

Review

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Zoonotic Bacteria Associated with Cats

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Background: There are several bacterial pathogens, including *Bartonella*, and *Pasteurella* that have been known to cause human infections from contact with cats. Recently, certain bacteria have emerged as causes of infection in cats, resulting in transmission to humans.

Objectives: This review presents updated information on the zoonotic bacterial pathogens associated with cats, with special emphasis on recent reports.

Results: Presently, an increase in the incidence of cat-associated *Yersinia pestis* human infections in the western USA has become a concern. In addition, infections due to *Mycobacterium bovis*, and *Brucella abortus*, are being recognized. Also, a number of human infections due to *Campylobacter*, *Helicobacter*, and *Salmonella* from cats have been documented worldwide. In addition, spread of bacteria resistant to antimicrobial drugs from cats is becoming a possibility.

Conclusion: Updated information shows that more zoonotic bacteria than previously recognized are associated with cats worldwide. Immunocompromised persons and young children are particularly at a risk of developing infection from household cats which are allowed to roam around outdoors. It is important to incorporate environmental and animal contact considerations into patient care. With proper handling and precautions, cats can help establish valuable human-animal bonds.

KEY WORDS: Cats; Bacteria, Zoonoses.

ABBREVIATIONS: CSD: Cat-scratch disease; PCR: Polymerase Chain Reaction; rRNA ribosomal Ribonucleic Acid; MRSA: Methicillin-Resistant *S. aureus*.

INTRODUCTION

Cats are quite adaptable pets, and interact closely with their owners. In the United States (US), 75% of cats sleep with humans.¹ Presently, there are 95.6 million household cats in the US.² The world population of cats is increasing and so is the emergence of zoonoses.³ Although, owning pets may pose risks to children and immunocompromised patients, pet ownership has been associated with both emotional and physical health benefits. With proper handling and husbandry, pets, including cats can help establish valuable human-animal bonds.⁴ However, awareness about potential risk may help reduce or prevent human infections. Also, one health, an emerging concept provides practical ways to incorporate environmental and animal contact considerations into patient care.⁵ A literature review shows that more zoonotic bacteria than have been previously recognized are associated with cats worldwide. This review briefly deals with the importance of these bacteria. The aspects of diagnosis and treatment of infections caused by these zoonotic bacteria are largely excluded from the study.

GRAM-NEGATIVE BACTERIA***Bartonella* spp.**

Bartonella henselae, one of the 11 species of *Bartonella* is pathogenic to humans, being the main causative agent of cat-scratch disease (CSD). Domestic cats, especially strays with flea in-

festation may harbor this bacterium, and generally show little or no pathology on cats themselves.^{6,7} The main source of infection to humans appears to be flea feces on cat claws.⁶ Clinical signs of CSD in humans can range from asymptomatic conditions to lymphadenopathy, proximal to the site of a cat scratch or bite to serious manifestations such as bacillary angiomatosis, hepatic peliosis, eye disorders, osteomyelitis, encephalitis, endocarditis, and other complications, particularly in patients with immunocompromising conditions such as AIDS.⁸ Although, most of the clinically reported cases do not need to be treated with antibiotics, the use of azithromycin has been shown to speed up recovery for those affected by CSD.^{8,9} Pradofloxacin, an extended spectrum fluoroquinolone may be useful for the treatment of infected cats.¹⁰ It may be possible to eliminate chronic infection in cats, but to date an optimal protocol has not been established.¹¹

***Pasteurella* spp.**

Healthy cats have a carriage rate of 70% to 90% for *Pasteurella multocida* in their oropharynx.¹² This organism can cause opportunistic infections in cats, including pneumonia, conjunctivitis, rhinitis, gingivostomatitis, abscess and osteonecrosis.^{13,14} Cat bites and scratches can result in *Pasteurella* infections in humans. *Pasteurella* species are isolated from over 75% of the cat bites. Wilson and Ho¹⁵ and Giordano et al¹² reviewed the clinical features and outcomes of *Pasteurella multocida* infection in humans. A wide spectrum of diseases from local infections to septic shock can result from *Pasteurella* infections. *Pasteurella multocida* bacteremia and septic shock in human patients following cat bite or scratch have been recently reported in the literature.^{16,17} Elderly patients with diabetes mellitus, hypertension, acquired immunodeficiency syndrome, malignancies and cirrhosis are the most vulnerable towards the development of such infections. Hey et al¹⁸ reported a case of a 47-year-old man with cirrhosis who developed a life-threatening spontaneous peritonitis and bacteremia due to *Pasteurella multocida* following the lick from a cat on a cellulitic wound.

Bordetella Bronchiseptica

B. bronchiseptica is a well recognized primary cause of infectious feline upper respiratory disease in kittens.¹⁹ Several cases of human infection due to *Bordetella bronchiseptica*, from exposure to cats have been documented in the last few years.²⁰⁻²² Mostly, immunocompromised individuals are affected; however, illness due to this organism can also occur in healthy adults and children. Normal children exposed to pets like dogs and cats usually get “pertussis-like” illness with paroxysmal cough.²³ The most common infection in humans is the respiratory form with severe pneumonia, but invasive fatal infections have also been reported, and the source is not always identified.²³⁻²⁵

***Brucella* spp.**

Recently, it has been confirmed that cats can develop active infections due to *Brucella abortus* from cattle. Consequently, close contact with infected cats is a risk factor for humans.²⁶ Ear-

lier, a case of human infection with brucellosis from a cat was reported,²⁷ and *Brucella* organisms were cultured from the cats in both instances. In another study, a cat from a farm area tested positive for *Brucella* spp. by polymerase chain reaction (PCR).²⁸

Yersinia Pestis

Plague, a well-known disease of ancient times, caused by *Yersinia pestis* is currently endemic in wild rodents in some parts of the US. Cats may acquire infection from rodents directly or via infected fleas. Cat-associated human plague cases, including fatalities, have been reported in the western United States since 1977. Handling infected cats could result in bubonic plague, primary pneumonic plague or primary septicemic plague.^{29,30} The risk of cat-associated human plague is likely to increase as residential development continues in areas where the plague foci exist.²⁹ For prevention, controlling pet roaming, and implementing a flea control program are some of the important steps.³⁰

***Campylobacter* spp.**

Campylobacter jejuni enteritis can be transmitted from cats to humans.^{31,32} *Campylobacter jejuni* has been observed in 1% of the cats with diarrhea and without diarrhea in a study conducted in the US.³³ In a study in Poland, up to 10% of the cats tested positive for *Campylobacter* spp. in the rectal swabs, with the predominance of *C. jejuni*.³⁴ In Norway, 18% of the healthy cats tested positive for *Campylobacter* spp., compared to 16% of the cats with diarrhea. However, only 3% of the cats tested positive for *C. jejuni*. The remaining isolates were those of *C. upsaliensis* and *C. coli*, both being less common human pathogens.³⁵ *Campylobacter coli* may be associated with neutrophilic inflammatory bowel disease in cats, posing a zoonotic risk.³⁶ Clinical signs such as diarrhea are not reliable predictors of whether a cat is actively shedding enteric organisms. For newly adopted pet cats, potential risks to the client should be considered.³⁷ Seventeen percent of the rectal swabs from stray cats in southern Italy were positive for *C. jejuni*, and cats aged up to 1 year are more likely to be carriers.³⁸ In Denmark, 33% of the cats living with human patients infected with *C. jejuni*, were found to carry these organisms.³⁹ Household cats in Ireland have also been found to shed *Campylobacter* spp., including *C. jejuni*.⁴⁰ In a recent study in Italy, rectal swabs of 15% of the cats tested positive for *Campylobacter* spp., and more than half the isolates were those of *C. jejuni*. The authors⁴¹ concluded that the household cats in Northern Italy might pose a zoonotic risk for humans.

***Helicobacter* spp.**

Domestic cats can occasionally be infected with *H. pylori*, the *Helicobacter* species which has been directly linked with active chronic gastritis, peptic ulceration, and gastric adenocarcinoma in humans.⁴²⁻⁴⁴ The frequency of *Helicobacter heilmannii* infection in cats can be as high as 80 to 100%, and its transmission from a household cat to a child has been documented.⁴⁵ *Helicobacter* spp. have been identified in the oral secretions of cats.⁴⁶ There are several non-*Helicobacter pylori* species, including

“*Helicobacter heilmannii*-like” organisms found in the stomachs of cats and dogs, and these have been detected in human patients.⁴⁷

Salmonella spp.

It has been shown that a small percentage of healthy pet cats can excrete *Salmonella* in their feces, and can pose a public health hazard to children and immunocompromised persons. Studies in Germany and USA have shown that 1 to 2% of the cats may have *Salmonella* in their fecal samples.^{33,48} A wide range of serovars, including *S. Typhimurium* is found in cats.⁴⁹ Van Immerseel et al⁵⁰ examined the excretion of *Salmonella* by pet cats and found that some of the excreted serotypes including Typhimurium were resistant to many important antimicrobial drugs. Carbapenem-resistant - *Salmonella* was recently isolated from 3 cats at an animal shelter in Australia, which is of great public health significance due to limited therapeutic options to treat infections caused by these strains.⁵¹ Recent research indicates that pet cats can serve as potential sources of *Salmonella* carrying various antimicrobial resistance genes and virulence genes.⁵²

Capnocytophaga Canimorsus

This bacterium is a commensal in the mouths of dogs and cats, and it can cause serious human infections by dog or cat bites, scratches, and licks, especially in immunocompromised and alcoholic patients.^{53,54} In a study conducted in Japan, using a species-specific PCR, which is more sensitive than culture methods, *C. canimorsus* was detected in 74% of the dogs and 57% of the cats studied.⁵⁵ PCR and 16S ribosomal ribonucleic acid (rRNA) sequencing can help correctly identify *C. canimorsus*, and to differentiate it from *C. cynodegmi*, which is less pathogenic.^{54,56} Most of the human infections occur from dogs; however, serious disease requiring emergency care and prolonged hospitalization following a cat scratch in a 49-year-old alcoholic has been reported. Ampicillin/sulbactam was administered intravenously for 13 days, which eventually helped in recovery.⁵⁷

MULTIDRUG-RESISTANT ESCHERICHIA COLI AND OTHER COMMENSAL BACTERIA

Escherichia coli from cats may play an important role in the dissemination of antimicrobial resistance, particularly to human hosts during contact. A recent study in the US detected antimicrobial resistance genes, class 1 integrons and transferable plasmid replicons in *E. coli* from healthy companion animals including cats.⁵⁸ Epidemic clones of extended-spectrum β -lactamase-producing *E. coli* have been recently reported to be present in cats in a study conducted in Japan.⁵⁹

GRAM-POSITIVE BACTERIA

***Mycobacterium* spp.**

Pesciaroli et al⁶⁰ reviewed tuberculosis in domestic animals,

including cats. In the United Kingdom, of 339 recent cases of mycobacterial disease in cats, 15% tested positive for *Mycobacterium bovis* infection by culture.⁶¹ Clinically significant mycobacterial infections occur commonly in cats in Great Britain.⁶² Although, cases of cat-to-human transmission have been reported, cats are considered to pose minimum risks of tuberculosis infection in humans.⁶⁰ Wildlife reservoirs such as badgers were probably involved in a cluster of cases of *M. bovis* infection diagnosed in cats in UK.⁶³ It may be noted that nosocomial cases of tuberculosis can occur, with the transmission of *M. bovis* infection occurring between cats due to contamination within the veterinary practice.⁶⁴ Recently, pulmonary tuberculosis due to *M. bovis* in two cats and their owner in the same household in Texas was reported. The owner had moved to USA from a country where bovine tuberculosis is considered endemic.⁶⁵

Streptococcus Canis

Streptococcus canis, a member of Lancefield group G is a zoonotic pathogen of increasing importance.⁶⁶⁻⁶⁸ In a study on feral cats in Grenada by Hariharan et al⁶⁹, *S. canis* was isolated from the rectum, vagina or wounds. A recent study in Germany showed that colonization by *S. canis* is not uncommon in pet cats, and 83% of the feline isolates harbor a novel *S. canis* M-like protein (SCM) that binds to human plasminogen and facilitates bacterial transmigration through fibrin thrombi.⁷⁰ Up to 47% of the group G streptococci from cats have been known to be capable of growing in human blood.⁷¹ Group G streptococci found in many cats could be pathogenic to humans, since their physiological and biological characteristics are very similar to those of group A streptococci.⁷²

Methicillin-Resistant *Staphylococcus Aureus*

Pet cats may play a role in household - *S. aureus* transmission and recurrent infection in humans due to methicillin-resistant *S. aureus* (MRSA).^{73,74} Recent studies in the US and Switzerland show that the presence of human MRSA clones in pet cats and dogs is of public health concern.^{75,76} A German study showed carriage of an MRSA variant in several cats. This variant is not detectable by routine PCR used to confirm methicillin resistance.⁷⁷ A latest study showed that the oral cavity of domestic cats may harbor a wide variety of *Staphylococcus* species with zoonotic potential, including multi-drug resistant strains containing plasmids.⁷⁸

UNCOMMON BACTERIAL PATHOGENS

Certain bacteria from cats can cause human disease occasionally. *Anaerobiospirillum succiniproducens*, a Gram-negative, anaerobic, spiral-shaped rod, found in the throats and feces of healthy cats is a rare cause of a potentially zoonotic invasive disease, including bacteremia in immunocompromised people.^{79,80}

Tularemia, a zoonotic disease caused by the Gram-negative bacterium, *Francisella tularensis* can be contracted from

cats. Recently a human case of cat-bite- induced tularemia was documented in Sweden. Cat-associated tularemia is uncommon, but has been reported previously in Sweden and other countries.⁸¹

Rickettsia felis, an obligate intracellular Gram-negative bacterium is globally distributed, and primarily associated with the cat flea *Ctenocephalides felis*. Although no clinical case has been reported in cats, its pathogenic role in humans has been demonstrated through molecular and serological tests. The disease in humans presents as a flu-like acute febrile syndrome. Flea-borne spotted fever caused by *R. felis* is an emerging rickettsiosis of medical importance, and deserves more attention.^{82,83}

Cats can get infected with *Coxiella burnetii*, the cause of Q fever, a worldwide zoonosis, by ingestion of carcasses of farm animals or by tick bite.⁸⁴ In a recent study in Australia, 9.3 % of 712 breeding cats were serologically positive for this bacterium.⁸⁵ A study in Brazil indicated the possibility of *C. burnetii* as a cause of culture-negative endocarditis in human patients.⁸⁶ Veterinary personnel attending parturient or aborting cats may be at higher risk of exposure to *C. burnetii*.⁸⁴

Lastly, *Erysipelothrix rhusiopathiae*, a Gram-positive bacterium, commonly associated with pigs, was isolated from a cat, with clinical manifestation and depression. Natural infection in a cat indicated the possible epidemiological significance and implication as a potential source of infection to other animals and humans.⁸⁷ Cat bite has caused human infection due to this bacterium.⁸⁸

CONCLUSIONS

A number of bacterial species have been identified to cause zoonotic infections from cats to humans. Certain bacteria such as *Mycobacterium bovis* have recently emerged as a potential cause of infection in cats, resulting in transmission to humans. In countries or areas where *Brucella abortus* is endemic in cattle, cats can acquire infections and pass on to humans. Disease trends show that cat-associated plague may increase due to residential development in areas where the plague foci exists. Household cats can shed enteropathogens, including *Campylobacter jejuni*. Also, the spread of bacteria resistant to antimicrobial drugs may occur *via* cats. Practice of proper hygiene such as hand washing is important to reduce the risk of acquiring infections. Immunocompromised persons need to take special precautions. A health provider should be consulted soon after getting bitten or scratched by a cat.

CONFLICTS OF INTEREST

The authors declare that there is no conflict of interest.

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