III B.sc.,VI Semester
Food intoxication and food infection

Salmonellosis

Salmonellosis is one of the most common and widely distributed foodborne diseases and is caused by the bacteria *salmonella*. It is estimated that tens of millions of human cases occur worldwide every year and the disease results in more than hundred thousand deaths. For *salmonella* species, over 2500 different strains (called "serotypes" or "serovars") have been identified to date. *salmonella* is a ubiquitous and hardy bacteria that can survive several weeks in a dry environment and several months in water.

Salmonellosis is a disease incurred by eating food (often raw or undercooked, or too frequently re-heated) which is contaminated by *S. enterica*. Infection usually occurs when a person ingests foods that contain a high concentration of the bacteria, similar to a culture medium. In otherwise healthy adults, the symptoms can be mild. Normally, no sepsis occurs, but it can occur exceptionally as a complication in the immunocompromised.

The organism enters through the digestive tract and must be ingested in large numbers to cause disease in healthy adults. Gastric acidity is responsible for the destruction of the majority of ingested bacteria. Bacterial colonies may become trapped in mucus produced in the oesophagus.

Causal organism: ***Salmonella*** is a genus of rod-shaped, Gram-negative, non-spore-forming, predominantly motile enterobacteria with diameters around 0.8 to 1.5 µm, lengths from 2 to 5 µm, and peritrichous flagella, (flagella that are all around the cell body). They are chemoorganotrophs, obtaining their energy from oxidation and reduction reactions using organic sources, and are facultative anaerobes.

Symptoms: It is usually characterized by acute onset of fever, abdominal pain, diarrhoea, nausea and sometimes vomiting. The onset of disease symptoms occurs 6 - 72 hours (usually 12-36 hours) after ingestion of *salmonella*, and illness lasts 2-7 days. Symptoms of salmonellosis include diarrhea, fever, and abdominal cramps. They develop 12 to 72 hours after infection, and the illness usually lasts 4 to 7 days. Most people recover without treatment. But diarrhea and dehydration may be so severe that it is necessary to go to the hospital. Older adults, infants, and those who have impaired immune systems are at highest risk.

Sources and transmission

- *Salmonella* bacteria are widely distributed in domestic and wild animals. They are prevalent in food animals such as poultry, pigs, cattle; and in pets, including cats and dogs, birds and reptiles such as turtles.
- *Salmonella* can pass through the entire food chain from animal feed, primary production, and all the way to households or food-service establishments and institutions.
- Salmonellosis in humans is generally contracted through the consumption of contaminated food of animal origin (mainly eggs, meat, poultry and milk), although

other foods, including green vegetables contaminated by manure, have been implicated in its transmission.

    - Person-to-person transmission through the faecal-oral route can also occur.

- Human cases also occur where individuals have contact with infected animals, including pets. These infected animals often do not show signs of disease.

Diagnosis: Salmonellosis is diagnosed based on a medical history and a physical exam. A stool culture and blood tests may be done to confirm the diagnosis.

Treatment

Treatment in severe cases is symptomatic, electrolyte replacement (to provide electrolytes, such as sodium, potassium and chloride ions, lost through vomiting and diarrhoea) and rehydration.

Routine antimicrobial therapy is not recommended for mild or moderate cases in healthy individuals. This is because antimicrobials may not completely eliminate the bacteria and may select for resistant strains, which subsequently can lead to the drug becoming ineffective. However, health risk groups such as infants, the elderly and immunocompromised patients may need to receive antimicrobial therapy. Antimicrobials are also administered if the infection spreads from the intestine to other body parts. Because of the global increase of antimicrobial resistance, treatment guidelines should be reviewed on a regular basis taking into account the resistance pattern of the bacteria.

Prevention methods

- Prevention requires control measures at all stages of the food chain, from agricultural production, to processing, manufacturing and preparation of foods in both commercial establishments and at home.
- National/regional surveillance systems are important means to detect and respond to salmonellosis and other enteric infections in early stages, and thus to prevent them from further spreading.

Botulism

Botulism (Latin, *botulinus*) is a rare and potentially fatal paralytic illness caused by a toxin produced by the bacteria *Clostridium botulinum*.

Causal organism: *C. botulinum* is a large anaerobic Gram-positive bacillus that forms subterminal endospores. Botulinum toxin is one of the most powerful known toxins: about one microgram is lethal to humans. It acts by blocking nerve function (neuromuscular blockade) through inhibition of the excitatory neurotransmitter acetyl choline's release from the presynaptic membrane of neuromuscular junctions in the somatic nervous system. This causes paralysis. Advanced botulism can cause respiratory failure by paralysing the muscles of the chest; this can progress to respiratory arrest.

In all cases illness is caused by the botulinium toxin produced by the bacterium *C. botulinum* in anaerobic conditions, and not by the bacterium itself. The toxin is a protein produced under anaerobic conditions (where there is no oxygen) by the bacterium *Clostridium botulinum*.

There are eight serological varieties of the bacterium denoted by the letters A to H. The toxin from all of these acts in the same way and produces similar symptoms: the motor nerve endings are prevented from releasing acetylcholine, causing flaccid paralysis and symptoms of blurred vision, ptosis, nausea, vomiting, diarrhea and/or constipation, cramps, and respiratory difficulty.

Botulinum toxin is broken into 8 neurotoxins (labeled as types A, B, C [C1, C2], D, E, F, G & H), which are antigenically and serologically distinct but structurally similar. Human botulism is caused mainly by types A, B, E, and (rarely) F. Types C and D cause toxicity only in other animals

Sign and symptoms: The muscle weakness of botulism characteristically starts in the muscles supplied by the cranial nerves. A group of twelve nerves controls eye movements, the facial muscles and the muscles controlling chewing and swallowing. Double vision, drooping of both eyelids, loss of facial expression and swallowing problems may therefore occur, as well as difficulty with talking. The weakness then spreads to the arms (starting in the shoulders and proceeding to the forearms) and legs (again from the thighs down to the feet).

Severe botulism leads to reduced movement of the muscles of respiration, and hence problems with gas exchange. This may be experienced as dyspnea (difficulty breathing), but when severe can lead to respiratory failure, due to the buildup of unexhaled carbon dioxide and its resultant depressant effect on the brain. This may lead to coma and eventually death if untreated.

In addition to affecting the voluntary muscles, it can also cause disruptions in the autonomic nervous system. This is experienced as a dry mouth and throat (due to decreased production of saliva), postural hypotension (decreased blood pressure on standing, with resultant lightheadedness and risk of blackouts), and eventually constipation (due to decreased peristalsis). Some of the toxins (B and E) also precipitate nausea and vomiting.

Clinicians frequently think of the symptoms of botulism in terms of a classic triad: bulbar palsy and descending paralysis, lack of fever, and clear senses and mental status ("clear sensorium").

There are three main kinds of botulism, which are categorized by the way in which the disease is acquired:

Food-borne botulism is caused by eating foods that contain the botulinum neurotoxin. Recent small outbreaks have occurred in Canada due to fermented fish and in New York due to unrefrigerated bulk tofu contamination.

- **Wound botulism** is caused by neurotoxin produced from a wound that is infected with the bacteria *Clostridium botulinum*.

- **Infant botulism** occurs when an infant consumes the spores of the botulinum bacteria. The bacteria then grow in the intestines and release the neurotoxin.

Diagnosis:

The most direct way to confirm the diagnosis is to identify the botulinum neurotoxin in the patient's blood, serum, or stool. This is done by injecting the patient's serum or stool into the peritoneal cavity of mice. An equal amount of serum or stool from the patient is treated with multivalent antitoxin and injected in other mice. If the antitoxin-treated serum- or stool-injected mice live while those injected with untreated serum or stool die, then this is a positive test for botulism and is called the mouse inoculation test. The bacteria can also be isolated from the stool of people with food-borne and infant botulism, but this is not a definitive test. However, stool cultures can help differentiate botulism from E. coli, Salmonella, and other infectious agents.

Treatment

The primary treatment of botulism is with an antitoxin (human botulinum immunoglobulin) and supportive care. The respiratory failure due to paralysis may require a person to be on a ventilated for weeks, plus intensive medical and nursing care. After several weeks, the paralysis slowly improves. If diagnosed early, foodborne and wound botulism can be treated by inducing passive immunity with a horse-derived antitoxin, which blocks the action of toxin circulating in the blood. This can prevent people from worsening, but recovery still takes many weeks. Physicians may try to remove contaminated food still in the stomach by inducing vomiting or by using enemas. Wounds should be treated, usually surgically, to remove the source of the toxin-producing bacteria. Good supportive care in a hospital is the mainstay of therapy for all forms of botulism.

Furthermore each case of food-borne botulism is a potential public health emergency in that it is necessary to identify the source of the outbreak and ensure that all persons who have been exposed to the toxin have been identified, and that no contaminated food remains.

Staphylococcal intoxication

Staphylococcal intoxication is caused by the *Staphylococcus aureus* bacterium, which is found on most people's skin naturally. It enters food and water when infected individuals with lesions or cuts on their skin contaminate the food, then the food is allowed to incubate at room temperature before it is served.

Causal organism: *S. aureus Greek-* ‘grape-cluster berry", Latin aureus, "golden") is a facultative anaerobic, Gram-positive coccal bacterium. *S. aureus* is catalase-positive (meaning it can produce the enzyme catalase). Catalase converts hydrogen peroxide (H_2O_2) to water and oxygen. Catalase-activity tests are sometimes used to distinguish staphylococci from enterococci and streptococci. Previously, *S. aureus* was differentiated from other staphylococci by the coagulase test

Symptoms: Symptoms occur suddenly, sometimes in as little as 30 minutes after eating contaminated food. They include severe nausea, cramps, vomiting and often diarrhea. In most cases the illness is short-lived usually lasting not longer than one to two days.

Causes: Staphylococcal food intoxication is caused by eating contaminated food. The most common way for food to become contaminated with the bacteria is through contact with food workers who carry the bacteria or through contaminated milk or cheeses. The *staphylococcal* bacteria are resistant to heat and cannot be destroyed by cooking. Common foods that can become contaminated are pastries, custards, salad dressings, sandwiches, sliced meat and meat products.

Pathogenesis: Signs and symptoms begin to show up 2-6 hours after ingestion of contaminated food, at which point the bacteria have begun to produce a type of toxin called an enterotoxin. This toxin causes water to leave the cells in the bloodstream and enter the intestines (electrolytes, or salts like Na, Ca, K, and Cl, soon follow the water to reestablish the osmotic gradient). Once in the intestines, the water and electrolytes are quickly flushed out of the body, resulting in abdominal cramps and diarrhea; vomiting may also accompany these signs. Antibiotics are often not prescribed because the diarrhea flushes the microbes out of the body, and patients often recover within a day or two (though it is suggested to replenish lost fluids and electrolytes).

Treatment

The toxin is not affected by antibiotics, thus antibiotics are not useful. Plenty of rest, plenty of fluids and medications to calm the stomach are recommended. Those most at risk for severe illness such as young children, the elderly and individuals with a weakened immune system may require intravenous therapy and care in the hospital.

Prevention

Staphylococcal food intoxication can be prevented by practicing safe handling and proper storage of food, frequent hand washing with soap and water, keeping kitchens and food serving areas clean and sanitized, and educating food handlers in strict food hygiene.