PATHOGENESIS OF SALMONELLOSIS IN HUMANS

Global Technical Services (2013) - Lohmann Animal Health

Introduction

Salmonella is a bacteria-type bacillus (rod shaped) that causes a very common intestinal infection in humans and domestic animals, called Salmonellosis. The term Salmonella refers to a group or family of bacteria that variously cause illness in humans. Salmonella serotype Typhimurium and Salmonella serotype Enteritidis are the most common worldwide. During the 1980s, S. Enteritidis emerged as an important cause of human illness in the United States. In 1976, the incidence of S. Enteritidis was 0.55% per 100,000 inhabitants and represented only 5% of all Salmonella isolates. By 1985, this proportion reached 10%, and the rate increased to 2.4% per 100,000 inhabitants. During the same period, total Salmonella infection rates rose from 10.7% per 100,000 in 1976 to 24.3% in 1985.

Etiology

The number of outbreaks of S. Enteritidis infection also increased during the 1980s, particularly in the northeastern United States. Of the Salmonella outbreaks that occurred from 1985 through 1999, five hundred twenty-two (62%) outbreaks of S. Enteritidis infection were associated with food prepared at commercial food establishments (restaurants, caterers, delicatessens, bakeries, cafeteria, or market).

Daniel Elmer Salmon (July 23, 1850 – August 30, 1914) was a veterinary surgeon. He earned the first D.V.M. degree awarded in the United States, and spent his career studying animal diseases for the U.S. Department of Agriculture. In 1885, this pioneering veterinary scientist, together with Theobald Smith (Dr. Salmon’s research assistant) discovered the first strain of Salmonella (Salmonella cholerae suis). Today the number of known strains of the bacteria totals over two thousand. Both, Salmonellosis and the Salmonella genus of microorganisms derive their names from a modern Latin coining after Daniel E. Salmon. The Dr. Daniel E. Salmon Award is presented annually to recognize outstanding contributions and notable service in the public’s interest by a veterinarian federally employed in any human health, environmental health or animal health discipline. This award is supported through the National Association of Federal Veterinarians in the United States. Dr. Daniel E. Salmon was a world-renowned veterinary medical scientist who pioneered research in bacterial diseases of animals and in immunology. His efforts
led to the development of killed vaccines and to the naming of the bacterial genus *Salmonella* in his honor. His work contributed immeasurably to improving the public's health and to disease control efforts in general.

- **Pathogenesis**

The pathogenesis consists of the mechanism by which the disease is originated, its development in the body, and type of manifestation, whether it is acute, chronic, or recurrent. The word comes from the Greek pathos (“disease”) and genesis (“creation”). An infectious process can only begin after living *Salmonella* (not only their toxins) reach the gastrointestinal tract. Some of the microorganisms are killed in the stomach, while the surviving *Salmonella* enter the small intestine and multiply in tissues (localized form). By the end of the incubation period, the macro-organisms are poisoned by endotoxins released from the dead *Salmonella*. The local response to the endotoxins is enteritis and gastrointestinal disorder. In the generalized form of the disease, *Salmonella* pass through the lymphatic system of the intestine into the blood of the patients (typhoid form) and are carried to various organs (liver, spleen, kidneys) to form secondary foci (septic form). Endotoxins first act on affected organs’ vascular and nervous systems manifested by increased permeability and decreased tone of the vessels, upset thermal regulation, vomiting and diarrhea. In severe forms of the disease, enough liquid and electrolytes are lost to upset the body’s water-salt metabolism, to decrease the circulating blood volume and arterial pressure, and to cause hypovolemic shock. Septic shock also may develop. Shock of mixed character (with signs of both hypovolemic and septic shock) is more common in severe Salmonellosis. Oliguria and azotemia develop in severe cases as a result of renal (kidney) involvement due to hypoxia and bacteremia.

Salmonellosis is an infection with *Salmonella* bacteria. Most people infected with *Salmonella* develop diarrhea, fever, vomiting and abdominal 12 to 72 hours after infection. In most cases, the illness lasts four to seven days, and most people recover without treatment. In some cases, though, the diarrhea may be so severe, the patient becomes dangerously dehydrated and must be hospitalized. At the hospital, the patient may receive intravenous fluids to treat the dehydration, and may be given medications to provide symptomatic relief, such as fever reduction. In severe cases, the *Salmonella* infection may spread from the intestines to the blood stream, and then to other body sites, and can cause death unless the person is treated promptly with antibiotics.

The elderly, infants, and those with impaired immune systems are more likely to develop severe illness. Some people afflicted with Salmonellosis later experience reactive arthritis, which can have long-lasting, disabling effects. The different kinds of *Salmonella* include *S. bongori* and *S. enterica*.

The type of *Salmonella* usually associated with infections in humans, non-typhoid *Salmonella*, is usually contracted from sources such as:

- Poultry, pork and beef if the meat is prepared incorrectly or is infected with the bacteria after preparation.
- Infected eggs, egg products, and milk when not prepared, handled, or refrigerated properly.
- Reptiles, such as turtles, lizards and snakes, which may carry the bacteria in their intestines.
- Tainted fruits and vegetables

The typhoidal form of *Salmonella* can lead to typhoid fever. Typhoid fever is a life-threatening illness, and about 400 cases are reported each year in the United States, and 75% of these are acquired while traveling out of the country. It is carried only by humans and is usually contracted through direct contact with the fecal matter of an infected person. Typhoid *Salmonella* is more commonly found in those locations where unsanitary conditions are more likely to occur, and can affect as many as 21.5 million persons each year worldwide.

**Symptoms in humans**

The bacterium induces responses in the person it is infecting, and this typically causes the symptoms, rather than any direct toxin produced. Symptoms are usually gastrointestinal, including nausea, vomiting, abdominal cramps, and bloody diarrhea with mucus. Headache, fatigue, and rose spots are also possible. These symptoms can be severe, especially in young children and the elderly. Symptoms last generally up to a week, and can appear 12 to 72 hours after ingesting the bacterium. After bacterial infections, reactive arthritis (Reiters syndrome) can develop. In sickle-cell anemia, osteomyelitis due to *Salmonella* infection is much more common than in the general population.

**Pathophysiology**

Pathophysiology is a convergence of pathology with physiology. Pathology is the medical and veterinary discipline that describes conditions typically observed during a disease state, whereas physiology is the biological discipline that describes processes or mechanisms operating within a healthy organism. Pathology describes the abnormal or undesired condition, whereupon pathophysiology seeks to explain the physiological processes or mechanisms whereby such condition develops and progresses. *Salmonella* lives in the intestinal tracts of humans and other animals, including birds (especially poultry species). *Salmonella* are usually transmitted to humans by eating foods contaminated with animal feces. Contaminated foods usually look and smell normal. Contaminated foods are often of animal origin, such as beef, poultry, milk, or eggs, but all foods, including vegetables may become contaminated. Many raw foods of animal origin are frequently contaminated, but fortunately, thorough cooking kills *Salmonella*. Food may also become contaminated by the unwashed hands of an infected food handler, who forgot to wash his or her hands with soap after using the bathroom. *Salmonella* may also be found in the feces of some pets, especially those with diarrhea, and people can become infected if they do not wash their hands after contact with these feces. Reptiles are particularly likely to harbor *Salmonella* and people should always wash their hands immediately after handling a reptile, even if the reptile is healthy. Adults should also be careful that children wash their hands after handling a reptile. Among all the sources of contamination it has been demonstrated that poultry meat and eggs are especially important.
References

- Centers for Disease Control and Prevention (CDC- Department of Health and Human Services, US).
- Partnership for Food Safety Education (PFSE) Fight BAC! Basic Brochure.
- USDA Internal Cooking Temperatures Chart. The USDA has other resources available at their Safe Food Handling fact-sheet page. See also the National Center for Home Food Preservation.