

Foodborne pathogens, Staphylococcus food intoxication, Foodborne gastroenteritis caused by Salmonella, Foodborne gastroenteritis caused by Listeria, Foodborne gastroenteritis caused by Vibrio cholera, Foodborne gastroenteritis caused by Vibrio parahaemolyticus, Foodborne gastroenteritis caused by Campylobacter

Staphylococcus food intoxication

Staphylococcal food poisoning is caused by the ingestion of enterotoxin formed in food during growth of certain strains of *Staphylococcus aureus*. This bacterium produces an exotoxin called enterotoxin which causes gastroenteritis or inflammation of intestinal tract. *S. aureus* is a Gram positive cocci appearing as bunch of grapes.

Most of the enterotoxin producing strains are coagulase positive (coagulate blood plasma), produce thermostable nuclease, facultatively anaerobic and grow better aerobically than anaerobic condition. However, some coagulase negative strain also produces enterotoxin. These produce six neurologically distinct enterotoxin (A, B, C, C2 D and E) which differ in toxicity. Most food poisoning involves types A or D. Grow in the temperature range of 4-40°C with rapid growth taking place in the temperature range of 20-45°C.

Source of staphylococcus to food

Source of staphylococci to foods are mainly from human and domestic animals (primary reservoirs). Commonly encountered in skin, hair, nasal passage, wound and throat of humans.

Food handlers are main source of food contamination with *S. aureus*. Besides, equipment and food contact surfaces also contribute for contamination with this organism.

Generally, conditions in foods that favour the growth of *S. aureus* (at about 40°C) are more susceptible for food poisoning. Enterotoxins are heat resistant and not inactivated at pasteurisation temperature. Normal cooking of food will not destroy toxin present in food. Seafoods support growth of *S. aureus* when contaminated. High salt tolerance and ability to grow at low water activity (0.86) helps this organism to have competitive advantage over other organisms especially in salt cured products such as smoked fish and salted fish.

Food involved in outbreaks

A variety of foods support the growth of *S. aureus*, and thus responsible for food poisoning outbreaks. The foods generally involved are Fish, meat, bakery products, salads etc.

Disease and symptoms

Individuals differ in their susceptibility to food poisoning and incubation period is more than 4 hrs. Symptoms of food poisoning is characterized by salivation, nausea, vomiting, abdominal cramps, diarrhoea, blood and mucus in stools, headache etc. Mortality is very low and infected persons recover except in extreme cases.

Condition necessary for outbreak

- Food must contain enterotoxin producing staphylococci
- Food must support the growth and toxin production by staphylococci
- Temperature must be favorable for growth, and there should be enough time lapses since contamination for toxin production.
- Enterotoxin bearing food must be ingested.

Prevention of food poisoning outbreaks

- Prevention of contamination of food with staphylococci

- Prevention of growth of staphylococci in foods.
- Avoiding consumption of contaminated food.

5.4. Foodborne gastroenteritis caused by *E. coli*

E. coli is the most common aerobic organism in the intestinal tract of humans and warm blooded animals. Generally the *E. coli* strains that colonize the gastrointestinal tract are harmless commensals, and they play an important role in maintaining intestinal physiology. However, certain strains of *E. coli* are pathogenic and cause gastrointestinal disturbances.

Pathogenic strains

Within the species of *E. coli* there are at least 4 types of pathogenic strains

- Enteropathogenic *E. coli* (EPEC)
- Enterotoxigenic *E. coli* (ETEC)
- Enteroinvasive *E. coli* (EIEC) or shiga dysentery-like *E. coli*
- Enterohaemorrhagic *E. coli* (EHEC) or Verocytotoxin producing *E. coli* (VTEC) or *E. coli* O157:H7

Characters

- Various *E. coli* types can be separated by serotyping, phage typing and genetic methods.
- No specified phenotypic marker is available to separate between pathogenic and non-pathogenic strains.
- However, some atypical properties such as being lactose-negative or failure to produce indole at 44°C are more common between the pathogenic strains.
- VTEC strains do not grow at all on selective media at a 44°C.
- Disease condition produced by pathogenic *E. coli* strains vary in severity from extremely mild to life-threatening depending on type of pathogenic strains involved, susceptibility of victim and degree of exposure.
- *E. coli* can be isolated from environments polluted by faecal material or sewage, and the bacterium can multiply and survive for a long time in the environment. There are reports of occurrence of *E. coli* in unpolluted warm tropical waters.
- Most infections are related to contamination of water or handling of food under unhygienic conditions. Seafoods have not been reported as important source of *E. coli* infection.

Prevention of food poisoning outbreaks

- Good personal hygiene and health education of food handlers are essential in the control of disease.
- Proper treatment (e.g. chlorination) of water and sanitary disposal of sewage.
- Risk of infection can be minimized or eliminated by proper cooking before consumption.
- The growth is generally inhibited in the presence of 4-5% NaCl. Increased inhibition is seen at low temperature/ or reduced pH.

5.5. Foodborne gastroenteritis caused by *Salmonella*

Food poisoning caused by the ingestion of viable cells of genus *Salmonella* is called Salmonellosis. This is one of the frequently occurring bacterial infections.

Characters

Salmonella are Gram negative, non-spore forming rods that ferment glucose usually producing gas. There are over 2000 serotypes based on antigenic characters and all serotypes are considered potential pathogen. The primary habitat is the alimentary tract of mammals, birds, amphibians and reptiles. Found to be non endemic to intestinal tract of finfishes, crustaceans and mollusks. Because of fecal origin, contaminates food due to pollution with sewage. The most common disease illness associated is gastroenteritis/salmonellosis.

Disease symptoms

A large variety of foods including fish and shellfish are involved in salmonellosis. Food poisoning symptoms include nausea, vomiting, abdominal cramps, diarrhea, fever and headache. Symptoms occur 6~8 hrs after ingestion of contaminated food. Infective dose varies depending on serotype and ranges from few cells on 10⁵ to cause illness. Persons of all age groups are susceptible. The infection is severe and prolonged among elderly and infants. The likelihood of infection depends on resistance of consumer, infectiveness of salmonella strain and number of organisms ingested. More severe form of infection is typhoid and paratyphoid caused by *S. Typhi* and *S. Paratyphi*. Septicemia caused could be fatal

Conditions necessary for outbreak

- Food (fresh / processed) must contain or contaminated with *Salmonella*
- Must be present in considerable numbers
- Viable organisms must be ingested.

Prevention

- Avoidance of contamination of food from animals, humans, diseased food handlers and carriers.
- Destruction of the organism by heat
- Prevention of growth in foods by keeping at low temperature.
- Avoidance of consumption of warmed left over foods without refrigerator.

5.6. Foodborne gastroenteritis caused by Listeria

Among Listeria species, *Listeria monocytogenes* is most important human pathogen causing the disease listeriosis and is of great concern to special risk groups. The susceptible groups include pregnant women and their fetuses, cancer patients and others undergoing immuno-suppressive therapy, as well as diabetics and cirrhotics and the elderly. Although the risk of contracting listeriosis is less for normal, healthy individuals, they may also contract the disease.

Characters

- *Listeria monocytogenes* is a facultative intracellular pathogen. The organism enters the body through the intestine and has a variable incubation period from 1 day to a month or longer. The ingested cells enter the body through ileal villi cells, subsequently taken up by macrophage cells in the bloodstream, multiply inside the host cell and released after bursting of macrophages and liberated cells infect other cells.
- *Listeria* is widely distributed in the environment, human beings and a variety of animals including seagulls. Most of these environmental strains are non-pathogenic. *Listeria* sp. other than *L. monocytogenes* appears to be more common in tropical areas. Though it has

been isolated from a variety of seafoods including refrigerated and frozen crabmeat, reports of listeriosis involving seafood is rare.

- Listeria are relatively heat resistant but unable to survive in foods receiving adequate heat treatment. The presence of *L. monocytogenes* in cooked seafood is mainly due to cross-contamination of the product or under processing.
- Listeria are aerobic under most circumstances but can be facultatively anaerobic and thus grow well under reduced levels of oxygen in packaged products. Listeria can also survive and grow under refrigeration temperature and also survive freezing conditions.
- Contaminated food is increasingly recognized as an important vehicle of *L. monocytogenes*. Dairy products, salads and vegetables have been implicated in outbreaks of listeriosis. Frequent isolations from seafood as well as its ability to grow in in chilled smoked salmon at +4°C is an indication of possible involvement of seafoods in the transmission of *L. monocytogenes*.

Listeria species involved in food poisoning

- Six species of Listeria are currently recognized, but only three species, *L. monocytogenes*, *L. ivanovii* and *L. seeligeri* are associated with disease in humans and / or animals. However, human cases involving *L. ivanovii* and *L. seeligeri* are extremely rare.
- Listeria are commonly identified by serotyping. Types 1-7 are known, with Types 1/a, 1/b, and 4b predominating as both environmental and clinical isolates. The serotyping scheme is based on both somatic and flagellar antigens. Phage typing has also been employed as a method of further identifying isolated strains. *L. monocytogenes* is subdivided into 13 serovars on the basis of somatic (O) and flagellar (H) antigens.

Symptoms

Typical Listeria infections result in septicemia, meningitis and encephalitis, and enteritis. High mortality is reported among infected individuals. Mortality rate of 29% is noticed among patients in a New England outbreak involving fluid milk. This causes the transitory flu-like symptoms at the initial stage of infection with or without symptoms of stomach disturbances and diarrhea. The actual disease known as listeriosis occurs only after the attainment of severe form of septicemia, encephalitis, lesions, or meningitis. All of these forms of listeriosis is noticed among individuals who are not immunocompetent.

Prevention of outbreak

To prevent risk due to *L. monocytogenes*, FDA in the US has recommended complete absence in ready-to-eat seafood products such as crabmeat or smoked fish. This zero-tolerance is also required for products which receive a listericidal treatment, and for products which have been directly implicated in a food borne outbreak. However this restriction does not apply to raw product that will be cooked before eating. Low number of *L. monocytogenes* is allowed in other types of products in which the organism is shown to die-off. But, numbers greater than 10 *L. monocytogenes* / g are likely to constitute a risk to human beings particularly predisposed persons (very old, very young or immuno-suppressed). Following proper GMP and factory hygiene is expected to maintain the level of *L. monocytogenes* contamination on fish products at very low level of less than 1-10/g.

5.6. Foodborne gastroenteritis caused by *Vibrio cholerae*

Characters

- *Vibrio cholera* is a causative organism of human cholera due to the consumption of contaminated food/water containing viable cells. *V. cholera* is a Gram negative, non spore forming, facultatively anaerobic, curved rods belonging to the family enterobacteriaceae.
- The epidemic/pandemic cholera is caused by *V. cholera* serovar "O" Group 1 (O1) and consists of 2 biotypes Viz. classical and El-Tor based on biochemical tests. These have ability to agglutinate O1 antiserum. Strains that do not agglutinate in O1 antiserum are referred to as non O1 or non-agglutinating vibrios (NAGs). The non O1 strains are autochthonous to estuarine environment and are widely distributed. These are generally non-pathogenic but known to cause gastroenteritis, soft tissue infection and septicemia in humans.
- *V. cholerae* grow well at 37°C, tolerant to alkali (pH up to 9.2), survive for long period in fresh and marine environment and enter in to VBNC phase during adverse conditions. Infections occur through oral route by contaminated food and water. Attach to intestinal mucosa and produce enterotoxin and cause loss of water and electrolytes due to the disruption in the cyclic AMP system.

Symptoms of illness

Symptoms vary from mild to severe diarrhea (rice water stool), abdominal cramps, nausea, vomiting, dehydration, shock and death in severe cases. Infection of non O1 serotype is associated with exposure to natural aquatic environments, consumption of seafood and exposure to polluted water. Non O1 *V. cholerae* show better survival and multiplication in a wide range of foods than O1 strains.

Conditions for outbreaks

- Consumption of live cells orally through food/water.
- Consumption of post process contaminated food.
- Consumption of food without heating before serving.
- Consumption of contaminated food/water.

Prevention of outbreaks

- Avoiding consumption of contaminated food and water.
- Preventing contamination by following sanitary measures.
- Keeping the surroundings of processing plant clean and disinfected.
- Adherence to good personal hygiene by food handlers.
- Use of potable water after chlorination.

5.7. Foodborne gastroenteritis caused by *Vibrio parahaemolyticus*

Characters

- Food poisoning by *V. parahaemolyticus* is caused mainly by the consumption of seafoods containing live bacteria. It is an autochthonous marine bacterium associated naturally with marine organisms.
- *V. parahaemolyticus* is G-ve, straight/curved rod, halophilic requiring 1~3% salt for growth, can grow at 7% NaCl, optimum temperature for growth is 35-37°C but can grow over a range of temperature (10-44°C), minimum temperature for growth is 7°C, grow in a pH range of 5~11, sensitive to freezing and chilling temperature and killed by heating at 100°C.

- Isolates from cases of food poisoning (about 97%) are haemolytic (Kanagawa positive), and majority of environmental isolates are non-haemolytic (Kanagawa negative).
- Food poisoning by this bacterium causes gastroenteritis. These are killed by heating. Following good sanitation and GMP would prevent its build up in foods. This organism is the major cause of gastroenteritis in Japan.

Symptoms of illness

Raw food of marine origin, marine fish, shellfish, crustaceans and fish products are involved in cases of food poisoning. Permissible limit in foods is 104 /g.

Symptoms of illness include abdominal cramps, diarrhea, nausea, vomiting, bloody stools, mild fever, chills and headache. Incubation period is 4-48 hrs and infected individuals recover with in 2-5 days.

Prevention of outbreak

- Cooking food thoroughly
- Chilling food rapidly
- Preventing cross contamination from marine fish
- Following sanitary measures

5.8. Foodborne gastroenteritis caused by *Campylobacter* Characters

- *Campylobacter* are represented by the species *C. jejuni* and *C. coli* are the major causative agents of bacterial gastroenteritis in humans worldwide.
- These are Gram negative curved rods, motile with single polar flagella at one or both ends.
- *C. jejuni* is associated with intestinal tract of warm-blooded animals and is often present in foods of animal origin through fecal contamination during processing.
- Foods of animal origin including milk and clams have been implicated in cases of food poisoning.
- This organism is unable to grow well and survive outside the animal host's environment, but ingestion of very low numbers can cause human illness.
- *C. jejuni* is microaerophilic aorganism requiring low levels of oxygen for growth. Growth is inhibited at oxygen concentration of less than 3% and more than 10-5%, with best growth at 5%. It grows within a narrow temperature of 30- 47°C with optimum temperature of 42-45°C, survives refrigerator temperature and is sensitive to freezing temperatures.
- *Campylobacter* are invasive and highly virulent requiring ingestion of only a few cells to cause illness.
- Though the actual mechanism of pathogenicity is not clearly understood, they are known to produce heat sensitive enterotoxins.

Symptoms of illness

- *Campylobacter* infections occurs due to the consumption of foods of animal origin and contaminated milk, bakery products, clams and water.
- Symptoms of illness include abdominal pain, nausea, vomiting, cramps, diarrhoea, headache, fever and occasional bloody stools.

- The onset of illness varies from 1 to 10 days, and illness may persist for from 1 day to few weeks but most recover within a week.
- *Campylobacter enteritis* is self limiting in most cases and resolve within few days of onset of symptoms.

Prevention of outbreak

- Proper cooking of food prior to consumption.
- Preventing cross contamination from raw meats to cooked foods.
- Chilling food rapidly.
- Following good sanitary measures while handling and processing of foods.