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Foodborne Diseases: Types, Symptoms, and Prevention

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Abstract: Foodborne diseases include all food and waterborne illness and are not confined to those primarily associated with the gastro-intestinal tract exhibiting symptoms such as diarrhoea and/or vomiting but can also produce neurological, gynaecological and immunological symptoms. Diarrheal diseases represent a significant global issue, disproportionately affecting low- and middle-income nations and children under five years of age. There are several preventive measures that one can follow for the packaging of food, for the safety and to decrease the chances for people to get affected by these diseases but sometimes due to the ignorance and some accidents in industry one may get affected by these diseases. Therefore, one needs to learn to be aware of how to avoid these situations from occurring, which will reduce monetary stress and discomfort in life. This paper has been prepared keeping these facts in mind.

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1. Introduction

The word 'Foodborne Disease' comprises 3 words: Food + Borne + Disease. The word 'Food' means anything that we consume that provides us energy and gives us a feeling of satiety. The word 'Borne' means carried or transported by things specified. The term 'Disease' refers to a change of structure or function in a human, animal, or plant, particularly one with a recognized etiology and a specific set of symptoms, signs, or anatomical modifications. Any step of the food production, distribution, and consumption chain can result in foodborne illnesses, which are brought on by food contamination. They can be brought on by a variety of environmental contaminations, such as improper food processing and storage practices and contamination of the air, water, or soil. Eating food infected with germs, viruses, parasites, or chemicals including

heavy metals can result in more than 200 ailments. Due to productivity losses and negative effects on trade and tourism, this expanding public health issue has a significant socioeconomic impact and puts a pressure on health care systems. These illnesses have a major impact on mortality and the burden of disease worldwide.

Though everyone is at risk for getting a foodborne illness, however, some people are at greater risk for experiencing a more serious illness or even death should they get a foodborne illness. Those are known as vulnerable groups of people as they are at greater risk. These include infants, young children, pregnant women and their unborn babies, older adults, and people with weakened immune systems (such as those with HIV/AIDS, cancer, diabetes, kidney disease, and transplant patients) (Arora, 2024).

2. How do Bacteria Enter Our Bodies?

Purchased food may have microorganisms that invade the product during packaging. For instance, ground meat and boneless chicken breasts wrapped in plastics. Eggs, poultry, seafood, milk, and raw meat are not sterile. Fresh vegetables including lettuce, tomatoes, melons, and sprouts are also not. Our surroundings are naturally home to thousands of different kinds of bacteria. Pathogens are microorganisms that cause illness. Foodborne disease may result from the entry of specific pathogens into the food supply. Not all bacteria are harmful to people. Some bacteria, for instance, are advantageous when utilized to make yoghurt and cheese. Pathogens from raw eggs and meat products can cross-contaminate foods, including those that are safely prepared and ready to consume. The pathogen can also enter the body if the person making food was infected with some disease, e.g., common cold. Sometimes pathogens can contaminate the food processing surface, utensils, kitchen cloths or sponges. Pathogens can enter through air or directly from animals to humans. When the food is contaminated through any of the reasons it enters the body and causes disease in humans. Most cases of foodborne illness can be prevented with proper cooking or processing of food to destroy pathogens.

3. Types of Foodborne Diseases

There are basically 3 types of foodborne disease:

1. Foodborne Infections: different disease covered under infection are- Salmonelosis, Shigellosis, *Vibrio parahaemolyticus* gastroenteritis, Enteropathogenic *E. coli* diarrhoea, Hepatitis A.

2. Foodborne Intoxication: different disease covered under intoxication are-Staphylococcal poisoning, *Bacillus cereus* poisoning, botulism.
3. Foodborne Toxic Infection: different diseases covered under toxic infections are-*Clostridium perfringens* gastroenteritis, enterotoxigenic *E. coli*, cholera.

3.1. Foodborne Infection

Food infection refers to foodborne illnesses caused by the entrance of bacteria into the body through ingestion of contaminated foods and the reaction of the body to their presence or to their metabolites.

1. Enterotoxigenic type of food infection, microorganisms produce enterotoxin in intestinal tract that cause disease. E.g., food infection caused by EPEC, *vibrio cholera.*
2. Invasive type of food infection microorganisms cause disease by invading through intestinal tract. E.g., food infection caused by *Shigella, EIEC.*

Food infections can be divided into two types:

1. Those in which the food does not ordinarily support growth of the pathogens but merely carries them, i.e., pathogens such as those causing tuberculosis, diphtheria, the dysenteries, typhoid fever, brucellosis, cholera, infectious hepatitis, Q fever, etc.,
2. Those in which the food can serve as a culture medium for growth of the pathogens to numbers that will increase the likelihood of infection of the consumer of the food; these include *Salmonella* spp., *Vibrio parahaemolyticus,* and enteropathogenic *Escherichia coli* (Table 1). Outbreaks of food infections of the second type are likely to be more explosive than outbreaks caused by other intestinal pathogens.

General Treatment

- replenish lost fluids with water, oral rehydration solutions
- resting and following a bland diet can help ease symptoms
- For severe cases or if symptoms persist in vulnerable group immediately seek medical attention
- Avoid anti-diarrheal medications unless prescribed, as they can prolong certain infections

Table 1: Some common Foodborne Infection

Disease	*Pathogen*	*Associated Food*	*Symptoms and Potential impact*	*Preventions*
Salmonelosis	*Salmonella* (over 2300 types)	Raw or undercooked eggs, poultry, and meat; unpasteurized milk and juice; cheese and seafood; and contaminated fresh fruits and vegetables.	Diarrhoea, fever, and abdominal cramps usually appear 12 to 72 hours after eating; may last 4 to 7 days. In people with weakened immune systems, the infection may be more severe and lead to serious complications, including death.	Cook raw meat, poultry, and egg products to a safe temperature Do not eat raw or undercooked eggs Avoid consuming raw or unpasteurized milk or other dairy products. Produce should be thoroughly washed before consuming.
Shigellosis or bacillary dysentery	*Shigella* (over 30 types)	Person-to-person by faecal-oral route; faecal contamination of food and water. Most outbreaks result from raw salads, and following poor personal hygiene.	Diarrhoea (watery or bloody), fever, abdominal cramps; 1 to 2 days from ingestion of bacteria and usually resolves in 5 to 7 days	Hand washing can prevent shigellosis. Always wash your hands with warm water and soap before handling food and after using the bathroom, changing diapers or having contact with an infected person
Vibrio parahaemolyticus gastroenteritis	*Vibrio parahaemolyticus*	Commonly associated with eating raw or undercooked seafood: oysters Fish and crustaceans and other food grown in seawater and aquatic products.	symptoms include watery diarrhoea, abdominal cramps, nausea, vomiting, fever, and headache. symptoms usually appear within 24 hours of eating contaminated food and last about 3 days.	Store seafood properly, cook seafood appropriately before eating it, avoid eating raw oysters and other shellfish, avoid exposing open wounds to brackish or saltwater.

Enteropathogenic *E. coli* Diarrhoea	*E. coli*	Uncooked meat (especially ground), unpasteurized milk and juices (e.g., "fresh" apple cider); contaminated raw fruits and vegetables, or water. Person to person contamination can also occur.	Severe diarrhoea (often bloody diarrhoea), abdominal cramps, and vomiting. Usually little or no fever. Can begin 2 to 8 days, but usually 3-4 days after consumption of contaminated food or water and last about 5 to 7 days depending on severity. Children under 5 are at greater risk of developing hemolytic uremic syndrome (HUS), which causes acute kidney failure	Cook meat products to a safe minimum internal temperature of 160°F. Drink only pasteurised milk, drinks, soups, juice, or cider. Rinse fruits and vegetables under running tap water, especially those that will not be cooked. Wash hands with warm water and soap after changing diapers, using the bathroom, handling pets or having any contact with feces.
Hepatitis A.	Hepatitis A virus	Shellfish raw or unpeeled fruits and vegetables, especially berries, salads, ice, milk, meat, poultry, and contaminated egg products	Fatigue, nausea, abdominal pain, loss of appetite and low-grade fever. pain areas: in the abdomen, joints or muscles gastrointestinal: diarrhoea, nausea or vomiting whole body: fatigue, fever or loss of appetite also common is dark urine, itching, weight loss or yellow skin and eyes	Cook eggs until the yolk and white are firm. Boil juices from raw meat or fish before using on cooked food serve cooked foods on clean plates forks, spoons and knives keep hot foods at 140°F (60°C) and cold foods below 40°F (4°C) Don't leave foods at room temperature for more than 2 hours or 1 hour if the room is hotter than 90°F(32°C)

(fsis.usda.gov; Martin *et al,* 2008; Jay, 2000; Arora, 2022; https://www.ncbi.nlm.nih.gov/books/NBK459164/#:~:text=First%20discovered%20in%20the%201950s,contact%20with%20the%20gastrointestinal%20system)

3.2. Foodborne Intoxication

Foodborne intoxication, also known as food poisoning, occurs when people consume food that contains toxins produced by bacteria, fungi, or chemicals. Unlike foodborne infections, where illness results from consuming live pathogens, foodborne intoxication is caused by toxins that can be present even if the bacteria are killed or absent by the time of ingestion (Table 2). These toxins are often resistant to heat, so cooking may not eliminate the risk of intoxication.

3.2.1. Types of Toxins

3.2.1.1. Bacterial Toxins: Certain bacteria produce toxins in food under favorable conditions. Examples include:

(a) *Staphylococcus aureus* toxins, often found in improperly refrigerated meats, salads, and dairy products.

(b) *Clostridium botulinum* (causing botulism), found in improperly canned or preserved foods.

(c) *Bacillus cereus*, common in rice, pasta, and other starchy foods that have been left at room temperature.

3.2.1.2. Mycotoxins: Produced by molds (e.g., *Aspergillus*), these toxins can contaminate grains, nuts, and dried fruits. Aflatoxins, for instance, are known carcinogens that can be harmful in small doses.

3.2.1.3. Marine Toxins: Toxins like ciguatera toxin (reef fish), scombroid toxin (decayed fish), and shellfish toxins occur in certain fish due to their diet or bacterial decomposition.

3.2.1.4. Chemical Contaminants: Pesticides, heavy metals, or chemical additives accidentally introduced can also cause intoxication.

Treatment

- Mild cases of foodborne intoxication often resolve on their own with rest, hydration, and supportive care.
- Severe cases, such as botulism, require immediate medical intervention and sometimes antitoxins (against botulin A, B, and E), as they can be life-threatening.

Table 2. Some Common Food borne intoxications

Disease	*Pathogen*	*Associated Food*	*Symptoms and potential impact*	*Prevention*
Staphylococcal Poisoning	*Staphylococcus aureus* Enterotoxigenic strains produce **seven** different enterotoxins: A, B, C1, C2, C3, D, and E (also designated as SEA, SEB, etc.).	Commonly found on the skin and in the noses of up to 25% of healthy people and animals. Person-to-person through food from improper food handling. Multiply rapidly at room temperature to produce a toxin that causes illness. Contaminated milk and cheeses.	Severe nausea, abdominal cramps, vomiting, and diarrhoea occur 30 minutes to 6 hours after eating; recovery from 1 to 3 days — longer if severe dehydration occurs.	It is crucial to avoid contamination of food before the toxin is formed because the toxins formed by these bacteria are heat-resistant and cannot be eliminated by cooking. Before and after preparing food, wash your hands with warm water and soap, and wash kitchen worktops with hot water and soap. Keep hot meals hot (above 140°F) and cold foods cold (40°F or less).
Bacillus Cereus poisoning	*Bacillus cereus*	Starchy and protein-rich food that have been improperly stored. Other foods include cooked rice left at room temperature for extended period pasta, milk products, meat and meat products, vegetable-based dishes, soups that are left out at room temperature after cooking	symptoms include nausea, vomiting, with occasional abdominal cramps which typically resolve within 24 hours severe cases might involve watery diarrhoea with severe abdominal cramps and excessive nausea; these symptoms usually resolve within 24-48 hours symptoms are generally mild to moderate and can resolve without medical intervention. Sometime this can lead to dehydration in vulnerable group It can also lead to loss of work schools' days and economic impacts in food industries	prevention primarily involve proper food handling, storage and cooking practises to inhibit bacterial growth and toxin production. different steps are : refrigerating food properly avoid leaving food at room temperature cook food at safe internal temp. reheat left over at at least 165^0F (74^0C) to eliminate bacteria store raw food properly, clean utensils properly, if starchy food is cooked it should not be left out for extended periods

Disease	*Pathogen*	*Associated Food*	*Symptoms and potential impact*	*Prevention*
Botulism	*Clostridium botulinum*	Improperly canned foods, garlic in oil, vacuum-packed and tightly wrapped food.	Bacteria produce a nerve toxin that causes illness, affecting the nervous system. Toxin affects the nervous system. Symptoms usually appear 18 to 36 hours, but can sometimes appear as few as 6 hours or as many as 10 days after eating; double vision, blurred vision, drooping eyelids, slurred speech, difficulty swallowing, dry mouth, and muscle weakness. If untreated, these symptoms may progress causing muscle paralysis and even death.	Do not use damaged canned foods or canned foods showing signs of swelling, leakage, punctures, holes, fractures, extensive deep rusting, or crushing/denting severe enough to prevent normal stacking. A pH of 4.6, a_w of 0.93, or 5.5% NaCl can prevent cell growth in canned food.

(fsis.usda.gov; Martin et al., 2008; Jay, 2000; https://www.rivm.nl/en/)

3.3. Food borne toxic infections

Foodborne toxic infections occur when a person ingests bacteria that produce toxins within the intestines after consumption. This is different from foodborne intoxication, where toxins are already present in the food before consumption. In food borne toxic infections, the illness results from both the bacteria and the toxins they produce once inside the body (Table 3).

Examples of Bacteria Causing Toxic Infections

- *Clostridium perfringens*: Commonly found in improperly stored meats, gravies, and stews. This bacterium produces toxins in the intestines after ingestion, leading to abdominal pain and diarrhea.
- *Vibrio cholerae*: The cause of cholera, often spread through contaminated water or seafood. It produces toxins in the intestines, causing severe diarrhea and dehydration.
- Enterotoxigenic *Escherichia coli* (ETEC): Often found in contaminated water or food, especially in developing countries, this strain of *E. coli* produces toxins in the intestines, leading to travelers' diarrhea.

4. Treatment

Cholera requires urgent medical attention, primarily for rehydration therapy (oral rehydration salts or IV fluids) to replace lost fluids and electrolytes. In severe cases, antibiotics may be used to shorten the course of the disease.

Early treatment is essential to reduce the risk of severe complications and death from cholera.

- Hydration: Rehydration is critical, especially for infections causing severe diarrhea.
- Medical Care: Antibiotics may be prescribed for certain infections like *Shigella* and *Vibrio cholerae*, but it's essential to consult a healthcare provider for appropriate treatment.

Foodborne toxic infections highlight the importance of food safety practices and prompt treatment, as they can be severe, especially in vulnerable populations.

Table 3. Some common Food Borne Toxic Infections

Disease	*Pathogens*	*Associated food*	*Symptoms and potential impact*	*preventions*
Clostridium perfringens gastroenteritis	*Clostridium perfringens*	Meats, meat products and gravy, food left for long periods in steam tables or at room temperature.	Intense abdominal cramps nausea, and diarrhea may appear 6 to 24 hours after eating; usually last about 1 day, but for immune comprised individuals, symptoms may last 1 to 2 weeks. Complications and/or death can occur only very rarely.	Cooked food should be held hot, at an internal temperature of 140 °F or above. Discard all perishable foods left at room temperature longer than 2 hours or 1 hour in temperatures above 90 °F.
Enterotoxigenic *E. coli*	*E. coli*	Uncooked meat (especially ground meat), unpasteurized milk and juices (e.g., "fresh" apple cider); contaminated raw fruits and vegetables, or water. Person to person contamination can also occur.	Severe diarrhea (often bloody diarrhea), abdominal cramps, and vomiting. Usually little or no fever. Can begin 2 to 8 days, but usually 3-4 days after consumption of contaminated food or water and last about 5 to 7 days depending on severity. Children under 5 are at greater risk of developing hemolytic uremic syndrome (HUS), which causes acute kidney failure.	Cook hamburgers and ground beef to a safe minimum internal temperature of 160°F. Drink only pasteurized milk, juice, or cider. Rinse fruits and vegetables under running tap water, especially those that will not be cooked. Wash your hands with warm water and soap after changing diapers, using the bathroom, handling pets or having any contact with feces.

Disease	*Pathogens*	*Associated food*	*Symptoms and potential impact*	*preventions*
Cholera	*Vibrio cholera*	Cholera is primarily associated with foods and drinks contaminated with *Vibrio cholerae*, especially in areas with poor sanitation. other reasons are: drinking untreated and contaminated water raw or undercooked seafood as the pathogen thrive in brackish water fruits or vegetables washed or irrigated with contaminated water rice, millets and other grains that have been improperly cooked, cooled or stored can also be cause the disease	Severe diarrhea-watery diarrhea often described as rice-water stool Dehydration, Vomiting, muscle cramps, rapid heart rate shock (in severe cases), restlessness or irritability, Without prompt treatment, cholera can lead to acute kidney failure, low blood pressure, and death due to the rapid loss of fluids and electrolytes.	Drink only purified or bottled water, especially in areas with known cholera outbreaks. Avoid raw or undercooked seafood, and thoroughly cook all seafood and shellfish. Wash fruits and vegetables with clean water or peel them before eating. Use clean water for evaporative cooling of fruits and vegeables. Cook rice, grains, and other foods thoroughly and store leftovers at safe temperatures

(fsis.usda.gov; Martin *et al*, 2008; Alam *et al*., 2024; www.encylopedia.com//cholera)

5. Food Safety Regulation and Standards

Food safety regulations and standards help in developing safe food for consumption. It focuses on prevention of food contamination, thus preventing foodborne diseases. These regulations are enforced by government agencies and international organizations and are based on scientific research and best practices for food handling. Here are key aspects of food safety regulations and standards:

5.1. International Food Safety Standards

- Codex Alimentarius: Established by the World Health Organization (WHO) and the Food and Agriculture Organization (FAO) of the United Nations, the Codex Alimentarius provides international guidelines and standards for food safety. It covers everything from food additives to pesticide residues and labeling requirements.
- World Health Organization (WHO): WHO sets international standards for food safety, including guidelines on foodborne diseases, pathogen control, and food safety management systems.

- Food and Agriculture Organization (FAO): FAO works alongside WHO to provide food safety recommendations and global standards.

5.2. National Food Safety Standards

In India, food safety regulations and standards are primarily governed by the Food Safety and Standards Authority of India (FSSAI), which is an autonomous body under the Ministry of Health and Family Welfare. FSSAI is responsible for setting food safety standards, regulating food businesses, and ensuring that food products are safe for consumption. **FSSAI** is the regulatory authority that sets standards for food quality, safety, and labelling (https://fssai.gov.in/). Its role includes:

- Developing food safety standards for the Indian food industry.
- Issuing licenses and registrations to food businesses.
- Conducting research, monitoring food safety, and establishing guidelines for food handling.
- Promoting awareness and training about food safety.

FSSAI has developed **Food Safety and Standards Regulations**, which cover a wide range of areas related to food safety, including:

- Food Quality Standards: Defines the permissible limits for various food products (e.g., additives, preservatives, contaminants, and toxins).
- Hygiene and Sanitation: Regulations on hygiene during food production, processing, packaging, and handling.
- Labeling and Packaging: Guidelines on how food products should be labeled, including nutritional information, ingredients, allergens, expiry dates, and batch numbers.
- Food Additives and Contaminants: Standards for the permissible levels of food additives (like colorants, preservatives) and limits for food contaminants (like heavy metals, pesticides)

5.3. Key Areas of Food Safety Standards

- Hygiene and Sanitation: Regulations cover hygiene practices in food handling, preparation, storage, and transport to minimize contamination risks.
- Temperature Control: Specific temperature guidelines are set for food storage and cooking, including recommendations for safe internal cooking temperatures for meat and poultry.

- Food Labeling: Standards require accurate labeling of ingredients, allergens, nutritional content, and expiration dates. This ensures consumers can make informed choices and avoid potential allergens.
- Pesticide Residues: Limits on pesticide residues are set for various food products to ensure that harmful chemicals do not enter the food supply.
- Food Additives: Use of food additives, preservatives, and colorants is regulated to ensure they are safe for human consumption in the amounts used.
- Pathogen Control: Guidelines exist to prevent contamination by pathogens like *Salmonella*, *E. coli*, *Listeria*, and *Norovirus*. This includes recommendations for sanitation, cooking, and handling practices to prevent foodborne illnesses (https://www.osha.gov/foodborne-disease/standards).
- Traceability: Food safety standards require systems for traceability, meaning that food products should be traceable through all stages of production, processing, and distribution. This helps identify the source of contamination in the event of an outbreak.

5.4. Food borne diseases prevention through education and awareness

Preventing foodborne diseases through education and awareness is an essential and effective strategy aimed at reducing the rates of illnesses caused by contaminated food. Education plays a critical role in shaping food safety practices, impacting both individuals and entire communities. Public education campaigns and awareness initiatives serve as powerful tools in promoting safe food handling and preparation habits. By effectively informing individuals about the importance of proper handwashing, especially before handling food, the likelihood of spreading harmful bacteria can be greatly diminished (http://needtoknow.nas.edu/id/infection/encountering-microbes/entering-the-human-host/).

Adaptation of emerging technologies such as high-pressure processing may be adapted to assure microbial safety of food products without compromising on the nutritional quality of food (Arora and Chauhan, 2018). Moreover, awareness about safe food storage and appropriate cooking techniques is necessary to minimize contamination risks. For instance, understanding the dangers of cross-contamination—such as the need to keep raw meats separate from ready-to-eat foods—is fundamental in preventing the spread of pathogens. Additionally, maintaining correct food temperatures during cooking and storage is vital in inhibiting the growth of harmful microorganisms.

Another critical aspect of food safety education involves teaching the public how to read and understand food labels. This includes recognizing safe food labels, interpreting expiration dates accurately, and properly managing leftovers to avoid spoilage. These skills contribute significantly to making informed choices that protect health.

Educational institutions, healthcare providers, and community organizations have the opportunity to strengthen these efforts by integrating food safety practices into their programs. By including food safety topics in school curriculums, community outreach projects, and public health campaigns, these entities can help foster a culture of food safety awareness.

Through comprehensive education and awareness initiatives, individuals are more likely to adopt healthier food habits. This proactive approach not only protects personal health but also reduces the overall burden of foodborne illnesses on public health systems. As the community becomes more educated about food safety, the collective effort to combat foodborne diseases becomes more effective, ultimately leading to improved public health outcomes.

6. Conclusion

In conclusion, foodborne diseases remain a significant global public health concern, with millions of people affected each year. These diseases not only result in severe illness and death but also place a considerable burden on healthcare systems and economies. The primary causes of foodborne diseases are contaminated food and beverages, often due to improper handling, storage, and cooking practices. The pathogens responsible for these illnesses—bacteria, viruses, and parasites—can spread easily through food that is not properly treated or prepared, making it essential for individuals and food businesses to adhere to safe food practices.

Prevention of foodborne diseases relies on a multi-faceted approach, including proper hygiene, safe food handling, and the implementation of stringent food safety regulations. While the responsibility for ensuring food safety lies primarily with food manufacturers, suppliers, and regulatory bodies, individual awareness and education play a pivotal role in reducing the risk of contamination. By educating consumers about safe food preparation, proper storage, and the importance of food labeling, we can empower people to take control of their health and minimize the risk of foodborne infections.

Governments, healthcare institutions, and international organizations must continue to collaborate on research, monitoring, and food safety education to address the challenges posed by foodborne diseases. As the world becomes

more interconnected and global food trade increases, the risk of foodborne illnesses may evolve, making it essential to continuously update and adapt food safety measures. Ultimately, a combined effort in food safety regulation, public awareness, and individual responsibility is crucial to minimizing the impact of foodborne diseases and ensuring that food remains safe for all consumers.

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