Overview of Zoonotic Diseases in Turkey: The One Health Concept and Future Threats -2

Leprosy is a serious human disease caused by Mycobacterium leprae. The transmission of the disease from an infected person to others is possible by close contact. However, the transmission of animal leprosy to man may be possible with armadillos that are the only other known natural hosts of the pathogen organism. The disease was a serious health problem almost 60 years ago in Turkey (151), but no leprosy case is seen in the country today. The disease was eradicated with systemic surveillance and treatment, intensive control measures, improvement in general health conditions, and with good coordination of health institutions in Turkey (152). Leptospirosis is a zoonotic disease caused by Leptospira interrogans and occurs worldwide. The infection predominantly affects some professionals who are in close contact with infected animals or their urine. The incidence of leptospirosis was found to be relatively high in humans (153) as well in animals (154, 155) in Turkey. Listeriosis is a sporadic bacterial zoonotic infection caused by Listeria monocytogenes and affects a wide range of animals, including man and birds. Encephalitis or meningencephalitis in adult ruminants is the most commonly recognized clinical form of the disease. The disease is primarily a winter-spring infection of feedlot or housed ruminants. Grazing animals ingest the organism and animal-to-animal transmission occurs via the fecaloral route. The transmission of listeriosis to man is possible by close contact or through handling of aborted material; nosocomial infection is also seen in hospitals. L. monocytogenes is an important cause of severe infection in patients with impaired cell-mediated immunity, neonates, pregnant women, the elderly, and transplant recipients. Human infection is generally observed as a food-borne disease. Various clinical forms, such as central nervous system infection, sepsis, endocarditis, gastroenteritis, and rarely other clinical forms, were reported in humans in Turkey (156). Several serosurveys indicate that seroprevalance of L. monocytogenes was relatively high in healthy animals and reported as 44.9% in cattle (157), 25.8% in sheep (158), 40.29% in horses (159), and 22.3% in dogs (160) in different regions of Turkey. Meanwhile, it was declared that the prevalence of L. monocytogenes was 42.2% in slaughterhouse workers in Ankara (161). Mycobacteriosis is a chronic or acute, systemic, granulomatous disease that occurs in aquarium and culture fish. Several species of Mycobacterium cause the infection. The two most important species in fish and humans are Mycobacterium marinum and M. fortuitum. The source of M. marinum infection is contaminated water. In the past, human outbreaks of M. marinum were sporadic and most commonly associated with swimming in contaminated pools. In humans, breaks in the skin serve as an entry point for the organism during contact with contaminated water sources or infected fish. In fish, transmission can occur by consumption of contaminated feed, cannibalism of infected fish or aquatic detritus, or by entry via injuries, skin abrasions, or external parasites. In Turkey, Mycobacterium spp. were detected in fish samples in the Mersin province (162). In contrast, avian mycobacteriosis is also an important disease that has been reported widely in pet birds, captive wild birds, as well as poultry and occurs worldwide (163). Recently, a case of avian mycobacteriosis was detected in a wild bird (Buteo rufinus) in the Kars province in Turkey (164). Pasteurellosis is an important zoonotic disease caused by Pasteurella species, which are highly prevalent among animal populations where they are often found as part of the normal microbiota of the oral, nasopharyngeal, and upper respiratory tracts. Many Pasteurella species are opportunistic pathogens that can cause endemic disease and are associated increasingly with epizootic outbreaks. Zoonotic transmission to humans usually occurs through animal bites or contact with nasal secretions, with P. multocida being the most prevalent isolate observed in human infections (165). In Turkey, bovine pasteurellosis is one of the prevalent infections and leads to important economic losses (166). Meanwhile, cellulitis due to Pasteurella multocida in a 5-year-old girl bitten by a dog (167) and acute osteomyelitis due to P. multocida in a 70year-old diabetic man bitten by a cat have been reported (168). Psittacosis is a zoonotic infectious disease of birds caused by Chlamydophila psittaci. The disease is also known as parrot fever or avian chlamydiosis. C. psittaci can be transmitted among birds by inhalation of infectious dust or airborne particles, such as feathers, and by ingestion of infectious material including carcasses. Humans usually get the infection by inhalation of contaminated dust, feathers, or aerosolized secretions and excretions. In Turkey, C. psittaci was detected in pet birds (169) and in some waterfowls in different zoos (170), while there is no official report on human chlamydiosis. Salmonellosis is a widespread food-borne contagious zoonotic infection both humans and animals worldwide caused by Salmonella enterica subspecies enterica serovar Typhimurium. Domestic animals and wild animals may serve as carriers in the epidemiology of the disease. The disease is typically transmitted to humans by consumption of Salmonella-contaminated food, with eggs being the most blamed food (171). In Turkey, few studies have been performed on salmonellosis in dogs (172) and in poultry (173). Recently, different Salmonello serotyps were detected in turkey ground meat and meat parts, and S. corvallis was shown to be the predominant serotype in poultry meat in Turkey (174). Although salmonellosis is considered a threat for public health, limited reports on confirmed cases of human salmonellosis were documented in Turkey. In a study that was conducted to investigate surveillance of enteric pathogens of public health importance, a total of 177 Salmonella strains were isolated from different patients during the period between 2008 and 2011 in Ankara. Salmonella Enteritidis was found as the most frequent Salmonella serovar. Its prevalence was detected as 61.4% with one Salmonella typhi strain isolated (175). An outbreak of Salmonella Enteritidis due to consumption of contaminated patisserie products was reported in 433 persons in Kadirli county of Osmaniye province located in the Mediterranean region of Turkey in 2014 (176). Streptococci are gram-positive and aerobic bacteria that cause several disorders, including pharyngitis, pneumonia, endocarditis, sepsis, and wound and skin infections. The wound and skin infections are seen in man and animals due to dog and cat bites or rarely wild predatory animal bites or rodent bites as well (177, 178). The numbers of bacterial isolates vary depending on the type of wound, which is commonly mixed as aerobic anaerobic infections (179). Streptococcus species are frequently isolated from dog bite wounds. Streptococcus mitis was found as the most common species among different members of the genus (180). In Turkey, the reports on the cases of wound and skin infections in animals and in man due to dog and cat bites are limited. In a retrospective study, 114 bite wounds were recorded in dogs and cats between 1999 and 2003 at small animal clinics of Veterinary Faculty of the Aydin province in the Aegean region of Turkey (181). Meanwhile, a total of 25,480 dog and cat bite cases were recorded in humans between 2005 and 2009 in Ankara (182). Recently, the number of animal-inflicted human wound cases was reported as 205 between 2013 and 2014 in the Erzurum province in Eastern Anatolia, Turkey (183). Tuberculosis (TB) is one of the most devastating and oldest known zoonotic disease in humans and occurs worldwide. The estimated global annual incidence rate of human TB is almost 128 new cases/100,000 populations (184). Although human TB is caused particularly by Mycobacterium tuberculosis, other major causative agents, such as M. bovis, M. caprae, M. avium, and M. marinum, can also cause human tuberculosis. M. bovis and to a lesser extent M. caprae are the main causative agents of bovine TB. These zoonotic pathogens are transmitted to humans by close contact with infected cattle or consumption of contaminated animal products, such as unpasteurized milk (185). In Turkey, the total number of human TB was reported as 16,551 while the rate of new cases of human TB was shown as 22/100,000 between 2005 and 2010 (186). Meanwhile, the prevalence of tuberculosis in cattle was reported as 0.38%–1.49% in Turkey (124). Vibrio diseases may be mainly classified into two different infections groups: Vibrio cholera (caused by V. cholerae) and noncholera Vibrio (caused by V. parahaemolyticus or V. vulnificus). Most of these Vibrio infections are related to consumption of contaminated food or water and hence these infections are considered as food-borne or water-borne diseases. Poor sanitation and adverse environmental conditions after natural disasters, such as hurricane, earthquake, and tsunami, may also increase the risk of Vibrio infections. Humans can acquire Vibrio infections by ingestion of raw or undercooked shellfish. Vibriosis is also an economically important disease of cultured fishes, such as gilthead sea bream (Sparus aurata). Initial infection is probably water-borne; however, once established in fish, the infection spreads by contact. Some epizoitics can also be seen because of the use of infected marine fish in the feeds of healthy fish. The zoonotic transmission of fish vibriosis is possible by ingestion of infected fish tissues (187). In Turkey, studies on vibriosis are very limited. However, fish vibriosis was diagnosed in cultured gilthead sea bream in the Aegean Sea coast farms of Turkey (188). There is no official report on cases of human vibriosis in Turkey. Yersiniosis is a food-borne zoonotic infection caused mostly by eating raw or undercooked contaminated foods with Yersinia enterocolitica. Y. enterocolitica and other Yersinia species were isolated from ground beef in Aydin (189). In another study that was conducted to investigate the incidence and pathogenicity of Y. enterocolitica in the Northeast Anatolia regions of Turkey (provinces of Kars, Igdir, and Ardahan), a total of 750 food samples, composed of ice cream, raw milk, feta cheese, chicken drumsticks, and minced meat were tested and 57 samples (7.6%) were evaluated positive for Yersinia spp; 18 (2.4%) of these isolated from 6 feta cheese, 4 ice cream, 2 chicken drumsticks, 4 minced meat, and 2 raw milk samples were determined as contaminated with pathogenic Y. enterocolitica (190). However, Y. enterocolitica and Y. pseudotuberculosis strains were isolated from humans in the Van province in East Anatolia, Turkey (191). Actinomycosis is caused by anaerobic Actinomyces species A. israelii and A. bovis. The disease occurs rarely in humans, but frequently in cattle, and the infection is called “lumpy jaw” because of large abscesses seen on the necks of infected cattle. A. israelii and A. bovis are normal commensal species in humans and in cattle, respectively. The infection develops due to a predisposing factor in the buccal cavity, such as dental problem or periodontal disease (192). The rare zoonotic transmission of the disease may be seen by contact with infected animals (193). In Turkey, a total of 167 cattle with actinomycosis were treated at the surgical clinic of Veterinary Faculty between 1957 and 1971 in Ankara (194). However, a total of 50 A. israelii strain were isolated from cervico-vaginal regions of women who were introduced to gynecology clinics of Medicine School between 2002 and 2004 in the Van province in Eastern Anatolia (195). Actinobacillosis is a bacterial zoonotic disease caused mostly by Actinobacillus lignieresii. The most common form of the disease occurs as mouth actinobacillosis in cattle and is called “wooden tongue.” However, the infection affects sheep as well. Actually, the pathogen is considered a microorganism of normal rumen flora of sheep and cattle. The organism enters via damaged tissues in the mouth of ruminants. Cutaneous route was indicated for zoonotic transmission of the infection in humans (36). In Turkey, two cattle with clinical actinobacillosis were treated in Ankara (194), whereas there is no report on actinobacillosis in humans. Arcanobacteriosis is a zoonotic infection characterized with granuloma caused by facultative anaerobic bacteria Arcanobacterium species, A. haemolyticum, and A. pyogenes. The infection can be transmitted by close contact from animal to animal, from animals to humans, or even from human to human (36, 196, 197). A. pyogenes leads summer mastitis in cows with huge economic losses (197) and causes thoracic pyogranuloma formation in dogs (198), while causes endocarditis in man (196). However, the insect transmission of summer mastitis in cows at a cattle herd was successful experimentally via Hydrotaea irritans flies (199). In Turkey, a total of 51 A. pyogenes strains were identified from samples collected from cattle and sheep in the Konya province of Central Anatolia (200). Meanwhile, the prevalence of A. haemolyticum was reported as 2% in children with tonsillophargytis in Istanbul (201). Dermatophilosis is a zoonotic bacterial infection caused by Dermatophilus congolensis. The infection is rare in humans but is frequent in horses, dogs, cats, and ruminants, particularly in cattle infested with ticks. In Turkey, a few cases of dermatophilosis in animals (202) and in humans have been reported (203). Nocardiosis is a bacterial disease in immunocompromized hosts caused by opportunistic species belonging to the Nocardia asteriodes complex. The pathogens can be found in environment, such as soil, decomposing vegetation, and other organic matter as well as in fresh and salt water. People with cancer or people taking steroid treatments are at risk for nocardiosis, and the infection often happens via several ways, such as inhalation (pulmonary nocardiosis), traumatic inoculation (cutaneous nocardiosis), and hospital-acquired (extra pulmonary nocardiosis) (204-206). In Turkey, a solitary case with granulomatous nocardial pleurisy was documented in a dog in Ankara (207). However, a total of 53 cases with mostly pulmonary nocardiosis were reported in humans between 1997 and 2004 (208); recently, a few new cases with clinical nocardiosis were also diagnosed in man in distinct areas of Turkey (209, 210). Fungal Zoonotic Diseases in Turkey Fungal Zoonotic Diseases are significant health problems in man and in animals worldwide. Today, many fungal zoonotic diseases have been described in the world and some of them also occur in Turkey (Table 1). Aspergillosis is a respiratory and non-contagious fungal infection caused by opportunistic Aspergillus species and occurs relatively rarely in humans, while it is a common and dangerous disease for birds. Although A. fumigatus is most common in humans, other common species, including A. flavus and A. niger, also cause problems in humans and in birds (211). Warm and moist environment, poor ventilation and insufficient sanitation, and long-term storage of feed, are predisposing conditions for aspergillosis and can increase the amount of the spores in the air. Spores often become airborne and spread to the environment by wind and can enter into the respiratory system by inhalation (212). In Turkey, aspergillosis has been detected predominantly in the homes of asthmatic patients (213, 214). Meanwhile, it was reported that aspergillosis is a prevalent fungi infection in pigeon herds, birds of zoo, geese, dogs, and horses (215). Blastomycosis is a zoonotic fungal infection caused by Blastomyces dermatitis, and the disease occurs in several endemic geographical areas, such as North America. The fungus mainly thrives in moist soil and decomposed matters, such as wood and leaves. The infection is transmitted to humans and animals by inhalation the fungal spores via the airway from the environment or by contact with contaminated soils. In Turkey, a case of blastomycosis in a 47year-old female was reported (216). Candidiasis is a zoonotic infection caused by particularly Candida albicans. Humans mainly serve as reservoirs, while animals only occasionally. Candida is present in the normal flora of humans and animals present on the skin, intestinal tract, and genital area of women; they generally do not cause any problems. However, the fungi sometimes lead to infections on the skin and in the mucous membrane of the mouth and the vagina. The transmission of disease is possibly via direct contact. In Turkey, Candida albicans was isolated from the fecal samples of cage birds in Istanbul (217). In contrast, different Candida species were isolated from the oral cavity of 65 of 125 healthy people between the ages 17 and 67 years in Istanbul, and the prevalence of C. albicans was found as 48% (218). Coccidioidomycosis is a fungal infection caused by Coccidioides immitis and C. posadasii. The disease occurs in non-human mammals, such as cattle, cats, horses, dogs, and wildlife and is transmitted through environmental exposure. The causative pathogens of the disease are found particularly in warm, arid, and desert areas of the Western Hemisphere. The zoonotic transmission of the infection to humans has not been reported yet. However, any person who resides in or travels to the endemic area can become infected with Coccidioides spp. after inhalation of airborne arthroconidia (219). Recently, an imported coccidioidomycosis case has been detected in a 41-year-old other wise healthy Turkish man who visited Texas area in the USA and returned to Turkey (220). Cryptococcosis is a zoonotic and serious fungal disease worldwide caused by opportunistic Cryptococcus neoformans. The disease is considered to be acquired by inhalation of the infectious propagule from the environment in endemic areas and occurs in three forms in humans, such as cutaneous, pulmonary, and meningitis. Its prevalence has been increasing over the past 20 years for many reasons parallel to the increase in the incidence of acquired immunodeficiency syndrome (AIDS) and the expanded use of immunosuppressive drugs. The infection is also common in livestock animals, dogs, cats, birds, and wild life. Soil, fowl manure, and particularly dropping and nest of pigeons could be sources for disease. In Turkey, it was reported that the prevalence of C. neoformans varies between 1% and 35% in natural sources, and most of the human cases were clinically characterized with meningitis (221). Histoplasmosis is a zoonotic fungal infection caused by Histoplasma capsulatum, and occurs worldwide in different forms, such as pulmonary and systemic infections in humans. The pathogen lives in the environment, mainly in the contaminated soil with fowl manure in the bat caves. Birds are not susceptible to the disease, but the pathogen causes infection in various animals, such as dogs, cats, farm animals, and other wild mammals besides humans. The causative agent is transmitted to the host by the inhalation of the spores (222). It was asserted that Turkey may be an endemic area for histoplasmosis by some earlier reports (223). Recently, a case report has been documented on histoplasmosis in humans (224). Dermatophytosis is a widespread fungal infection of the skin caused by three types of fungi called trichophyton, microsporum, and epidermophyton, which infect both humans and animals. The infection on the skin clinically reflects typical enlarging raised rings called “ringworm.” The spores of these fungi may survive for a long term in the soil. Humans and animals can acquire the infection by direct contact with contaminated soil, and the disease can also spread via contact with infected hosts. In an investigation conducted to determine the prevalence of dermatophytosis in the introduced patients in the dermatology clinic of Medical School in Elazig province in Eastern Anatolia, several fungi were isolated from 142 of 651 samples (21.8%). The prevalence of Trichophyton rubrum, T. mentagrophytes, T. violaceum, T. tonsurans, Epidermophyton floccosum, and Microsporum canis in the isolates were diagnosed as 70.4%, 15.4%, 2.11%, 0.7%, 2.8%, and 4.2%, respectively (225). However, the prevalence of dermatophytosis in cattle, sheep, goats, and cat displayed in the Van province in the same region of Turkey were 33.3%, 18.1%, 33.3%, and 47.1%, respectively (226). Sporotrichosis is an infection caused by the saprophytic fungus Sporothrix schenckii worldwide. It is characterized by skin, lung, and circulate types. The pathogen is present in the soil and on various plant matters, such as sphagnum moss, rose bushes, and hay. Humans can acquire the infection by contact with the spores of the fungus in the contaminated environment. The skin form of the disease is the most common and sometimes has been associated with cat scratches. Skin sporotrichosis is frequently seen in cats and horses, and infected cats can also play a role in zoonotic transmission of the infection. Hence, the disease is a major and close hazard for veterinarians. In Turkey, sporotrichosis is rare (227), but a few cases have been reported. A case of subcutaneous sporotrichosis was reported from a 48-year-old man in Kayseri in Central Anatolia (228). Sporothrix schenckii was isolated from a patient with nodular lymphangitic cutaneous sporotrichosis in the Edirne province of the Thrace region (227). Penicilliosis is an emerging fungal zoonotic disease caused by Penicillium marneffei. P. marneffei has an enigmatic epidemiology, and more investigations are needed to understand its zoonotic or sapronotic transmission. This opportunistic fungus is generally seen in immunocompromized individuals, particularly in human immunodeficiency virus positives (229). The pathogen lives in the soil as its natural habitat and endemically occurs in south Asian countries. Bamboo rats and dogs can serve as reservoirs for the pathogen in endemic areas; important points about the zoonotic nature of its transmission is remains unknown (230). Penicillium spp was found as predominant allergen (46%) in a study that was carried out to investigate fungus species at atmospheric air of elementary schools in the Denizli province of the Aegean region, Turkey (231). Malassezia infection or Pityriasis is a fungal infection caused by Malassezia pachydermatis. The infection affects both humans and animals. Malassezia species can be involved in skin disorders, such as pityriasis versicolor, seborrheic dermatitis, atopic eczema, and folliculitis and occur at higher population densities on scalps with dandruff than on scalps without dandruff. The zoonotic transmission of pityriasis is possible mechanically through hands (232). Patients under total parenteral nutrition and immunocompromized patients with an increased length of stay in intensive care units are at risk for Malassezia infections. Dogs and cats become infected with M. pachydermatis that are normally present on their skin and in the ear canal (233). In Turkey, a limited number of studies on pityriasis have been performed to date (234-236). Adiaspiromycosis is a rare chronic pulmonary disease caused by Emmonsia crescens, Emm. Parva, and Emm. pasteuriana and effects both humans and animals. The disease is mainly characterized by the presence of large adiaspores in the lungs of infected humans and animals. Among the etiologic agents, Emm. crescens is prevalent in continental Europe and England, whereas E. parva occurs in Asian, African, and American continents. Emmonsia species are environmental pathogens and their transmission to the host is possible by inhalation of their spores (230). In Turkey, some adiaspiromycosis cases were reported from several small wild mammals (237). Pneumocystosis is a fungal disease caused by Pneumocystis jirovecii (previously known as Pneumocystis carinii) that primarily leads to pulmonary infection in AIDS or in immunocompromized patients (238, 239). The airborne transmission of Pneumocystis sp. from host-to-host has been demonstrated in rodent models (240). In Turkey, pneumocystis pneumonia due to P. carinii in AIDS patients was reported in 1990s (241, 242). The prevalence of P. jirovecii was also displayed as 54% in the respiratory samples introduced to the parasitology laboratory between 2003 and 2011 in the Samsun province of the Black Sea region (243). Microsporidiosis is an opportunistic fungi infection of humans. The infection is caused by several microsporidian species, such as Encephalitozoon cuniculi, Enc. intestinalis, Enc. Hellem, and Enterocytozoon bieneusi. The infection occurs in immune-deficient individuals with persistent diarrhea. Microsporidial species also infect a wide range of animals, including birds, raising the concern for zoonotic transmission. Microsporidian spores are relatively resistant to harsh environmental conditions and exist in water sources. Humans and animals get the infection by ingestion or inhalation of the spores (244). A study in Turkey, which was conducted to investigate the prevalence of Enc. intestinalis and Ent. bieneusi in cancer patients under chemotherapy at the Erciyes University Hospital in Kayseri showed that 65 of 93 patients (69.9%) with cancer were found positive; 43 (46.2%) of the positive samples were identified as Enc. intestinalis, while the 9 were determined as (9.7%) Ent. Bieneusi, and the other 13 (14%) were diagnosed as mixed infections (245). However, a study was performed to investigate the molecular epidemiology of microsporidian infections in dogs around Kayseri in the Cappadocia region, and 41 of 282 stool samples (14.5%) were found positive for microsporidiosis; 35 of 41 positive samples (85.3%) were identified as Enc. intestinalis, while the reaming 6 (14.6%) were detected as Enc. cuniculi. In the same study, three haplotypes that showed 99.4% identity to each other were characterized within the Enc. intestinalis isolates. However, only one haplotype was displayed in the sequences of Enc. cuniculi isolates and this haplotype was described as Enc. cuniculi Genotyp III (dog genotype), and no polymorphic region was found in the sequences of the Enc. cuniculi isolates (246). Furthermore, Enc. cuniculi and Ent. bieneusi were molecularly detected from household cats in the Samsun province of the Black Sea region (247).