

Food Hazards — Learn How to Avoid Them and the Foodborne Illnesses They Cause **By Jacqueline S. Gutierrez, MS, MEd, RD, CDN**

Suggested CDR Learning Codes: 8000, 8040; Level 2

Lately, numerous news reports have detailed various food hazards that have tainted our food supply. For example, in April 2013, 200 of 825 guests became sick with stomach cramps caused by norovirus after a sorority brunch in a New York hotel. This occurred even after additional precautions were taken because of two other norovirus outbreaks at the same hotel earlier in the week.¹ Nine people in Connecticut experienced severe diarrhea in 2009 after consuming *Salmonella*-contaminated potato salad at a reception, and there was a multistate outbreak of *Escherichia coli* in 2006 caused by contaminated spinach. At that time, the FDA issued a nationwide alert telling consumers to avoid eating bagged fresh spinach, and during the next 68 weeks, sales of the product decreased by 20%.²

Bacteria, viruses, and parasites ingested through contaminated foods can enter the human body, resulting in foodborne illnesses. Toxins and certain fungi also can cause foodborne illnesses when accidentally ingested, while other chemical and physical hazards, such as cleaning solutions and small pieces of broken glass, can cause serious injury as well. The Centers for Disease Control and Prevention (CDC) estimates that approximately one in every six Americans (roughly 48 million people) experiences a foodborne illness each year. Of that number, the CDC says 128,000 require hospitalization and 3,000 die.³ Infants and young children, pregnant women, the elderly, and people with compromised immune systems particularly are vulnerable to contracting foodborne illnesses.⁴

The most practical way to avoid contracting a foodborne illness is prevention, and RDs can help clients by providing information on how to keep their food safe at all times. Moreover, RDs in foodservice can educate staff to ensure proper handling practices are followed in this environment.

This continuing education course examines the various hazards that affect our food supply, the ways in which they contaminate our food and contribute to morbidity and even mortality, and strategies for avoiding these hazards.

Categories of Food Safety Hazards

Food safety hazards are divided into three categories: biological, chemical, and physical. The food industry uses the system of Hazard Analysis and Critical Control Points, which involves seven steps to reduce or eliminate such hazards. The first step is to identify potential food hazards, which is the focus of this course. Other steps determine critical control points, set critical limits, establish monitoring procedures, identify which corrective actions should be used if needed, create verification procedures, and develop procedures for keeping records and documentation as needed.⁵

Biological Hazards

Most people think of bacteria when they hear the term “biological hazards,” yet a virus is responsible for the greatest number of foodborne illnesses. The CDC says norovirus was responsible for 58% of the foodborne illness cases reported in 2011.³ *Salmonella*, a bacterium, was responsible for 11% of such cases and was the second most common cause of such illnesses; it also accounted for 35% of hospitalizations related to foodborne illnesses and was the most common cause of such hospitalizations.⁶ *Salmonella* also was the leading cause of death related to foodborne illness (28%), followed by *Toxoplasma gondii* (24%), *Listeria monocytogenes* (19%), and norovirus (11%).⁶ It’s estimated that each year in the United States, 31 major pathogens cause 9.4 million cases of foodborne illness, more than 55,000 hospitalizations, and close to 1,400 deaths.⁷

In 2012, the Foodborne Diseases Archive Surveillance Network (FoodNet) identified 19,531 laboratory-confirmed cases of foodborne illness from biological sources, including 7,800 *Salmonella* infections, 6,793 *Campylobacter* infections, 2,138 *Shigella* infections, 1,234 *Cryptosporidium* infections, and other infections from Shiga-toxin producing *E coli* (STEC) O157 and non-O157, *Vibrio*, *Listeria*, *Yersinia*, and *Cyclospora*.⁸ These data don’t include cases that may have gone unreported by people with relatively mild symptoms who thought they had a stomach virus when, in fact, they had a foodborne illness.

Bacteria

Bacteria need time to grow, and they double in number every 20 minutes. After four hours, their numbers are high enough to sicken people who eat bacteria-contaminated food. In addition, some types of bacteria produce toxins that can accumulate and lead to illness.

Bacteria also need an energy source in which to thrive and, unfortunately, our food supply often is this source. Most bacteria prefer foods that are slightly acidic or have a neutral pH, ranging from 4.6 to 7.5; many require oxygen. They also need moisture to grow and thrive in temperatures between 41°F (5°C) and 135°F (57°C).⁹ Any temperature inside this range is considered part of the “danger zone.”

Though many bacteria are killed during the cooking process, foods still can contain a level high enough to render them unsafe if the following occurs: They don’t reach the required internal cooking temperature and stay at that temperature for the length of time needed to kill the bacteria (which depends on the type, cut, and size of the food); they contain toxins produced by bacteria during the cooking process; or they become contaminated from another source after the cooking process (cross-contamination).

Some bacteria can grow relatively well under refrigeration, such as *Yersinia enterocolitica*, which often are found in contaminated dairy products, water, tofu, and pork. *Yersinia* affect babies younger than the age of 1 at a rate 40 times greater than that of adults and can survive in a frozen environment for nearly 450 days. Pasteurization and properly cooking foods can minimize infection from this microorganism.¹⁰

Listeria also thrive under refrigeration and cause listeriosis, which produces flulike symptoms, often fooling people into thinking they have a simple cold or the flu rather than a serious

bacterial infection. Listeriosis is particularly hazardous to pregnant women who, according to the CDC, are roughly 13 times more likely to develop it than are others.¹¹ The disease can cause stillbirth, miscarriage, premature delivery, or infection in newborns.^{11,12} *Listeria* can grow in deli meat that's left on the counter or in the refrigerator for too long and in unpasteurized milk, cheese made with unpasteurized milk, smoked seafood, pâté, hot dogs, and contaminated melons even when under refrigeration.

Ingesting *Campylobacter* strains can lead to campylobacteriosis, which causes diarrhea, abdominal cramping, and fever within two to five days of exposure. Those with a mild case of campylobacteriosis may have a few symptoms that resolve in less than a week. However, in those with compromised immune systems, the infection can be severe and spread to the bloodstream, thus requiring medical treatment.¹³

Campylobacter are common in beef, pork, and poultry, and thrive in reduced-oxygen environments. They can be killed by introducing oxygen, drying, or freezing. To prevent campylobacteriosis, food generally should be cooked until it maintains an internal temperature of 165°F (74°C) for at least 15 seconds, and thorough hand washing should occur before and after handling.¹³ To prevent cross-contamination, separate utensils should be used for cooked and raw foods.

Clostridium botulinum form spores in water and soil, and also thrive in an environment without oxygen, producing a potentially deadly botulism. The bacteria inhabit improperly canned foods, dented or bulging cans, temperature-abused vegetables, and garlic-in-oil mixtures that don't contain preservatives to minimize bacterial growth. Symptoms of botulism include nausea, vomiting, weakness, double vision, and difficulty speaking or swallowing.

To prevent botulism, any damaged cans should be discarded, and foods should spend the least amount of time possible in the danger zone. To keep garlic-in-oil mixtures safe, the FDA recommends keeping the mixture's pH below 4.6 using acetic or phosphoric acid, refrigerating it or storing it hot (outside the danger zone), and keeping it at room temperature for only short periods of time.^{9,14} It may be wise to advise clients at high risk of foodborne illness not to use such mixtures and recommend that those who make homemade garlic-in-oil include an acid such as vinegar to help preserve it. Those using commercial garlic-in-oil should be sure to keep it refrigerated and use it within one week after opening.

Clostridium perfringens, bacteria related to *Clostridium botulinum* that also are found in soil, form spores, and produce a toxin, are carried in human and animal intestines as well as foods grown in contaminated soil. They multiply rapidly in the danger zone, and diarrhea and abdominal pain are symptoms of the related illness. To prevent *Clostridium perfringens* gastroenteritis, clients should minimize the amount of time food remains in the danger zone.⁹ To limit the growth of *Clostridium perfringens*, make sure that stews and chilis reach an internal temperature of at least 145°F during cooking, even if a slow cooker is used, and refrigerate any leftovers as quickly as possible, within at least two hours.

E coli include several strains of related bacteria. While many harmless strains inhabit the lower bowel, *E coli* O157:H7 and a few other strains produce STEC. Symptoms of illness caused by

STEC include abdominal cramps, diarrhea, and vomiting, which begin one to 10 days after exposure. Bloody or watery stool is one of the first symptoms of hemorrhagic colitis caused by *E coli*. Hemolytic uremic syndrome also can develop. Proper hand washing, especially after using the restroom or coming in contact with farm animals or their feces; thoroughly cooking meats; avoiding raw milk; and preventing cross-contamination can help prevent this illness.¹⁵

Salmonella often are found on farm animals such as chickens and turkeys as well as on their eggs. Symptoms of the related illness include diarrhea, abdominal cramps, vomiting, and fever. To prevent illness, poultry and eggs should be cooked until they maintain an internal temperature of 165°F for at least 15 seconds, and cross-contamination should be avoided by thoroughly washing raw foods and utensils, and keeping raw foods separate from cooked foods.⁹

Shigella, which inhabit the feces of infected animals and people, cause shigellosis. The illness often is transmitted by contaminated food or water and can be transferred to food by flies that previously have landed on feces. Symptoms of shigellosis include bloody diarrhea, abdominal pain and cramps, and sometimes fever.⁹ Foodservice personnel who have diarrhea shouldn't handle food. Proper hand washing, especially after using the restroom, is the best way to prevent transmission.

Staphylococcus aureus often are found on human hair and in the nose and throat, and the related illness often is transmitted from unwashed or improperly washed hands to salads or deli meats, which aren't cooked before being served. These bacteria produce toxins that aren't deactivated by cooking and lead to staphylococcal gastroenteritis. Symptoms include nausea, vomiting, and abdominal cramps.⁹ As with *Shigella*, proper hand washing is the key to prevention.

Vibrio vulnificus and *Vibrio parahaemolyticus* are related species of bacteria found in contaminated shellfish, such as oysters, as well as contaminated seawater. Symptoms of the related illness include nausea, vomiting, diarrhea, a low-grade fever, and chills. In those with compromised immune systems, *Vibrio* infection can lead to septicemia which, without medical treatment, can lead to death.⁹ These bacteria grow well in the danger zone, so cooking to an internal temperature of at least 145°F for 15 seconds is important.

Parasites

Less commonly, parasites that live in beef, poultry, pork, seafood, animal and human feces, and contaminated water cause foodborne illnesses. Because refrigeration doesn't kill parasites, it's important to purchase meats and seafood from only reputable suppliers that are inspected on a regular basis and to be aware of alerts concerning water safety. Sushi-grade fish are required to undergo deep freezing before use to kill such parasites.

The parasite *Anisakis simplex* is found in contaminated raw and undercooked fish and seafood. The illness it creates, anisakiasis, causes tingling in the throat and leads those infected to cough up worms. Advise clients to cook fish so that it maintains an internal temperature of at least 145°F for 15 seconds or they should use sushi-grade fish that was properly deep frozen.^{9,16}

Cyclospora cayetanensis can occur in produce grown on farms that used contaminated water. Infection can last for one day to two weeks, and symptoms include diarrhea, nausea, weight loss, cramps, flatulence, fatigue, and low-grade fever.¹⁷

Cryptosporidium parvum and *Giardia duodenalis* are found in the feces of those who are infected with the parasite. These parasites contaminate fresh produce and are spread through contaminated water. The illnesses they produce, cryptosporidiosis and giardiasis, often result from improper hand washing. Symptoms include watery diarrhea, abdominal cramps, and nausea; cryptosporidiosis also can produce a fever.⁹

Probably the most widespread case of cryptosporidiosis reported by the media occurred in 1993 when *Cryptosporidium* contaminated the water supply of Milwaukee, causing watery diarrhea in approximately 403,000 residents and killing 69 of them. The cause was traced to a filtration problem in a municipal water treatment plant.^{18,19} The best way to prevent *Cryptosporidium*-related illness is to boil water if there's an advisory.

Trichinella is found in the raw or undercooked meat of infected animals and can lead to trichinellosis (also called trichinosis), though this is rare. Typical symptoms occur one to two days after infection and include nausea, diarrhea, vomiting, and abdominal pain. After two to eight weeks, the infected person also can experience headaches, fever, chills, coughing, eye swelling, aching joints, muscle pain, and itchy skin. In severe cases, heart and breathing problems and even death can occur.²⁰

To avoid illness, pork and wild game meats should be cooked to their proper internal temperatures. For whole cuts of pork, the CDC recommends an internal temperature of 145°F for 15 seconds and for ground pork, as well as both whole and ground wild game meats, 160°F (71°C) for 15 seconds.²⁰

Fungi

Fungi such as mold and yeast can spoil foods and ultimately cause illness. Mold can produce toxins that lead to allergic reactions, central nervous system difficulties, and kidney and liver damage. It thrives in acidic foods with low water content, such as jams or cured meats, but will grow on any food that's held out for too long. Refrigeration and freezing will slow fungal growth but won't kill fungi.⁹

Some varieties of mold are harmless and can be beneficial when used to ripen certain types of cheese and produce antibiotics, but any food that unintentionally has grown mold should be thrown away.⁹

A product that has been spoiled by yeast will emit an odor or taste of alcohol. The item may appear white or pink in color or a slime may be present. Yeast grows in the same types of foods as does mold. The best way to avoid becoming ill is to discard any food that's discolored or has an odor of alcohol.⁹

Aspergillus flavus and *Aspergillus parasiticus*, which are fungal pathogens, produce aflatoxin; they can contaminate corn, peanuts, cottonseed, milk, and tree nuts and cause liver disease.⁹

Viruses

Foodborne viruses, which primarily are transmitted when people fail to properly wash their hands after using the bathroom,⁹ cause diseases such as hepatitis A and norovirus gastroenteritis. They lie dormant until ingested and can reproduce only when inside a living organism. They can survive under both refrigeration and freezing, and can be transmitted directly to food from a person infected with the virus. These viruses especially are prevalent among foodservice employees who don't take proper hygienic measures, but they're also found in shellfish grown in water contaminated with sewage. Symptoms of hepatitis A include mild fever, nausea, abdominal pain, and jaundice; symptoms of norovirus include nausea, vomiting, and diarrhea.

Proper hand washing is the best way to prevent outbreaks of both hepatitis A and norovirus, and foodservice employees who are infected with either of these pathogens or who have symptoms of diarrhea shouldn't prepare foods. Also, shellfish should be purchased only from reputable suppliers who fish in uncontaminated waters.⁹

Prions

Prions are small pathogenic proteins that, much like viruses, require a living host to grow and survive. They were discovered relatively recently and are best known for causing mad cow disease (bovine spongiform encephalopathy), a fatal infection of the brain in cattle and other livestock. FDA regulations that took effect in 1997 prohibit the use of animal protein in the veterinary feed of cows, sheep, and goats.²¹ Prions can't be detected by color, odor, or taste, so avoiding contaminated meats and heeding food warnings are the best ways to avoid this pathogen.

Toxins

Bacteria in food items that are time and temperature abused (generally spending more than four hours in the danger zone) can produce toxins. In these instances, although the bacteria are killed, the toxin remains even after cooking, freezing, smoking, or curing.

The time for bacteria to grow to a hazardous level varies depending on the type of bacteria involved, the initial contamination level, and time in the danger zone. Seafood toxins produced in pufferfish, moray eels, and freshwater minnows can't be detected by smell or taste and aren't destroyed in the cooking or freezing process.⁹ The only way to avoid these toxins is to consume only seafood items that were safely handled by a regularly inspected supplier and never subjected to time and temperature abuse. If such items are on the menu at your foodservice establishment, it's important to hire a chef trained in their preparation, include a disclaimer on your menu, and possibly prepare a customer waiver as well.

Scombroid poisoning occurs when people consume high levels of histamine found in affected fish, such as tuna, bonito, mackerel, or mahi mahi. When these fish are time and temperature abused, associated bacteria produce a toxin that leads to illness. Symptoms of scombroid poisoning include reddening of the face and neck, sweating, headache, burning or tingling in

the mouth or throat, diarrhea, and vomiting. To prevent poisoning, if there's any chance these types of fish have been time and temperature abused, they should be discarded.⁹ It's important to use a reputable supplier who uses proper time and temperature control practices during harvesting.

Ciguatera poisoning results from the ingestion of ciguatoxin, which is produced by some marine algae. The toxin builds up in the bodies of barracuda, grouper, jacks, and snapper that ate contaminated smaller fish. This toxin can't be detected by smell or taste and isn't destroyed by cooking or freezing. Symptoms of ciguatera poisoning can last for months or years and include alternating hot and cold sensations; nausea; vomiting; tingling in the fingers, lips, or toes; and joint and muscle pain. To avoid this illness, purchase fish from approved suppliers that are regularly inspected and maintain a good reputation.¹⁰ Also, foodservice establishments should purchase all shellfish from suppliers on the Interstate Certified Shellfish Shippers List.

Paralytic, neurotoxic, and amnesic shellfish poisoning are caused by ingesting saxitoxin, brevetoxin, and domoic acid—toxins found in shellfish such as clams, mussels, oysters, and scallops that filter toxic algae from the water. *Nitzschia pungens* is an example of an organism that produces a toxin that could lead to amnesic shellfish poisoning.⁷ These toxins can't be detected by smell or taste and aren't destroyed by cooking or freezing. Symptoms of shellfish poisoning include numbness; tingling of the mouth, face, arms, and legs; dizziness; nausea; vomiting; diarrhea; and possibly even death caused by paralysis. It's important to purchase shellfish from approved suppliers to avoid this illness.⁹

Some wild mushrooms contain toxins that aren't destroyed by cooking or freezing. In addition, raw and undercooked kidney beans contain phytohemagglutinin, a type of lectin that's reduced and deactivated during cooking. Its presence can lead to symptoms such as nausea, vomiting, and diarrhea. Before cooking, kidney beans have 20,000 to 70,000 hemagglutinating units (hau), while well-cooked beans contain 200 to 400 hau.^{9,22}

Vermin

Vermin such as cockroaches, flies, and other insects can create contamination by falling into food or leaving behind droppings, which can contain millions of pathogenic microorganisms. They also can track bacteria from one part of the kitchen, such as the garbage can, to another area, including where food is prepared.

Rodents and other animals can leave hair, urine, and droppings that present a biological hazard. Rodents also can carry diseases not commonly associated with a foodborne illness, such as hantavirus, which are beyond the scope of this article. The presence of vermin is a critical violation during a restaurant's health inspection, and owners risk losing their licenses to operate a food establishment. Regular pest-control service is crucial in preventing such infestations.

Proper Handling to Avoid Food Hazards

Properly cooking and cooling foods and avoiding cross-contamination generally will prevent the growth of most bacteria and fungi.

Foods should be cooked at the temperatures listed in their directions and for the appropriate amount of time to kill bacteria. The time and temperature vary according to the product being prepared. Thoroughly rinse raw fruits and vegetables under cool water before preparing; minimize the amount of time any food spends in the danger zone; and refrigerate meats and dairy products when not in use.

Refrigerate items such as deli meats rather than let them sit out during meals or events. To prevent cross-contamination between raw and cooked foods, separate utensils and cutting boards should be used for raw and cooked foods. In addition, utensils, cutting boards, countertops, and hands should be periodically washed with soap and warm water during preparation.

As a good practice, all foods should be refrigerated in a timely manner and not left out for more than 30 to 60 minutes to cool after cooking and before refrigeration. To cool foods properly after cooking—and minimize their time in the danger zone—they should be stored in shallow containers to allow for more equal and efficient cooling, and refrigerated in a timely manner to prevent bacterial growth. If large quantities are prepared and cooked foods still are hot after that time, use an ice bath to help cool the food quickly before refrigerating. Any foods left at room temperature for four hours or more should be discarded.⁵

In a commercial foodservice establishment, the two-stage cooling method must be used when cooling hot foods for later use. During the first stage, cool hot foods from 135°F to 70°F (57°C to 21°C) within two hours. If the food doesn't reach 70°F within two hours, it should be either reheated or discarded. During the next stage, cool the food to 41°F or lower over the next four hours. The total cooling time should never be more than six hours.¹⁶

Also, proper hand washing, especially after using the restroom, will decrease foodborne infections.

Treatment and Recovery From Biological Illnesses

The treatment of foodborne illness varies depending on the infected person's immune system and the concentration of the pathogenic organism or toxin that's ingested. Incubation times vary; some pathogens, such as *Staphylococcus aureus*, can cause symptoms within 30 minutes of ingestion, while others, such as *Listeria monocytogenes*, have incubation times as long as two to six weeks.¹⁷

In many cases, foodborne illnesses can resolve without treatment, especially in people with strong immune systems who have mild infections that produce symptoms resembling those of a stomach virus or upset stomach. Often, these people don't even recognize that the nausea or diarrhea they're experiencing was caused by contaminated food. However, infections from toxins, such as those produced by *Clostridium botulinum*, could be fatal if the patient doesn't receive immediate medical treatment.

For those more susceptible to foodborne illnesses, instances of nausea, vomiting, and diarrhea lasting for more than one to two hours should be reported to a health professional because, without treatment, these infections can be fatal. Extreme symptoms such as double vision,

paralysis, or slurred speech require an immediate trip to the nearest emergency department.⁹ Hospitalization ultimately may be necessary.

Chemical Hazards

Chemical hazards, such as alcohol, ammonia, bleach, cleaning solutions, dishwashing liquid, polishes, and solvents, enter the food supply because of simple human error. In 2008, for example, a foodservice employee forgot to rinse the sanitizer from a beverage machine before adding the beverage. A customer drinking tea from that machine consequently experienced burning in her mouth from the residual sanitizer.²³

Whether in the home or professional kitchen, chemicals should be stored safely and be properly labeled so they're immediately identifiable as hazardous substances. They also should be kept away from food and cooking areas, and only food-grade lubricants should be used on food equipment.²⁴

In the foodservice industry, it's important that employers keep up-to-date Material Safety Data Sheets in binders within easy reach of all kitchen employees. These documents contain information about the toxicity of each chemical and how to clean a spill. They can be obtained directly from the various chemical suppliers.

It's important to use only food-grade utensils and serving equipment because non-food-grade equipment may contain toxic metals that could dissolve in acidic foods and lead to heavy-metal poisoning. For example, lead in the pewter used to make pitchers can react negatively with acidic drinks such as tomato juice.

Copper pots and pans may be good for cooking certain items because copper is a great heat conductor, but they're not recommended for preparing acidic foods, such as tomato sauce. For safety, copper pots should be lined inside with a less reactive metal, such as stainless steel.

In foodservice kitchens, copper also can filter into carbonated beverages that backflow into pipes. A professional plumber should install all fixtures in a facility to ensure the equipment prevents backflow. Zinc is used to make galvanized metal items, such as buckets and tubs, and also can filter into acidic foods. To be safe, stainless steel equipment is a much better cooking alternative.²⁴

Physical Hazards

Physical hazards also pose a danger to our food supply. Although a strand of hair in food is more of a nuisance, pieces of broken glass or metal can cause damage if they're accidentally ingested, including causing lacerations to the gastrointestinal track.

It's important to use shatterproof glass when cooking, cover lightbulbs with a mesh shield, and throw away any foods suspected of being contaminated with glass, plastic, or metal shards, no matter how small the pieces may be. In 2012, the US Consumer Product Safety Commission asked a company to recall its cookware set after there were 65 reports of broken or shattered glass lids.²⁵

Within the past two years, several people have been hospitalized when they accidentally ingested bristles from wire brushes used for cleaning grills; they ultimately needed emergency surgery to repair internal bleeding.²⁶ A bristle can puncture the lining of the intestinal wall and allow bacteria to seep into the bloodstream.

The Consumer Product Safety Commission is conducting a review to determine whether grill brushes with metal bristles are safe for public use, and it has compiled nearly a dozen complaints throughout the country about such brushes.²⁶

Other items that easily can fall into food include shattered lightbulbs, chips of nail polish, strands of hair, and shards of metal from the edges of cans opened with a damaged can opener. To help prevent these hazards, advise clients to use shatterproof lightbulbs and can openers that are in good condition and cut cleanly. Foodservice employees should avoid wearing nail polish and should wear hairnets or ponytails (often a requirement for working in a commercial kitchen).

Jewelry also can fall into foods or possibly get caught in machinery and cause an injury to a food preparer. For example, an earring can fall off as potato salad is being mixed or a necklace can get caught in a slicing machine, leading to injury to the food preparer as well as physical contamination of the food.²⁷ The Federal Food Code permits only a simple ring, such as a plain wedding band, to be worn during food preparation, which may be advisable for home cooks as well.

Bandages or finger cots should be covered with gloves to prevent the items from falling into food.²⁷

In addition, clear drinking glasses shouldn't be used to scoop ice out of an ice machine because they can chip, and the glass chips will blend in with the ice and can become invisible. Instead, metal or plastic scoops should be used and stored near the ice machine.

Last, a system should be in place in a commercial kitchen to prevent food tampering, which can be done by limiting kitchen access to only screened employees.

A Little Precaution Is Worth a Pound of Cure

There's a minefield of biological, chemical, and physical hazards that can contaminate our food supply. It's important for RDs to recognize these dangers so they can effectively and accurately advise clients how to prevent them. Proper hand washing, buying foods and supplies from approved vendors, proper cooking, and preventing cross-contamination will help clients avoid most of these hazards.

— *Jacqueline S. Gutierrez, MS, MEd, RD, CDN, is a New York-based freelance writer and an adjunct instructor who teaches culinary and nutrition classes.*

Resources

- Foodborne Diseases Active Surveillance Network (www.cdc.gov/foodnet)
- FoodSafety.gov
- USDA Food Safety and Inspection Service (www.fsis.usda.gov/wps/portal/fsis/home)

Common Biological Hazards

Bacteria: *Bacillus cereus*, *Campylobacter fetus*, *Campylobacter jejuni*, *Clostridium botulinum*, *Clostridium perfringens*, *Cryptosporidium*, *Escherichia coli*, *Listeria monocytogenes*, *Nitzschia pungens*, *Salmonella enteritidis*, *Salmonella typhimurim*, *Shigella flexner*, *Staphylococcus aureus*, *Vibrio vulnificus*, *Vibrio parahaemolyticus*, *Yersinia enterocolitica*

Viruses: hepatitis A, norovirus

Parasites: *Anisakis simplex*, *Cyclospora*, *Trichinella*

Prions: mad cow disease (bovine spongiform encephalopathy)

Toxins: amnesic, neurotoxic, and paralytic shellfish poisoning; Ciguatera fish poisoning; scombroid poisoning, wild mushrooms

Vermin: cockroaches, flies, and other insects; rodents and other vermin

The Danger Zone

The danger zone—41°F (5°C) to 135°F (57°C)—is the temperature range that allows most bacteria to grow. Between these temperatures, bacteria can double every 20 minutes. After four hours in the danger zone, the amount of bacteria present in the food will render it unsafe to eat. Foods left sitting outside within these parameters for any length of time are considered time and temperature abused and should be discarded.

Certain foods are more likely to become unsafe when left in the danger zone than others, including dairy products, fish, and eggs as well as baked potatoes, sliced melons, bean sprouts, and unrefrigerated, untreated garlic-in-oil.

Other factors contributing to bacterial growth include acidity levels, the presence or absence of oxygen, and the presence of moisture. The acronym FATTOM makes these factors easier to remember: food, acidity, temperature, time, oxygen, and moisture.

Time in the danger zone needs to be minimized, and any foods left in the danger zone for four hours or more must be discarded.

— JSG

Proper Hand Washing

Engaging in proper hand washing practices is one of the most effective ways to prevent bacterial and viral contamination and to even save lives. Hand washing must be done before and after preparing foods and after using the restroom, eating, smoking, or handling garbage.

The Centers for Disease Control and Prevention recommends the following procedure for ensuring infection control through proper hand washing: Wet your hands with clean running water (hot enough to tolerate) and apply soap. Rub your hands together to form a lather and scrub them well. Be sure to scrub the back of your hands, between the fingers, and under and around the nails. Continue scrubbing for at least 20 seconds, or the length of time it takes to hum or sing “Happy Birthday” twice. Rinse well and dry with a clean towel or allow to air dry.²

If soap and water aren’t available, an alcohol-based hand sanitizer that contains at least 60% alcohol should be used. However, hand sanitizers don’t remove dirt or debris from hands, so washing with soap and water is preferred.

— JSG

Preventing Biological Food Hazards

- Purchase foods from reputable suppliers who operate clean establishments that have appropriate refrigeration and are subject to proper health inspections.
- Refrigerate foods that need cold storage, such as milk and other dairy products, raw and cooked vegetables, fruits (after being cut), and meats as well as opened jars, bottles, and cans.
- Cook seafood, poultry, pork, beef, and other meats to their proper internal temperatures and for the time required to kill microorganisms. Note that this time and temperature varies based on the type of meat, so following label instructions is critical.
- Wash hands with soap and water hot enough to tolerate, especially after using the restroom.
- Thoroughly rinse raw vegetables and fruit before cutting or serving.
- Serve only cheeses made with pasteurized milk and drink only pasteurized milk.
- Carefully wash cooking equipment, utensils, and food surfaces both before and after food preparation using soap and water hot enough to tolerate or in a dishwasher that uses water at a temperature that kills microorganisms.
- Separate cooked meats from raw foods to prevent cross-contamination.
- Minimize the time any food spends in the danger zone.

- Follow instructions and advisories of local authorities when your community water supply has been compromised (eg, boil water for the appropriate time needed to kill the invading parasite).
- Discard any food that has been time and temperature abused, has visible mold, is discolored, or has an unusual odor.
- Avoid serving refrigerated smoked seafood to pregnant women because of the risk of *Listeria*.
- Discard food from damaged or bulging cans.
- Discard cut and prepared foods, especially cut melons, that have been at room temperature for four hours or longer.
- Discard any meats, dairy products, cut vegetables, or cut fruits suspected of being contaminated or that haven't undergone proper refrigeration.

— JSG

Keeping Chemical and Physical Hazards at Bay

Agent	Prevention
Chemicals (eg, bleach, caustic acids or bases, cleaners, detergents, drying agents, polishes, sanitizers, metals that dissolve in acidic food, pesticides, whitening agents)	<p>Chemicals should always be kept separate from food supplies, preferably in a separate cabinet, and bottles should be clearly labeled as containing chemicals.</p> <p>If cooking with copper pots, the interior should be lined with a nonporous metal, such as stainless steel.</p> <p>In a commercial kitchen, up-to-date Material Safety Data Sheets should be easily accessible.</p> <p>All containers, pots, and pans should be thoroughly washed and rinsed using cleaning solutions before beginning new food preparations.</p>
Physical (eg, bandages, nail polish chips, hair, jewelry, pieces of bone or broken glass, dirt or soil, fruit pits, metal brush bristles, nails, metal shavings, packing material, small pieces of metal or plastic, staples, broken glass from light bulbs, falling dust, wood splinters)	<p>When preparing food, gloves should be worn to cover any finger cots or bandages.</p> <p>Other than a plain wedding band, jewelry should not be worn while cooking so that pieces don't fall into food or get caught in machinery.</p> <p>Nail polish and artificial nails should be avoided to prevent chips from falling into food.</p> <p>Glass cookware should be shatterproof so that pieces of glass do not get into food.</p>

References

1. Suspected norovirus outbreak strikes swanky Hilton Westchester hotel. CBS New York website. <http://newyork.cbslocal.com/2013/04/30/suspected-norovirus-outbreak-strikes-hilton-westchester-hotel/>. Last updated April 30, 2013. Accessed May 25, 2013.
2. Arnade C, Calvin L, Kuchler F. Consumer response to a food safety shock: the 2006 food-borne illness outbreak of E. coli O157:H7 linked to spinach. *Appl Econ Perspect Pol*. 2009;31(4):734-750.
3. CDC 2011 estimates: findings. Centers for Disease Control and Prevention website. <http://www.cdc.gov/foodborneburden/2011-foodborne-estimates.html>. Last updated October 10, 2012. Accessed April 15, 2013.
4. Providing safe food. In: National Restaurant Association. **ServSafe Coursebook**. 5th ed. Chicago, IL: National Restaurant Association; 2008:1.1-1.16.
5. Food safety management systems. In: National Restaurant Association. **ServSafe Coursebook**. 5th ed. Chicago, IL: National Restaurant Association; 2008:10.1-10.30.
6. Centers for Disease Control and Prevention. Preliminary FoodNet data on the incidence of infection with pathogens transmitted commonly through food-10 states, 2009. *MMWR Morb Mortal Wkly Rep*. 2010;59(14):418-422.
7. Scallan E, Hoekstra RM, Angulo FJ, et al. Foodborne illness acquired in the United States—major pathogens. *Emerg Infect Dis*. 2011;17(1):7-15.
8. Table 2a FoodNet—number of laboratory-confirmed infections by year 2012. Centers for Disease Control and Prevention website. <http://www.cdc.gov/foodnet/data/trends/tables/2012/table2a-b.html>. Last updated April 18, 2013. Accessed May 25, 2013.
9. The microworld. In: National Restaurant Association. **ServSafe Coursebook**. 5th ed. Chicago, IL: National Restaurant Association; 2008:2.1-2.33.
10. Wesley IV. Yersinia enterocolitica remains a potent threat. *Nat Provision*. 2007;221(8):108.
11. Protect your unborn baby or newborn from infections. Centers for Disease Control and Prevention website. <http://www.cdc.gov/features/prenatalinfections>. Last updated January 14, 2013. Accessed May 4, 2012.
12. Listeria (listeriosis): prevention. Centers for Disease Control and Prevention website. <http://www.cdc.gov/listeria/prevention.html>. Last updated September 21, 2011. Accessed May 22, 2012.

13. Campylobacter: general information. Centers for Disease Control and Prevention website. <http://www.cdc.gov/nczved/divisions/dfbmd/diseases/campylobacter>. Last updated July 20, 2010. Accessed May 28, 2012.
14. Chapter 8. Framework developed to determine whether foods need time/temperature control for safety. US Food and Drug Administration website. <http://www.fda.gov/Food/FoodScienceResearch/SafePracticesforFoodProcesses/ucm094159.htm>. Last updated April 9, 2013. Accessed August 14, 2012.
15. E. coli (Escherichia coli). Centers for Disease Control and Prevention website. <http://www.cdc.gov/ecoli>. Updated March 29, 2013. Accessed May 25, 2013.
16. The flow of food: preparation. In: National Restaurant Association. **ServSafe Coursebook**. 5th ed. Chicago, IL: National Restaurant Association; 2008:8.1-8.27.
17. Guide to confirming a diagnosis in foodborne disease. Centers for Disease Control and Prevention website. http://www.cdc.gov/outbreaknet/references_resources/guide_confirming_diagnosis.html. Last updated February 16, 2011. Accessed August 10, 2012.
18. Mac Kenzie WR, Hoxie NJ, Proctor ME, et al. A massive outbreak in Milwaukee of cryptosporidium infection transmitted through the public water supply. **N Engl J Med**. 1994;331(3):161-167.
19. Corso PS, Kramer MH, Blair KA, Addiss DG, David JP, Haddix AC. Cost of illness in the 1993 waterborne Cryptosporidium outbreak, Milwaukee, Wisconsin. **Emerg Infect Dis**. 2003;9(4):426-431.
20. Trichinellosis FAQs. Centers for Disease Control and Prevention website. http://www.cdc.gov/parasites/trichinellosis/gen_info/faqs.html. Last updated August 8, 2012. Accessed May 28, 2012.
21. US Food and Drug Administration. FDA issues final rules to prevent 'mad cow' disease. **Nation's Health**. 1997;27(6):7.
22. Raw kidney beans. Penn State Extension website. <http://extension.psu.edu/food-safety/food-preservation/faq/raw-kidney-beans>. Accessed May 28, 2012.
23. Silverberg D. Woman sues McDonald's after drinking sanitizer. Digital Journal website. <http://digitaljournal.com/article/266661>. February 5, 2009. Accessed May 25, 2013.
24. Contamination, food allergens, and foodborne illness. In: National Restaurant Association. **ServSafe Coursebook**. 5th ed. Chicago, IL: National Restaurant Association; 2008:3.1-3.12.
25. Circulon 13-piece cookware set recalled by Meyer Corporation due to laceration hazard from glass lid. US Consumer Product Safety Commission website.

<http://www.cpsc.gov/en/Recalls/2012/Circulon-13-Piece-Cookware-Set-Recalled-by-Meyer-Corporation-Due-to-Laceration-Hazard-from-Glass-Lid-Sold-Exclusively-at-Costco>. May 17, 2012.

26. Schumer raises concerns about metal grill. MyFoxNY.com website.
<http://www.myfoxny.com/story/18641347/schumer-raises-concerns-about-metal-grill-brushes>.
Last updated June 18, 2012. Accessed May 29, 2012.

27. FDA food code 2009: chapter 2 — management & personnel. US Food and Drug Administration website.
<http://www.fda.gov/Food/GuidanceRegulation/RetailFoodProtection/FoodCode/ucm181242.htm>.
Updated March 27, 2013. Accessed May 21, 2012.

Examination

1. In the kitchen, which of the following is the best place to keep a spray bottle of bleach?

- A. On the counter so it can be used to sanitize work surfaces between items
- B. Near the beverage machine to keep it handy
- C. Separate from food and the cooking and food preparation areas, such as in a designated cabinet
- D. Near the stove in case a spill needs to be wiped and sanitized

2. Which pathogen is the most common cause of foodborne illness in the United States?

- A. Norovirus
- B. *Escherichia coli*
- C. *Staphylococcus aureus*
- D. *Campylobacter jejuni*

3. Which of the following statements is true regarding the longevity of the bacteria *Yersinia enterocolitica*?

- A. Freezing temperatures deactivate them.
- B. The bacteria can survive in ice and produce a toxin that remains after cooking.
- C. Freezing temperatures kill them.
- D. The bacteria can survive in ice, but pasteurization and cooking foods properly minimize the possibility of infection.

4. Which of the following statements is true regarding the effects of listeriosis, caused by the bacteria *Listeria*?

- A. The condition causes flulike symptoms and may lead to miscarriage, stillbirth, premature delivery, and infections in newborns.
- B. Immediate nausea and vomiting are experienced after ingesting the contaminated food.
- C. The condition affects the general population at a greater rate than it affects pregnant women.
- D. Cooking meats to an internal temperature of 165°F or higher does not eliminate the bacteria.

5. Which of the following foods can contain the parasite *Anisakis simplex*?

- A. Beef
- B. Melons
- C. Raw and undercooked fish
- D. Chicken

6. Proper hand washing after using the restroom helps to prevent which of the following?

- A. Foodborne illness caused by norovirus
- B. Ciguatera poisoning
- C. Foodborne illness caused by *Clostridium botulinum*
- D. Scombroid poisoning

7. Copper can leach into acidic foods, leading to heavy-metal toxicity. Which of the following can prevent this from happening?

- A. Using copper pots lined with a less reactive metal, such as stainless steel
- B. Avoiding the use of copper pots
- C. Using copper pots in which the outside has been lined with a less reactive metal, such as stainless steel
- D. Thoroughly greasing a copper pot before use

8. If accidentally ingested, broken glass can cause damage to the gastrointestinal tract. Which of the following can prevent this from happening?

- A. Using only plastic utensils in the kitchen
- B. Using shatterproof glass and discarding any foods that may be contaminated with tiny glass shards
- C. Filtering any foods that become contaminated with glass shards
- D. Keeping glass scoops away from the ice machine

9. Within the past two years, several people have been hospitalized after they accidentally ingested which of the following?

- A. High levels of *E coli* in grilled food
- B. Hepatitis A transmitted by grilled food
- C. Loose bristles from metal grill-cleaning brushes that fell onto grilled food
- D. Bone fragments that ended up in grilled food

10. Why is it important for foodservice workers to wear gloves if they have cuts on their hands covered with bandages?

- A. To protect the wound from bacteria found in the food
- B. To prevent the injury from getting worse because of irritation from the food
- C. To prevent the bandage from accidentally falling into the food
- D. To protect the food from bacteria on the bandage