

Yersinia pseudotuberculosis (Infection with)

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AETIOLOGY

Classification of the causative agent

Yersinia pseudotuberculosis is a Gram-negative, zoonotic bacterium within the family *Enterobacteriaceae*. Clinical disease caused by *Y. pseudotuberculosis* is termed yersiniosis or pseudotuberculosis. *Y. pseudotuberculosis* is known for its role as a human enteric and foodborne pathogen, but it also commonly infects wildlife and domestic mammals. While clinical disease caused by *Y. pseudotuberculosis* more closely resembles that of *Y. enterocolitica*, it bears closer genetic similarity to *Y. pestis*. Since its discovery in 1883, the organism has undergone multiple taxonomic reclassifications and has been historically referred to as a *Bacillus*, a *Pasteurella*, and a *Shigella* species, in chronological order.

Resistance to physical and chemical action

Temperature: Tolerates 5°C-42°C; can survive freezing for extended periods; certain virulence factors are only expressed at higher temperatures (e.g., 37°C vs 25°C); flagellar antigens expressed only between 18°C-26°C

pH: Grows from pH 4-10 with an optimum of 7.6

Chemicals/Disinfectants: 2-5% phenol disinfectants, 1% sodium hypochlorite, 70% ethanol, 4% formaldehyde, 2% glutaraldehyde, 2% peracetic acid, 3-6% hydrogen peroxide, 0.16% iodine

Survival: Facultatively anaerobic and relatively resistant to external factors; greater proliferative ability in stored cooked food relative to raw foods due to increased nutrient availability

EPIDEMIOLOGY

Hosts

- Wild and domestic rodents
 - Beavers (*Castor canadensis*)
 - Chinchillas (*Chinchilla* spp.)
 - Guinea pigs (*Cavia* spp.)
 - Rats (*Rattus rattus*, *R. norvegicus*)
- Order Artiodactyla (even-toed ungulates)
 - Addax (*Addax nasomaculatus*)
 - Blackbuck antelope (*Antilope cervicapra*)
 - Blesbok (*Damaliscus pygargus*)
 - Dik-dik (*Madoqua kirkii*)
 - Muskox (*Ovibos moschatus*)
 - Wild and domestic cervids
- Wild and domestic birds
 - Pigeons (*Columba livia*)
 - Raptors (*Accipitriformes*, *Falconiformes*, *Strigiformes*)
- Wild and domestic swine
- Wild and domestic carnivores

- Foxes (*Vulpes* spp.)
- Wild and domestic marsupials
- European hares (*Lepus europaeus*)
- Giant anteaters (*Myrmecophaga tridactyla*)
- Raccoons (*Procyon itor*)
- Non-human primates (New World and Old World)
- Humans (*Homo sapiens*)
- Bacterial isolation from ectothermic vertebrates and invertebrates is rare

Transmission

- Ingestion of infectious prey or contaminated food
- Faecal-oral transmission

Sources

- Contaminated food and water
- Infected prey
- Faeces from infected individuals

Occurrence

Y. pseudotuberculosis was initially identified in and localised to Europe where it remains as an appreciable agent of foodborne illness. Currently, it is enzootic globally with the sole exception of Antarctica. It is often isolated from a wide variety of substrates, including milk, meat products, seafood, produce, soil, and water. Some geographic localisation of bioserotypes does occur, but it is not believed to be significant.

Most infected animals - domestic and wild - are believed to be asymptomatic carriers that develop clinical signs under stress; outbreaks in wild species are associated with increased population stressors, such as cold and wet weather, food scarcity, overcrowding, et cetera. Occurrence is decreased in summer when the weather is warm.

Rodents and wild birds are believed to be the primary reservoir hosts.

DIAGNOSIS

Infection may be subacute, acute, or chronic. As such, incubation periods are variable and may range from days to months. Similarly, the course of disease may also vary considerably and may even follow an asymptomatic carrier state.

Clinical diagnosis

Mild gastroenteritis is the most common feature of disease in animals, but progression to septicaemia may occur in severe cases. Gastroenteritis may manifest as lethargy, anorexia, diarrhoea, emaciation, fever, and/or incoordination. Respiratory distress may develop if bacteria spread to the lungs.

Lesions

- Mesenteric lymphadenitis and infiltration of Peyer's patches
- Gray-yellow, granulomatous nodules 1-3 cm in diameter in the lungs, liver, and/or spleen
 - On histopathology, these lesions exhibit caseous to liquefactive necrosis and are surrounded by bacteria, macrophages, and lymphocytes.

- Necrotising gastroenteritis with mucosal erosions
- Typhlocolitis
- Splenomegaly

Differential diagnoses

- Bacterial septicaemia
 - Plague (*Y. pestis*)
 - *Y. enterocolitica*
 - Tularemia (*Francisella tularensis*)
 - Clostridial enterotoxaemia
 - Salmonellosis
 - Pasteurellosis
- In humans:
 - Appendicitis
 - Crohn's disease

Laboratory diagnosis

Samples

For isolation of agent

- Faeces
- Mesenteric lymph nodes
- Intestine
- Liver
- Spleen
- Lungs, if lesions are present

Serological tests

- Whole blood
- Serum

Procedures

Identification of the agent

- Bacterial culture
 - Recovery is greatly facilitated by a 2-week cold enrichment in phosphate-buffered saline broth with 1% mannitol and 0.15% bile salts before inoculating enteric media agar plates.
 - Cefsulodin-irgasan-novobiocin (CIN) selective agar is currently the most frequently used culture medium (incubated at ambient temperatures), but not all strains of *Y. pseudotuberculosis* are able to grow on CIN; utilising MacConkey agar with CIN may increase the likelihood of recovery.
 - Generally speaking, there is no single culture medium shown to support the growth of all *Y. pseudotuberculosis* strains.
- API 20E identification systems provide a 90% positive identification rate if incubated between 25°C-30°C and read after 24h and 48h.
- Polymerase chain reaction (PCR) for the chromosomal *inv* gene or the pYV-borne genes *virF* and *yadA*
 - PCR assays are currently the diagnostic method of choice for consistent identification.

Serological tests

- Caution should be taken when interpreting serology results; significant cross-reactivity with other pathogens may occur depending on the infectious strain's bioserotype (due to similarities in LPS structure, namely the "O" antigen). Relevant cross-reactive pathogens include, but are not limited to: *Salmonella* groups B and D, some strains of *E. coli*, *Brucella abortus*, and *Enterobacter cloacae*.
 - IgG, IgM, and IgA are all utilised diagnostically but their levels and persistence may vary significantly depending on clinical presentation. Careful consideration should be given to this fact, and consultation with the appropriate diagnostic facilities is recommended.
 - It is recommended to test paired acute and convalescent sera.
- Serotypes I-IV can be consistently typed using commercial antisera
- Agglutination assays utilising a live antigen suspension
- Sodium dodecyl sulfate polyacrylamide gel electrophoresis (SDS-PAGE) and immunoblotting
- Antibody capture enzyme-linked immunosorbent assay (ELISA)

PREVENTION AND CONTROL

Sanitary prophylaxis

- Proper hygiene is very effective in preventing *Y. pseudotuberculosis* infection; proper hand-washing and environmental cleanliness should be targeted control methods.
- Take precautions when handling animal carcasses, especially from animals hunted for consumption or other human use such as fur (e.g., wild hares, foxes, swine, chinchillas, guinea pigs). Wear gloves when preparing, and cook meat thoroughly.
- While rare, guinea pigs and chinchillas used for research may develop *Y. pseudotuberculosis* infections. Laboratory animal personnel should take particular care around these animals, as they may become persistent carriers.
 - Similar precautions should be taken regarding non-human primate colonies.
- *Y. pseudotuberculosis* has been culpable for many morbidity and mortality events in captive zoological parks; ensuring environmental cleanliness and routinely disinfecting enclosures can significantly decrease the risk of disease in these settings.

Medical prophylaxis

- No vaccination is available or recommended for wildlife
- Gentamicin or cefotaxime are generally recommended as treatment

POTENTIAL IMPACTS OF DISEASE AGENT BEYOND CLINICAL ILLNESS

Risks to public health

- *Y. pseudotuberculosis* infection in humans is typically more mild than disease caused by other *Yersinia* species and often yields a self-limiting enterocolitis. Rare cases may develop more serious disease with extra-intestinal manifestations.
- The young, old, and immunocompromised are at a higher risk of developing significant disease. Additionally, individuals expressing HLA-B27 or related antigens are more likely to develop a secondary immune-mediated post-enteritis arthritis.

Risks to agriculture

- *Y. pseudotuberculosis* is not considered a high-risk pathogen to most domestic species, however, severe disease in livestock is not impossible.
- Cervid farmers should take care to reduce crowding and environmental stressors, as these animals are believed to be at an unusually high risk of morbidity and mortality compared to other livestock. It is one of the most common infectious causes of death in farmed Australian deer.

REFERENCES AND OTHER INFORMATION

- British Society for Immunology (n.d.). Pseudotuberculosis. Accessed 2020: <https://www.immunology.org/public-information/bitesized-immunology/pathogens-and-disease/pseudotuberculosis>
- Chart, H. & Cheasty, T. (2006). The serodiagnosis of human infections with *Yersinia enterocolitica* and *Yersinia pseudotuberculosis*. *FEMS Immunology & Medical Microbiology*, 47(3), 391-397.
- Collins, C. H., & Kennedy, D. A. (Eds.). (1983). *Laboratory-acquired Infections* (4th ed.). Oxford: Butterworth-Heinemann.
- Donnelly, T. M. (n.d). Chinchillas. *Merck Veterinary Manual*. Accessed 2020: <https://www.merckvetmanual.com/all-other-pets/guinea-pigs/disorders-and-diseases-of-guinea-pigs?query=yersiniosis#v3227488>
- European Food Safety Authority (2007). Scientific opinion of the panel on BIOHAZ on a request from EFSA on monitoring and identification of human enteropathogenic *Yersinia* spp. *The EFSA Journal*, 595, 1-30.
- Food and Drug Administration (2012). *Yersinia enterocolitica* and *Yersinia pseudotuberculosis*. *Bad Bug Book, Foodborne Pathogenic Microorganisms and Natural Toxins* (2nd ed., pp. 18-21).
- Gasper, P. W., & Watson, R. P. (2001). Plague and Yersiniosis. In E. S. Williams and I. K. Barker (Eds.), *Infectious Diseases of Wild Mammals* (3rd ed., pp. 313-326). Iowa State Press.
- Queensberry, K. E. & Donnelly, T. M. (n.d). Disorders and Diseases of Guinea Pigs. *Merck Veterinary Manual*. Accessed 2020: <https://www.merckvetmanual.com/all-other-pets/guinea-pigs/disorders-and-diseases-of-guinea-pigs?query=yersiniosis#v3227488>
- Wanger, A. (1998). *Yersinia*. In A. Balows and B. I. Duerden (Eds.), *Microbiology and Microbial Infections* (pp. 1051). New York: Arnold.

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The OIE will periodically update the OIE Technical Disease Cards. Please send relevant new references and proposed modifications to the OIE Science Department (scientific.dept@oie.int). Last updated 2020. Written by Samantha Gieger and Erin Furmaga with assistance from the USGS National Wildlife Health Center.