Bad Bug Book

Handbook of Foodborne Pathogenic Microorganisms and Natural Toxins

Introduction

Food safety is a complex issue that has an impact on all segments of society, from the general public to government, industry, and academia. The second edition of the Bad Bug Book, published by the Center for Food Safety and Applied Nutrition, of the Food and Drug Administration (FDA), U.S. Department of Health and Human Services, provides current information about the major known agents that cause foodborne illness. The information provided in this handbook is abbreviated and general in nature, and is intended for practical use. It is not intended to be a comprehensive scientific or clinical reference.

Under the laws administered by FDA, a food is adulterated if it contains (1) a poisonous or otherwise harmful substance that is not an inherent natural constituent of the food itself, in an amount that poses *a reasonable possibility* of injury to health, or (2) a substance that is an inherent natural constituent of the food itself; is not the result of environmental, agricultural, industrial, or other contamination; and is present in an amount that *ordinarily* renders the food injurious to health. The first includes, for example, a toxin produced by a fungus that has contaminated a food, or a pathogenic bacterium or virus, if the amount present in the food *may be* injurious to health. An example of the second is the tetrodotoxin that occurs naturally in some organs of some types of pufferfish and that *ordinarily* will make the fish injurious to health. In either case, foods adulterated with these agents are prohibited from being introduced, or offered for introduction, into interstate commerce.

Our scientific understanding of pathogenic microorganisms and their toxins is continually advancing. When scientific evidence shows that a particular microorganism or its toxins can cause foodborne illness, the FDA may consider that microorganism to be capable of causing a food to be adulterated. Our knowledge may advance so rapidly that, in some cases, an organism found to be capable of adulterating food might not yet be listed in this handbook. In those situations, the FDA still can take regulatory action against the adulterated food.

The agents described in this book range from live pathogenic organisms, such as bacteria, protozoa, worms, and fungi, to non-living entities, such as viruses, prions, and natural toxins. Included in the chapters are descriptions of the agents' characteristics, habitats and food sources, infective doses, and general disease symptoms and complications. Also included are examples of outbreaks, if applicable; the frequency with which the agent causes illness in the U.S.; and susceptible populations. In addition, the chapters contain brief overviews of the analytical methods used to detect, isolate, and/or identify the pathogens or toxins.

However, while some general survival and inactivation characteristics are included, it is beyond the scope of this book to provide data, such as D and z values, that are used to establish

processes for the elimination of pathogenic bacteria and fungi in foods. One reason is that inactivation parameters for a given organism may vary somewhat, depending on a number of factors at the time of measurement. For more information on this topic, readers may wish to consult other resources. One example is the International Commission on Microbiological Specifications for Foods, the source of a comprehensive book (*Microorganisms in Foods 5. Characteristics of Microbial Pathogens*) on the heat resistance (D and z values) of foodborne pathogens in various food matrices, as well as data on survival and growth in many foods, including data on water activity and pH.

The Bad Bug Book chapters about pathogenic bacteria are divided into two main groups, based on the structure of the microbes' cell wall: Gram negative and Gram positive. A few new chapters have been added, reflecting increased interest in certain microorganisms as foodborne pathogens or as potential sources of toxins.

Another new feature is the brief section for consumers that appears in each chapter and is set apart from the main text. These sections provide highlights of information, about the microbe or toxin, that will be of interest to consumers, as well as information and links regarding safe food-handling practices. A glossary for consumers is included at the end of the book, separately from the technical glossary.

Various chapters link readers to Federal agencies with an interest in food safety, including the FDA, the Centers for Disease Control and Prevention (CDC), and the U.S. Department of Agriculture Food Safety Inspection Service. These are the primary agencies that collaborate to investigate outbreaks of foodborne illness, prevent foodborne illness, and advance the field of food safety, to protect the public's health. In addition, some technical terms have been linked to the National Library of Medicine's Entrez glossary.

Links to recent articles from the CDC's Morbidity and Mortality Weekly Reports are provided in selected chapters, to provide readers with current information about outbreaks or incidents of foodborne disease. At the end of selected chapters about pathogenic microorganisms, hypertext links are included to relevant Entrez abstracts and GenBank genetic loci.

Suggested citation: Food and Drug Administration. Bad Bug Book, Foodborne Pathogenic Microorganisms and Natural Toxins. Second Edition. [chapter title, pp. ___]. 2012.

Introduction for Consumers: A Snapshot

Each chapter in this book is about a pathogen – a bacterium, virus, or parasite – or natural toxin that can contaminate food and cause illness. The book was prepared by the Food and Drug Administration (FDA) and contains scientific and technical information about the major pathogens that cause these kinds of illnesses. A separate "consumer box" in each chapter provides non-technical information, in everyday language. The boxes describe plainly what can make you sick and, more important, how to prevent it.

Most foodborne illnesses, while unpleasant, go away by themselves and don't have lasting effects. But you'll read about some pathogens that can be more serious, have long-lasting effects, or cause death. To put these pathogens in perspective, think about how many different foods and how many times you eat each day, all year, without getting sick from the food. The FDA and other Federal agencies work together and with the food industry to make the U.S. food supply one of the safest in the world.

You also play a part in the safety of what you eat. When you read the consumer boxes, you'll see that different pathogens can be risky in different ways, and that a safety step that's effective against one might not be as effective against another. So what should you do? The answer is to follow some simple steps that, together, lower the risk from most pathogens.

- Washing your hands before and after handling food, and in between handling different foods, is one of the most important steps you can take. Do the same with equipment, utensils, and countertops.
- Wash raw fruits and vegetables under running water. These nutritious foods usually are safe, as you probably know from the many times you've eaten them, but wash them just in case they've somehow become contaminated. For the most part, the less of a pathogen on a food – if any – the less chance that it can make you sick.
- Cooking food to proper temperatures kills most bacteria, including *Salmonella*, *Listeria*, and the kinds of *E. coli* that cause illness, and parasites.
- Keep any pathogens that could be on raw, unwashed foods from spreading by keeping raw and cooked foods separate. Keep them in different containers, and don't use the same equipment on them, unless the equipment is washed properly in between. Treat countertops the same way.
- Refrigerate food at 40°F as soon as possible after it's cooked. Remember, the less of a pathogen there is in a food, the less chance that it can make you sick. Proper refrigeration keeps most types of bacteria from growing to numbers that can cause illness (although if a food already has high numbers of bacteria when it's put in the refrigerator, it could still cause illness).

Here are a few examples of why following *all* of these steps is important. Some types of bacteria form spores that aren't killed by cooking. Spores are a survival mode in which those bacteria make an inactive form that can live without nutrition and that develops very tough protection against the outside world. After cooking, the spores may change and grow into bacteria, when the food cools down. Refrigerating food quickly after cooking can help keep the bacteria from multiplying. On the other hand, cooking does kill most harmful bacteria. Cooking is especially important when a pathogen is hard to wash off of a particular kind of food, or if a bacterium can grow at refrigerator temperatures, as is true of *Listeria monocytogenes* and *Yersinia enterocolitica*.

As you read about the differences among the pathogens, remember that there's a common theme: following *all* the safety steps above can help protect you. The exceptions are toxins, such as the poisons in some mushrooms and a few kinds of fish and shellfish. Cooking, freezing, and washing won't necessarily destroy toxins. Avoiding them is your best protection, as you'll see when you read the chapters.

Authorship

The second edition of the Bad Bug Book would not have been possible without the contributions of the many FDA scientists who donated their time and expertise to update the chapters. The result of their efforts is a handbook that can serve as a valuable tool for food-safety professionals and others with an interest in food safety.

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Acknowledgments

The second edition of the Bad Bug Book would not have been possible without the contributions of the many FDA scientists who donated their time and expertise to update the chapters. The result of their efforts is a handbook that can serve as a valuable tool for food-safety professionals and others with an interest in food safety. Our gratitude is extended to Drs. Mickey Parish and Fred S. Fry Jr., for the insight they offered in their expert reviews of the book. The first edition of the Bad Bug Book was the concept of Dr. Mark Walderhaug, who executed it with the help of the many scientists working with him at the time, and the field is indebted to him and to them for their vision.

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Foodborne Pathogenic Microorganisms and Natural Toxins

Salmonella species

1. Organism

Salmonella species (spp.)

Salmonella is a motile, non-sporeforming, Gram-negative, rod-shaped bacterium in the family *Enterobacteriaceae* and the tribe *Salmonellae*. Non-motile variants include *S.* Gallinarum and *S.* Pullorum. The genus *Salmonella* is divided into two species that can cause illness in humans:

- *S. enterica*
- *S. bongori*

Salmonella enterica, which is of the greatest public health concern, is comprised of six subspecies:

- *S. enterica* subsp. *enterica* (I)
- *S. enterica* subsp. *salamae* (II)
- *S. enterica* subsp. *arizonae* (IIIa)
- *S. enterica* subsp. *diarizonae* (IIIb)
- *S. enterica* subsp. *houtenae* (IV)
- *S. enterica* subsp. *indica* (VI)

Salmonella is further subdivided into serotypes, based on the Kaufmann-White typing scheme first published in 1934, which differentiates *Salmonella* strains by their surface and flagellar antigenic properties. *Salmonella* spp. are commonly referred to by their serotype names. For example, *Salmonella enterica* subsp. *enterica* is further divided into numerous serotypes, including *S.* Enteritidis and *S.* Typhimurium, which are common in the U.S. (Note that species names are italicized, but serotype names are not.) When Kaufmann first proposed the scheme, 44 serotypes had been discovered. As of 2007, the number of serotypes discovered was 2,579.

For Consumers: A Snapshot

Salmonella causes two kinds of illness:
(1) Gastrointestinal illness, which causes nausea, vomiting, diarrhea, cramps, and fever, with symptoms generally lasting a couple of days and tapering off within a week. In otherwise healthy people, the symptoms usually go away by themselves, but long-term arthritis may develop.
(2) Typhoidal illness causes high fever, diarrhea or constipation, aches, headache, and lethargy (drowsiness or sluggishness), and, sometimes, a rash. It's a very serious condition; up to 10% of people who don't get treatment may die. Many kinds of food can become contaminated with the first type, from meats and eggs to fruits and vegetables, and even dry foods, like spices and raw tree nuts. The typhoidal illness usually is associated with sewage-contaminated drinking water, or crops irrigated with sewage-contaminated water. Some pets, like turtles and other reptiles, and chicks, can carry *Salmonella*, which can spread to anything that comes into contact with the pet. For example, a pet owner can, through unwashed hands, contaminate foods or even his or her own face with *Salmonella*. This bacterium is hard to wash off of food, even with soapy water, so important measures for preventing foodborne illness from *Salmonella* include thorough cooking, hand washing, keeping raw foods separated from cooked foods, and keeping foods at the correct temperature (refrigerate foods at 40°F or below). In people with weak immune systems, *Salmonella* can spread to other organs and cause very serious illness.

2. Disease

Salmonella can cause two types of illness, depending on the serotype:

(1) nontyphoidal salmonellosis and (2) typhoid fever, both of which are described below. The symptoms of nontyphoidal salmonellosis can be quite unpleasant, but this illness is generally self-limiting among healthy people with intact immune systems (although it can cause life-threatening illness even in healthy people). Typhoid fever is more serious and has a higher mortality rate than does nontyphoidal salmonellosis.

Nontyphoidal Salmonellosis

- Caused by serotypes ***other than*** *S.* Typhi and *S.* Paratyphi A.
- **Mortality**: Generally less than 1%; however, *S.* Enteritidis has a 3.6% mortality rate in outbreaks in nursing homes and hospitals, with the elderly being particularly affected.
- **Onset**: 6 to 72 hours after exposure.
- **Infective dose**: As low as one cell, depending on age and health of host and strain differences among members of the genus.
- **Symptoms**: Nausea, vomiting, abdominal cramps, diarrhea, fever, headache.
- **Duration**: Symptoms generally last 4 to 7 days, with acute symptoms usually lasting 1 to 2 days or longer, depending on host factors, the dose ingested, and strain characteristics.
- **Complications**: (1) Dehydration and electrolyte imbalance may occur as a result of diarrhea and vomiting. This can lead to death in the very young, the elderly, and the immunocompromised, if not treated promptly. (2) In 2% of culture-proven cases, reactive arthritis (i.e., arthritis from an immune reaction to the infection – an autoimmune response – rather than directly from the infection itself) may follow 3 to 4 weeks after the onset of acute symptoms. Indications of reactive arthritis may include, for example, joint inflammation, urethritis, uveitis, and/or conjunctivitis. (3) Nontyphoidal *Salmonella* can sometimes escape from the gastrointestinal tract into the body and cause blood poisoning (septicemia) or infect the blood, internal organs, and/or joints (bacteremia). *S.* Dublin is sometimes associated with this complication.
- **Route of entry**: oral (e.g., ingestion of contaminated food, fecal particles, or contaminated water).
- **Pathway**: Penetration and passage of *Salmonella* organisms from gut lumen into epithelium of small intestine, where inflammation occurs. There is evidence that enterotoxin may be produced, perhaps within enterocytes.

Typhoid Fever

- Caused by serotypes *S.* Typhi and *S.* Paratyphi A, both of which are found only in humans.
- **Mortality**: Untreated, as high as 10%.

- **Onset**: Generally 1 to 3 weeks, but may be as long as 2 months after exposure.
- **Infective dose**: Fewer than 1,000 cells.
- **Symptoms**: High fever, from 103° to 104°F; lethargy; gastrointestinal symptoms, including abdominal pains and diarrhea or constipation; headache; achiness; loss of appetite. A rash of flat, rose-colored spots sometimes occurs.
- **Duration**: Generally 2 to 4 weeks.
- **Illness / Complications**: Septicemia, with colonization of other tissues and organs; e.g., may lead to endocarditis. Septic arthritis may occur, in which the infection directly affects the joints and may be difficult to treat. Chronic infection of the gallbladder may occur, which may cause the infected person to become a carrier.
- **Route of entry**: Oral (e.g., ingestion of contaminated food, fecal particles, or contaminated water).
- **Pathway**: Penetration and passage of typhoid *Salmonella* organisms from gut lumen into epithelium of small intestine and into the bloodstream (i.e., septicemia), which may carry the organisms to other sites in the body, where inflammation occurs. There is evidence that enterotoxin may be produced, perhaps within enterocytes.

3. Frequency of Disease

Annually in the United States:

- ***Nontyphoidal salmonellosis*** – A recent report from the Centers for Disease Control and Prevention (CDC) estimates that 1,027,561 cases of domestically acquired nontyphoidal salmonellosis occur annually in the U.S., when under-reporting and under-diagnosis are taken into account.
- ***Typhoid fever*** – In terms of domestically acquired *S. enterica* serotype Typhi, the same CDC report estimated that a mean of 1,821 cases occur annually in the U.S. Additional cases in the U.S. are associated with foreign travel. The report estimates that 433 cases of typhoid fever in the U.S., overall (i.e., whether or not they are domestically acquired), are culture-confirmed. The last case of a foodborne, noncarrier-based typhoid outbreak in the U.S. was in 1999 and was associated with the tropical fruit mamey.

4. Sources

Salmonella is widely dispersed in nature. It can colonize the intestinal tracts of vertebrates, including livestock, wildlife, domestic pets, and humans, and may also live in environments such as pond-water sediment. It is spread through the fecal-oral route and through contact with contaminated water. (Certain protozoa may act as a reservoir for the organism). It may, for example, contaminate meat, farm-irrigation water (thus contaminating produce in the field), soil and insects, factory equipment, hands, and kitchen surfaces and utensils.

Since *S.* Typhi and *S.* Paratyphi A are found only in human hosts, the usual sources of these organisms in the environment are drinking and/or irrigation water contaminated by untreated

sewage. It is highly recommended that only potable water and cooked vegetables be consumed in areas where these organisms are endemic.

Various *Salmonella* species have long been isolated from the outside of egg shells, but *S.* Enteritidis can be present inside the egg. This and other information strongly suggest vertical transmission; i.e., deposition of the organism on the albumen (egg white) side of the yolk-sack membrane (vitelline membrane) by an infected hen, prior to shell formation.

Outbreaks also have been linked to the handling of certain animals sometimes kept as pets, such as turtles, frogs, and chicks.

Food Sources

Although *Salmonella* traditionally was thought of as being associated with animal products in the past, fresh produce also has been the source of major outbreaks, particularly recently. The organism also survives well on low-moisture foods, such as spices, which have been the vehicles for large outbreaks.

A few examples of foods that have been linked to *Salmonella* illness include meats, poultry, eggs, milk and dairy products, fish, shrimp, spices, yeast, coconut, sauces, freshly prepared salad dressings made with unpasteurized eggs, cake mixes, cream-filled desserts and toppings that contain raw egg, dried gelatin, peanut butter, cocoa, produce (fruits and vegetables, such as tomatoes, peppers, and cantaloupes), and chocolate.

Cross Contamination

Cross contamination occurs when *Salmonella* is spread from a contaminated source – a contaminated food or an infected food handler or animal – to other foods or objects in the environment. An example of how this may occur is when potentially contaminated raw meats, poultry, seafood, produce, or eggs are not kept separate from each other during preparation or cooking, or when a food handler does not adequately clean utensils, surfaces, equipment, and hands after they have come into contact with these products.

The contamination can spread to factory and equipment surfaces, as well as kitchen surfaces and utensils. Cross contamination may occur at any point in the food process.

Cross contamination also may occur from handling pets or wildlife, such as turtles or frogs (or their water, soil, or food and water bowls), then handling food, food-preparation utensils, or other objects in the environment. (Even culinary frog legs have caused outbreaks of salmonellosis.)

5. Diagnosis

Serological identification of cultural isolates from stool. Genetic identification of approximately 100 *Salmonella* serotypes from pure culture is now possible, but the remaining 2,400-plus serotypes can be identified only through traditional serotyping.

6. Target Populations

Anyone, of any age, may become infected with *Salmonella*. Particularly vulnerable are people with weak immune systems, such as the very young and the elderly, people with HIV or chronic

illnesses, and people on some medications; for example, chemotherapy for cancer or the immunosuppressive drugs used to treat some types of arthritis. People with HIV are estimated to have salmonellosis at least 20 times more than does the general population and tend to have recurrent episodes.

7. Food Analysis

Isolation and detection methods have been developed for many foods having prior history of *Salmonella* contamination. Conventional culture and identification methods may require 4 to 6 days for presumptive results. To screen foods, several rapid methods are available, which require 1 to 2 days. These rapid methods include antibody and molecular (DNA or RNA) based assays, but in most cases, require a cultural means to confirm the presence of *Salmonella*, for regulatory purposes.

8. Examples of Outbreaks

For information on recent outbreaks, see the Morbidity and Mortality Weekly Reports from the Centers for Disease Control and Prevention (CDC).

9. Other Resources

- The CDC provides information about *Salmonella*, including information about preventing *Salmonella* Enteritidis infection, on avoiding salmonellosis from animal-handling, and on typhoid fever.
- Loci index for genome *Salmonella* Enteritidis is available from GenBank.

The above description of *Salmonella* is an example of the in-depth information that is provided for each of the "bad bugs."

The entire Bad Bug Book can be downloaded from the following website:

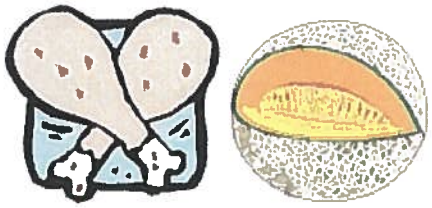
http://www.fda.gov/food/foodsafety/foodborneillness/foodborneillnessfoodbornepathogensnaturaltoxins/badbugbook/default.htm

Bad Bug Book

The following is a condensed version of FDA's "Bad Bug Book". For more details on any of the organisms listed, or to find out about other organisms, you may want to go to FDA's Bad Bug Book at: http://vm.cfsan.fda.gov/~mow/intro.html.

BACTERIA

SALMONELLA
(sal·mo·nel'ah)



Characteristics of Illness: Fever, cramps, diarrhea and sometimes vomiting.
Onset: Illness may begin between 7 hrs to 3 days after eating contaminated food.
Duration: Illness may last 2-3 days.

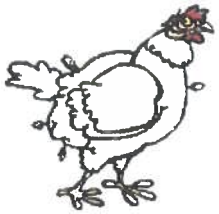
Foods Associated with Salmonella: Raw poultry products, eggs, pork, processed meats. Less commonly, Salmonella has been found to be associated with raw fruits and vegetables such as cantaloupe, tomatoes and alfalfa sprouts.

Prevention of Illness:

- Avoid cross-contamination of ready-to-eat foods with raw meats or their juices.
- Thoroughly cook meat and poultry.
- Cook eggs thoroughly and never eat runny yolks or raw eggs.
- Always refrigerate processed meat products.
- Wash fruits and vegetables thoroughly.

CAMPYLOBACTER

(kam´ pĭ·lo·bak´ ter)



Characteristics of Illness: Diarrhea, often associated with fever, abdominal pain, nausea, headache and muscle pain. Illness can appear very similar to Salmonellosis.
Onset: Illness may begin between 2-5 days after eating contaminated food.
Duration: Illness may last 7-10 days.

Foods Associated with Campylobacter: Raw chicken and raw milk

Prevention of Illness:

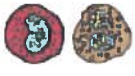
- Avoid cross-contamination of ready-to-eat foods with raw meats or their juices.
- Cook meat and poultry thoroughly.
- Never drink raw milk.

STAPHYLOCOCCUS AUREUS

(staf´ ı·lo·kok´us au´reus)

Foods Associated with Staphylococcus aureus: This bacteria has been associated with a wide range of foods, including meat and meat products, poultry and egg products, salads such as egg, tuna, potato and macaroni, cream-filled bakery products and pies, sandwich fillings and milk and dairy products. In general, Staph poisoning often occurs when a food has been handled a great deal (such as the chopping and handling involved in making a salad or sandwich) and is then left at temperatures above refrigeration which allow the bacteria to multiply and produce toxin.

Characteristics of Illness: Vomiting, diarrhea and abdominal cramps.



Onset: Illness may begin within 3-8 hrs. after eating contaminated food.
Duration: Illness usually lasts about 2 days.

Prevention of Illness:

- Always wash hands well when preparing foods.
- Keep foods refrigerated.

LISTERIA MONOCYTOGENES

(lis·ter'e-ah mon o·sit-og'ens)

Foods Associated with Listeria monocytogenes: Raw milk, raw meats and raw vegetables. Ice cream, soft-ripened cheeses, smoked fish, lunch meats, hot dogs and refrigerated salad-type products. This organism is unique in that it is able to grow even at refrigerated temperatures and so, while refrigeration of foods will slow the growth of Listeria, it will not stop it completely.

Characteristics of Illness: In healthy individuals this organism may result in diarrhea, vomiting and nausea. However, in immunocompromised individuals (the very young, the elderly, pregnant women, those with AIDS or undergoing cancer treatment) Listeriosis may first appear as mild flu-like symptoms, but may then be followed by septicemia, meningitis, encephalitis and spontaneous abortion or stillbirth in pregnant women.
Onset: Illness may occur anywhere from 12 hrs to a few weeks after contaminated food is consumed.
Duration: In otherwise healthy individuals, mild symptoms may disappear in a day or two, but medical attention is required for immunosuppressed individuals who develop the above mentioned complications.

Prevention of Illness:

- Wash fresh fruits and vegetables thoroughly under running water.
- Keep foods refrigerated to slow the growth of Listeria, if it is present.

- Immunocompromised individuals should try to avoid eating implicated foods, such as soft-ripened cheeses or lunchmeat products.

E. COLI O157:H7

(esh'er-i'ke-ah cō lī)

Foods Associated with E.coli O157:H7: Undercooked raw ground beef, unpasteurized apple cider, raw milk and raw produce.

Characteristics of Illness: Severe cramping and diarrhea which is initially watery but becomes grossly bloody. Young children are especially susceptible and in some cases, complications which lead to hemolytic uremic syndrome (HUS) may occur. HUS may lead to permanent loss of kidney failure, or fatality occurs in up to 15% of HUS cases.

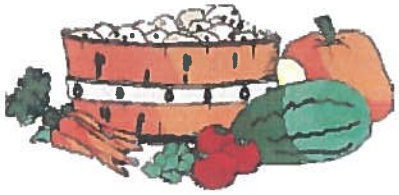
Onset: Illness may occur anywhere between 1 to 10 days after eating contaminated food, but usually occurs between 3 to 4 days.

Prevention of Illness:

- Cook ground beef to an internal temperature of 160°F.
- Wash fresh fruits and vegetables thoroughly with running water.
- Do not drink unpasteurized milk.
- Do not drink unpasteurized apple cider unless it is well refrigerated.

CLOSTRIDIUM BOTULINUM

(klo·strid'e-um boch'ōō·li-num)



Foods Associated with Clostridium botulinum: Improperly processed home canned foods. Improperly processed or damaged canned or aseptically

processed foods. Botulism is extremely rare but when it does occur it is often (>65% cases) fatal. Infant botulism may occur when infants ingest honey containing C. botulinum spores which then colonize and produce toxin in their intestines.

Characteristics of Illness: Symptoms include double vision, vertigo, inability to swallow, speech difficulty and progressive respiratory paralysis. Nausea may also be present initially.
Onset: Symptoms may begin within 18 hrs to 2 days of ingesting the toxin.
Duration: Greater than 65% of cases are fatal. In non-fatal botulism poisoning, recovery may take weeks to years, depending upon the severity of the poisoning.

Prevention of Illness:

- Follow appropriate techniques when home canning.
- Do not eat food from swollen, leaking or severly damaged cans.
- Keep foods which are supposed to be refrigerated below 40o F.
- Do not feed honey to infants under 1 year old.

CLOSTRIDIUM PERFRINGENS

(klo-strid'e-um per-fring'ens)

Foods Associated with Clostridium perfringens: Meat and/or gravy dishes are most often associated with this type of foodborne illness. Generally C. perfringens poisoning occurs when such meat dishes are not cooked to high enough temperatures and then are allowed to sit out at room temperature for serving for an extended period of time.

Characteristics of Illness: Abdominal cramping and diarrhea.
Onset: Illness may begin between 8 to 22 hrs after ingesting contaminated food.
Duration: Illness may last 1-2 days.

Prevention of Illness:

- Keep hot foods hot (>140°F) or refrigerate them rapidly in shallow containers (<40°F) if they will not be served immediately.

BACILLUS CEREUS

(bah-sil'lus cer'eus)

Characteristics of Illness: Bacillus cereus may cause two different types of illness. The first is know as the Diarrheal illness, which results in diarrhea and abdominal cramps occurring within 6 to 15 hrs of eating contaminated food. This illness may persist up to about 24 hours and resembles Clostridium perfringens food poisoning. The second type of illness caused by Bacillus cereus is know as the Emetic illness and results in nausea and vomiting within 3-6 hours of eating contaminated food. This illness also lasts about 24 hrs and it tends to resemble Staphylococcal food poisoning.

Foods Associated with Bacillus cereus: Rice and grain products, dairy products such as milk, cream, custards and dried milk.

Prevention of Illness:

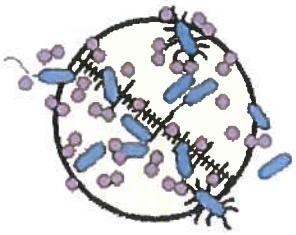
- Keep hot foods hot (>140°F) and keep cold foods cold (<40°F)!

VIBRIO PARAHEAMOLYTICUS

(vib'ri-o para-hea'mo-li-tI-cus)

Foods Associated with Vibrio paraheamolyticus: Seafoods, especially shellfish.

Characteristics of Illness: Diarrhea, abdominal cramps and nausea.
Onset: Illness may occur within 1 to 4 days after eating contaminated food.
Duration: Illness may last for 2 to 3 days.



Prevention of Illness:

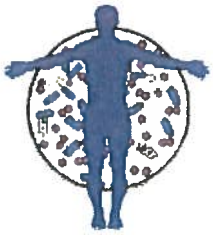
- Keep seafood well refrigerated.
- Avoid eating raw shellfish.

SHIGELLA

(shi·gel'ah)

Foods Associated with Shigella: Salads, raw produce, milk and dairy products. Contamination of foods with this bacteria is most commonly because of:

1. unsanitary handling of food by the food handlers or
2. contaminated water.



Characteristics of Illness: Severe watery diarrhea, including bloody diarrhea, fever and cramping.
Onset: Illness may begin between 12 hrs and 2 days after consuming contaminated food or water.

Prevention of Illness:

- Wash fresh fruits and vegetables thoroughly under running water.
- Always wash hands well when preparing foods.

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