washed and the juice is freshly squeezed immediately before consumption
Eggs	<i>Salmonella</i>	Children should not eat raw or undercooked eggs, unpasteurized powdered eggs or products containing raw eggs
Raw or undercooked meat, poultry	<i>Salmonella</i> , <i>Campylobacter</i> , <i>E coli</i> O157, <i>Yersinia</i> , <i>Listeria</i> , <i>Toxoplasma</i> , <i>Brucella</i> , <i>Trichinosis</i>	Children should not eat raw or undercooked meat, poultry or meat products (including hot dogs)
Raw fish and shellfish	Vibrios, norovirus, hepatitis A, many other pathogens, toxins and parasites	Children should not eat raw shellfish. Some experts caution against eating any raw fish
Fresh fruits and vegetables	<i>Cryptosporidium</i> , <i>Cyclospora</i> , calicivirus, norovirus, <i>Giardia</i> , <i>Shigella</i> , <i>E coli</i> O157, other <i>E coli</i> species, hepatitis A	All fruits and vegetables should be washed before they are eaten. Lettuce, spinach and other salad greens require careful attention
Sprouts (alfalfa, mung bean)	<i>Salmonella</i> , <i>E coli</i> O157, hepatitis A	Children should avoid eating raw or undercooked alfalfa, mung bean or other sprouts. Seeds sold for sprouting may be contaminated
Honey	<i>C botulinum</i>	Children younger than one year of age should not be given honey
Cream-filled pastry; potato, egg or other salad with creamy dressing	<i>Staphylococcus aureus</i> , <i>Bacillus cereus</i>	These items should be eaten immediately on preparation or stored promptly in the refrigerator

Exposure of food to a controlled source of low-dose ionizing radiation enhances food safety by eliminating most microbial pathogens. Parents may be concerned about the safety of irradiated foods. Properly irradiated food is nutritious and safe (28-30). Those concerned about the risks of ingesting a radioactive substance should be reassured that irradiated food is not radioactive. However, irradiation does not rid food of all microbes and, thus, is not a substitute for appropriate food production, processing and preparation.

COUNSELLING TIPS FOR SAFE FOOD HANDLING

Ten rules for safe food preparation (31,32):

- **Choose foods that are safe.** Unpasteurized milk and unpasteurized juices (unless freshly prepared immediately before consumption) are inherently unsafe and without a noticeably improved nutritional value. Fresh fruits and vegetables can be contaminated and should be washed carefully, especially if they are to be eaten uncooked.
- **Separate food to be eaten raw from food to be cooked.** Keep uncooked meat, poultry, fish or seafood separate from foods that will be consumed uncooked (eg, fruits and vegetables). Cooked food can also become contaminated through casual contact with raw

food. Contamination can be from direct contact or indirect contact via contaminated cutting utensils, chopping boards and unwashed hands. It is important to carefully wash hands, utensils, chopping boards and work surfaces before and after manipulating raw food. When barbecuing, do not place cooked meats back on the plate that held uncooked meats.

- **Hands should be washed carefully before starting food preparation.** Hands should also be washed after handling raw food, especially meat and poultry. In addition, hands should be washed after any interruption in food preparation, especially for activities such as using the toilet, changing a diaper or touching a pet.
- **Cook meats, poultry, eggs and seafood thoroughly.** Raw meat, particularly poultry, is often contaminated with pathogens. Cooking these foods until they are steaming hot will ensure that most of the microorganisms are destroyed. It is particularly important to cook ground beef thoroughly (until it is no longer pink on the inside and the juices run clear) because inadequately cooked ground beef can cause *E coli* O157:H7 enteritis and hemolytic-uremic syndrome. Special care is required to ensure meat is thoroughly cooked when barbecuing (33).

Salmonella may be acquired from undercooked chicken, which should not be raw near the bones. Eggs should be thoroughly cooked to prevent transmission of *Salmonella*.

- **Eat foods soon after they are cooked.** Cooked foods should, whenever possible, be consumed as soon as possible after they are cooked. Setting foods aside to cool at room temperature before eating runs the risk of permitting the growth of residual microorganisms.
- **Store cooked foods appropriately.** If food must be cooked in advance, it should be kept above 60°C, or rapidly cooled and stored below 4°C to avoid growth of residual microorganisms. Store leftovers in the refrigerator or freezer promptly. Safe storage practices are particularly important for susceptible populations such as infants, toddlers and immunocompromised individuals.
- **Reheat cooked foods adequately.** If cooked food is to be reheated before consumption, an adequate temperature must be reached to destroy any microbial growth that may have occurred during storage. If a microwave oven is used, ensure that the food has reached a uniformly hot temperature.
- **Keep the kitchen meticulously clean.** Food debris can sustain microbial proliferation. Clean all used dishes, utensils and other equipment promptly.
- **Protect foods from insects, rodents and other animals (including pets).** These can be carriers of pathogenic microorganisms. Store nonperishable foods in closed containers in a safe place.
- **Always use safe water for food preparation.** If in doubt about water quality, boil it.

FOOD SAFETY FOR IMMUNOCOMPROMISED PATIENTS

Physicians should advise parents of children who are immunocompromised to be particularly vigilant. These children are at an increased risk of severe disease following the acquisition of foodborne microorganisms, including *Salmonella*, *Toxoplasma*, *Cryptosporidium* and *Listeria*.

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Therefore, special care should be taken in selecting and preparing foods for them. Uncooked foods that contain high microbial loads or that cannot be adequately cleaned should be avoided. Recommendations for preventing food-borne illnesses in individuals with immunodeficiency after hematopoietic stem cell transplantation (34) or due to HIV (35,36) have been published. Advice in these documents is also pertinent to patients who are immunocompromised because of other illnesses or therapy.

- It is especially important that meats, including casseroles containing raw meat, be cooked to the appropriate temperatures (33). A thermometer should be used to measure internal temperature. Meat patés and other meat spreads that require refrigeration may contain bacteria and should be avoided or heated before being consumed.
- Caution should be taken with foods that may contain raw or undercooked eggs (eg, certain preparations of hollandaise sauce, salad dressings, homemade mayonnaise, homemade eggnog, uncooked cake or cookie batter). These should be avoided, unless it can be confirmed that they do not contain raw eggs.
- Soft cheeses and cheeses to which live microbial cultures have been added should be avoided.
- Fresh fruits and vegetables should be thoroughly washed, then peeled or cooked. Raw fruits and vegetables that cannot be peeled and cannot easily be washed (eg, raspberries and strawberries) should be avoided.
- Raw seed sprouts should be avoided.

ADDITIONAL INFORMATION ON FOOD SAFETY FOR FAMILIES

- The Canadian Partnership for Consumer Food Safety Education. <<http://www.canfightbac.org/en/>> (Version current at October 21, 2008).
- The Food Safety Network. <<http://www.foodsafetynetwork.ca/en/>> (Version current at October 21, 2008).

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