

## Foodborne infections and food safety

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### ABSTRACT

Foodborne infections are very serious and pose a serious public health challenge, especially in the tropical countries. Toxins produced by microorganisms can lead to watery diarrhea, loose stool, or invasive diarrhea. Some proper safety practices and norms can help mitigate foodborne infections to a large extent. One needs to be vigilant and aware of food hygiene and this can help in preventing microbiological contamination in food.

**Key words:** Food poisoning, Food safety, Hygiene

Every year, many people suffer from foodborne infections and many even die. It leads to financial losses and loss of productivity. Consequently, healthy food saves lives. A healthy diet improves both individual and societal well-being. The economic development of an area is improved if food safety is practiced and amended. Both strong research and just enforcement of the law are essential to a safe food supply. As technology develops, new laws must be passed to safeguard a steady stream of foodstuffs that are healthy and safe for people's health and wellbeing. Thus, it is very important to study and know the foodborne pathogens, their route of entry in food, and ways to stop foods from being contaminated by these pathogens.

Food contamination may occur by airborne contamination, dirty hands, dirty containers, as well as poor storage and processing conditions.

### TYPES OF MICROORGANISMS FOUND IN FOOD

#### Bacteria

The most prevalent foodborne pathogens include Enterohemorrhagic *Escherichia coli* (EHEC), *Campylobacter*, and *Salmonella* spp. [1]. Fever, headache, nausea, vomiting, abdominal pain, and diarrhea are among the common symptoms. Eggs, poultry, and other goods made from animals have been recognized as the sources of salmonellosis. Drinking water, raw or undercooked poultry meat, and raw milk are sources of foodborne *Campylobacter* infection. Unpasteurized milk, undercooked meat, and fresh fruits and vegetables are all linked to EHEC. Stillbirths and spontaneous abortions are more likely to occur when there is a *Listeria* infection in the gut or other sites. *Listeria* may multiply well at low temperatures and is present in unpasteurized dairy products and other ready-to-eat items. One

can become infected with *Vibrio cholera* through tainted food or water. Abdominal pain, vomiting, and watery diarrhea are some of the symptoms, which can cause severe dehydration and even death. Vegetables, gruel made from millet, and different types of seafood have been linked with cholera outbreaks.

#### Viruses

The symptoms of a norovirus infection include nausea, violent vomiting, diarrhea, and stomach pain. Hepatitis A-infected food handlers are a frequent source of infection by this hepatotropic virus, in which they can often transfer through raw or undercooked seafood or other raw food products [1].

#### Parasites

Some parasites, like trematodes found in fish, can only spread through food. Some, like *Echinococcus* spp., can spread to humans through food or close contact with animals. Other parasites that contaminate fresh vegetables include *Ascaris*, *Cryptosporidium*, *Entamoeba histolytica*, and *Giardia* spp. They enter the food chain by water or soil.

#### Worms

The types of worms that are most common in areas, where proper food preparation and storage, personal hygiene, water sanitation, and environmental health are not regularly followed are cestodes, nematodes, trematodes, and helminths. Although worm-related foodborne illnesses are not as lethal as those caused by viruses and bacteria, they nevertheless account for a sizable portion of foodborne disability.

## Chemicals

Many epidemics have been brought on by naturally occurring poisons and environmental contaminants. In addition, chemical residues that were employed to get rid of or manage worms and bugs might also provide a danger for foodborne illness. Natural poisons include mycotoxins, marine biotoxins, cyanogenic glycosides, and deadly mushrooms. Mycotoxins such as Aflatoxin and Ochratoxin can be found in high concentrations in staple foods such as corn and grains. Long-term exposure can harm the immune system, impair growth, or even result in cancer. Pediatricians and public health professionals are becoming increasingly concerned about environmental toxins.

Compounds known as persistent organic pollutants build up in both the environment and the human body. By-products of industrial processes and garbage incineration include dioxins and polychlorinated biphenyls. They are present in the environment and build up in the food chains of animals. Dioxins are highly hazardous and can cause reproductive and developmental disorders, impair the immune system, interfere with hormones, and cause cancer. Finally, kidney and neurological damage can be brought on by heavy metals such as lead, cadmium, and mercury. Environmental pollution of the air, water, and soil is the main cause for heavy metal contamination of food. Table 1 explains foodborne pathogens and infections, whereas Table 2 explains about the potentially contaminated food products.

**Table 1: Common foodborne pathogens, and their medical and economic impacts**

Foodborne hazards	Common Infectious or toxic agents	Incidence of foodborne illness	Death due foodborne illness	Total DALYs
Bacteria	<i>Salmonella</i> spp., <i>Vibrio</i> spp., <i>EHEC</i> , <i>Shigella</i> , <i>Listeria</i> , <i>Brucella</i> , <i>Listeria</i> , <i>Campylobacter</i>	359,747,420	272,554	20,188,792
Virus	Norovirus, Hepatitis A	138,513,782	120,814	3,849,845
Protozoa	<i>Entamoeba</i> spp., <i>Giardia lamblia</i> , <i>Cryptococcus</i> spp. <i>Toxoplasma</i> spp.	77,462,734	6242	1,311,435
Worms	Cestodes (tapeworms), Nematodes (round worms), Trematodes (flatworms); helminths (parasites)	26,063,664	90,261	11,599,735
Chemicals	Aflatoxins, Cyanogenics, Dioxins, Heavy Metals (2)	217,632	19,712	908,356

**Table 2: Potentially contaminated food products**

Food	Major organisms involved	Recommendation
Unpasteurized milk, cheese and other dairy products	<i>Salmonella</i> , <i>Campylobacter</i> , <i>Escherichia coli</i> , O157, <i>Listeria</i> , <i>Mycobacterium bovis</i> , <i>Brucella</i>	Children should not drink unpasteurized milk or eat unpasteurized soft cheeses
Unpasteurized fruit or vegetable juices	<i>E. coli</i> O157, <i>Salmonella</i> , <i>Clostridium botulinum</i>	Children should drink only pasteurized juice products, unless the fruit or vegetable is washed and the juice is freshly squeezed immediately before consumption
Eggs	<i>Salmonella</i>	Children should not eat raw or undercooked eggs, unpasteurized powdered eggs or products containing raw eggs
Raw or undercooked meat, poultry	<i>Salmonella</i> , <i>Campylobacter</i> , <i>E. coli</i> O157, <i>Yersinia</i> , <i>Listeria</i> , <i>Toxoplasma</i> , <i>Brucella</i> , <i>Trichinosis</i>	Children should not eat raw or undercooked meat, poultry or meat products (including hot dogs) (2,3)
Raw fish and shellfish	<i>Vibrio</i> spp., norovirus, Hepatitis A virus, many other pathogens, toxins and parasites	Children should not eat raw shellfish. Some experts caution against eating any raw fish
Fresh fruits and vegetables	<i>Cryptosporidium</i> , <i>Cyclospora</i> , Calicivirus, Norovirus, <i>Giardia</i> , <i>Shigella</i> , <i>E. coli</i> O157, Other <i>E. coli</i> species, Hepatitis A	All fruits and vegetables should be washed before they are eaten. Lettuce, spinach, other salads, and greens require careful attention
Sprouts (alfalfa, mung bean)	<i>Salmonella</i> spp., <i>E. coli</i> O157; H7, Hepatitis A virus	Children should avoid eating raw or undercooked alfalfa, mung bean or other sprouts. Seeds sold for sprouting may also be contaminated
Honey	<i>C. botulinum</i>	Children younger than one year of age should not be given honey
Cream-filled pastry; potato, egg or other salad with creamy dressing	<i>Staphylococcus aureus</i> , <i>Bacillus cereus</i>	These items should be eaten immediately on preparation or stored promptly in the refrigerator

## MATERIALS AND METHODS

Thorough literature search was used for citing scientific information, using MeSH (Medical Scientific Headings) terms and PubMed as search engine.

## SIGNIFICANT OBSTACLES TO FOOD SAFETY

Food safety challenges can be found in four main areas.

- **Microbiological Safety:** Food is biological by nature. It can foster the growth of microorganisms that could be the cause of foodborne illnesses. Although bacteria are more often to blame for hospitalizations and fatalities linked to foodborne diseases, viruses still account for the bulk of foodborne illnesses. Mild gastroenteritis to neurologic, hepatic, and renal disorders can result from either toxin produced by the pathogen microorganism. The majority of serious and deadly foodborne infections are caused by bacterial pathogens found in food. Species of *Staphylococcus*, *Salmonella*, *Clostridium*, *Campylobacter*, *Listeria*, *Vibrio*, *Bacillus*, and *E. coli* are responsible for more than 90% of foodborne diseases.
- **Chemical Safety:** Foods have been discovered to include contaminants such as pesticide residues as well as nonfood grade chemical additives such as colourants and preservatives. Heavy metal concentrations in some food samples were greater than average, including lead, cadmium, arsenic, mercury, and copper, indicating possible utensil leaching and poor food hygiene.
- **Personal Hygiene:** The health of individuals and the general public is seriously endangered by the poor personal hygiene habits of food handlers and preparers. Numerous foodborne infections can be avoided with simple measures like thorough hand washing and access to proper facilities for washing.
- **Environmental Hygiene:** Food that is rotten and tainted accumulates as a result of inadequate recycling and waste disposal infrastructure. This results in a rise in pest and bug populations, which raises the possibility of food spoiling and contamination. Poor food storage and transportation, as well as the sale of contaminated food, are all caused by unsanitary circumstances in the region, where foods are processed and prepared.

## VARIOUS FOODBORNE BACTERIAL, VIRAL, AND PARASITIC INFECTIONS

Bacteria are of prime importance as regards food contamination and food poisoning. Viruses also can cause incidences of food poisoning, particularly Norovirus and Hepatitis A virus.

### Food Poisoning

Food poisoning can be caused by different bacteria. These are mediated by the toxins produced by the bacteria. Various bacteria are incriminated in food poisoning, such as *Bacillus cereus*,

*Staphylococcus aureus*, *Vibrio parahaemolyticus*, and others [1]. Norovirus present in shrimps and oysters is also an important cause of food poisoning, especially in Western countries.

### Invasive Foodborne Infections

Bacteria such as *Shigella* spp., EHEC, and *Campylobacter* spp. can cause invasive infections of the gut and inflammation, in which there can be substantial gut tissue damage [2]. Hence, these infections are manifested by bloody diarrhea and dysentery. Dysentery means the release of pus, mucus, and blood in stool; there may or may not be abdominal cramps [3].

## SOURCES OF FOODBORNE PATHOGENS

These pathogens come either from the food or arise from the surface continuation of the food that is from the hands of the handler. Food kept open for a long time in the air for cooling after cooking, which may get contaminated by airborne bacteria. Food can get contaminated with microbes during stages such as production, processing, distribution, preparation, and improper handling or mishandling at various points [4].

### MYCOTOXINS IN FOOD

Various mycotoxins can be found in food grains, such as Aflatoxin and Patulin. The nature of these toxins depends on the food substrates they grow. Commonly these are produced by molds such as *Aspergillus* spp., *Fusarium* spp., and *Penicillium* spp. Aflatoxin can cause liver affection and also Hepatocellular Carcinoma.

## LABORATORY DIAGNOSIS OF BACTERIAL FOOD POISONING

Samples such as food, vomitus, and feces can be chosen for Gram stain and culture for diagnosis of foodborne infections. A cutoff colony count of more than  $10^6$  Colony forming units of bacteria per gram of feces for *S. aureus* and  $10^6/g$  for *B. cereus*, respectively, is diagnostic of food poisoning by these bacteria. Standard laboratory tests such as catalase, coagulase, and lecithinase test can be done to identify the colonies. Mycotoxins can also be detected by UV light, thin layer chromatography, and ELISA.

### FOOD SAFETY

Food safety should be given prime importance if one wants to avoid foodborne infections. There are many points for food safety. These should be remembered by cooks, people who are distributing food, canteen workers as well as consumers. CDC advises four points for food safety, that is, "clean, separate, cook, and chill" [5]. The basic points for food safety are as follows:

- Vegetarian food and non-vegetarian food should be chopped in separate utensil.

- b. The utensil for chopping should be different from those used for cooking or storage.
- c. Once cooked and cooled to room temperature, food if not consumed, should be refrigerated immediately.
- d. Hands should be washed meticulously by following all the steps before preparing and handling food. Furthermore, food handlers, cooks, and consumers should wash their hands before eating and after defecation.
- e. Fresh fruits and uncooked vegetables should be washed meticulously under running water before consuming them.

Food should also be microbiologically safe. It should not contain too many *S. aureus* or *B. cereus*. It should also not contain spores of *Clostridium* spp. Food should meet some essential microbiological criteria. These are important to assess the quality of food, adherence to safety norms, the utility of that food for specific purposes, and their potential to cause infections as well as their shelf life [6,7].

### HACCP AND FOOD SAFETY

HACCP is Hazard Analysis and Critical Control Points. These are the points where food is likely to get contaminated, for example, during cooking, during storage, and other times. Hence, these are called Critical care points. There are seven principles to remember in HACCP. HACCP is a systematic approach for the identification, evaluation, and control of food safety hazards which are based on the following seven principles:

Principle 1: Carrying out a hazard analysis.

Principle 2: Find the critical control points.

Principle 3: Setting up the critical limits.

Principle 4: Establishing the monitoring strategies.

Principle 5: Devising corrective actions.

Principle 6: Setting up the verification procedures.

Principle 7: Establish record-keeping as well as documentation procedures [8].

### DISCUSSION

Foodborne infections are widely prevalent and need to be diagnosed and managed early. They are especially difficult to tackle in developing countries [9,10]. Thus, safe and hygienic practices can go a long way in preventing foodborne infections. These are

to be remembered by cooks, food handlers, and consumers as well as nutritionists [9]. The four principles of clean, separate, cook, and chill should be applied for food safety [5]. Doctors and nutritionists need to work hand-in-hand to control such infections. Only then can safe and hygienic food can be a reality.

### CONCLUSION

Food safety should be given its true importance to prevent foodborne infections. One needs to be vigilant in many aspects to minimize foodborne infections.

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