MedCrave
Step into the World of Research

Journal of Dairy, Veterinary & Animal Research

Review Article

Open Access

CrossMark

Bacterial zoonosis - a public health importance

Abstract

Several infectious diseases are classified as Zoonotic disease as they are caused by bacterial, virus, fungus and insects. "Zoonotic diseases are disease that can be transmitted from animal to human and human to animals". This review article discusses some of the main bacterial Zoonotic animal diseases and the risks of infection. The most common bacterial Zoonotic disease transmitted between humans and animals through a number of route including food, water, direct contact. Common Bacterial Zoonotic diseases are Anthrax, Brucellosis, Bovine tuberculosis, Listeriosis, Salmonellosis, Leptospirosis, Camphylobacteriosis, Cat scratch disease and Psittacosis. Farmer, animal holders, veterinary workers, persons involve in production and processing of livestock production such as abattoir, dairy and poultry enterprises are at high risk for these diseases. Public health educations can be taken to prevent zoonotic bacterial infections.

Keywords: bacterial zoonoses, disease, human and animal

Volume 5 Issue 2 - 2017

Sandhya Morwal, Sharma SK
Department of Veterinary Medicine, College of Veterinary and Animal Science, India

Correspondence: Sandhya Morwal, Assistant Professor, Department of Veterinary Medicine, College of Veterinary and Animal Science, Navania, Vallabhnagar, Udaipur- 313601, Rajasthan, India, Email sandhyamorwal@gmail.com

Received: February 26, 2017 | **Published:** April 05, 2017

Introduction

Zoonotic diseases are of major concern worldwide. The word 'Zoonosis' (Pleural: Zoonoses) was introduced by Rudolf Virchow in 1880 to include collectively the diseases shared in nature by man and animals. Later WHO in 1959 defined that Zoonoses are "those diseases and infections which are naturally transmitted between vertebrate animals and man". The infectious diseases such as bacterial, viral, fungal, protozoal and parasitic are responsible for most losses in the food animals, therefore of great economic importance.[1]

These zoonotic diseases can be transmitted to humans in many ways like animal bites and scratches, food animals, farmers and veterinarians, vectors like mosquitoes, tick, fleas, and lice's.[2,3] Following factors influencing prevalence of zoonoses like ecological changes in man's environment, handling animal by-products and wastes (occupational hazards), increased movements of man, increased trade in animal products, and increased density of animal population.

People who have close contact with large numbers of animals such as farmers, abattoir workers, shearers, knackery workers and veterinarians are at a higher risk of contracting a zoonotic disease. This manuscript reviews the most common bacterial zoonoses. Bacterial zoonotic infections are one of the zoonotic diseases, which can, in particular, re-emerge after they are considered to be eradicated or under control.[4] Bacterial zoonotic Diseases in animals are anthrax, brucellosis, bovine tuberculosis, Listeriosis, Salmonellosis, Leptospirosis, Cat scratch disease and Psittacosis. The most commonly suffered zoonotic bacterial infections in humans are transmitted via animal bites and scratches.[5–7] Bacterial Zoonotic disease can be spread to human by Close contact with infected animals like livestock, pets and wildlife. Direct and Indirect contact with an infected animals saliva, blood, urine and faeces. Water or soil that has been contaminated by infected animals. Eating and drinking unpasteurised dairy product. Undercooked meat or unwashed fruit and vegetables that are contaminated with faeces from infected animals.

Most common bacterial zoonotic diseases

Anthrax: Anthrax is a zoonotic disease, which primarily occurs in animals and then spreads to human. *Bacillus anthracis* (*B. Anthracis*), the causative organism of anthrax is a Gram-positive spore forming bacillus commonly found in soil of endemic areas. Human anthrax usually spreads to human populations through close occupational proximity to infected livestock by handling infected domestic animals including cattle and goats or their products like skin, meat, hides and bones.[8] On the basis of route of infection, there are three clinical forms of anthrax *viz*., cutaneous (skin), gastrointestinal (ingestion) and pulmonary (through inhalation of spores).[9]

People working with carcases especially animals that died suddenly - for example knackery workers, farmers and veterinarians are most at risk. Occupational exposure can also occur via animal products such as contaminated wool or hides. The disease is also known as splenic fever due to the fact that there is extensive enlargement of spleen (splenomegaly) to this infection. Anthrax spores pose the biggest bioterrorism threat because it is easier to produce and preserve them. Anthrax is still a concern of human as well as veterinary public heath in several states of country. Kumar et al.[10] sporadic cases of anthrax continue to be reported from many parts of the world.[10] From India, both sporadic cases and outbreaks are being reported regularly. The Union Territory of Pondicherry (a former French colony) lies on the coast of Bay of Bengal, where the incidence of anthrax is on the rise with 28 cases being detected in the year 1999 and 2000 alone. So far, about 34 human cases have been encountered in this region. Most cases have occurred in agricultural laborers who gave history of handling animal meat or skin of infected animals. Awareness among clinicians and mandatory reporting of cases to public health departments along with public education will help control morbidity and mortality due to anthrax. Effective immunization of animals is the other important control measure for anthrax.

Brucellosis: Brucellosis is an infectious, contagious, and worldwide spread, an important zoonotic disease caused by bacteria of the genus Brucella. The disease primarily affects cattle, sheep, goats, swine, and dogs. Brucellosis is usually caused by Brucella in cattle, B. Melitensis or *B. Ovis* in small ruminants, *B. Suis* in pigs and *B. Canis* in dogs. Abortions, placentitis, epididymitis and orchitis are the most common clinical signs in affected animals. Brucellosis is mainly transmitted from its animal reservoirs to human by direct contact with infected animals or through the ingestion of raw milk or unpasteurized cheese.[11]

Submit Manuscript | http://medcraveonline.com

© 2017 Morwal et al. This is an open access article distributed under the terms of the Creative Commons Attribution License, which permits unrestricted use, distribution, and build upon your work non-commercially.

Copyright: ©2017 Morwal et al.

Brucella spp. can survive for long periods in dust, dung, water, slurry, aborted foetus, soil, meat and dairy product. Cross transmission of brucellosis can occur between cattle, swine, sheep and goats and other species including dogs, horses, feral swine, bison, rein deer and camels.[12,13] B. Melitensis is highly pathogenic for human beings.[13,14] It is an occupational hazard with those particularly at risk such as laboratory workers, veterinarians, abattoir workers, farmers and animal keepers either living in close proximity with animals or handling aborted fetus and animal products that contaminated by Brucella agents.[15–17] The spread of the disease from one herd to another and from one area to another is almost always due to the movement of infected animals from an infected herd into a non infected susceptible herd. Brucellosis one of the most common laborator acquired infection mostly because aerosolization is a mechanism of transmission in this setting (Rajasekhar et al., 2002).

Brucellosis remains endemic[18] worldwide with the exception of countries where the disease has been eradicated.[19] The global distribution of brucellosis is continuously changing with emergence or re-emergence of few foci.[18] Lack of strict movement control of animal from one area to another, lack of proper hygienic practices and good husbandry management play a great role in increment of the prevalence of brucellosis.

Bovine Tuberculosis: Bovine tuberculosis is an infectious disease of domestic animals that are most commonly seen in cattle and buffalo and humans. It is caused by the bacterium *Mycobacterium bovis*. Infected animals shed bacteria in respiratory secretions, faeces and milk. Humans can become infected with TB through exposure from drinking infected milk, breathing in the bacterium shed by infected animals or direct contact with a cut or other skin breaks. Humans can protect themselves by not drinking or eating raw milk products. Tuberculosis is a disease of humans and animals that is caused by the *Mycobacterium tuberculosis* complex (MTC). Mycobacteria of the Mycobacterium tuberculosis complex cause tuberculosis (TB) in various mammalian hosts but exhibit specific host tropisms.[20] The two major pathogenic species in this complex are *M. Tuberculosis* and M. bovis, the causative agents of TB in humans and cattle, respectively. However, it is well known that M. bovis is zoonotic, while infection with *M. Tuberculosis* has been sporadically reported in domestic and wild animal species, most frequently in animals living in prolonged, close contact with humans.[21–23] Among domestic animals, infection with *M. Tuberculosis* has been most frequently identified in cattle.[24–27] In Ethiopia, TB is prevalent in humans (0.6% prevalence)[28] and livestock, as indicated by tuberculin test and slaughterhouse data.[26,29,30] Humans suffering from active TB are the most probable source of *M. tuberculosis* in animals, with infection spread via sputum, and rarely urine or faeces.[31]

Prasada et al.[25] studied extrapulmonary clinical samples obtained from cattle and humans were investigated. Predominance of *M. Tuberculosis* (15.7%) and *M. Bovis* (26.8%) was seen in humans and cattle, respectively. However, more importantly, both mycobacterial pathogen (mixed infection) were identified in a number of samples. In humans 8.7% of the samples and 35.7% in cattle were classified as mixed infection. Veterinary practices should be initiated to reduce the risks for exposure to animals infected with M. tuberculosis.

Camphylobacteriosis: Barun[32] reported the prevalence of Campylobacter was found to be 12% from chicken meat sample, 12% from chevon and 5.45% from pork, with an overall prevalence of 9.6%. Sharma[33] reported a high prevalence (13.9%) in chicken meat sample as compared to 3.3% and 8% in beef and pork respectively. Singh[34] reported 3.03% beef sample contaminated with Camphylobacter. Camphylobacteriosis is among the most frequently reported and widespread bacterial zoonoses globally. Camphlobacteriosis is caused mainly by *C. Jejuni* and *C. Coli* which are responsible for nearly 95% of the cases. Survey have revealed that around 0.8million cases of food born illness in the United States[35] and 0.5million cases in the United Kingdom[36] each year are caused by *Camphylobacter spp.* The dramatic increase in North America, Europe and Australia is alarming, and data from parts of Africa, Asia and the middle East indicates the endemicity of the infection in these area.[37]

Listeriosis: Listeriosis is an emerging zoonotic disease.[38] *Listeria monocytogenes* is most commonly associated with clinical disease in ruminants including encephalitis, abortion (third trimester), septicaemia and mastitis (Clinical Mastitis). It is transmitted through the ingestion of contaminated feed, often silage. It can also be transmitted through the upper respiratory tract mucosa, conjunctiva and wounds. Listeriosis in humans is predominantly a food borne disease that is associated with soft cheeses, vegetables, meats and milk.

Salmonellosis: It is a food borne zoonosis, an infectious disease of all domestic animals caused by various specious of salmonellae and is characterized by 3 major syndromes like per acute, Septicemia, acute enteritis and chronic enteritis. *Salmonella sp.* is bacteria that live in the intestinal tract of carrier animals of many species including livestock, poultry and reptiles. Infective numbers of the bacteria are shed into the faeces of these animals particularly during periods of stress such as being yarded and transported. Other animals and humans can ingest the salmonella bacteria through direct or indirect contact with faecal material and infection then produces gastroenteritis. Humphery[39] observed the ubiquity of Salmonella, any food, if not handled properly and protected from contamination can cause infection. In recent times, contaminated chicken and eggs are the most commonly identified vehicles in human salmonellosis as they have been responsible for the pandemic associated with *S. Enteritidis* between the mid 1980 and mid 1990s.[40] Many outbreaks implicating poultry meat as the source of infection have been reported.[41] People may become infected with *S. Enteritidis* as a result of infected broiler breeder flocks and broiler rearing flocks and contamination of broilers at slaughter.[42]

Leptospirosis: The disease caused by *Leptospira interrogans*. Leptospirosis is an infection caused by corkscrew shaped bacteria called leptospira. Signs and symptoms can range from none to mild such as headaches, muscle pains, and fevers; to severe with bleeding from the lungs and meningitis. Man and cattle are incidental hosts.[38] If the infection causes the person to turn yellow, have kidney failure and bleeding, it is then known as Weil's disease.[43] If it causes lots of bleeding from the lungs it is known as severe pulmonary hemorrhage syndrome. Most countries in the South East Asia region are endemic to leptospirosis. Outbreaks have been reported from different parts of India. It has been reported to be a common cause of acute renal failure in south India. Multi centric investigation in India indicates that leptospirosis account for about 12.7% of cases of acute febrile illness repoting to the hospitals.[44]

Cat scratch disease: *(Bartonella henselae)* Cat Scratch Disease (CSD) is a bacterial infection caused by *Bartonella henselae,* which is generally spread to people through cat bites or scratches. The etiological agent *Bartonella henselae,* which was transmitted by cat scratches and bites, was only identified in 1992.[45] However, contact

with cat saliva on broken skin or sclera can also cause Bartonellosis. Affecect person show papules and pustules at the site of injury (the first initial sign). The disease may progress with a chronic non-healing wound, fever (sometimes), and abscession. Cat owners and veterinarians are most at risk.[46]

Psittacosis: Psittacosis is found worldwide. Infection with *Chlamydophila psittaci* is cause of systemic illness in companion birds and poultry. This illness is often referred to as avian chlamydiosis (also known as psittacosis, ornithosis, and parrot fever) in birds. The incidence seems to be increasing in developed countries, which is correlated to the import of exotic birds. *Chlamydia psittaci* is a bacteria that can chronically infect birds respiratory tract (lungs, throat, nasal cavity and even eyes). Some birds can even be carriers and show no clinical signs. If a bird is showing clinical signs of the disease the most common symptoms are being fluffed up and quiet, sneezing, runny eyes and diarrhoea. In people the most common sign is respiratory disease, symptoms such as a chronic cough and sneezing. Zoonotic transmission mainly occurs via inhalation of infected excretions and discharges.[47,48] Intermittent shedding by animal carriers represents an important path of infection for birds and humans. In domesticated birds, *C. psittaci* infections occur most commonly in turkeys and ducks. Recent studies reported frequent *C. psittaci* infections in European and Asian chickens.[49–51]

Precautions: We can protect ourselves by taking some precaution like: - good personal hygiene; Isolating and treating sick animals. Providing prompt and effective first aid treatment to cuts and scratches; Using personal protective equipment e.g. overalls, gloves, boots, goggles, aprons; Cleaning and disinfecting work spaces and equipment; Vaccinating pets and livestock; Worming pets; Control rodents. Respiratory Protection – Preventing the inhalation of a zoonotic disease transmitted via the air will require respiratory protection.

Discussion and conclusion

Bacterial Zoonotic diseases are the world wide spread global public health problem of recent times, and it cause health and economy losses. Bacterial zoonotic disease spread to inadequate collection of sample for laboratory analysis. There is need to educate the people working especially with domestic animals and slaughter house. Appropriate routine veterinary care including vaccination, deworming and proper care for sick animals, should be reduce the risk of bacterial Zoonotic disease transmission. Epidemiological studies indicate that a wide Varity of foods (Milk and Meat) are responsible for food borne bacterial Zoonotic disease. Several outbreak of Salmonella food poisoning association with eating beef have been reported.[52]

Brucella spp. can survive for long periods in dust , dung, water, slurry, aborted foetus, soil, meat and dairy product. Brucella infection is an occupational risk for farmers, veterinarians, abattoir workers, laboratory workers and those people who work with animals and those who consume their products.[53] Zoonotic bacterial pathogens are a major source of emerging Zoonotic disease. Feeding of pets with raw food diet is a potential source of Salmonella, Camphylobacter and other bacterial diseases. Camphylobacteriosis were the most frequently reported Zoonotic bacterial diseases in 2009 among EU member countries in humans.[54–58]

Always use the pasteurized all milk and other dairy product. Unpasteurized dairy products should not be eaten while traveling to endemic areas. Identification and control of bacterial Zoonotic disease require good human and animal's health approach, which demands joined efforts of veterinarians, medico, epidemiologists, veterinary extension workers and public health workers.

Acknowledgements

None.

Conflict of interest

Author declares that there is no conflict of interest.

References

1. Gracey JF, OS Collins, RJ Huey. Meat hygiene. (10th edn.), Bailliere Tindall, London, UK, pp: 223-260.
2. Wiwanitkit V. Emerging zoonotic diseases: can it be the case of bioterrorism. *J Bioterr Biodef*. 2015;S14:e101.
3. Dahal R, Kahn L. Zoonotic diseases and one health approach. *Epidemiol.* 2014;4:e115.
4. PAHO. *Zoonoses and Communicable Diseases Common to Man and Animal.* 3rd ed. DC: World Health Organization; 2001. p. 441–490.
5. MMWR. Dog-bite-related fatalities-United States, 1995-1996. *MMWR*. 1997;46(21):463–467.
6. Sacks JJ, Lockwood R, Hornreich J, et al. Fatal dog attacks, 1989-1994. *Pediatrics.* 1996;97(6 Pt 1):891–895.
7. Griego RD, Rosen T, Orengo IF, et al. Dog, cat, and human bites: A review. *J Am Acad Dermatol* 1995;33(6):1019–1029.
8. Dixon TC, Meselson M, Guillemin J, et al. Anthrax. *N Engl J Med*. 1999;341(11):815–826.
9. Goossens PL. Animal models of human anthrax: the Quest for the Holy Grail. *Mol Aspects Med*. 2009;30(6):467-480.
10. Kumar A, Kanungo R, Bhattacharya S, et al. Human anthrax in India: urgent need for effective prevention. *J Commun Dis.* 2000;32(4):240–246.
11. Pappas G, Akritidis N, Bosilkovski M, et al. Brucellosis. *N Engl J Med*. 2005;352(22):2325–2336.
12. Than N. Prevalence Survey of Bovine Brucellosis (*Brucella abortus*) in Dairy Cattle in Yangon, Myanmar. 2007.
13. FAO. Guidelines for coordinated human and animal brucellosis surveillance. 2003.
14. SCAHAW. Brucellosis in Sheep and Goat (*Brucella melitensis*). 2001.
15. Radostits ED, Gay CC, Inchcliff WK. Veterinary Medicine. *Textbook of the Diseases of Cattle, Sheep, Pigs, Goats and Horses*. 9th ed. USA: WB Saunders Company Ltd; 2000. p. 867–882.
16. FAO W. Brucellosis in Humans and Animals. In: Bennett, editor. *The World Health Organization in collaboration with the Food and Agriculture Organization of the United Nations and World Organization for Animal Health*. 2012.
17. Jim K. Public Health Implications of *Brucella canis*, Infections in Humans Summary Findings and Recommendations of the Brucella canis Workgroup, National Association of State Public Health Veterinarians. *Journal of Veterinary Medicine B*. 2012;49:415–418.
18. Boral R, Singh M, Singh DK. Status and Strategies for control of Brucellosis. A review. *Indian J Anim Sci.* 2009;79:1191–1199.
19. Mantur BG, Amarnath SK. Brucellosis in India-A review. *J Biosci.* 2008;33(4):539–547.

20. Smith NH, Kremer K, Inwald J, et al. Ecotypes of the *Mycobacterium tuberculosis* complex. *J Theor Biol*. 2006;239:220–225.

21. Montali RJ, Mikota SK, Cheng LI. *Mycobacterium tuberculosis* in zoo and wildlife species. *Rev Sci Tech.* 2001;20(1):291–303.

22. Pavlik IA, Parmova WY, Melicharek I, et al. *Mycobacterium tuberculosis* in animal and human populations in six Central European countries during 1990-1999. *Czech Veterinary Medicine.* 2003;48(4):83–89.

23. Alfonso R, Romero RE, Diaz A, et al. Isolation and identification of mycobacteria in New World primates maintained in captivity. *Vet Microbiol*. 2004;98(3–4):285–295.

24. Sulieman MS, Hamid ME. Identification of acid-fast bacteria from caseous lesions in cattle in Sudan. *J Vet Med B Infect Dis Vet Public Health*. 2002;49(9):415–418.

25. Prasad HK, Singhal A, Mishra A, et al. Bovine tuberculosis in India: potential basis for zoonosis. *Tuberculosis (Edinburgh)*. 2005;85(5–6):421–428.

26. Berg S, Firdessa R, Habtamu M, et al. The burden of mycobacterial disease in Ethiopian cattle: implications for public health. *PLoS One*. 2009;4(4):e5068.

27. Chen Y, Chao Y, Deng Q, et al. Potential challenges to the stop TB plan for humans in China; cattle maintain M. Bovis and *M. tuberculosis*. *Tuberculosis (Edinburgh)*. 2009;89(1):95–100.

28. Global Tuberculosis Control - Surveillance, Planning, Financing: WHO Report. *WHO*. 2008. p. 1–304.

29. Ameni G, Aseffa A, Engers H, et al. High prevalence and increased severity of pathology of bovine tuberculosis in Holsteins compared to zebu breeds under field cattle husbandry in central Ethiopia. *Clinical and Vaccine Immunology*. 2007;14(10):1356–1361.

30. Demelash B, Inangolet F, Oloya J, et al. Prevalence of bovine tuberculosis in Ethiopian slaughter cattle based on post-mortem examination. *Tropical Animal Health and Production*. 2009;41(5):755–765.

31. Thoen CO, Steele JH. *Mycobacterium bovis Infection in Animals and Humans*. 2nd ed. USA: Iowa State University Press; 1995.

32. Barun R. *Studies on prevalence of Campylobacter jejuni in man, animals and foods*. 2003.

33. Sharma AK. *Detection of Zoonotic Campylobacter species in animals, human being and Foods*. 2004.

34. Singh R, Singh PP, Rathor RS, et al. Prevalence of *Campylobacter jejuni* and *Campylobacter coli* in chicken meat and carcasses collected from local poultry farms and retail shops of Bareilly, Utter Pradesh, India. *Indian J Comp Microbial Immunol Infect Dis.* 2009;30(1):90–93.

35. Scallan E, Hoekstra RM, Angulo FJ, et al. Food borne illness acquired in the United states- major pathogen. *Emerg Infect Dis.* 2011;17(1):7–15.

36. Tam CC, Rodrigues LC, Viviani L, et al. Longitudinal study of infection intestinal disease in the UK (IID2 study): incidence in the community and presenting to general practice. *Gut.* 2011;61(1):69–77.

37. Kaakoush NO, Castaño Rodríguez N, et al. Global epidemiology of Camphylobacter infection. *Clin Microbiol Rev.* 2015;28(3):688–720.

38. Chugh TD. Emerging and Re-emerging bacterial Diseases in India. *J Biosci*. 2008;33(4):549–555.

39. Humphrey T. Public health aspects of Salmonella infection. In: Wray C, Wray A, editors. *Salmonellosis in domestic animals*. UK: CAB publishing; 2000. p. 245–264.

40. Rodrigue DC, Tauxe RV, Rowe B. International increase in salmonella Enteritidis: a new Pandemic? *Epidemiol Infect.* 1990;105(1):21–27.

41. Leach SA, Willians A, Davies AC, Willson J, Marsh PD, et al. (1999) Aerosol route enhance the contamination of intact eggs and muscle of experimentally infected laying hens by *Salmonella Typhimurium* DT104. *Microbiol Lett.* 1999;171(2):203–207.

42. Corkish JD, Davies RH, Wray C, et al. Observation on a broiler breeder flock naturally infected with Salmonella Enteritidies phage type 4. *Vet Record.* 1994;134(23):591–594.

43. Sharma RD, Kumar M, Sharma MC. Textbook of Preventive medicine and Epidemiology. Indian Council of Agricultural Research, India; 2010.

44. Sehgal SC, Sugunan AP, Vijayachari P. Leptospirosis: disease burden estimation and surveillance networking in India. *Southeast Asian J Trop Med Public Health Suppl*. 2003;2:170–177.

45. Stechenberg BW, Bartonella. In: Kliegman, editor. 19th ed.

46. Slater LN, Welch DF. Bartonella including cat-scratch disease. In: Mandell, editor. 7th ed.

47. Beeckman DS, Vanrompay DC. Zoonotic *Chlamydophila psittaci* infections from a clinical perspective. *Clin Microbiol Infect*. 2009;15(1):11–17.

48. Stewardson AJ, Grayson ML. Psittacosis. *Infect Dis Clin North Am.* 2010;24(1):7–25.

49. Dickx V, Geens T, Deschuyffeleer T, et al. Chlamydophila psittaci zoonotic risk assessment in a chicken and turkey slaughterhouse. *J Clin Microbiol*. 2010;48(9):3244–3250.

50. Dickx V, Vanrompay D. Zoonotic transmission of *Chlamydia psittaci* in a chicken and turkey hatchery. *J Med Microbiol*. 2011;60(Pt 6):775–779.

51. Yin L, Kalmar ID, Lagae S, et al. Emerging *Chlamydia psittaci* infections in the chicken industry and pathology of *Chlamydia psittaci* genotype B and D strains in specific pathogen free chickens. *Vet Microbiol.* 2013;162(2–4):740–749.

52. Roels TH, Frazak PA, Kazmierczak JJ, et al. Incomplate sanitation of a meat grinder and ingestion of raw ground beef: contributing factors to a large outbreak of *S. Typhimurium* infection. *Epidemiol Infect*. 1997;119(2):127–134.

53. Smits H, Cutler SJ. Contributions of biotechnology to the control and prevention of brucellosis in Africa. *Afr J Biotechnol.* 2004;3(12):631–636.

54. Lahuerta A, Westrell T, Takkinen J, et al. Zoonoses in the European Union: origin, distribution and dynamics- the EFSA-ECDC summary report 2009. *Euro Surveill.* 2011;16(13).

55. Dijkstra F, Van Der Hoek W, Wijers N, et al. The 2007-2010. Q fever epidemic in the Netherlands: characteristics of notified acute Q fever patients and the association with dairy goat farming. *FEMS Immunol Med Microbiol*. 2012;64(1):3–12.

56. Prasad HK, Singhal A, Mishra A, et al. Bovine tuberculosis in India: Potential basis for zoonosis. *Tuberculosis (Edinb)*. 2005;85(5–6):421–428.

57. Mikota S, Sargent EL, Ranglack GS. Medical management of the elephant. *Tuberculosis and Tuberculin Testing*. 1994:33–39.

58. Saunders G. Pulmonary Mycobacterium tuberculosis infection in a circus elephant. *J Am Vet Med Assoc*. 1983;183(11):1311–2.