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A REVIEW
MARIN MAMMALS TUBERCULOSIS CAUSED BY *MYCOBACTERIUM PINNIPEDII*

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Abstract

Tubercilosis in marine mammals caused by *M. pinnipedii* which has been reported in species of fur seals and sea lions in different countries as well as in terrestrial animals and human. In marine mammals, *M. pinnipedii* causes granulomatous lesions in internal organs and may be presence of acid-fast organisms in the granulomatous lesions. Disease transmission mainly by aerosols, direct contact or indirect. the disease transmitted from marine animals to human so, is a public health concern and precautions should be taken when dealing with these animals.
Keywords : Tuberculosis; *M. pinnipedii*; marine mammals; fur seal; sea lion

Introduction

Mammals that live in marine including two main mammal group, cetaceans group consisting of two suborders: baleen whales (*Mysticeti*) suborder and toothed whales (*Odontoceti*) suborder which contains dolphins and porpoises; pinnipeds includes true seals, eared seals and walrus; while sirenians consisting of manatees and dugong; polar bear (*Ursus maritimus*) and several species of otters (Born *et al.,* 1997; Stirling, 2009). Ocean health depends on the presence of marine mammals in the littorals and seas; Cetaceans have great environmental and commercial importance, and consider as essential source of protein and fat for human; in addition are regarded as an important tourist attraction (Endo *et al.,* 2005; Antonioli and Reveley, 2005; Lloret and Riera, 2008).

Marine mammals can be infected with many bacterial zoonotic pathogenic microorganisms such as *Brucella*, *Leptospira, Erysipelothrix* and *Mycobacteria* (Hunt *et al.,* 2008; Colegrove *et al.,* 2005; Nymo *et al.,* 2011; Kriz *et al.,* 2011). Tuberculosis is a disease caused by microorganism belonging to the *Mycobacterium tuberculosis* complex (MTBC) group which characterized by the development of tuberculous granulomas lesions in the body. It is described as the first time in pinnipeds in1913 (Blair *et al.,* 1913), then Cousins co-authors (2003) named this etiological agent as *Mycobacterium pinnipedii* (*M. pinnipedii*). This agent causing significant disease in both marine mammals and terrestrial animals and has zoonotic potential to human (Kiers *et al.,* 2008; Moser *et al.,* 2008; Kriz *et al.,* 2011; Martins *et al.,*2019).

History of marine tuberculosis

In 1913, Tuberculosis was first discovered in pinnipeds by (Blair, 1913), then the disease reported in different marine mammal during the period 1986 and 1995, it is reported in Australian sea lions (*Neophoca cinerea*) in both captive and wild sea lions, in Australian sea lions and in animals trainer in Australia (Forshaw and Phelphs, 1991; Thompson *et al.,*1993).Then tuberculosis described in New Zealand fur seals (*Arctocephalus forsteri*), an Australian fur seal (*Arctocephalus pusillus doriferus*), initially, the causative agent attributed to MTBC group (Cousins, 1993; Woods *et al.,* 1995). Another researcher and between 1989–2000, MTBC were described in captive southern sea lions, wild south American fur seals and a wild Subantarctic fur seal (*Otaria flavescens*, *Arctocephalus australis*, *Arctocephalus tropicalis*) respectively (Bernardelli *et al.,*1996; Castro Ramos *et al.,* 1998; Bastida *et al.,* 1999).

Many studies discovered that these isolates shared biochemical and phenotypicly characteristics, but differed in their genotypic features with *M. bovis* and thereafter were named as "seal bacillus". After that, causative bacteria found different from other members of the MTBC and it is a separate species, so the name "*M. pinnipedii*" was suggested (Cousins, 1990; Cousins *et al.,* 1993; Bernadelli *et al.,* 1996; Bastida *et al.,* 1999; Cousins *et al.,* 2003).

Description of *M. pinnipedii*

M. pinnipedii it is a slowly growing microorganism, acid-fast bacilli, non sporulated, non motile. Growth occurs within 6 weeks of incubation on *Mycobacterium* media at 36–37ºC, and the growth enhanced by sodium pyruvate. Colonies are non-photochromogenic, flat, dysgonic and rough. Microscopic features, *M. pinnipedii* are red bacilli and have a cords of mycobacterial cells. *M. pinnipedii* susceptible to rifampicin, pyrazinamide, paraminosalicylic acid, streptomycin, isoniazid, ethambutol which are used as antituberculosis (Cousins *et al.,* 2003; Kriz *et al.,* 2011).

Epidemolgy of marine tuberculosis in marine animals

The incidence of marine tuberculosis caused has increased since the causative agent was discovered. An outbreak occurred in 13/28 (46.4%) in zoo sea lions in the Netherlands using the btuberculin skin test (TST) and necropsied (Kiers *et al.,* 2008). Also in 2008, tuberculosis infections reported in sea lion (*Otaria byronia*) in South American (Mores *et al.,* 2008). In France, *M. pinnipedii* was discovered in a Patagonian Sea Lion (*Otaria flavescens*) by molecular characterization (Lacave *et al.,* 2009). In the Czech Republic, the first case of tuberculosis detected in a kept Southern sea lion (*Otaria flavescens*) in a zoo (Kriz *et al.,* 2011). marine tuberculosis infections a wild sea lion (*Otaria flavescens*) in southern Brazil and in South American sea lion were reported by (Derek *et al.,*2014; Martins *et al.,* 2019). The first case of tuberculosis in South Australia, *M.*

pinnipedii infection recorded in a fur seal (*Arctocephalus pusillus doriferus*) (Wayen *et al.,* 2014).

Symptoms of tuberculosis in marine

Clinical signs in pinnipeds affected with tuberculosis, predominantly nonspecific that include: lethargy, anorexia, weight loss and pulmonary signs. Classic chronic coughing is not a differentiate signs of active disease in affected marine mammals as in human tuberculosis (Forshaw and Phelps, 1991; Kiers *et al.,* 2008). Emaciation and severe dyspnea and died within hours were reported in sea lion (Martins *et al.,* 2019).

Pathology and histology characterizations

On necropsy, typically granulomas or nodular granulomatous lesions varies in sizes were found in the internal organs of body and enlarged mesenteric lymph nodes (Kiers *et al.,* 2008; Lacave *et al.,*2009; Kriz *et al.,* 2011). Multifocal or coalescing region caseous necrosis, miliary lesions in pulmonary parenchyma, mucoid and purulent exudate full the airways, turbid greyish or blood tinged effusion consist of clots of fibrin was observed in pleural (Derek *et al.*, 2014 Roe *et al.,* 2019; Martins *et al.,* 2019).

Histologically, lesions associated with *M. pinnipedii* involve granulomas, another study revealed diffuse neoplastic proliferation or diffuse tumoral proliferation in the ovaries (Kiers *et al.,* 2008; Lacave *et al.,* 2009). Severe pyogranulomatous pleuropneumonia and intra histocytic acid-fast beaded filamentous bacilli was seen. In a study, tuberculous infected pinnipeds shown multifocal or coalescing granulomas in lung, pericardium and the mediastinum. Some of these granulomas were characterized by a combination of epithelioid macrophages, plasma cells, few numbers of lymphocytes and plump fibroblasts, other were present of zones of necrosis in the centre of granulomas and enclosed by macrophages, lymphocytes ,plasma cells, and various amounts of fibrous tissue within or surrounding the granulomatous inflammation (Wayen *et al.,*2014; Roe *et al.,* 2019).

Marine tuberculosis in other animals

Marine tuberculosis has been detected in different terrestrial animal species, in a zoo in Great Britain marine tuberculosis described in lama lowland gorillas (*Gorilla* and Brazilian tapir due to contact with infected South American fur seals (Cousins *et al.,* 2003; Cousins, 2006). Marine tuberculosis infections were investigated in Camelus, crested porcupine and malayan tapirs transmitted from infected Sea Lion (Mores *et al*., 2008; Urczynski *et al.,* 2011). Seven cases of marine tuberculosis infection wee recorded in beef cattle which was attributed to sharing the beach grazing area with seals and also due to the direct contact of the waterways with the ocean. At necropsy, infected cattle developed caseous necrotic lesions in a lymph node, other lesions are the same those reported in *M. bovis* infections. Histologically, developed granulomatous leions with center of mineralization and caseation, the necrotic tissue was surrounded by lymphoid, epithelioid, and langhans giant cells (Loeffler *et al.,* 2014).

Marin tuberculosis in human

Marin tuberculosis caused by *M. pinnipedii* has an important role on public health as as a potential zoonotic pathogen, few cases were recorded in humans. The first time of *M. pinnipedii* infection in human was transmitted from sea lion (Thompson *et al.,* 1993). *M. pinnipedii* infection has been reported in people (Bastida *et al*., 1999). And also, marine tuberculosis has been recorded in nine out of twenty five sea lion keepers were in close contact with these infected animals (Kiers *et al.,* 2008). Studies have not indicated signs in humans, Australian seal trainer case due to close contact with infected seals developed pulmonary tuberculosis signs (*M. tuberculosis* complex), the signs involved, chronic productive cough, fatigue, night sweats and weight loss (Thompson *et al.,* 1993).other cases were diagnosed by TST and interferongamma release assay (Kiers *et al.,* 2008)

Tramsmission

Aerosols is the main rout of infection. In human, persons, especially, zookeepers and trainers transmission occurs through direct contact with infected animals or during the cleaning of these animals, indirectly through contamination of the environment or materials with *M. pinnipedii*. Marine animals infected by direct contact with diseased marine animals or by contaminated materials and environment. Other animals may infect directly when contact with diseased sea animals or with contaminated water when When grazing near the beach or ocean (Thompson *et al.,* 1993; Kiers *et al*., 2008; Moser *et al.,* 2008; Loeffler *et al.,* 2014).

Diagnosis

Diagnosis in animals depends on clinical signs, isolating and identified by *M. pinnipedii*, pathological and historgical features, and by skin test using tuberculin (TST) which is purified protein derivative (PPD) (Kiers *et al.,* 2008; Lacave *et al.,* 2009; Kiers *et al.,* 2011; Roe *et al.,* 2019). Molecular characterization (PCR-RFLP gyrB) (Lacave *et al.,* 2009). In human, diagnosed by clinical signs, TST, interferon-gamma release assay (IGRA) (Kiers *et al.,* 2008). Detected the infection using ELISA and the serological rapid test was developed (Moser *et al.,* 2008).

References

Antonioli, C. and Reveley, M.A. (2005). Randomised controlled trial of animal facilitated therapy with dolphinsin the treatment of depression. BMJ 331: 1231.

Arbiza, J.; Andrea, B.; Miguel, C.; Helena, K.; Alberto, P.L. and Mario, C. (2012). Uruguayan Pinnipeds (*Arctocephalus australis* and *Otaria flavescens*): Evidence of Influenza Virus and *Mycobacterium pinnipedii* Infections.Chapter 7. New Approaches to the Study of Marine Mammals Edited by Aldemaro Romero and Edward O. Keith.

Bastida, R.; Loureiro, J.; Quse, V.; Bernardelli, A.; Rodriguez, D. and Costa, E. (1999). Tuberculosis in a wild Subantarctic fur seal from Argentina. J Wildl Dis., 35: 796–798.

Bernardelli, A.; Bastida, R.; Loureiro, J.; Michelis, H.; Romano, M.I.; Cataldi, A. and Costa, E. (1996). Tuberculosis in sea lions and fur seals from the south-western Atlantic coast. Revue Scientifique et Technique de L Office International des Epizooties, 15: 985–1005.

Blair, W.R. (1913). Report of the veterinarian. In: 17th Annual Report of the New York Zoological Society, 74.

Born, E.W.; Wiig, Ï. and Thomassen, J. (1997). Seasonal and annual movements of radio-collared polar bears (*Ursus maritimus*) in northeast Greenland. Journal of Marine Systems, 10: 67-77.

Castro, R.; Ayala, M.; Errico, M.F. and Silvera, F.V. (1998). Aislamiento de Mycobacterium bovis en Pinnipedos Otaria byronia (*Lobo marino comun*) en Uruguay. Rev Med Vet., 79: 197–200.

Colegrove, K.M.; Lowenstine, L.J. and Gulland, F.M.D. (2005). Leptospirosis in northern elephant seals (*Mirounga angustirostris*) stranded along the California coast. J. Wildl. Dis. 41: 426–430.

Cousins, D.V. (2006). Tuberculosis in fur seals and sea lions caused by *Mycobacterium pinnipedii*. In: Thoen CO, Steele JH, Gilsdorf MJ (eds.): *Mycobacterium bovis* infection in animals and humans. 2nd ed. Blackwell Publishing, 258–270.

Cousins, D.V.; Bastida, R.; Cataldi, A.; Quse, V.; Redrobe, S.; Dow, S.; Duignan, P.; Murray, A.; Dupont, C.; Ahmed, N.; Collins, D.M.; Butler, W.R.; Dawson, D.; Rodriguez, D.; Loureiro, J.; Romano, M.I.; Alito, A.; Zumarraga, M. and Bernardelli, A. (2003). Tuberculosis in seals caused by a novel member of the Mycobacterium tuberculosis complex: *Mycobacterium pinnipedii* sp. nov. International Journal of Systematic and Evolutionary Microbiology, 53: 1305–1314.

Cousins, D.V.; Francis, B.R.; Gow, B.L.; Collins, D.M.; McGlashan, C.H. and Gregory, A. (1990). Tuberculosis in captive seals: bacteriological studies on an isolate belonging to the *Mycobacterium tuberculosis* complex. Res Vet Sci.; 48: 196–200.

Cousins, D.V.; Williams, S.N.; Reuter, R.; Forshaw, D.; Chadwick, B.; Coughran, D.; Collins, P. and Gales, N. (1993). Tuberculosis in wild seals and characterisation of the seal bacillus. Australian Veterinary Journal, 70: 92–97.

Cousins, D.V.; Williams, S.N.; Reuter, R.; Forshaw, D.; Chadwick, B.; Coughran, D.; Collins, P. and Gales, N. (1993). Tuberculosis in wild seals and characterisation of the seal bacillus. Aust Vet J, 70: 92–97.

Derek, B.; de Amorim, R.A.; Casagrande, M.M.; Alievi, F.; Wouters, L.G.S.; De Oliveira, David, D., Maurício, T.; Cássia, Y.; Ikuta, E.O. and José, S.F. (2014). *Mycobacterium pinnipedii* in a Stranded South American Sea Lion (*Otaria byronia*) in Brazil. Journal of Wildlife Diseases, 50(2): 419-422.

Endo, T.; Haraguchi, K.; Hotta, Y.; Hisamichi, Y.; Lavery, S.; Dalebout, M.L. and Baker, C.S. (2005). Totalmercury, methyl mercury, and selenium levels in the red meat of small cetaceans sold for human consumption in Japan. Environ. Sci. Technol., 39: 5703–5708.

Forshaw, D. and Phelphs, G.R. (1991). Tuberculosis in a captive colony of pinnipeds. J Wildlife Dis., 27: 288–295.

Hunt, T.D.; Ziccardi, M.H.; Gulland, F.M.D.; Yochem, P.K.; Hird, D.W.; Rowles, T. and Mazet, J.A.K. (2008). Health risks for marine mammal workers. Dis. Aquat. Org. 81: 81–92.

Kiers, A.; Klarenbeek, A.; Mendelts, B.; Van Soolingen, D. and Koeter, G. (2008). Transmission of *Mycobacterium pinnipedii* to humans in a zoo with marine mammals. Internat. J. Tuberc. Lung Dis., 12: 1469–1473.

Kriz, P.; Kralik, P.; Slany, M.; Slana I, Svobodova J, Parmova I. *Mycobacterium pinnipedii* in a captive Southern Sea lion (*Otaria flavescens*): a case report. Vet Med., 56: 307–13.

Lacave, G.; Alexis, M.; Vanessa, A.; Maria, L. Bo. and Alexis, L. (2009). Atypical Case of Mycobacterium pinnipedii in a Patagonian Sea Lion (*Otaria flavescens*) and Tuberculosis Cases History Review in Captive Pinnipeds. Infectious & Parasitic Diseases. Proceedings of the 40thInternational Association for Aquatic Animal Medicine annual meeting. San Antonio, USA, 155-156.

Lloret, J.; Zaragoza, N.; Caballero, D. and Riera, V. (2008). Biological and socioeconomic implications of recreational boat fishing for the management of fishery resources in the marine reserve of Cap de Creus (NW Mediterranean). Fisheries Research No 91(2): 252-259.

Loeffler, S.H.; de Lisle, G.W.; Neill, M.A.; Collins, D.M.; Price-Carter, M. and Paterson, B. (2014). The seal tuberculosis agent, *Mycobacterium pinnipedii*, infects domestic cattle in New Zealand: Epidemiologic factors and DNA strain typing. J Wildl Dis., 50(2): 180–7.

Martins, M.A.; da S.; Filho, R.P.; von, G.A. and Reis, A.J. (2019). Tuberculosis caused by *Mycobacterium pinnipedii* in a wild South American sea lion *Otaria flavescens* stranded in southern Brazil. Dis Aquat Org., 133: 189-194.

Moser, I.; Prodinger, W.M.; Hotzel, H.; Greenwald, R.; Lyashchenko, K.R.; Bakker, D.; Gomis, D.; Seidler, T.; Ellenberger, C.; Hetzel, U.; Wuennemann, K. and Moisson, P. (2008). *Mycobacterium pinnipedii*: transmission from South American sea lion (*Otaria byronia*) to Bactrian camel (*Camelus bactrianus bactrianus*) and Malayan tapirs (*Tapirus indicus*). Vet. Microbiol. 127: 399–406.

Nymo, I.H.; Tryland, M. and Godfroid, J. (2011). A review of Brucella infection in marine mammals, with special emphasis on *Brucella pinnipedialis* in the hooded seal (*Cystophora cristata*). Vet. Res., 4: 2.

Roe, W.D.; Lenting, B.; Kokosinska, A.; Hunter, S.; Duignan, P.J. and Gartrell, B. (2019). Pathology and molecular epidemiology of *Mycobacterium pinnipedii* tuberculosis in native New Zealand marine mammals. PLoS ONE 14(2): e0212363.

Stirling, I. (2009). Polar Bear (*Ursus maritimus*). In: Perrin, W.F., Wursig, B., Thewissen, J.G.M. (Eds), Encyclopedia of Marine Mammals. Elserier Inc., Academic Press, Burlington, USA. San Diego, USA. New York, USA. London, UK., 888-890.

Thompson, P.J.; Cousins, D.V.; Gow, B.L.; Collins, D.M.; Williamson, B.H. and Dagnia, H.T. (1993). Seals, seal trainer and mycobacterial infection. Am Rev Respir Dis., 147: 164–167.

Urczynski, K.; Konstantin, P.; Lyashchenko, D.G.; Moser, R.G. and Pierre, M. (2011). Pinniped Tuberculosis In Malayan Tapirs (*Tapirus Indicus*) and its transmission

to Other Terrestrial Mammals." Journal of Zoo and Wildlife Medicine, 42(2): 222–227.

Wayne, S.J.; Boardman, L.S.; Ivan, B.; Maria, G.; Janet, A.; Fyfe, M.; Debby, V.; Cousins, A.M. and Lucy, W. (2014). "*Mycobacterium pinnipedii* Tuberclosis in A Free-ranging Australlan Fur Seal (*Arctocephalus Pusilus Dorlferus*) In South Australia," Journal of Zoo and Wildlife Medicine, 45(4): 970-972.

Woods, R.; Cousins, D.V.; Kirkwood, R. and Obendorf, D.L. (1995). Tuberculosis in a wild Australian fur seal (*Arctocephalus pusillus doriferus*) from Tasmania J Wildlife Dis., 31: 83–86.