Houston Department of Health and Human Services

FOOD SAFETY THREATS

What is foodborne disease?

Foodborne disease is caused by consuming contaminated foods or beverages. Many different disease-causing microbes, or pathogens, can contaminate foods, so there are many different foodborne infections. In addition, poisonous chemicals or other harmful substances can cause foodborne diseases if they are present in food.

More than 250 different foodborne diseases have been described. Most of these diseases are infections, caused by a variety of bacteria, viruses, and parasites that can be foodborne. Other diseases are poisonings, caused by harmful toxins or chemicals that have contaminated the food, for example, poisonous mushrooms. These different diseases have many different symptoms, so there is no one "syndrome" that is foodborne illness. However, the microbe or toxin enters the body through the gastrointestinal tract, and often causes the first symptoms there, so nausea, vomiting, abdominal cramps, and diarrhea are common symptoms in many foodborne diseases.

Many microbes can spread in more than one way, so we cannot always know that a disease is foodborne. The distinction matters, because public health authorities need to know how a particular disease is spreading in order to take the appropriate steps to stop it. For example, *Escherichia coli O157:H7*

(E.coli O157:H7) infections can spread through contaminated food, contaminated drinking water, contaminated swimming water, and from toddler to toddler at a day care center. Depending on which means of spread caused a case, the measures to stop other cases from occurring could range from removing contaminated food from stores, chlorinating a swimming pool, or closing a child day care center.

What are the most common foodborne diseases?

The most commonly recognized foodborne infections are those caused by the bacteria ***Campylobacter*, *Salmonella*, and *E.coli O157:H7*,** and by a group of viruses called ***calicivirus*,** also known as the ***Norwalk*** and ***Norwalk-like viruses*.**

Campylobacter is a bacterial pathogen that causes fever, diarrhea, and abdominal cramps. It is the most commonly identified bacterial cause of diarrheal illness in the world. These bacteria live in the intestines of healthy birds, and most raw poultry meat has *Campylobacter* on it. Eating undercooked chicken, or other food that has been contaminated with juices dripping from raw chicken, is the most frequent source of this infection.

Salmonella is also a bacterium that is widespread in the intestines of birds, reptiles and mammals. It can spread to humans via a variety of different foods of animal origin. The illness it causes, *salmonellosis*, typically includes fever, diarrhea and abdominal cramps. In persons with poor underlying health or weakened immune systems, it can invade the bloodstream and cause life-threatening infections.

E.coli O157:H7 is a bacterial pathogen that has a reservoir in cattle and other similar animals. Human illness typically follows consumption of food or water that has been contaminated with microscopic amounts of cow feces. The illness it causes is often a severe and bloody diarrhea and painful abdominal cramps, without much fever. In 3% to 5% of cases, a complication called hemolytic uremic syndrome (HUS) can occur several weeks after the initial symptoms. This severe complication includes temporary anemia, profuse bleeding, and kidney failure.

***Calicivirus*, or Norwalk-like virus** is an extremely common cause of foodborne illness, though it is rarely diagnosed because the laboratory test is not widely available. It causes an acute gastrointestinal illness, usually with more vomiting than diarrhea, that resolves within two days. Unlike many foodborne pathogens that have animal reservoirs, it is believed that Norwalk-like viruses spread primarily from one infected person to another. Infected

kitchen workers can contaminate a salad or sandwich as they prepare it, if they have the virus on their hands. Infected fishermen have contaminated oysters as they harvested them.

Some common diseases are occasionally foodborne, even though they are usually transmitted by other routes. These include infections caused by ***Shigella, hepatitis A,*** and the parasites ***Giardia lamblia*** and ***Cryptosporidia.*** Even strep throats have been transmitted occasionally through food.

In addition to disease caused by direct infection, some foodborne diseases are caused by the presence of a toxin in the food that was produced by a microbe in the food. For example, the bacterium ***Staphylococcus aureus*** can grow in some foods and produce a toxin that causes intense vomiting. The rare but deadly disease ***botulism*** occurs when the bacterium ***Clostridium botulinum*** grows and produces a powerful paralytic toxin in foods. These toxins can produce illness even if the microbes that produced them are no longer there.

Other toxins and poisonous chemicals can cause foodborne illness. People can become ill if a pesticide is inadvertently added to a food, or if naturally poisonous substances are used to prepare a meal. Every year, people become ill after mistaking poisonous mushrooms for safe species, or after eating poisonous reef fishes.

Are the types of foodborne diseases changing?

The spectrum of foodborne diseases is constantly changing. A century ago, *typhoid fever, tuberculosis* and *cholera* were common foodborne diseases. Improvements in food safety, such as pasteurization of milk, safe canning, and disinfection of water supplies have conquered those diseases. Today, other foodborne infections have taken their place, including some that have only recently been discovered. For example, in 1996, the parasite *Cyclospora* suddenly appeared as a cause of diarrheal illness related to Guatemalan raspberries. These berries had just started to be grown commercially in Guatemala, and somehow became contaminated in the field there with this unusual parasite. In 1998, a new strain of the bacterium *Vibrio parahemolyticu*s contaminated oyster beds in Galveston Bay and caused an epidemic of diarrheal illness in persons eating the oysters raw. The affected oyster beds were near the shipping lanes, which suggested that the bacterium arrived in the ballast water of freighters and tankers coming into the harbor from distant ports. Newly recognized microbes emerge as public health problems for several reasons - microbes can easily spread

around the world, new microbes can evolve, the environment and ecology are changing, food production practices and consumption habits change, and better laboratory tests can now identify microbes that were previously unrecognized.

In the last 15 years, several important diseases of unknown cause have turned out to be complications of foodborne infections. For example, we now know that the Guillain-Barre syndrome can be caused by *Campylobacter* infection, and that the most common cause of acute kidney failure in children, hemolytic uremic syndrome, is caused by infection with *E.coli O157:H7* and related bacteria. In the future, other diseases whose origins are currently unknown may turn out be related to foodborne infections.

What happens in the body after the microbes that produce illness are swallowed?

After they are swallowed, there is a delay, called the incubation period, before the symptoms of illness begin. This delay may range from hours to days, depending on the organism, and on how many of them were swallowed. During the incubation period, the microbes pass through the stomach into the intestine, attach to the cells lining the intestinal walls, and begin to multiply there. Some types of microbes stay in the intestine, some produce a toxin that is absorbed into the bloodstream, and some can directly invade the deeper body tissues. The symptoms produced depend greatly on the type of microbe. Numerous organisms cause similar symptoms, especially diarrhea, abdominal cramps, and nausea. There is so much overlap that it is rarely possible to say which microbe is likely to be causing a given illness unless laboratory tests are done to identify the microbe, or unless the illness is part of a recognized outbreak.

How are foodborne diseases diagnosed?

The infection is usually diagnosed by specific laboratory tests that identify the causative organism. Bacteria such as *Campylobacter, Salmonella,* and *E.coli O157:H7* are found by culturing stool samples in the laboratory and identifying the bacteria that grow on the agar or other culture medium. Parasites can be identified by examining stools under the microscope. Viruses are more difficult to identify, as they are too small to see under a light microscope and are difficult to culture. Viruses are usually identified by testing stool samples for genetic markers that indicate a specific virus is present.

Many foodborne infections are not identified by routine laboratory procedures and require specialized, experimental, and/or expensive tests that are not generally available. If the diagnosis is to be made, the patient has to seek medical attention, the physician must decide to order diagnostic tests, and the laboratory must use the appropriate procedures.

Because many ill persons to not seek attention, and of those that do, many are not tested, many cases of foodborne illness go undiagnosed. For example, CDC estimates that 38 cases of *salmonellosis* actually occur for every case that is actually diagnosed and reported to public health authorities.

How are foodborne diseases treated?

There are many different kinds of foodborne diseases and they may require different treatments, depending on the symptoms they cause. Illnesses that are primarily diarrhea or vomiting can lead to dehydration if the person loses more body fluids and salts (electrolytes) than they take in. Replacing the lost fluids and electrolytes and keeping up with fluid intake are important. If diarrhea is severe, oral rehydration solution, such as Ceralyte*, Pedialyte*, or Oralyte*, should be drunk to replace the fluid losses and prevent dehydration. Sports drinks such as Gatorade* do not replace the losses correctly and should not be used for the treatment of diarrheal illness. Preparations of bismuth subsalicylate (e.g., Pepto-Bismol)* can reduce the duration and severity of simple diarrhea. If diarrhea and cramps occur, without bloody stools or fever, taking an antidiarrheal medication may provide symptomatic relief, but these medications should be avoided if there is high fever or blood in the stools because they may make the illness worse.

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When should I consult my doctor about a diarrheal illness?

A health care provider should be consulted for a diarrheal illness is accompanied by:

- high fever (temperature over 101.5 F, measured orally);
- blood in the stools;
- prolonged vomiting that prevents keeping liquids down (which can lead to dehydration);
- signs of dehydration, including a decrease in urination, a dry mouth and throat, and feeling dizzy when standing up;
- diarrheal illness that lasts more than 3 days.

Do not be surprised if your doctor does not prescribe an antibiotic. Many diarrheal illnesses are caused by viruses and will improve in 2 or 3 days without antibiotic therapy. In fact, antibiotics have no effect on viruses, and using an antibiotic to treat a viral infection could cause more harm than good It is often not necessary to take an antibiotic even in the case of a mild bacterial infection. Other treatments can help the symptoms, and careful hand washing can prevent the spread of infection to other people. Overuse of antibiotics is the principal reason many bacteria are becoming resistant. Resistant bacteria are no longer killed by the antibiotic. This means that it is important to use antibiotics only when they are really needed. Partial treatment can also cause bacteria to become resistant. If an antibiotic is prescribed, it is important to take all of the medication as prescribed, and not stop early just because the symptoms seem to be improving.

What are foodborne disease outbreaks and why do they occur?

An outbreak of foodborne illness occurs when a group of people consumes the same contaminated food and two or more of them come down with the same illness. It may be a group that ate a meal together somewhere, or it may be a group of people who do not know each other at all, but who all happened to buy and eat the same contaminated item from a grocery store or restaurant. For an outbreak to occur, something must have happened to contaminate a batch of food that was eaten by the group of people. Often, a combination of events contributes to the outbreak. A contaminated food may be left out at room temperature for many hours, allowing the bacteria to multiply to high numbers, and then be insufficiently cooked to kill the bacteria.

Many outbreaks are local in nature. They are recognized when a group of people realize that they all became ill after a common meal, and someone calls the local health department. This classic local outbreak might follow a catered meal at a reception, a pot-luck supper, or eating a meal at an understaffed restaurant on a particularly busy day. However, outbreaks are increasingly being recognized that are more widespread, that affect persons in many different places, and that are spread out over several weeks. For example, a recent outbreak of *salmonellosis* was traced to persons eating a breakfast cereal produced at a factory in Minnesota, and marketed under several different brand names in many different states. No one county or state had very many cases and the cases did not know each other. The outbreak was recognized because it was caused by an unusual strain of *Salmonella,* and because state public health laboratories that type *Salmonella* strains noticed a sudden increase in this one rare strain. In another recent

outbreak, a particular peanut snack food caused the same illness in Israel, Europe and North America. Again, this was recognized as an increase in infections caused by a rare strain of *Salmonella*.

The vast majority of reported cases of foodborne illness are not part of recognized outbreaks, but occur as individual or "sporadic" cases. It may be that many of these cases are actually part of unrecognized widespread or diffuse outbreaks. Detecting and investigating such widespread outbreaks is a major challenge to our public health system. This is the reason that new and more sophisticated laboratory methods are being used at CDC and in state public health department laboratories.

How are outbreaks of foodborne disease detected?

The initial clue that an outbreak is occurring can come in various ways. It may be when a person realizes that several other people who were all together at an event have become ill and he or she calls the local health department. It may be when a physician realizes she has seen more than the usual number of patients with the same illness. It may be when a county health department gets an unusually large number of reports of illness. The hardest outbreaks to detect are those that are spread over a large geographic area, with only a few cases in each state. These outbreaks can be detected by combining surveillance reports at the regional or national level and looking for increases in infections of a specific type. This is why state public health laboratories determine the serotype of *Salmonella* bacteria isolated from people. New "DNA fingerprinting" technologies can make detecting outbreaks easier too. For example, the new molecular subtyping network, PulseNet, allows state laboratories and CDC to compare strains of *E.coli O157:H7* and an increasing number of other pathogens from all across the United States to detect widespread outbreaks.

After an apparent cluster of cases is detected, it is important to determine whether these cases represent a real increase above the expected number of cases and whether they really might be related. Sometimes a cluster of reported cases is caused by something other than an actual outbreak of illness. For example, if the person responsible for reporting has just returned from a vacation and is clearing up a backlog of cases by reporting them all at once, the sudden surge of reports is just a false cluster.

How does food become contaminated?

We live in a microbial world, and there are many opportunities for food to become contaminated as it is produced and prepared. Many foodborne

microbes are present in healthy animals (usually in their intestines) raised for food. Meat and poultry carcasses can become contaminated during slaughter by contact with small amounts of intestinal contents. Similarly, fresh fruits and vegetables can be contaminated if they are washed or irrigated with water that is contaminated with animal manure or human sewage. Some types of *Salmonella* can infect a hen's ovary so that the internal contents of a normal looking egg can be contaminated with *Salmonella* even before the shell is formed. Oysters and other filter feeding shellfish can concentrate *Vibrio* bacteria that are naturally present in sea water, or other microbes that are present in human sewage dumped into the sea.

Later in food processing, other foodborne microbes can be introduced from infected humans who handle the food, or by cross-contamination from some other raw agricultural product. For example, *Shigella bacteria, hepatitis A virus* and *Norwalk virus* can be introduced by the unwashed hands of food handlers who are themselves infected. In the kitchen, microbes can be transferred from one food to another food by using the same knife, cutting board, or other utensil to prepare both foods without washing the surface or utensil in between. A food that is fully cooked can become recontaminated if it touches other raw foods or drippings from raw foods that contain pathogens.

The way that food is handled after it is contaminated can also make a difference in whether or not an outbreak occurs. Many bacterial microbes need to multiply to a larger number before enough are present in food to cause disease. Given warm, moist conditions and an ample supply of nutrients, one bacterium that reproduces by dividing itself every half hour can produce 17 million progeny in 12 hours. As a result, lightly contaminated food left out overnight can be highly infectious by the next day. If the food were refrigerated promptly, the bacteria would not multiply at all. In general, refrigeration or freezing prevents virtually all bacteria from growing but generally preserves them in a state of suspended animation. This general rule has a few surprising exceptions. Two foodborne bacteria, *Listeria monocytogenes* and *Yersinia enterocolitica* can actually grow at refrigerator temperatures. High salt, high sugar or high acid levels keep bacteria from growing, which is why salted meats, jam, and pickled vegetables are traditional preserved foods.

Microbes are killed by heat. If food is heated to an internal temperature above 160^{o}F, or 78^{o}C, for even a few seconds, this sufficient to kill parasites, viruses, or bacteria. The exception is *Clostridium* bacteria, which produce a heat-resistant form called a spore. *Clostridium* spores are killed only at

temperatures above boiling. This is why canned foods must be cooked to a high temperature under pressure as part of the canning process.

The toxins produced by bacteria vary in their sensitivity to heat. The *staphylococcal* toxin that causes vomiting is not inactivated even if it is boiled. Fortunately, the potent toxin that causes *botulism* is completely inactivated by boiling.

What foods are most associated with foodborne illness?

Raw foods of animal origin, such as raw meat and poultry, raw eggs, unpasteurized milk, and raw shellfish, are the most likely to be contaminated. Because filter-feeding shellfish strain microbes from the sea over many months, they are particularly likely to be contaminated if there are any pathogens in the seawater. Foods that mingle the products of many individual animals, such as bulk raw milk, pooled raw eggs, or ground beef, are particularly hazardous because a pathogen present in any one of the animals may contaminate the whole batch. A single hamburger may contain meat from hundreds of animals. A single restaurant omelet may contain eggs from hundreds of chickens. A glass of raw milk may contain milk from hundreds of cows. A broiler chicken carcass can be exposed to the drippings and juices of many thousands of other birds that went through the same cold water tank after slaughter.

Fruits and vegetables consumed raw are a particular concern. Washing can decrease but not eliminate contamination, so the consumers can do little to protect themselves. Recently, a number of outbreaks have been traced to fresh fruits and vegetables that were processed under less than sanitary conditions. These outbreaks show that the quality of the water used for washing and chilling the produce after it is harvested is critical. Using water that is not clean can contaminate many boxes of produce. Fresh manure used to fertilize vegetables can also contaminate them. Alfalfa sprouts and other raw sprouts pose a particular challenge, as the conditions under which they are sprouted are ideal for growing microbes as well as sprouts, and because they are eaten without further cooking. That means that a few bacteria present on the seeds can grow to high numbers of pathogens on the sprouts. Unpasteurized fruit juice can also be contaminated if there are pathogens in or on the fruit that is used to make it.

What can consumers do to protect themselves from foodborne illness?

A few simple precautions can reduce the risk of foodborne diseases:

- **COOK:** Meat, poultry and eggs should be cooked thoroughly. Using a thermometer to measure the internal temperature of meat is a good way to be sure that it is cooked sufficiently to kill bacteria. For example, ground beef should be cooked to an internal temperature of 160°F. Eggs should be cooked until the yolk is firm.

- **SEPARATE:** Don't cross-contaminate one food with another. Avoid cross-contaminating foods by washing hands, utensils, and cutting boards after they have been in contact with raw meat or poultry and before they touch another food. Put cooked meat on a clean platter, rather back on one that held the raw meat.

- **CHILL:** Refrigerate leftovers promptly. Bacteria can grow quickly at room temperature, so refrigerate leftover foods if they are not going to be eaten within 4 hours. Large volumes of food will cool more quickly if they are divided into several shallow containers for refrigeration.

- **CLEAN:** Wash produce. Rinse fresh fruits and vegetables in running tap water to remove visible dirt and grime. Remove and discard the outermost leaves of a head of lettuce or cabbage. Because bacteria can grow well on the cut surface of fruits or vegetables, be careful not to contaminate these foods while slicing them up on the cutting board, and avoid leaving cut produce at room temperature for many hours. Don't be a source of foodborne illness yourself. Wash your hands with soap and water before preparing food. Avoid preparing food for others if you yourself have a diarrheal illness. Changing a baby's diaper while preparing food is a bad idea that can easily spread illness.

- **REPORT:** Report suspected foodborne illnesses to your local health department. The local public health department is an important part of the food safety system. Often, calls from concerned citizens are how outbreaks are first detected. If a public health official contacts you to find our more about an illness you had, your cooperation is important. In public health investigations, it can be as important to talk to healthy people as to ill people. Your cooperation may be needed even if you are not ill.

Are some people more likely to contract a foodborne illness? If so, are there special precautions they should take?

Some persons at particularly high risk should take more precautions. Pregnant women, the elderly, and those with weakened immune systems are at higher risk for severe infections such as *Listeria* and should be particularly careful not to consume undercooked animal products. They should avoid soft French-style cheeses, pates, uncooked hot dogs and sliced deli meats, which have been sources of *Listeria* infections. Persons at high risk should also avoid alfalfa sprouts and unpasteurized juices.

A bottle-fed infant is at higher risk for severe infections with *Salmonella* or other bacteria that can grow in a bottle of warm formula if it is left at room temperature for many hours. Particular care is needed to be sure the baby's bottle is cleaned and disinfected and that leftover milk formula or juice is not held in the bottle for many hours. Persons with liver disease are susceptible to infections with a rare but dangerous microbe called *Vibrio vulnificus*, found in oysters. They should avoid eating raw oysters.

There is only so much the consumer can do. How can food be made safer in the first place?

Making food safe in the first place is a major effort, involving the farm and fishery, the production plant or factory, and many other points from the farm to the table. Many different groups in public health, industry, regulatory agencies, and academia have roles to play in making the food supply less contaminated. Consumers can promote general food safety with their dollars by purchasing foods that have been processed for safety. For example, milk pasteurization was a major advance in food safety that was developed 100 years ago. Buying pasteurized milk rather than raw unpasteurized milk still prevents an enormous number of foodborne diseases every day. Now juice pasteurization is a recent important step forward that prevents *E. coli O157:H7* infections and many other diseases. Consumers can look for and buy pasteurized fruit juices and ciders. In the future, meat and other foods that have been treated for safety with irradiation will be available. These new technologies are likely to be as important a step forward as the pasteurization of milk.

Foodborne diseases are largely preventable, though there is no simple one-step prevention measure like a vaccine. Instead, measures are needed to prevent or limit contamination all the way from farm to table. A variety of good agricultural and manufacturing practices can reduce the spread of microbes among animals and prevent the contamination of foods. Careful review of the whole food production process can identify the principal

hazards and the control points where contamination can be prevented, limited, or eliminated. A formal method for evaluating the control of risk in foods exists; it is called the Hazard Analysis Critical Control Point, or HACCP system. This was first developed by NASA to make sure that the food eaten by astronauts was safe. HACCP safety principles are now being applied to an increasing spectrum of foods, including meat, poultry, and seafood.

For some particularly risky foods, even the most careful hygiene and sanitation are insufficient to prevent contamination, and a definitive microbe-killing step must be included in the process. For example, early in the century, large *botulism* outbreaks occurred when canned foods were cooked insufficiently to kill the *botulism* spores. After research was done to find out exactly how much heat was needed to kill the spores, the canning industry and the government regulators went to great lengths to be sure that every can was sufficiently cooked. As a result, *botulism* related to commercial canned foods has disappeared in this country. Similarly the introduction of careful pasteurization of milk eliminated a large number of milk-borne diseases. This occurred after sanitation in dairies had already reached a high level. In the future, other foods can be made much safer by new pasteurizing technologies, such as in-shell pasteurization of eggs, and irradiation of ground beef. Just as with milk, these new technologies should be implemented in addition to good sanitation, not as a replacement for it.

In the end, it is up to the consumer to demand a safe food supply; up to industry to produce it; up to researchers to develop better ways of doing so; and up to government to see that it happens, to make sure it works and to identify problems still in need of solutions.

Where can I learn more about food safety and foodborne diseases?

General information

- **National Food Safety Initiative:** http://www.foodsafety.gov/~dms/fs-toc.html
- **CDC's Food Safety Initiative home page:** http://www.cdc.gov/foodsafety/about.htm
- **U.S. Food and Drug Administration:** http://www.fda.gov/
- **Gateway to government food safety information:** http://www.foodsafety.gov/

Specific illnesses

- **Botulism:** http://www.cdc.gov/ncidod/dbmd/diseaseinfo/botulism_g.htm
- **Brucellosis:** http://www.cdc.gov/ncidod/dbmd/diseaseinfo/brucellosis_g.htm
- **Escherichia coli O157:H7 (E.coli)**: http://www.cdc.gov/ncidod/dbmd/diseaseinfo/escherichiacoli_g.htm
- **Salmonellosis (Salmonella)**: http://www.cdc.gov/ncidod/dbmd/diseaseinfo/salmonellosis_g.htm
- **Shigella dysentariae Type 1 (Shigella):** http://www.cdc.gov/ncidod/dbmd/diseaseinfo/shigellosis_g.htm
- **Typhi (Typhoid Fever):** http://www.cdc.gov/ncidod/dbmd/diseaseinfo/typhoidfever_g.htm
- **Vibrio cholerae (Cholera):** http://www.cdc.gov/ncidod/dbmd/diseaseinfo/cholera_g.htm

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