

SALMONELLA ENTERICA SPP.

PATHOGEN SAFETY DATA SHEET - INFECTIOUS SUBSTANCES

INFECTIOUS AGENT

NAME: *Salmonella enterica* spp. (formerly *Salmonella choleraesuis*)

SYNONYM OR CROSS REFERENCE: *Salmonella enterica* spp. - Salmonellosis.

Serotype Typhi - Typhoid fever, Enteric fever, Typhus abdominalis, *Salmonella enterica* serotype Typhi.

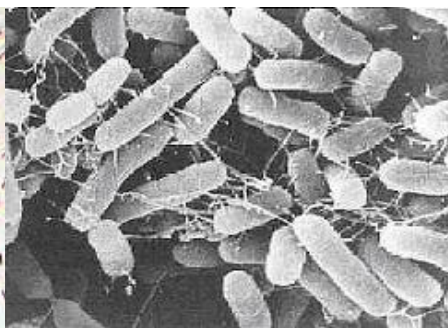
Serotype Choleraesuis - *Salmonella* septicaemia, hog cholera, hog typhoid, *Samonella enterica* serotype Choleraesuis, salmonellosis.

Serotype Paratyphi - Enteric fever, Paratyphoid fever, *Salmonella paratyphi* type A, B and C, *Salmonella enterica* serotype Paratyphoid A, B and C.

CHARACTERISTICS: *Salmonella enterica* is one of two *Salmonella* species (*enterica* and *bongori*) and a member of the *Enterobacteriaceae* family. *Salmonella enterica* spp. is subdivided into 6 subspecies (*enterica* (I), *salamae* (II), *arizonae* (IIIa), *diarizonae* (IIIb), *houtenae* (IV) and *indica* (VI)). The usual habitat for subspecies *enterica* (I) is warm-blooded animals. The usual habitat for subspecies II, IIIa, IIIb, IV and VI is cold-blooded animals and the environment. All species of *Salmonella* can infect humans. *Salmonella enterica* subspecies *enterica* has 2610 different serotypes; the most well-known being serotypes Typhi, Paratyphi, Enteritidis, Typhimurium and Choleraesuis. The serotypes are characterized by three surface antigens: the flagellar "H" antigen, the oligosaccharide "O" antigen and the polysaccharide "Vi" antigen (found in Typhi and Paratyphi serotypes). *Salmonella enterica* is a facultative anaerobe and is a gram negative, motile and non-sporing rod that is 0.7-1.5 by 2.0-5.0 µm in size.



Salmonella spp., gram-stained¹⁾



Salmonella spp. cells²⁾

HEALTH HAZARD

PATHOGENICITY: *Salmonella enterica* can cause four different clinical manifestations: gastroenteritis, bacteremia, enteric fever, and an asymptomatic carrier state. It is more common in children under the age of 5, adults 20-30 year olds, and patients 70 years or older.

Gastroenteritis: Gastroenteritis or “food poisoning” is usually characterized by sudden nausea, vomiting, abdominal cramps, diarrhea, headache chills and fever up to 39°C. The symptoms can be mild to severe and may last between 5-7 days. The Typhimurium serotype is the most common cause of gastroenteritis and there are an estimated 1.3 billion cases and 3 million deaths annually (1.4 million cases and 600 deaths in the US alone) due to non-typhoidal *Salmonella*. In well-resourced countries with low levels of invasive complications, the mortality rate due to non-typhoidal *Salmonella* is lower than 1%; however, in developing countries, the mortality rate can be as high as 24%.

Bacteremia: Bacteremia occurs in 3-10% of individuals infected with *Salmonella enterica* and certain serotypes (particularly serotype Choleraesuis) have higher mortality rates. Immunosuppressed individuals and patients with comorbid medical conditions (e.g. human immunodeficiency virus (HIV)-Acquired immunodeficiency syndrome (AIDS), diabetes, mellitus, malignancy, cirrhosis, chronic granulomatous disease, sickle cell disease, lymphoproliferative disease, or collagen vascular disease) have a higher risk of developing bacteremia due to a *Salmonella* infection. Bacteremia can cause septic shock; endocarditis, especially in patients older than 50 or with heart conditions; infection of the aorta, especially in patients with pre-existing atherosclerotic disease; liver, spleen, and biliary tract infections in patients with underlying structural abnormalities; mesenteric lymphadenitis; osteomyelitis in long bones and vertebrae; urinary tract infection; pneumonia; pulmonary abscess; brain abscess; subdural and epidural empyema; meningitis; central nervous system (CNS) infections (rarely); and death.

Enteric fever: Also known as typhoid fever, this infection is caused by serotypes Typhi and Paratyphi. Enteric fever is characterized by fever (rising within 72 hours after the onset of illness) and headache, bradycardia, faint rose-colored rash on the abdomen and chest, anorexia, abdominal pain, myalgias, malaise, diarrhea (more common in children) or constipation (more common in adults), hepatosplenomegaly, segmental ileus, meningismus, and neuropsychiatric manifestations. Less common symptoms are sore throat, cough, and bloody diarrhea. Complications include myocarditis, encephalopathy, intravascular coagulation, infections of the biliary tree and intestinal tract, urinary tract infection, and metastatic lesions in bone, joints, liver, and meninges. The most severe complication (occurs in about 3% of patients) is haemorrhage due to perforations of the terminal ileum of proximal colon walls. If untreated, the fever can last for weeks; however, with proper antimicrobial therapy, patients usually recover within 10-14 days. The disease is milder in children and, if treated, has a mortality rate of less than 1%; untreated cases can have a mortality rate greater than 10 %.

EPIDEMIOLOGY: Infections with *Salmonella enterica* occur worldwide; however, certain diseases are more prevalent in different regions. Non-typhoid salmonellosis is more common in industrialized countries whereas enteric fever is mostly found in developing countries (with the most cases in Asia). There are about 1.3 billion cases of non-typhoid salmonellosis worldwide each year and the WHO estimates that there are 17 million cases and over 500,000 deaths each year caused by typhoid fever. There is a peak in disease in the summer and fall, and it is most common in children. In the developing world, salmonellosis contributes to childhood diarrhea morbidity and mortality as bacteria are responsible for about 20% of cases. Epidemics of salmonellosis have been reported in institutions such as hospitals and nursing homes.

HOST RANGE: For serotypes causing non-typhoidal salmonellosis, the primary hosts are domestic and wild animals such as cattle, swine, poultry, wild birds, and pets (particularly reptiles) as well as flies. Humans are usually the final host. For *Salmonella typhi*, humans are the only known host.

INFECTIOUS DOSE: The infectious dose varies with the serotype. For non-typhoidal salmonellosis, the infectious dose is approximately 10^3 bacilli. For enteric fever, the infectious dose is about 10^5 bacilli by ingestion. Patients with achlorhydria, depressed cell-mediated immunity, or who are elderly may become infected with at a lower infectious dose. The infectious dose may also be dependent on the level of acidity in the patient’s stomach.

MODE OF TRANSMISSION: Human infection usually occurs when consuming contaminated foods and water, contact with infected feces, as well as contact with infective animals, animal feed, or humans. Foods that pose a higher risk include meat, poultry, milk products, and egg

products. In hospitals, the bacteria have been spread by personnel in pediatric wards, either on their hands or on inadequately disinfected scopes. Flies can infect foods which can also be a risk for transmission to humans.

INCUBATION PERIOD: For non-typhoidal salmonellosis, the incubation period is variable, depends on the inoculum size, and usually ranges between 5 and 72 hours. For typhoid fever, the incubation period can be between 3 and 60 days, although most infections occur 7-14 days after contamination. The incubation period for typhoid fever is highly variable and depends on inoculum size, host susceptibility, and the bacterial strain.

COMMUNICABILITY: Humans can spread the disease for as long as they shed the bacterium in their feces. Certain carriers shed the bacteria for years and 5 % of patients recovering from non-typhoidal salmonellosis can shed the bacteria for 20 weeks. Animals can have a latent or carrier state where they excrete the organism briefly, intermittently or persistently.

DISSEMINATION

RESERVOIR: For non-typhoidal salmonellosis, the reservoir hosts are domestic and wild animals such as cattle, swine, poultry, wild birds, flies and pets (particularly reptiles), as well as other humans (with the chronic carrier state). For serotype Typhi, humans with the chronic carrier state are the only reservoir for the disease.

ZOONOSIS: Yes. Transmission between animals and humans occur when humans are in contact with infective animals and their feces.

VECTORS: Flies are a possible indirect vector as they may transmit the bacterium to foods.

STABILITY AND VIABILITY

DRUG SUSCEPTIBILITY: Susceptible to chloramphenicol, ciprofloxacin, amoxicillin, co-trimoxazole, trimethprim-sulfonamid, cephalosporins and norfloxacin. Some resistance to chloramphenicol has been reported and, in 1989, 32% of strains were multi-drug resistant.

SUSCEPTIBILITY TO DISINFECTANTS: Gram negative bacteria are susceptible to 2-5% phenol, 1% sodium hypochlorite, 4% formaldehyde, 2% glutaraldehyde, 70% ethanol, 70% propanol, 2% peracetic acid, 3-6% hydrogen peroxide, quaternary ammonium compounds and iodophors; however, *Salmonella* spp. is resistant to nitrites.

PHYSICAL INACTIVATION: Susceptible to moist heat (121 °C for at least 15 minutes) and dry heat (170 °C for at least 1 hour). *Salmonella* spp. can also be disinfected with ozone.

SURVIVAL OUTSIDE HOST: Serotype Choleraesuis can survive in wet swine feces for at least 3 months and in dry swine feces for at least 13 months. Serotype Dublin can survive in feces spread on concrete, rubber, and polyester for almost six years. Serotype Typhimurium can survive in cattle slurry for 19-60 days, cattle manure for 48 days, soil for 231 days, and water for up to 152 days. Flies have been shown to excrete certain serotypes for 8 days and bed bugs can excrete bacilli for up to 21 days. Certain serotypes have been shown to survive on fingertips for up to 80 minutes, depending on the inoculum size. *Salmonella* serotypes have been found to live up to 63 days on lettuce, 231 days on parsley, 32 weeks in pecans, 10 months on refrigerated cheddar cheese, 9 months in butter, up to 63 days in frozen yogurt, and up to 20 weeks on frozen minced beef and chicken.

FIRST AID / MEDICAL

SURVEILLANCE: Monitor for symptoms. Confirm diagnosis by isolation from stool or blood and by serotyping to identify the serotype.

Note: All diagnostic methods are not necessarily available in all countries.

FIRST AID/TREATMENT: Treatment depends on the clinical symptoms presented by the patient.

Gastroenteritis: Fluid and electrolyte replacement as well as control of the nausea and vomiting are the usual treatments for these symptoms. Antibiotic treatment is not usually used; however, it may be necessary for neonates, children, the elderly, and the immunosuppressed, in which case ciprofloxacin, co-trimoxazole, ampicillin, and cephalosporins may be used.

Bacteremia: Antibiotic treatment is used to treat bacteremia (e.g. ciprofloxacin, co-trimoxazole, ampicillin, or cephalosporins), especially for neonates, children, the elderly, and the immunosuppressed.

Enteric fever: Chloramphenicol is the most common antibiotic used for enteric fever although ampicillin, trimethoprim-sulfonamid, cephalosporins, ciprofloxacin, and norfloxacin are also being used to treat the disease.

Asymptomatic carrier state: Carriers can be treated with ciprofloxacin in order to reduce the spread of the infectious agent.

IMMUNIZATION: There is no vaccine to prevent non-typhoidal salmonellosis currently available. Three vaccines (2 parenteral and 1 oral) are licensed for use in the US and should be considered for those working with serotype Typhi in a laboratory setting and for travellers who are going to spend extended periods of time in endemic areas. The vaccines available offer moderate protection against typhoid fever; however, they do not protect against the Paratyphi serotype of the bacterium. It has been shown that a live oral vaccine protects 70% of children inoculated in endemic areas. Vaccination is not recommended for pregnant women and patients with HIV-AIDS.

PROPHYLAXIS: Antibiotics can be used as prophylaxis in at-risk individuals (for example neonates and the immunocompromised). Clean water supplies, sanitation, and treatment of carriers are the best prophylactic measures to prevent the spread of enteric fever in endemic areas.

LABORATORY HAZARDS

LABORATORY-ACQUIRED INFECTIONS: Until 1974, 258 cases and 20 deaths due to laboratory-acquired typhoid fever were reported. 48 cases of salmonellosis were reported until 1976. 64 cases and 2 deaths due to *Salmonella* spp. infections were reported between 1979 and 2004, most of them associated with *S. typhi*.

SOURCES/SPECIMENS: All *Salmonella enterica* subspecies (with the exception of serotype Typhi) are found in blood, urine, feces, food and feed and environmental materials. Serotype Typhi is found in blood, urine, feces and bile.

PRIMARY HAZARDS: Primary hazards when working with *Salmonella enterica* are accidental parenteral inoculation and ingestion. The risk associated with aerosol exposure is not yet known.

SPECIAL HAZARDS: Infected animals are a risk (for all serotypes except Typhi and Paratyphi).

EXPOSURE CONTROLS / PERSONAL PROTECTION

RISK GROUP CLASSIFICATION: Risk group 2. The risk group associated with *Salmonella enterica* ssp. reflects the species as a whole, but does not necessarily reflect the risk group classification of every subspecies.

CONTAINMENT REQUIREMENTS: Containment level 2 practices, safety equipment and facilities are recommended for work involving infectious or potentially infectious materials, animals, or cultures. Containment level 3 practices and procedures are recommended for

activities with serotype Typhi that might generate aerosols or large quantities of organisms. These containment requirements apply to the species as a whole, and may not apply to each subspecies within the species.

PROTECTIVE CLOTHING: Lab coat. Gloves when direct skin contact with infected materials or animals is unavoidable. Eye protection must be used where there is a known or potential risk of exposure to splashes.

OTHER PRECAUTIONS: All procedures that may produce aerosols, involve high concentrations or large volumes should be conducted in a biological safety cabinet (BSC). The use of needles, syringes and other sharp objects should be strictly limited. The use of needles, syringes, and other sharp objects should be strictly limited. Additional precautions should be considered with work involving animals or large scale activities.

HANDLING AND STORAGE

SPILLS: Allow aerosols to settle, then, wearing protective clothing, gently cover the spill with absorbent paper towel and apply appropriate disinfectant, starting at the perimeter and working towards the center. Allow sufficient contact time before starting the clean-up.

DISPOSAL: All wastes should be decontaminated before disposal either by steam sterilization, incineration or chemical disinfection.

STORAGE: The infectious agent should be stored in a sealed and identified container.

REFERENCE

Pathogen Safety Data Sheet (PSDS) for *Salmonella enterica* spp. has been modified from the ones produced by the Public Health Agency of Canada as educational and informational resources for laboratory personnel working with infectious substances.

- 1) Picture from www.avianbiotek.com
- 2) Picture from www.food-info.net