Salmonella

In 1885, pioneering American veterinary scientist, Daniel E. Salmon, discovered the first strain of Salmonella from the intestine of a pig. This strain was called Salmonella choleraesuis, the designation that is still used to describe the genus and species of this common human pathogen.

Salmonella is a type of bacteria that causes typhoid fever and many other infections of intestinal origin. Typhoid fever, rare in the U.S., is caused by a particular strain designated Salmonella typhi. But illness due to due to other Salmonella strains, just called "salmonellosis," is common in the U.S. Today, the number of known strains (technically termed "serotypes" or "serovars") of this bacteria total over 2300.

Salmonella serotypes typhimurium and enteritidis are the most common serotypes in the United States. In recent years, concerns have been raised because many strains of Salmonella have become resistant to several of the antibiotics traditionally used to treat it, in both animals and humans.

What is the risk of Salmonella infection?

Salmonella is one of the most common enteric (intestinal) infections in the U.S. In some states (e.g. Georgia, Maryland) it is the most common, and overall it is the second most common foodborne illness (usually slightly less frequent than Campylobacter infection.) 1 The reported incidence of salmonellosis is about 17 cases per each 100,000 persons.1 Over 40,000 actual cases are reported yearly in the U.S.2 As only about 3% of Salmonella cases are officially reported nationwide, 3 and many milder cases are never diagnosed, the true incidence is undoubtedly much higher. It is more common in the warmer months of the year. Approximately 5003 to 1,0004 persons die annually from Salmonella infections in the U.S. every year.

1CDC. Preliminary FoodNet Data on the Incidence of Foodborne Illnesses - Selected Sites, United States, 1999. MMWR, 2000; 49:210-205.
2 CDC. Summary of Notifiable Diseases, United States, 1999. MMWR, 2001; 48:1-104.
3Mead PS, Slutsker L, Dietz V, et al. Food-related illness and death in the United States. Emerg Infect Dis 199;5:607-25.
4http://www.cdc.gov/health/diseases.htm

How is Salmonella transmitted?

About 95% of the time Salmonella is transmitted in food.1 Although Salmonella will commonly contaminate any food of animal origin, eggs are the most common vehicle for transmission of

salmonellosis. Of reported outbreaks, eggs and egg-containing foods are implicated 82% of the time.2 This likely is the case because hens lay eggs through a passageway called the "vent," which is an exit shared by their intestines, where Salmonella is a normal inhabitant.

Other foods of animal origin commonly implicated as vehicles for the transmission of salmonellosis include meat, especially barbecue, poultry, cheese, ice cream and yogurt, and raw (unpasteurized) milk.

Of great concern are recent reports of Salmonella being transmitted via foods that are not cooked or pasteurized. For example, a recent outbreak of salmonellosis was traced to U.S. grown tomatoes.3 Similar problems have arisen from orange juice4 and alfalfa sprouts.5 In these outbreaks, the foods became contaminated from animals at the site of production.

Salmonellosis can also be transmitted directly from person to person, but this is less common because many bacteria (1,000 - 1,000,000) must be ingested to start an infection. Salmonellosis after direct contact with animals is more common. Salmonella have been transmitted to persons, usually children, from birds, cats, dogs, fowl, hamsters, and monkeys,6 but amphibian and reptilian pets pose the greatest risk.1 These pets commonly are colonized with Salmonella and continually excrete it, so pet turtles, snakes and iguanas pose a substantial risk.

1Mead PS, Slutsker L, Dietz V, et al. Food-related illness and death in the United States. Emerg Infect Dis 1999;5:607-25.
2Mishu B, Koehler J, Lee LA, et al. Outbreaks of Salmonella enteritidis intections in the United States. J Infect Dis, 1994; 169:547-52.
3Cummings K, Barrett E, Mohle-Boetani JC, et al. A multistate outbreak of Salmonella enterica serotype Baildon associated with domestic raw tomatoes. Emerg Infect Dis, 2001; 6:1046-48.
4Cook KA, Dobbs TE, et al. Outbreak of Salmonella serotype Hartford infections associated with unpasteurized orange juiec. JAMA, 1998; 280:1504-09.
5Proctor ME, Hamacher M, Tortorello ML, Archer JR, Davis JP. Multistate outbreak of salmonella serovar muenchen infections associated with alfalfa sprouts grown from seeds pretreated with calcium hypochlorite. J Clin Microbiol. 2001 Oct;39(10):3461-5.
6Fang G, Arauja V, Guerrant RL. Enteric infections associated with exposure to animals or animal product. Infect Dis Clin NA, 1991; 5:681-701.

How can a Salmonella infection be prevented?

In order to stop the increasing numbers of cases of Salmonella, consumers and producers must be educated on proper handling and cooking of eggs and other high-risk foods. Quick reporting and cooperation between all local, state and federal agencies are critical in identifying outbreaks, so fewer people are affected once foodborne outbreaks occur.

Cross-contamination of foods must be avoided. Uncooked eggs, poultry and meats should be kept separate from produce and ready-to-eat foods. Hands, cutting boards, counters, knives, and other utensils should be washed thoroughly after handling uncooked foods. Hands should be washed before handling any food, and between handling different food items.

· Cook poultry, ground beef, and eggs thoroughly before eating. In order to insure that eggs do not contain viable Salmonella they must be cooked at least until the yoke is solid1 and meat and poultry must reach 160ºF or greater throughout.2
· Do not eat or drink foods containing raw eggs. Examples include homemade eggnog, hollandaise sauce, and undercooked french toast.
· Never drink raw (unpasteurized) milk.
· If you are served undercooked meat, poultry or eggs in a restaurant don't hesitate to send it back to the kitchen for further cooking.
· Wash hands, kitchen work surfaces, and utensils with soap and water immediately after they have been in contact with foods of animal origin.
· Be particularly careful with foods prepared for infants, the elderly, and those with a compromised immune system.
· Wash hands with soap after handling reptiles, amphibians or birds, or after contact with pet feces. Infants and immunocompromised persons should have no direct or indirect contact with such pets.

1Humphrey TJ, Greenwood M, Gilbert RJ, et al. The survival of salmonellas in shell eggs cooked under simulated domestic conditions. Epidem Inf, 1989; 103:35-45. 2http://vm.cfsan.fda.gov.

What are the symptoms of Salmonella?

The incubation period for salmonellosis, i.e. the time in between ingestion and the onset of the first symptom, may be from 6 hours to 10 days, but usually falls between 6 hours and 48 hours.1 Salmonella causes a gastroenteritis; persons experience diarrhea, often with fever and abdominal cramps. The onset may be sudden and there may be nausea and vomiting initially. The diarrhea often includes mucous and is occasionally bloody.

Infants, the elderly, immune suppressed persons and persons with sickle cell anemia are most susceptible to disease and suffer the most severe symptoms. It is in these individuals that the organism is most likely to gain access to the blood stream and possible persist in sites of the body distant from the intestine, such as on the aorta or in bone. 1CDC. Guidelines for confirmation of foodborne-disease outbreaks. MMWR, 1996; 45:59-66.

What is the treatment for salmonellosis?

Salmonella infections usually resolve in 5-7 days, and often do not require treatment. However, in more severe cases, cases requiring hospitalization, and in high-risk groups, there is a risk of dissemination and even rarely mortality; in these groups treatment with antibiotics is indicated. The currently recommended antibiotics include ciprofloxacin, azithromycin, and ceftriaxone.1

In the past, ampicillin, gentamicin, trimethoprim/sulfamethoxazole were the recommended treatments, but resistance to these antibiotics has markedly increased, especially overseas2 and resistance to ciprofloxacin may be increasing now as well.3

In all cases of gastroenteritis, whether due to Salmonella or other pathogens, it is imperative to maintain hydration, usually by mouth, but often with intravenous fluids.

1Gilbert DN, Moellering RC, Sande MA. The Sanford guide to antimicrobial therapy 2001. Antimicrobial Therapy, Inc., Hyde Park VT, 2001.
2Hakanen A, Kotilainen, P, Huovinen P, et al. Reduced fluoroquinolone susceptibility in Salmonella enterica serotypes in travelers returning from Southeast Asia. Emerg Infect Dis, 2001; 7:996-1003.
3Threlfall EJ, Skinner JA, Ward LR. Detection of decreased in vitro susceptibility to ciprofloxacin in Salmonella enterica serotypes Typhi and Paratyphi A. J Antimicrob Chemother. 2001 Nov;48(5):740-1.

Are there any serious medical problems that can arise from a Salmonella infection?

Persons with diarrhea usually recover completely, although it may be several months before their bowel habits are entirely normal. A small number of persons who are infected with Salmonella will go on to develop pains in their joints, irritation of the eyes, and discomfort on urination. This is called Reiter's syndrome or reactive arthritis and starts a few weeks after the gastroenteritis. It can last for months or years, and can lead to chronic arthritis that may be difficult to treat. Antibiotic treatment does not make a difference in whether or not the person later develops Reiter's syndrome.

Salmonella septicemia (invasion of the blood stream) has been associated with the subsequent infection of virtually every organ system. In persons with atherosclerosis of the aorta it may grow there and persons with sickle cell disease or its variants tend to get infection in the bone (osteomyelitis) or joints (septic arthritis). Salmonella infection may persist in the gallbladder for months or years in rare individuals.

Salmonella is rarely fatal; the fatality rate is much less than one percent. It is the very young, the very old, and the very immune-compromised that are at risk for death.

How is Salmonella detected?

The diagnosis of salmonellosis is confirmed by cultures of stool or blood. In other words, specimens of blood or feces are placed in nutrient broth or on agar and incubated for 2-3 days. After that time, a trained microbiologist can recognize Salmonella bacteria if present by its unique characteristics.

However, blood cultures are often not performed and in most cases the blood stream is not infected. In the stool, the laboratory is challenged to pick out Salmonella from many other similar bacteria that are normally present. In addition, many persons submit cultures after they have started antibiotics, which may make it even more difficult for a microbiology lab to grow Salmonella. So, the diagnosis of salmonellosis may be problematic and many mild cases are culture negative.

Selected Listing of Prior Salmonella Outbreaks

Pathogen Date Cases / Source Location
Salmonella 2001 225 / Deli Sandwiches VA
Salmonella 1994 158 / Raw ground beef WI
Salmonella 1999 200 / Orange Juice WA, CA
Salmonella 1998-99 14 / Mamey fruit FL
Salmonella 1997 54 / Raw milk / cheese WA
Salmonella 1995 62 / Orange Juice (unpasteurized) FL
Salmonella 1995 241 / Alfala sprouts 6 States & Finland
Salmonella 1993 19 / Egg rolls TX
Salmonella 1990 690 / Bread pudding IL
Salmonella 1989 164 / Mozzarella and shredded cheese from a single plant MN, WI. NY
Salmonella 1974 3,400 / Potato salad Navajo Indian Res.
Salmonella 1997 24 / Cantaloupe CA
Salmonella 1996 44 / Chile relleno GA
Salmonella 1997 31 / Unpasteurized cheese CA
Salmonella 1997 79 / Cheese / raw milk CA
Salmonella 1996 52 / Roast Beef SD
Salmonella 1995 133 / Alfalfa sprouts OR, BC
Salmonella 1998 209 / Toasted oats cereal Nationwide
Salmonella 1996 66 / Chicken MA
Salmonella 1994 est. 224,000 / Ice cream 41 states
Salmonella 1993 6 / Eggs CA
Salmonella 1993 23 / Hollandise and bearnaise sauce CA
Salmonella 1993 22 / Mayonnaise CA

Van Beneden CA, Keene WE, Strang RA, et al. Multinational outbreak of Salmonella enterica

serotype Newport infections due to contaminated alfalfa sprouts. JAMA 1999;281:158--62. Available on the Internet at <http://jama.amaassn.org/issues/v281n2/rfull/joc80937.html. Accessed December 8, 2000.

Mahon BE, Slutsker L, Hutwagner L, et al. Consequences in Georgia of a nationwide outbreak of Salmonella infections: what you don't know might hurt you. Am J Public Health 1999;89:31--5.

Glynn MK, Bopp C, Dewitt WK, Dabney P, Mokhtar M, Angulo FJ. Emergence of multidrug-resistant Salmonella enterica serotype typhimurium DT104 infections in the United States. N Engl J Med 1998;338:1333--8.

CDC. Multistate outbreak of Salmonella serotype Agona infections linked to toasted oats cereal---United States, April--May, 1998. MMWR 1998;47:462--4. Available on the Internet at <ftp://ftp.cdc.gov/pub/Publications/mmwr/wk/mm4722.pdf. Accessed November 21, 2000.