

Food Infections

Food infection is an illness caused by microorganisms. It results from the consumption of food that contains living bacteria which are multiplying and capable of producing disease. The illness which results is the reaction of the body to the presence of microorganisms or to their metabolites. The gastric juices secreted in the stomach is acidic and destroys some bacteria. In the small intestine the pH is neutral and bacteria multiply rapidly. This irritates the lining of the intestines, resulting in nausea, diarrhoea and abdominal pains. The incubation period for an infection to occur is 12 hours or more (Refer Table 4.1).

For bacterial food poisoning or infection to occur, approximately one million or more bacteria must be present in food. It is likely that food could be contaminated with several hundred causative bacteria. If conditions for growth are favourable, these bacteria could multiply to over one million in a short span of three to four hours (Refer Fig. 4.6).

The time lapse between the consumption of food and the appearance of symptoms is called the incubation time. The incubation time and the severity of the attack of bacterial poisoning or infection will depend on several factors such as:

1. The type of organism causing the illness: Some types cause a more severe illness than others.
2. The susceptibility of the individual: This depends on the age of the person as well as his or her state of health. The very young, the old and infirm and people who are convalescing are more susceptible. They may suffer even after ingesting fewer bacteria.
3. The number of bacteria or the amount of toxin consumed: The greater the number of bacteria and the greater the amount of toxin swallowed, the quicker and more severe is the attack.

Table 4.1 Difference between Food Poisoning and Food Infection

<i>Food poisoning</i>	<i>Food infection</i>
Caused by toxin	Caused by living microorganisms
Incubation period: two hours	Incubation period: 12-24 hours
Symptoms: nausea and vomiting diarrhoea, usually no fever	Symptoms: diarrhoea, abdominal pain, vomiting, fever
Duration: one day, sometimes longer	Duration: one to seven days, sometimes longer

BACTERIAL FOOD INFECTIONS

■ Salmonellosis

This is the commonest cause of bacterial food-borne disease and the most serious. Organisms of the salmonella group cause an infection in the intestine. Many species are infectious. These rod-shaped bacteria are aerobic and non-spore producing. They are present in the intestine of humans and animals and are excreted in the faeces. Illness occurs when living organisms are ingested in large numbers. If a small number of organisms are allowed to multiply in food then infection can result.

Organism: viable cells of *Salmonella choleraesuis* or *Salmonella enteritidis*, Serotype typhimurium

Incubation period: twelve to 24 hours

Duration of illness: one to seven days

Mode of transmission:

1. contact transmission: direct contact by food handler ill with salmonellosis or a carrier of the disease
2. cross-contamination: if the food handler does not wash hands after handling raw meat and poultry, after a visit to the toilet or does not adequately clean and sanitise the chopping board and other equipments
3. vector transmission by rodents and flies from faecal matter
4. use of cracked eggs or seafood from polluted waters

Symptoms: diarrhoea, abdominal pain, chills, fever, vomiting, dehydration, enteritis or local infection may also occur; watery, greenish, foul-smelling stools

Foods commonly involved:

1. animal products like meat, poultry, dirty shelled eggs and products made from them: meat and poultry that may have got contaminated at the slaughter house by diseased animals
2. ducks' eggs
3. high risk foods exposed to warm temperatures for long hours, for example, milk, fish, mutton biriyani
4. seafood from polluted waters
5. canned foods that are opened, have got contaminated and are held without refrigeration once opened

Conditions necessary for an outbreak:

1. the food must contain or get contaminated with the organism
2. these bacteria should be present in considerable numbers
3. live organisms should be ingested

Prevention:

1. Purchase meat, poultry, eggs and fish that have been thoroughly inspected for wholesomeness.
2. Wash hands often, especially after using the toilet and after handling raw meat, poultry and any soiled objects.
3. The food handler's nails should be trimmed and clean.
4. Keep equipment clean and hygienic.
5. Rodents and insects in the vicinity of food preparation areas should be controlled.
6. Growth of the organism may be prevented by adequate refrigeration as *Salmonella* are very sensitive to temperature and do not multiply in low temperatures.
7. These bacteria can be destroyed by thorough cooking to at least 66°C for at least twelve minutes.
8. Leftover food should be reheated quickly and thoroughly.

■ Typhoid and Paratyphoid (Enteric Fever)

Typhoid Typhoid fever is caused by *Salmonella typhi*, whereas paratyphoid fever is caused by *Salmonella enteritidis*. Both organisms are excreted in the faeces and urine of patients suffering from the disease or are excreted by healthy carriers. Outbreaks of both diseases are caused by water contaminated by sewage and food contaminated by food handlers directly or indirectly.

Typhoid is a common infection seen in India, especially in areas where hygiene standards are poor.)

Organism: *Salmonella typhi*

Incubation period: fourteen days

Duration of illness: one to eight weeks

Mode of transmission:

1. vehicle transmission through contaminated milk and water
2. direct contact through hands that are contaminated
3. vector transmission by flies and other insects

Symptoms: malaise, headache, high and continued fever, cough, anorexia, vomiting, diarrhoea, bleeding from the bowels

Foods commonly involved: raw milk, vegetables grown on sewage farms, especially if eaten raw, and contaminated water

Prevention:

1. Ill persons or suspected carriers should not be allowed in food preparation and service areas.
2. Use boiled cooled water.
3. There should be proper sewage disposal and non-leaky sewer pipes.
4. Use pasteurised milk and other dairy products.
5. Control the growth of rodents and insects.
6. Protect by immunisation with vaccines.

Paratyphoid Organism: *Salmonella enteritidis*, serotype Paratyphi A, B and C.

Incubation period: one to 15 days

Duration of illness: one to three weeks

Mode of transmission:

1. vehicle transmission through contaminated foods like frozen foods, ice and ice creams
2. direct contact by infected carriers and persons who have not washed hands adequately; the source is the faeces and urine of infected persons
3. vector transmission through houseflies

Foods commonly involved: contaminated foods, especially confectionery; frozen foods and ice creams

Prevention: same as for typhoid

■ Bacillary Dysentery or Shigellosis

It is caused by a rod-shaped bacteria that causes an infection in the intestine of humans. The main cause for spread of this infection is poor personal hygiene and faulty sewage disposal.

Organism: *Shigella sonnei*, *S. dysenteriae*

Incubation period: one to seven days

Mode of transmission:

1. direct contact with hands and clothing soiled with excreta of a person who is ill with the disease or is a carrier
2. vehicle transmission through contaminated food and water
3. vector transmission through houseflies

Symptoms: abdominal cramps, fever, chills, diarrhoea, watery stools (frequently containing blood and or mucous), nausea, dehydration

Foods commonly involved:

1. moist, mixed foods like fish or macaroni salad, mutton cutlets,
2. mutton pie, blancmanges and puddings
3. milk, beans and potatoes

Prevention:

1. Practice methods of personal hygiene. Ill persons or carriers should not be allowed in food preparation and service areas.
2. Cook foods thoroughly. Chill foods promptly in small portions.
3. Protect and treat water.
4. Control flies and other pests.
5. Dispose of sewage in a sanitary manner.

■ Cholera

Cholera is caused by the comma-shaped bacteria *Vibrio cholerae* which is present in water contaminated by faeces of people suffering from cholera. When bacteria enter the body, they multiply rapidly in the small intestine and violent diarrhoea sets in. This infection occurs mainly in Asia and Southern Europe.

Organism: *Vibrio cholerae*

Incubation period: one to six days

Mode of transmission:

1. direct contact with hands and clothing soiled with the excreta of a diseased person
2. ingestion of polluted and contaminated water, food and aerated water
3. contaminated equipment
4. vector transmission by houseflies

Symptoms: sudden onset of severe watery diarrhoea, vomiting, cramps in the legs, thirst and rapid dehydration; the stools are compared to rice water; there may be griping pain in the abdomen; epidemics take a serious turn and mortality rate varies from five to 75 per cent or more.

Foods commonly involved:

1. fish and shellfish from polluted waters
2. aerated drinks prepared from polluted waters
3. contaminated, stale food

Prevention:

1. Protect food and drink from flies and dust.
2. Use suitable disinfectants and wash hands properly.
3. Dispose of wastes and excreta properly.
4. Water should be chlorinated and boiled before consumption.
5. Do not consume suspect food which may be raw, stale or overripe fruit which may be exposed to the source of infection.
6. Cook food thoroughly as vibrios are killed by boiling for a few seconds.

■ Vibrio Parahaemolyticus

This is a common cause of food poisoning in Japan. These non-cholera vibrios are found in seafood such as fish and shellfish and in coastal waters. The infection occurs when seafood is not cooked thoroughly.

Organism: Vibrio parahaemolyticus

Incubation period: Twelve hours

Mode of Transmission:

1. contaminated seafood and seawater
2. cross-contamination from salt water fish and sea water used for cleaning food and food contact surfaces

Symptoms: acute diarrhoea, abdominal pain, mild fever, vomiting, chills, headache and prostration

Foods Commonly Involved: salt water fish, prawns, crabs and other shellfish

Prevention:

1. Cook foods thoroughly.
2. Chill foods to be held, immediately.
3. Avoid cross-contamination from salt-water fish.
4. Do not use sea water for washing foods which are to be eaten raw.
5. Sanitise equipment and work surfaces.
6. Do not use sea water for cleaning production areas.

■ Enteropathogenic Infection or Gastro-enteritis

Although *Escherichia coli* is a normal inhabitant of the intestinal tract of humans, many strains cause acute diarrhoea in infants and some can infect adults also. It is also often the cause of a gastro-intestinal upset called 'travellers diarrhoea'. The disease causing strains are enteropathogenic, i.e., they cause disease in the enteron or intestine. They are present in the human and animal intestine and are excreted in faeces.

Organism: Enteropathogenic Escherichia coli (EEC)

Incubation period: Twelve hours to two days

Mode of transmission: Raw food contaminated with sewage, contaminated hands, cross-contamination of food and careless storage, sewage pollution of water

Symptoms: Two types of infections are seen. In the 1st type E. coli may produce an enterotoxin and result in a cholera-like illness. The ingested organism colonises in the upper small intestine and produces the toxin resulting in travellers' diarrhoea and infantile diarrhoea.

The second type of *E. Coli* infection results in an invasive type of illness. This is a dysentery-like syndrome with fever, chills, profuse watery diarrhoea with mucous and blood and colitis.

Foods Commonly Involved: Raw meat and poultry contaminated with excreta, salads and other vegetables consumed raw

Prevention:

1. Chill food rapidly in small quantities.
2. Cook food thoroughly.
3. Practice personal hygiene.
4. Wash all vegetables thoroughly, especially salad vegetables and chutney ingredients like coriander leaves, mint and green chillies.
5. Protect and treat water.
6. Dispose sewage in a sanitary manner.

LISTERIOSIS

Listeria are aerobic, non-spore forming bacteria that can cause serious food borne infection in the vulnerable age group, particularly the old, infirm, chronically ill patients, pregnant women and infants. These bacteria are found in the soil, vegetables and animal feed.

This fatal food borne illness is uncommon but if infected, the chances of death are high. *Listeria monocytogenes* was responsible for causing more than 40 deaths in the United States in 1985. *Listeria* is capable of forming and growing in biofilms. Bacteria in biofilms are more difficult to kill with sanitisers and disinfectants and the bacterium thrives in wet areas, refrigerators and food store drains.

Organism: *Listeria monocytogenes*, a bacterium.

Incubation Period: When food contaminated with *Listeria* is consumed, the bacteria multiplies in the gastrointestinal tract causing listeriosis.

Mode of Transmission: Milk and meat of infected animals; susceptible foods which are refrigerated, like soft cheese, salads, sausages. *Listeria* is a ubiquitous organism and because of its ubiquitous nature is difficult to keep out. Airborne droplets from contaminated drains contaminate the floor and ultimately food. Cockroaches, backflow in drains, cracks and crevices in the kitchen, cutting boards etc. harbour *Listeria*.

Symptoms: Miscarriages and still births in pregnant women, meningitis and septicaemia in infants.

Foods commonly involved: Refrigerated foods that are likely to be contaminated and cannot be heated like soft cheeses, prepacked salads, sausages, meat, milk products and foods served in Deli's, also chilled raw chicken and unpasteurised milk. Since the organism is capable of growing at 5°C, hence the refrigerator which is used to control the growth of most other pathogens cannot be relied upon to control the growth of *Listeria*. The bacterium grows in mildly acidic conditions. They have been isolated from fruits, vegetables, milk, cheese, meats and seafood.

Prevention:

1. Proper maintenance of drains and grease trap systems in the kitchen to prevent backflow of water.
2. Regular pest control as fruit flies and cockroaches that thrive in drains can spread the disease.
3. Introducing technically sound cleaning practices for floor drains, sinks and greasetraps that prevent the formation of potentially harmful airborne droplets from drain water, which gets sprayed into the air through traditional cleaning methods.
4. Washing any item that accidentally falls on the floor before placing it on a food contact surface.
5. Discarding food items that accidentally fall on the floor.
6. Thorough cleaning of both food contact and non-food contact areas specially difficult to clean and frequently missed nooks and corners in the kitchen. Areas in and around equipment, especially wet grinding and refrigeration areas, chopping boards and slicers as well as wash-up areas, sinks and drainage boards.
7. Thorough heating up of frozen and refrigerated foods.
8. Pasteurisation of milk and use of the same for making cheese.

VIRAL INFECTIONS

■ Infectious Hepatitis

This is an acute communicable disease caused by a virus. It is very common in India, especially in overcrowded areas where standards of personal hygiene are low. It spreads through contaminated water or food. The hepatitis virus is found in the faeces, urine and vomit of infected people and in polluted waters. The disease has a fairly long incubation time as well as duration. Because of severe nausea and dehydration, the patient may need to be hospitalised. The virus may survive ordinary cooking practices.

Organism: Hepatitis A virus

Incubation period: twenty-five days

Mode of transmission:

1. contact transmission: food or water contaminated by direct contact with the faecal-oral route of the diseased person or carrier
2. contact with the hands of an infected person which are not adequately washed
3. vehicle transmission by consuming contaminated food, polluted drinking water or shellfish
4. vector transmission by houseflies.

Symptoms: jaundice, loss of appetite, abdominal discomfort, severe nausea and vomiting which could result in dehydration, fever, weakness, marked weight loss

Foods commonly involved: milk and other beverages; shellfish, contaminated foods, contaminated water

Prevention:

1. The food handler should maintain proper standards of cleanliness.
2. Prevent the entry of persons sick with hepatitis or those who are carriers in food preparation and service areas.
3. Control the growth of houseflies.
4. Shellfish should be cooked thoroughly and foods like milk should be adequately heated.
5. Keep plumbing in excellent order; prevent contact of sewage with food or food contact surfaces.

PARASITIC INFESTATIONS

■ Amoebic Dysentery

Amoebiasis is caused by the protozoan *Entamoeba histolytica*. The disease may occur with or without clinical manifestations. Amoebic dysentery is considered to be the intestinal manifestation of the disease.

Organism: *Entamoeba histolytica*

Incubation period: three to four weeks

Mode of transmission: by ingestion of cysts in food and drink, vehicle transmission by contaminated vegetables from fields irrigated with contaminated water, vector transmission due to flies and rodents

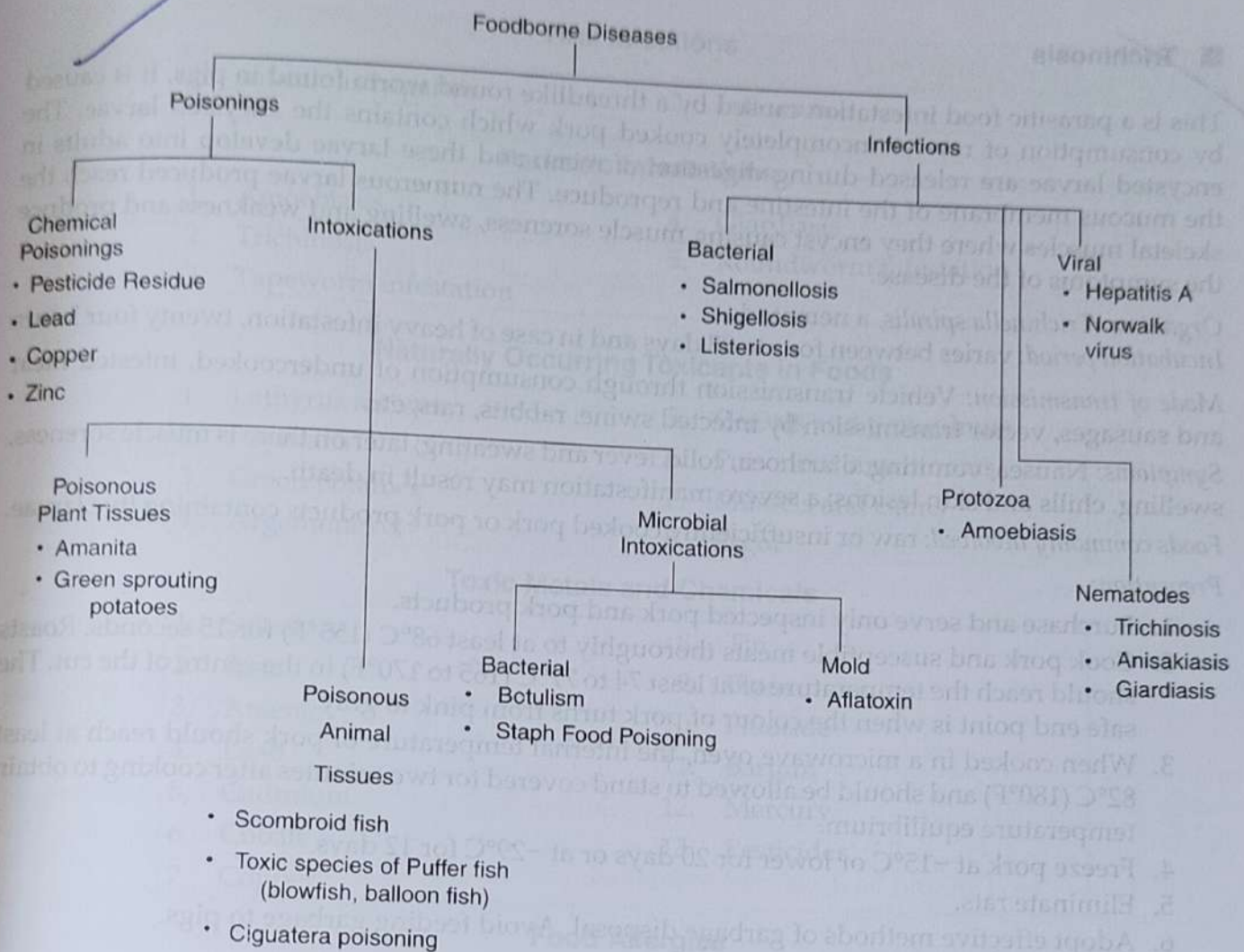


Fig. 4.11 Classification of foodborne diseases

that feed and settle on uncovered food, infected food handlers can spread the infection through unhygienic habits – viable cysts could be present on the hands and under the fingernails of these carriers

Symptoms: these range from abdominal discomfort to slight diarrhoea, alternatively, constipation or severe diarrhoea

Foods commonly involved: water contaminated with sewage, moist foods contaminated with human faeces

Prevention:

1. Use boiled drinking water.
2. Wash or disinfect uncooked fruits and vegetables thoroughly.
3. Protect food against rodents and flies.
4. Food handlers should be medically examined periodically to identify those who are ill or are carriers. They should not be allowed to handle food and equipment in food preparation areas.
5. Proper sewage disposal methods should be adopted.

■ Trichinosis

This is a parasitic food infestation caused by a threadlike round worm found in pigs. It is caused by consumption of raw or incompletely cooked pork which contains the encysted larvae. The encysted larvae are released during digestion of meat, and these larvae develop into adults in the mucous membrane of the intestine and reproduce. The numerous larvae produced reach the skeletal muscles where they encyst causing muscle soreness, swelling and weakness and produce the symptoms of the disease.

Organism: *Trichinella spiralis*, a nematode

Incubation period: varies between four to 28 days and in case of heavy infestation, twenty four hours

Mode of transmission: Vehicle transmission through consumption of undercooked, infested meat and sausages, vector transmission by infected swine, rabbits, rats, etc.

Symptoms: Nausea, vomiting, diarrhoea, colic, fever and sweating; later on there is muscle soreness, swelling, chills and skin lesions; a severe manifestation may result in death.

Foods commonly involved: raw or insufficiently cooked pork or pork products containing live larvae.

Prevention:

1. Purchase and serve only inspected pork and pork products.
2. Cook pork and susceptible meats thoroughly to at least 68°C (155°F) for 15 seconds. Roasts should reach the temperature of at least 74 to 77°C (165 to 170°F) in the centre of the cut. The safe end point is when the colour of pork turns from pink to gray.
3. When cooked in a microwave oven, the internal temperature of pork should reach at least 82°C (180°F) and should be allowed to stand covered for two minutes after cooking to obtain temperature equilibrium.
4. Freeze pork at -15°C or lower for 20 days or at -29°C for 12 days.
5. Eliminate rats.
6. Adopt effective methods of garbage disposal. Avoid feeding garbage to pigs.

FOOD-BORNE ILLNESS

Microorganisms which cause food-borne illnesses are bacteria, viruses, protozoans and nematodes. Among all these microorganisms, bacterial contamination is the most common cause of food poisoning in the catering industry. It usually results from mishandling of food. These illnesses are characterised by a severe disturbance of the stomach and intestines which occurs after consuming food in which the offending bacteria were given a chance to multiply. Such illnesses are broadly divided into two categories: food poisonings and food infections.

Food Poisoning

Food poisoning or food intoxication is an illness caused by toxins present in contaminated food. The toxin may be a poisonous chemical toxin which is accidentally or intentionally added, a naturally occurring poison like solanine in green potatoes or a toxic metabolite excreted by bacteria.

In bacterial food poisoning, the toxin is produced during multiplication of cells. When food is consumed, the toxin already present irritates the lining of the stomach and causes vomiting. If the toxin reaches the intestine, it may cause abdominal pain and diarrhoea. The incubation period for such food poisonings is comparatively shorter (one to six hours) than that for bacterial food infections. The offensive food may not contain any living bacteria, which may have been destroyed during heating.

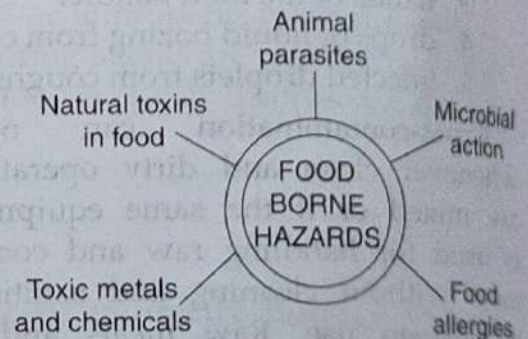


Fig. 4.5 Food-borne hazards result in food-borne illnesses

SOME IMPORTANT FACTS

- Food poisoning causes more than 23 million lost working days in a year
- The number of reported cases has doubled in the last ten years
- In spite of more public awareness about hygiene, food poisoning is on the increase
- The standards of food hygiene in most establishments is very poor

Toxins need much higher temperatures to be destroyed than the bacteria which produce them. They may thus be present in inadequately heated foods, even if the bacteria have been destroyed. However, some food poisonings occur only when large numbers of live bacteria are ingested. When these bacteria reach the intestinal tract they produce the toxin, for example, *Clostridium perfringens*.

- more susceptible. They may suffer even after ingesting fewer bacteria.
3. The number of bacteria or the amount of toxin consumed: The greater the number of bacteria and the greater the amount of toxin swallowed, the quicker and more severe is the attack.

Table 4.1 Difference between Food Poisoning and Food Infection

<i>Food poisoning</i>	<i>Food infection</i>
Caused by toxin	Caused by living microorganisms
Incubation period: two hours	Incubation period: 12-24 hours
Symptoms: nausea and vomiting diarrhoea, usually no fever	Symptoms: diarrhoea, abdominal pain, vomiting, fever
Duration: one day, sometimes longer	Duration: one to seven days, sometimes longer

BACTERIAL FOOD POISONINGS OR INTOXICATIONS

■ Staphylococcus Food Intoxication

Staph food poisoning is one of the most common types of food poisoning caused by the toxin produced by *Staphylococcus aureus*. This bacteria is widespread and is frequently found in the throat and nose of 30 per cent of all healthy people and in the nasal discharges of persons recovering from a cold. On the skin,

Fig. 4.6 *The number of bacteria doubles every twenty minutes under favourable conditions*

it is present in pimples, boils and infected wounds. Droplets from the nose or throat sneezed or coughed into the air could contaminate air, clothing, handkerchiefs and skin. Hands could be contaminated by soiled handkerchiefs or tissues or by touching the nose or any eruptions on the skin, and could get heavily contaminated with these microorganisms. If hands are not washed and scrubbed well, contamination

is transferred to food, utensils or equipment during food preparation. Hence, the need for food service personnel to follow proper sanitary procedures in food preparation and practise correct hand habits.

Staphylococci are facultative aerobes and are able to survive without oxygen. They do not form spores. The toxin they produce is heat resistant, therefore, although the bacteria are easily destroyed by heating for ten minutes at 66°C the toxin may survive heating at 100°C for 30 minutes.

Like in other bacteria, acid type foods are not suitable for the growth of staphylococci. However, they are not affected by high levels of sugar or salt and may be found in cured meats.)

Organism: strains of *Staphylococcus aureus*

Type of toxin: enterotoxin

Incubation period: two to six hours

Duration of illness: six to 24 hours

Symptoms: salivation, nausea, vomiting, abdominal cramps, diarrhoea, sub-normal body temperatures; mortality is extremely low, in severe cases blood and mucous may be found in the stools.

Foods commonly involved:

1. protein-rich foods that have undergone much handling like meat, fish, milk and poultry
2. cooked foods intended to be eaten cold for example, custards, trifles, cream puddings, sandwiches with egg, ham or meat filling, ham salad, cold cuts
3. foods exposed to lukewarm temperatures for a few hours
4. foods insufficiently refrigerated due to large bulk or high refrigeration temperatures
5. left-over foods along with gravy which are not stored at adequately low temperatures

Mode of transmission: sources from where microorganisms enter food are mostly human or animal and include droplet infection from nasal passages, for example, sneezing, and direct contact with boils and infected wounds.

Prevention

1. Use raw ingredients free from *Staphylococcus aureus*, for example, pasteurised milk, and keep employees with any Staphylococcal infection like boils etc. away from food.
2. Prevent cross-contamination from raw meat to cooked meat and from contaminated equipment, utensils or hands to high risk foods.
3. Kill the organisms by heat treatment, for example, pasteurisation.
4. Since the toxin is resistant to heat and hence is destroyed only when boiled gradually for at least 30 minutes, we cannot rely on cooking to prevent the illness.
5. The growth of Staphylococci can be controlled by rapid cooking, chilling and prompt refrigeration.
6. Practice personal hygiene.

Botulism

This is an uncommon type of food poisoning. It is produced by an anaerobic spore-forming bacteria which is found in the soil. The organism produces a toxin which is extremely poisonous and affects the nervous system resulting in the death of approximately two-thirds of the affected victims.

As these bacteria are present in the soil, they contaminate vegetables. When they are present in marine soil and beds of fresh water lakes, fish also get contaminated. Since the organism is a strict anaerobe, it is unable to grow unless oxygen is excluded. Therefore, it is usually able to grow in canned, bottled and vacuum packed foods. The spores of this organism are extremely heat

resistant. Some spores can survive boiling for six hours. However, the organism cannot grow if the pH is below 4.5, so canned acidic foods are safe. In addition, the toxin is easily destroyed by heat. Heating food to 80°C for 15 minutes is sufficient to destroy the toxin.)

✓ Organism: *Clostridium botulinum*

✓ Toxin: neurotoxin

✓ Incubation period: 18 to 38 hours

✓ Duration of illness: death in 24 hours to eight days, or slow convalescence over six to eight months

✓ Symptoms: nausea, vomiting, diarrhoea, fatigue, dizziness, double vision, difficulty in swallowing and in speaking, dryness of the mouth and constriction of the throat, paralysis of involuntary muscles which spreads to the respiratory system and the heart. Death results due to respiratory failure.

✓ Therapy: anti-toxin should be given immediately.

Foods commonly involved:

1. Inadequately processed home-canned foods, including low and medium acid foods, acid foods like canned tomatoes, peaches and pears in which other microorganisms are present. These microbes aid the growth and toxin production of *C. botulinum* by raising the pH.
2. Smoked products that have been under-processed.
3. Damaged, leaky and rusty cans or cans with broken seals. The contents may or may not have a spoiled appearance.

Mode of transmission: The spores are transferred from the soil into food which is then consumed.

Prevention:

1. Use approved heat processes for canned food.
2. Reject gassy or spoiled canned food and refuse to taste doubtful food.
3. Avoid leftover cooked foods that are not well reheated, or raw and precooked foods that have been frozen, thawed and held at room temperature.
4. Smoked fish should be heated to at least 85°C for 30 minutes and should be frozen immediately after packaging.
5. Heat food to 100°C for a few minutes to destroy toxin which is thermolabile.

■ Bacillus cereus Food Poisoning

Bacillus cereus is a spore-forming aerobic rod-shaped bacteria which causes a toxic type of food-borne illness. It is found in soil, dust, water and on cereal grains. It is a common type of food poisoning. The food usually affected is rice, especially boiled rice which is prepared and used on the following day. The spores survive boiling. They germinate, multiply and release a toxin in rice if it is not refrigerated. If the rice is not reheated thoroughly the toxin is not destroyed and the rice will cause food poisoning.

Outbreaks sometimes follow celebrations where rice was not washed properly in clean water or was boiled in advance and cooled slowly.)

Organism: *Bacillus cereus*

Toxin: an enterotoxin produced in food

Incubation period: one to 16 hours

Duration of illness: twelve to 24 hours

Symptoms: the onset of the symptoms is sudden and they include abdominal pain, acute vomiting and diarrhoea; usually there is no fever

Foods commonly involved: cereals like reheated boiled rice, cornflour thickened sauce, Chinese fried rice, spices

Mode of transmission: contaminated cereals, grains especially rice, from the environment, as spores are present in soil.

Prevention:

1. Cool cooked food rapidly and refrigerate promptly.
2. Reheat food thoroughly and serve immediately.
3. Keep the interval between cooking and eating as short as possible.

■ Perfringens Food Poisoning

Clostridium perfringens is a spore-forming anaerobe found in the human and animal intestinal tract, soil, dust, contaminated raw meat, poultry and some dried foods.

The illness is caused by large numbers of rod-shaped microorganisms growing in food. The spores can survive normal cooking temperatures and multiply rapidly in cooked meat which is cooled slowly or stored in a warm place. The toxin is released in the intestine after the living microorganisms have been ingested.

Fig. 4.9 Transmission of *Clostridium perfringens* food poisoning

Organism: *Clostridium perfringens* (welchii)

Toxin: enterotoxin produced in intestine

Incubation period: eight to 24 hours

Duration of illness: one to two days

Mode of transmission: from human faeces via hands to the food by direct contact, vector transmission by flies sitting on excreta, cross contamination from raw to cooked meat, dusty kitchens and dirty cardboard boxes placed on work tables. In raw meat from intestines and excreta

Symptom: abdominal pain, diarrhoea and nausea, vomiting rarely occurs, mild vertigo; mortality rate may be as high as two per cent

Foods commonly involved:

1. meat dishes, rolled joints which provide anaerobic conditions necessary for growth
2. rechauffe dishes or reheated dishes kept at warm temperatures for considerable periods of time
3. stewed and roasted meat and poultry
4. sauces, gravies, pies, salads and casseroles

Prevention:

1. Thorough cooking of food, especially meat preparations.
2. Cool food rapidly to prevent multiplication of bacteria and reheat thoroughly just before serving.
3. Handle raw and cooked food separately to prevent cross-contamination.
4. Kitchen and personal hygiene.
5. Wash all fruits and vegetables thoroughly.

given in table 1.

INVESTIGATION OF FOOD POISONING

(a) *Secure complete list of people involved and their history* : All the people who have shared part of the food should be interviewed. They may be supplied questionnaires concerning the foods eaten during the previous 2 days, and place of consumption; time of onset of symptoms; symptoms of illness (e.g., nausea, vomiting, diarrhoea, abdominal pain, headache, fever, prostration, etc.) in order of occurrence; personal data such as age, sex, residence, occupation, and any other helpful information. Questionnaires may be administered to kitchen employees and those working in the dining halls. (b) *Laboratory investigations* : An important part of the investigation. The object is not only to incriminate the

causative agent from stool, vomit or remnants of food by inoculating into appropriate media, but also to determine the total number of bacteria and the relative numbers of each kind involved. This will give a better indication of the organism involved. Stool samples of the kitchen employees and food handlers should also be investigated. The samples should be examined aerobically and anaerobically. Phage typing of the organisms should be done to complete the laboratory investigation. ~~(c) Animal experiments~~ : It may be necessary to feed rhesus monkeys with the remnants of food. Protection tests are useful in the case of botulism; in this, a saline filtrate of food-stuff is injected subcutaneously into mice protected with antitoxic sera, keeping suitable controls. ~~(d) Blood for antibodies~~ : This is useful for retrospective diagnosis. ~~(e) Environmental study~~ : This includes inspection of the eating place(s), kitchen(s), and questioning of food handlers regarding food preparation. ~~(f) Data analysis~~ : The data should be analyzed according to the descriptive methods of time, place and person distribution. Food-specific attack rates should be calculated. A case control study may be undertaken to establish the epidemiologic association between, illness and the intake of a particular food.

PREVENTION AND CONTROL

~~(a) FOOD SANITATION~~ : ~~(i) Meat inspection~~ : The food animals must be free from infection. This can be ensured by their examination by veterinary staff, both before and after slaughter. ~~(ii) Personal hygiene~~ : A high standard of personal hygiene among individuals engaged in the handling, preparation and cooking of food is needed. ~~(iii) Food handlers~~ : Those suffering from infected wounds, boils, diarrhoea, dysentery, throat infection, etc should be excluded from food handling. The medical inspection of food handlers is required in many countries; this is of limited value in the detection of carriers, although it will remove some sources of infection (12). ~~(iv) Food handling techniques~~ : The handling of ready-to-eat foods with bare hands should be reduced to a minimum. Time between preparation and consumption of food should be kept short. The importance of rapid cooling and cold storage must be stressed. Milk, milk products and egg products should be pasteurized. Food must be thoroughly cooked. The heat must penetrate the centre of the food leaving thereby no

cool spots. Most food poisoning organisms are killed at temperatures over 60 deg. C. (v) Sanitary improvements : Sanitization of all work surfaces, utensils and equipments must be ensured. Food premises should be kept free from rats, mice, flies and dust. (vi) Health education : Food handlers should be educated in matters of clean habits and personal hygiene, such as frequent and thorough hand washing.

(b) REFRIGERATION : In the prevention of bacterial food poisoning, emphasis must be placed on proper temperature control. Food should not be left in warm pantries; a few germs can multiply to millions by the next morning. Foods not eaten immediately should be kept in cold storage to prevent bacterial multiplication and toxin production. "Cook and eat the same day" is a golden rule. When foods are held between 10 deg. C (50 deg. F) and 49 deg. C (120 deg. F) they are in the danger zone for bacterial growth. Cold is bacteriostatic at temperature below 4 deg. C (40 deg. F), and refrigeration temperature should not exceed this level.

SURVEILLANCE : Food samples must be obtained from the food establishments periodically and subjected to laboratory analysis if they were unsatisfactory. Continuing surveillance is necessary to avoid outbreaks of foodborne diseases.