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Reptile-Associated Salmonellosis

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Overview

- Organism
- History
- Epidemiology
- Transmission
- Disease in Humans
- Disease in Animals
- Prevention and Control

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In today's presentation, we will cover information regarding the organism that causes reptile-associated salmonellosis and its epidemiology. We will also talk about the history of the disease, how it is transmitted, species that it affects and clinical and necropsy signs observed. Finally, we will address prevention and control measures for reptile-associated salmonellosis.

[Photo: Chameleon, Wikimedia Commons]

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The Organism

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Reptile-Associated Salmonellosis

- Gram negative, facultative rod
- *Salmonella* spp.
  - *S. enterica* subsp. *enterica* serovars
  - More than 2500 known serovars
  - Associated with reptile, amphibians, fish, and environment

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Salmonella spp. are members of the family Enterobacteriaceae. They are Gram negative, facultatively anaerobic rods. *Salmonella* species are classified into serovars (serotypes). There are more than 2500 known serovars. A number of *Salmonella* serovars have been associated with reptiles including the *S. enterica* subsp. *enterica* serovars Chameleon, Java, Marina, Poona, and Stanley. Other *S. enterica* subsp. are found in poikilotherms (reptiles, fish, amphibians) and in the environment.

[Photo: *Salmonella* spp., CDC Public Health Image Library]

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Importance

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History

- 1970s: Pet turtles major source of *Salmonella* infection in U.S.
  - 280,000 reported cases/yr
- 1975: FDA banned interstate shipment of pet turtles
- 1991 to 2001
  - Reptiles as pets
  - 3% of households in U.S. have a reptile

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During the 1970s, small pet turtles were a major source of *Salmonella* infection in the United States, leading to an estimated 280,000 reported cases of salmonellosis each year. In 1975, the Food and Drug Administration (FDA) banned all interstate shipments of pet turtles with a carapace length less than 4 inches. This prevented almost 100,000 cases of salmonellosis among children 1 to 9 years of age each year. However, more recently, the popularity of reptiles as pets has led to an increase in the number of reptile-associated cases. During 1991 to 2001, the estimated number of households with reptiles doubled from approximately 850,000 to 1.7 million; an estimated 3% of households in the United States have a reptile.

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Epidemiology

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Geographic Distribution

- Reptile-associated salmonellosis occurs worldwide
- United States cases
  - 1998 to 2002
    - California, Connecticut, Florida, Ohio, North Dakota, Wisconsin
  - 2006 to 2007 (turtle-associated)
    - Multiple states

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Reptile associated salmonellosis occurs worldwide. From 1998 to 2002, cases were reported to the CDC by California, Connecticut, Florida, Ohio, North Dakota, and Wisconsin. From 2006 to 2007, turtle-associated salmonellosis occurred in multiple U.S. states.

[Photo: World map, Wikimedia Commons]

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Morbidity/Mortality

- Humans
  - 500 to 600 fatal cases/year in U.S.
    - Mortality rate is <1%
  - Elderly and immunocompromised at risk of invasive disease
- Animals
  - Asymptomatic infections common
    - Carrier rate in reptiles: 36 to 90%
  - Death or disease rarely reported

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Approximately 500-600 fatal cases of salmonellosis in humans are reported each year in the U.S. The overall mortality rate for most forms of salmonellosis is less than 1%; however, some serovars or syndromes are more likely to be fatal. During outbreaks, approximately 10% of all cases and 18% of cases in the elderly result in invasive disease. *Salmonella* gastroenteritis is rarely fatal in healthy people. In animals, asymptomatic *Salmonella* infections are common. Estimates of the carrier rate among reptiles vary from 36% to more than 80-90%, and several serovars can be found in a single animal. Some authorities consider most or all reptiles to be *Salmonella* carriers. Deaths or disease are occasionally reported in reptiles, but seem to be rare.

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Transmission

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Transmission

- Fecal-oral
- Humans
  - Direct: handling infected reptile
  - Indirect: Contact with contaminated objects, bites, scratches
- Animals
  - Contaminated feces, food, water, or soil
  - In utero, perinatal, transovarial

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Salmonella spp. are mainly transmitted by the fecal-oral route. They are carried asymptomatically in the intestines of infected reptiles and are continuously or intermittently shed in the feces. *Salmonella* is most commonly transferred between reptiles by contact with contaminated feces of other reptiles or contaminated food, water or soil. Transmission may also occur in utero, perinatally, or by ingestion of contaminated prey. Transovarian passage has also been reported. People are often infected by ingesting organisms in animal feces. Direct transmission occurs through handling of reptile and indirect transmission occurs by contact with an object contaminated by a reptile, its feces or contaminated food or water. Clothing in contact with reptiles has served as a source of transmission, as have claw scratches and bites.

[Photo: Boy handling turtle, CDC]

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Disease in Humans

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Disease in Humans

- Most cases of reptile-associated salmonellosis in children <10, immunocompromised persons
- Often severe
- May be fatal
  - Septicemia
  - Meningitis

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Salmonellosis acquired from reptiles is often severe, and may be fatal due to septicemia or meningitis. Most cases of reptile-associated salmonellosis are seen in children under 10 and people who are immunocompromised. Death is rare except in these individuals.

[Photo: Person holding turtles, Wikimedia Commons]

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Clinical Signs

- Incubation period: 6 to 73 hours
  - Symptoms last from 24 hrs to 12 days
- Clinical Signs
  - Gastroenteritis
    - Nausea, vomiting, cramps, diarrhea
    - Sequela: Reiter's syndrome
  - Septicemia: severe form
  - Enteric fever: severe form

The incubation period for *Salmonella* gastroenteritis in humans is from 6 to 73 hours. Symptoms can last from 24 hours to 12 days. Clinical signs in humans can range from self-limiting gastroenteritis to invasive infections that can lead to septicemia. Gastroenteritis is characterized by nausea, vomiting, cramping abdominal pain and diarrhea, which may be bloody. Reiter's syndrome may be a sequela in some cases of gastroenteritis. This syndrome is characterized by mild to sever arthritis, nonbacterial urethritis or cervicitis, conjunctivitis and small, painless, superficial mucocutaneous ulcers. Reiter's syndrome occurs in approximately 2% of cases of salmonellosis. In addition to gastroenteritis, headache, fever, chills and myalgia may also be seen. Enteric fevers are a severe form of systemic salmonellosis and most are caused by *S. typhi*, a human pathogen.

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Diagnosis

- Isolation of organism from feces or blood
  - Enrichment
  - Grows on wide variety of media
- Biochemical tests for serovar ID
  - O, H, and Vi antigens
  - Plasmid profiling, phage typing
- PCR testing

Salmonellosis can be confirmed by isolating the organisms from feces or, in cases of disseminated disease, from the blood. *Salmonella* will grow on a wide variety of selective and non-selective media. *Salmonella* spp. are identified with biochemical tests, and the serovar can be identified using serology for the somatic (O), flagellar (H) and capsular (Vi) antigens. Phage typing or plasmid profiling is also used for some serovars. Further characterization, if needed, can be carried out at any reference laboratory. Polymerase chain reaction (PCR) and genetic techniques may also be available.

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Treatment

- Antibiotics
  - Base choice on susceptibility testing
  - Usually not for gastroenteritis
  - Does not shorten course of disease
- Healthy persons may recover in 2 to 7 days without antibiotics
- Elderly and immunocompromised prone to complications

Salmonellosis in humans can be treated with a number of antibiotics including ampicillin, amoxicillin, gentamicin, trimethoprim/sulfamethoxazole and fluoroquinolones. Many isolates are resistant to one or more antibiotics, and the choice of drugs should, if possible, be based on susceptibility testing. Antibiotics are used mainly for septicemia, enteric fever, or focal extraintestinal infections. Focal infections may require surgery and prolonged courses of antibiotics. In the elderly, infants and immunosuppressed persons, who are prone to septicemia and complications, antibiotics may be given for gastroenteritis. However most healthy people recover spontaneously in 2 to 7 days and may not require antibiotic treatment. Antibiotics do not usually shorten this form of the disease. They also prolong the period of bacterial shedding and increase the development of antibiotic -resistant strains. Symptomatic treatment of dehydration, nausea, and vomiting may be required.

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Disease in Animals

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Animal Disease

- Species affected
  - Turtles
  - Tortoises
  - Snakes
  - Lizards (including chameleons and iguanas)
- Incubation period is variable
  - Symptoms show when stressed

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Salmonella spp. have been found in all species of reptiles that have been investigated. Infection has been documented in turtles, tortoises, snakes and lizards (including chameleons and iguanas). The incubation period in animals is highly variable. In many cases, infections become symptomatic only when the animal is stressed.

[Photo: Iguana, Wikimedia Commons]

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Clinical Signs

- Uncommon
  - Often carry *Salmonella* spp. asymptomatically
- May see signs when stressed
  - Transportation, crowding, food deprivation, concurrent disease
- Syndromes reported:
  - Septicemia, osteomyelitis, osteoarthritis, subcutaneous abscesses

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Clinical disease in reptiles seems to be uncommon. *Salmonella* spp. are often carried asymptomatically. Clinical disease may appear when animals are stressed by factors such as transportation, crowding, food deprivation, exposure to cold, a concurrent viral or parasitic disease, sudden change of feed, or overfeeding following a fast. In some cases, oral antibiotics may also precipitate disease. Syndromes that have been reported include septicemia (characterized by anorexia, listlessness and death), osteomyelitis, osteoarthritis and subcutaneous abscesses. Progressive, fatal bone infections have been seen in snakes. In one group of free-living turtles, the symptoms included emaciation, lesions of the plastron, a discolored carapace and intestinal, respiratory and hepatic lesions. *Salmonella* spp. have also been implicated in sporadic deaths among tortoises in zoos.

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Post-Mortem Lesions

- Not pathognomonic
- Intestinal lesions most common and severe
  - Lower ileum
  - Large intestine
  - Acute enteritis
  - Necrotizing fibrinous enteritis

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The necropsy lesions are not pathognomonic. They may include necrotizing fibrinous enteritis (bottom photo: tortoise), lesions associated with septicemia or both. Intestinal lesions are most common and severe in the lower ileum and large intestine. In acute enteritis, there is extensive hemorrhagic enteritis, with mucosal erosions and often whole blood in the lumen (seen in the top photo of a tortoise; dark mass in center is of a swollen dilated and hemorrhagic intestine caused by salmonellosis). Similar lesions may be found in the abomasum. The mesenteric lymph nodes are usually edematous and hemorrhagic, and there may be inflammation in the wall of the gall bladder. Other lesions may include fatty degeneration in the liver, bloodstained fluid in the serous cavities, and petechial hemorrhages in the heart and sometimes other organs.

[Photos: Tortoise with salmonellosis, Dr. John M. King, Cornell University]

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Diagnosis

- Isolate from feces or blood
- Identify *Salmonella* spp. with biochemical tests
  - Serovar identification via serology
  - Plasmid profiling
- Found in healthy carriers
- Impossible to determine if reptile is *Salmonella*-free

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Salmonellosis can be confirmed by isolating the organisms from feces or, in cases of disseminated disease, from the blood. Pre-enrichment, enrichment and selection of several colonies may be particularly useful for reptiles, which can carry several species of *Salmonella* simultaneously. *Salmonella* spp. are identified with biochemical tests, and the serovar can be identified by serology. Phage typing or plasmid profiling is also used for some serovars. Further characterization, if needed, can be carried out at a reference laboratory. PCR and other genetic techniques may also be available. Diagnosis of clinical cases and identification of carriers is complicated because *Salmonella* spp. can be found in healthy carriers and isolation of these bacteria from the feces is not a definitive diagnosis of salmonellosis. Reptiles may shed *Salmonella* spp. intermittently. Currently, it is impossible to determine whether an individual reptile is *Salmonella*-free.

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Treatment

- Do not treat reptiles with antibiotics to eliminate *Salmonella*
  - May increase emergence of resistant strains
- Supportive care
  - Fluid replacement therapy
  - NSAIDS
- Antibiotics if septicemic

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The Association of Reptile and Amphibian Veterinarians (ARAV) discourages veterinarians from treating reptiles with antibiotics to eliminate *Salmonella* because antibiotics can favor the persistence of *Salmonella* spp. in the intestines after recovery, affect the intestinal flora, and increase the emergence of antibiotic-resistant strains. Fluid replacement, correction of electrolyte imbalances and other supportive care is important in cases of enteritis. Non-steroidal anti-inflammatory drugs may be given to decrease the effects of endotoxemia. Septicemic salmonellosis may be treated with a number of antibiotics including ampicillin, amoxicillin, gentamicin, trimethoprim/sulfamethoxazole, third generation cephalosporins, chloramphenicol, and fluoroquinolones.

[Photo: Person holding snake, CDC]

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Prevention and Control

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Prevention in Humans

- Frequent/thorough hand washing
- Change clothing after contact
- Persons <5 yrs or immuno-compromised should avoid contact
- No free roaming of reptiles
- No vaccine exists

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To prevent reptile-associated *Salmonella* infections, the CDC has issued recommendations for handling reptiles including: 1) frequent and thorough hand washing with soap and water after handling reptiles or reptile cages, 2) clothing should be changed following contact with reptiles especially before close contact with infants, 3) eating, drinking or smoking while handling reptiles or their environments should be avoided, and 4) people who are at increased risk for infection or serious complications of salmonellosis (e.g. children < 5 years of age and immuno-compromised persons) should avoid contact with reptiles. No human vaccines to prevent zoonotic or foodborne salmonellosis exist. A vaccine is available to prevent typhoid fever, an infection transmitted from person to person.

[Photo: Boy washing hands after handling reptile, CDC]

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Prevention in Animals

- ALL reptiles should be considered potential sources of *Salmonella*
- Good hygiene
- Minimizing stressful events


All reptiles should be considered to be potential sources of *Salmonella*. In many cases, elimination of *Salmonella* infections is impractical, and control is limited to preventing clinical disease and/or the transmission of bacteria to humans. Clinical salmonellosis can be decreased by good hygiene and minimizing stressful events.

[Photo on left: Brown anole, Wikimedia Commons; Photo on right: turtle (*Graptemys nigrinoda*) hatchlings, Wikimedia Commons]

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Additional Resources

- World Organization for Animal Health (OIE)
  - www.oie.int
- U.S. Department of Agriculture (USDA)
  - www.aphis.usda.gov
- Centers for Disease Control and Prevention (CDC)
  - http://www.cdc.gov/healthypets/animals/reptiles.htm
- Center for Food Security and Public Health
  - www.cfsph.iastate.edu

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