Fowl Typhoid and Pullorum Disease

Bacillary White Diarrhea
(Pullorum Disease)

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Importance

Fowl typhoid and pullorum disease are among the most important diseases of poultry. These conditions are caused by two very closely related organisms, which were once thought to be different species but have recently been classified as biovars of *Salmonella enterica* subsp. *enterica*. Pullorum disease is usually symptomatic only in young birds. The mortality rate varies, but it can be as high as 100%. Fowl typhoid resembles pullorum disease in young birds, but it is also a serious concern in growing and adult poultry. The control of these diseases is complicated by vertical transmission: hens can become subclinically infected carriers, and pass the infections to their embryos in the egg. Fowl typhoid and pullorum disease have been eradicated from commercial poultry in many developed countries including the United States and Canada, but they may persist in backyard poultry flocks and game birds. Pullorum disease is an increasing concern in pheasant chicks. On rare occasions, these diseases have been reintroduced to commercial chicken or turkey farms.

Etiology

Fowl typhoid results from infection by *Salmonella enterica* subsp. *enterica* serovar Gallinarum biovar Gallinarum (*Salmonella* Gallinarum), a Gram negative bacterial rod in the family Enterobacteriaceae (serogroup D). Pullorum disease is caused by the closely related organism *S. enterica* subsp. *enterica* ser. Gallinarum biovar Pullorum (*Salmonella* Pullorum). Other names may also be used for these bacteria. Some classification schemes consider them to be different serovars (i.e., *S. enterica* subsp. *enterica* serovar Pullorum and *S. enterica* subsp. *enterica* serovar Gallinarum), or place them both in the species *S. enterica* subsp. *enterica* serovar Pullorum-Gallinarum. At one time, *Salmonella* Gallinarum and *Salmonella* Pullorum were considered to be separate species. Isolates may display a degree of host species tropism. For example, some isolates found in pheasants do not usually occur among chickens.

Species Affected

Chickens are the natural hosts for *Salmonella* Gallinarum and *Salmonella* Pullorum, but other birds can also be infected. In addition to chickens, *Salmonella* Gallinarum has been reported in turkeys, quail, guinea fowl, pheasants, peafowl, grouse, parrots, sparrows, ostriches and ring–necked doves. Although infections have been described in ducks and pigeons, most currently raised breeds of ducks, geese and pigeons seem to be resistant to clinical fowl typhoid. *Salmonella* Pullorum infections can be found in many avian species including chickens, turkeys, quail, guinea fowl, pheasants, ducks, pigeons, sparrows, canaries, bullfinches and parrots; however, pullorum disease is uncommon except in chickens, turkeys and pheasants.

Although *Salmonella* Pullorum and *Salmonella* Gallinarum are considered to be highly adapted to birds, a few infections have been reported in mammals after experimental inoculation or natural exposure. *Salmonella* Pullorum has been reported in pigs, cattle, cats, dogs, foxes, mink, rabbits, guinea pigs, laboratory and wild rats, chinchillas and chimpanzees. *Salmonella* Gallinarum has been documented in experimentally infected rats.

Geographic Distribution

Fowl typhoid and pullorum disease are common in some countries of Central and South America, Africa and Asia. These diseases have been eradicated from commercial poultry in many developed nations including the U.S., Canada, New Zealand, Australia, Japan and most countries in Europe. In areas where they are absent from commercial chickens and turkeys, *Salmonella* Gallinarum and *Salmonella* Pullorum may still be present in backyard flocks and wild birds. In these areas, pullorum disease can also occur in intensively reared game birds including pheasants, partridges and guinea fowl.

Transmission

Horizontal and vertical transmission are both important in the epidemiology of fowl typhoid and pullorum disease. Birds can become chronic carriers for both

organisms, passing them to their offspring in eggs. Horizontal transmission occurs via the respiratory and oral routes. Birds can ingest bacteria after environmental contamination or during cannibalism. Wound infections are also possible. *Salmonella* Gallinarum and *Salmonella* Pullorum can be transmitted on fomites including contaminated feed, water and litter; they may survive in a favorable environment for many months and up to several years. Wild birds, mammals, and insects can act as mechanical or biological vectors. Red mites, in particular, are involved in spreading fowl typhoid, and limited evidence suggests that rodents might be biological vectors for *Salmonella* Pullorum.

Incubation Period

The incubation period is usually 4 to 6 days.

Clinical Signs

If birds are hatched from *Salmonella* Pullorum- or *Salmonella* Gallinarum- infected eggs, dead and dying chicks may be found shortly after hatching. Chicks and poults develop nonspecific signs such as depression, weakness, somnolence, loss of appetite, drooping wings, huddling, dehydration and ruffled feathers. Labored breathing or gasping, as well as diarrhea and pasting of the vent feathers, may be seen. The droppings can be white and viscous in pullorum disease. In somewhat older birds, pullorum disease can be subacute, and lameness and joint swelling may be apparent. Blindness has also been described. Birds that survive may be underweight and poorly feathered, and may not mature into productive adults.

In growing birds and adults, *Salmonella* Pullorum infections are likely to be inapparent. Fowl typhoid can occur in older as well as young birds. The clinical signs may include decreased appetite, depression, dehydration, weight loss, ruffled feathers, and watery to mucoid diarrhea. A progressive loss of condition can lead to anemia with pale, shrunken combs. Occasionally, *Salmonella* Pullorum may cause a disease similar to fowl typhoid in older birds; the most common signs are anorexia, depression, diarrhea and dehydration. *Salmonella* Gallinarum and *Salmonella* Pullorum can cause decreased egg production, fertility or hatchability in inapparent carriers as well as in birds with systemic signs.

Post Mortem Lesions

The lesions in young birds may include unabsorbed yolk sacs, peritonitis and signs of septicemia. The subcutaneous blood vessels may be dilated, the liver, spleen and kidneys are often enlarged and congested, and the spleen may be mottled. Congestion can also occur in the lungs; lung lesions can be prominent in pheasants with pullorum disease and guinea fowl with fowl typhoid. The cecum may be enlarged and can contain firm, cheesy material (cecal cores). White necrotic foci or nodules may be found in the liver, spleen, lungs, heart, pancreas and gizzard, and sometimes in the cecum; some of these nodules may resemble tumors. The joints may be swollen and contain a viscous creamy fluid. Exudates can also occur in the anterior chamber of the eye. Birds that die peracutely may exhibit no gross lesions

Adult birds with acute fowl typhoid may have a swollen, friable, often bile-stained liver, as well as an enlarged spleen and kidneys. Catarrhal enteritis with viscous, bile-stained, slimy intestinal contents may be found. In some cases, necrotic foci may be visible through the intestinal wall. Focal necrosis can also occur in the heart, liver, pancreas, intestine and testes. The bone marrow is dark brown. In more chronic cases, birds may be wasted or emaciated, and the carcass can be intensely anemic. Fibrinous pericarditis may be seen. Similar lesions can occur in clinically affected adults with pullorum disease.

In carrier birds, the lesions may be limited to nodular or regressing ovarian follicles, an inactive ovary with small, undeveloped ova, or a few misshapen, discolored, cystic and/or pedunculated ova among normal ovules. Caseous material is often found in the oviduct, and ovarian dysfunction may lead to peritonitis. Ascites may be seen, especially in turkeys. Some carriers have perihepatitis, a mottled pancreas, pericarditis, arthritis, caseous granulomas in the lungs and air sacs, or necrotic foci in the testes.

Morbidity and Mortality

Fowl typhoid frequently affects growing and adult poultry, although it can also occur in young birds. Pullorum disease is usually symptomatic only in young birds, but occasional outbreaks are reported in older animals. Morbidity and mortality also vary with the species and breed, as well as nutrition and management, stress and concurrent infections. Among chickens, lighter breeds such as leghorns are more resistant to pullorum disease than heavier breeds such as Rhode Island Reds, Barred Plymouth Rocks, White Wyandottes or New Hampshires. Genetic differences in susceptibility to fowl typhoid have also been reported. Mortality is usually highest in chicks and poults, particularly in two to three–week old birds. In chickens and turkeys, the mortality rate for fowl typhoid and pullorum disease varies from less than 1% to 100%; the morbidity rate is often significantly higher than the mortality rate, and some birds recover. In young pheasants with pullorum disease, mortality rates as high as 50% have been reported. Mortality rates in experimentally infected, young, northern bobwhite quail with pullorum disease are 65–100%.

Diagnosis

Clinical

The clinical signs, flock history, mortality and post–mortem lesions can be suggestive, but may resemble septicemia caused by other agents. Laboratory confirmation is essential.

Differential diagnosis

Fowl typhoid and pullorum disease must be differentiated from infections with other *Salmonella* species, *Mycoplasma synoviae*, *Staphylococcus aureus*, *Pasteurella multocida*, *Erysipelothrix rhusiopathiae* and fungi including *Aspergillus*. In chicks, the white nodules in internal organs can be confused with Marek's disease or hepatic lesions caused by *Yersinia pseudotuberculosis*. In adult carriers, infections with staphylococci, streptococci, coliform bacteria, other salmonellae, and *P. multocida* must also be considered.

Laboratory tests

Fowl typhoid and pullorum disease can be diagnosed by isolating *S. enterica* subsp. *enterica* serovar Gallinarum from affected birds. Biovar Gallinarum occurs in fowl typhoid, and biovar Pullorum is found in cases of pullorum disease. These organisms are Gram negative, facultative anaerobes. They will grow on most standard nonselective media, as well as on selective media including MacConkey, brilliant green and xylose lysine deoxycholate agars. *Salmonella* Pullorum occasionally fails to grow on brilliant green or salmonella-shigella agar. To prevent the overgrowth of competing flora, selective enrichment should be used for fecal samples, intestinal contents and environmental samples. Colonies on nutrient or blood agar are small (1–2 mm in diameter), circular, glistening, smooth, translucent, slightly raised and entire after a 24 to 48 hour incubation. *Salmonella* Pullorum may grow more slowly than *Salmonella* Gallinarum. Treatment with antibiotics during the 2 to 3 weeks before testing can lead to false negatives.

Identification of the organism and differentiation of the biovars Pullorum and Gallinarum is by standard biochemical and serologic tests. Commercial kits such as the Analytical Profile Index (API) system can be used for identification; however, the results should be interpreted with caution, as the API system may misidentify Salmonella Pullorum as Hafnia spp. Isolates can be sent to a reference laboratory for serotyping and for phage typing of Salmonella Pullorum. Plasmid profile analysis, pulsed field gel electrophoresis or ribotyping are used to characterize isolates during epidemiological investigations. Polymerase chain reaction (PCR) assays can be used to identify Salmonella Pullorum and Salmonella Gallinarum in research laboratories and possibly in some commercial laboratories.

Serology can be used to detect infected flocks and estimate the prevalence of infection within a flock. The rapid whole blood plate agglutination test can identify reactors in the field. Agglutinating antibodies appear from three to 10 or more days after infection. This test is not reliable in turkeys and ducks, due to false positives. Other serological tests include the rapid serum agglutination test, tube agglutination, microagglutination, microantiglobulin, immunodiffusion, hemagglutination, and enzyme–linked immunosorbent (ELISA) assays. Cross–reactions with other species or serovars of *Salmonella*, particularly *S. enterica* subsp. *enterica* serovar Enteritidis, can complicate the interpretation of serological tests. Vaccination can also interfere with testing. Testing for reactors should be repeated at three to five week intervals, as a single test may not detect all carrier birds. Seropositive birds should be confirmed by culture.

Flocks participating in official testing should follow the recommendations established by government programs such as the National Poultry Improvement Program (NPIP) in the U.S.

Samples to collect

Before collecting or sending any samples from animals with a suspected foreign animal disease, the proper authorities should be contacted. Samples should only be sent under secure conditions and to authorized laboratories to prevent the spread of the disease. Precautions should be taken to prevent zoonotic infections.

Swabs or tissue samples should be collected for bacterial isolation. Culture is more likely to be successful in birds that have not been treated with antimicrobials for approximately 2 to 3 weeks. In live birds, cloacal swabs may be taken. More often, swabs or tissue samples are collected from grossly abnormal tissues and intestinal and/or cloacal contents at necropsy. The preferred tissues for culture in clinical cases are the liver, spleen, yolk sac and cecum, which are most often involved. The heart, gizzard, pancreas, lungs, peritoneum, joint, interior of the eye, oviducts, ovaries and ovarian follicles can also be cultured. The tissues most likely to yield bacteria in carriers are the ovary and oviduct, with the addition of the liver and gall bladder for *Salmonella* Gallinarum. In practice, pooling a variety of tissues including the liver, gall bladder, spleen, heart, kidney, pancreas, digestive tract, ovary/ testis and oviduct is often the most successful approach in carrier birds. Highly seropositive birds should be selected for culture. Large amounts of tissue may be needed if the birds are asymptomatic.

Organisms can also be isolated from eggs, embryos, feces, and the environment including incubators, transport boxes and/or poultry houses. Samples should include moist and dry litter, swabs from open drinkers, and aliquots of fluff, dust and broken eggshells from hatching chicks. Red mites and feed samples can also be cultured. Successful culture from the environment is more difficult than isolation of the organism from sick or recently dead birds.

Serum should be collected for serology.

Recommended actions if fowl typhoid suspected

Notification of authorities

Fowl typhoid or pullorum disease must be reported to state or federal authorities immediately upon diagnosis or suspicion of the disease.

Federal: Area Veterinarians in Charge (AVIC):
http://www.aphis.usda.gov/animal_health/area_offices/

State Veterinarians:
http://www.usaha.org/Portals/6/StateAnimalHealthOfficials.pdf

Control

The eradication of fowl typhoid and pullorum disease requires the establishment of infection-free breeding flocks. Poultry should be purchased from certified infection-free stock or tested before adding them to a flock. They should be hatched and reared in conditions where they cannot contact infected birds, potentially infected surface water, or other sources of organisms. Rodents and wild birds should be excluded, and insects, particularly flies, poultry mites and mealworms, should be controlled. The premises and equipment should be cleaned and disinfected regularly. Infected flocks are quarantined in fowl typhoid- or pullorum-free countries.

Repeated testing and removal of carriers can sometimes eliminate the infection from a flock. More often, the entire flock is depopulated and the premises are cleaned and disinfected before restocking. Compounds that contain phenol are the most effective disinfectants under field conditions, but quaternary ammonium compounds and iodophores may be used. Heat treatment, formalin, dichloride of mercury and potassium permanganate can also inactivate these organisms. Exposure to sunlight and high environmental temperatures increase the efficacy of cleaning and disinfection procedures.

Fowl typhoid vaccines are used in chickens in some countries where this disease is endemic. Vaccination can reduce clinical disease and mortality, but does not prevent infection. Antibiotics can reduce mortality, but do not eliminate the infection from the flock.

Public Health

Salmonella Gallinarum is highly host adapted, and it is not considered to be a serious public health concern. In one survey, only eight out of more than 450,000 isolations of *Salmonella* from humans were *Salmonella* Gallinarum. *Salmonella* Pullorum occasionally causes acute, self-limiting enteritis in people who eat massively contaminated food.

Internet Resources

Food and Agriculture Organization of the United Nations (FAO). Manual for the Recognition of Exotic Diseases of Livestock
http://www.spc.int/rahs/

The Merck Veterinary Manual
http://www.merckvetmanual.com/mvm/index.jsp

World Organization for Animal Health (OIE)
http://www.oie.int/

OIE Manual of Diagnostic Tests and Vaccines for Terrestrial Animals
http://www.oie.int/international-standard-setting/terrestrial-manual/access-online/

OIE Terrestrial Animal Health Code
http://www.oie.int/international-standard-setting/terrestrial-code/access-online/

References

Anderson LA, Miller DA, Trampel DW. Epidemiological investigation, cleanup, and eradication of pullorum disease in adult chickens and ducks in two small-farm flocks. Avian Dis. 2006;50(1):142-7.

Basnet HB, Kwon HJ, Cho SH, Kim SJ, Yoo HS, Park YH, Yoon SI, Shin NS, Youn HJ. Reproduction of fowl typhoid by respiratory challenge with *Salmonella* Gallinarum. Avian Dis. 2008;52(1):156-9.

Berchieri A Jr, Murphy CK, Marston K, Barrow PA. Observations on the persistence and vertical transmission of *Salmonella enterica* serovars Pullorum and Gallinarum in chickens: effect of bacterial and host genetic background. Avian Pathol. 2001;30(3):221-31.

Cobb SP, McVicar CM, Davies RH, Ainsworth H. Fowl typhoid in caged layer birds. Vet Rec. 2005;157(9):268.

Kahn CM, Line S, editors. The Merck veterinary manual [online]. Whitehouse Station, NJ: Merck and Co; 2006. Fowl typhoid. Available at: http://www.merckvetmanual.com/mvm/index.jsp?cfile=htm/bc/204103.htm. Accessed 16 Jun 2009.

Kahn CM, Line S, editors. The Merck veterinary manual [online]. Whitehouse Station, NJ: Merck and Co; 2006. Pullorum disease. Available at: http://www.merckvetmanual.com/mvm/index.jsp?cfile=htm/bc/204102.htm. Accessed 16 Jun 2009.

Lister SA, BarrowP. Fowl typhoid (*Salmonella* Gallinarum infection). In: Pattison M, McMullin PF, Bradbury JM, Alexander DJ, editors. Poultry diseases. 6th ed. Philadelphia, PA: Saunders Elsevier; 2008. p. 130-3.

Lister SA, BarrowP. Pullorum disease. In: Pattison M, McMullin PF, Bradbury JM, Alexander DJ, editors. Poultry diseases. 6th ed. Philadelphia, PA: Saunders Elsevier; 2008. p. 126-30.

Mississippi State University Cooperative Extension Service. Bacterial diseases: fowl typhoid [online]. Mississippi State University; 1997. Available at: http://www.msstate.edu/dept/poultry/disbact.htm.* Accessed 11 Oct 2001.

Pennycott. T. Diseases of game birds: Salmonellosis. In: Pattison M, McMullin PF, Bradbury JM, Alexander DJ, editors. Poultry diseases. 6th ed. Philadelphia, PA: Saunders Elsevier; 2008. p. 562-3.

Pennycott TW, Duncan G. *Salmonella pullorum* in the common pheasant (*Phasianus colchicus*). Vet Rec. 1999;144(11):283-7.

Shivaprasad HL, Barrow PA. Pullorum disease and fowl typhoid. In: Saif YM, Fadley AM, Glisson JR, McDougald LR, Nolan LK, Swayne DE, editors. Diseases of poultry. 12th ed. Ames, IA: Blackwell Publishing; 2008. p. 620-34.

Shivaprasad HL. Fowl typhoid and pullorum disease. Rev Sci Tech. 2000;19(2):405-24.

World Organization for Animal Health (OIE). World animal health information database (WAHID) [database online]. Fowl typhoid. Paris:OIE;2009 Mar. Available at: http://www.oie.int/wahid-prod/public.php. Accessed 16 Jun 2009.

World Organization for Animal Health (OIE). World animal health information database (WAHID) [database online]. pullorum disease: Paris:OIE;2009 Mar. Available at: http://www.oie.int/wahid-prod/public.php. Accessed 16 Jun 2009.

World Organization for Animal Health [OIE]. Manual of diagnostic tests and vaccines for terrestrial animals [online]. Paris: OIE; 2008. Fowl typhoid and pullorum disease. Available at: http://www.oie.int/eng/normes/mmanual/2008/pdf/2.03.11_FOWL_TYPHOID.pdf. Accessed 16 Jun 2009.

*Link defunct as of 2009.