Occurrence and Impact of Zoonoses in Pet Dogs and Cats At US Air Force Bases

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Abstract: A descriptive epidemiologic study was conducted to quantitate the occurrence of zoonoses in pet animals (almost exclusively dogs and cats) at 30 Air Force bases in nine regions of the United States during 1980 and 1981. Reviews of reported cases of pet-associated zoonoses in humans at these bases were included. Occurrence of a zoonotic disease in dogs and cats was expressed as a ratio of reported cases per 100 rabies vaccinations (cs/Crv). Overall, the four zoonoses reported most frequently from these pets were hookworms, roundworms, tapeworms, and fleas. Annual ratios revealed geographic variations: for example, hookworms in dogs and cats in the southeast ranged from 12.3 to 9.4 cs/Crv; in the northern Great Plains, hookworms ranged from 0.9 to 0.4 cs/Crv. Dermatomycoses in the southeast ranged from 1.3 to 1.1 cs/Crv, and in Alaska from 0.3 to 0.2 cs/Crv. Quarterly zoonoses occurrence revealed seasonal variations in several regions. Reports of zoonoses in people from these bases indicated that five less frequent zoonoses in dogs and cats (*Microsporum canis* dermatomycosis, fleas, *Sarcoptes scabiei* var *canis*, Gram-positive bacterial infections, and rabies) presented greater acute threats to humans than did the four most frequent zoonoses reported from their pets. (*Am J Public Health* 1984; 74:1239–1243.)

Introduction

Both lay and medical publications have devoted considerable attention during the past five or six years to the zoonoses,* especially as human pediatric problems.[1–4] Characteristics of some zoonoses can present unique diagnostic challenges to practitioners.[5] Few zoonoses have pathognomonic signs; many of them mimic more common diseases. Occupational, recreational, vector, or foodborne exposures may not enter medical histories. If a zoonotic disease is suspected in a human, consultation between the attending physician and a veterinarian may establish the correct diagnosis, and both practitioners can gain valuable information.[5]

The medical literature lists between 150 and 200 zoonotic agents, and the number increases as research continues.[6–9] Transmission patterns can affect both hospital precautions and community preventive measures, especially in military deployment environments. The value of a patient history increases with knowledge of agent transmission: direct or indirect contact, intermediate host, invertebrate vector, or environmental reservoir.[6]

Two frequent questions concern the occurrence of such diseases: 1) How common is a particular zoonosis in animals?; and 2) What are the most frequent animal zoonoses in a given area? Nevertheless, little information is available on the relative frequency of several zoonotic diseases in pet animal populations. This study estimated nationwide and regional occurrence of zoonoses in dogs and cats diagnosed at Air Force veterinary clinics in the United States. Abstracts of some human cases were used to highlight epidemiological aspects and local impact.

Reporting Zoonoses in the Air Force

Base veterinary services are required to report numbers of animal zoonotic diagnoses and any known cases of human involvement to command environmental health officers. Animal-associated human zoonoses are cases identified by health care providers and found to be temporally or spatially associated with an animal case. This is a "passive" system (reporting what is diagnosed in the clinic) as opposed to an "active" system of disease survey. Obviously, some data from such a passive system are biased.[10] Diagnoses are not always reported by species. Accurate pet animal census data are lacking, and comparisons based on diagnoses alone are often meaningless.

Materials and Methods

Veterinary officers or non-commissioned officers-in-charge at 34 bases were asked to supply data for this study. Two bases did not reply, and two bases supplied incomplete data. This was a convenience sample.

Twenty bases provided data for both 1980 and 1981; three provided data for 1980 only; and seven for 1981 only. Data from each base were consolidated into quarterly summaries, and dog and cat zoonotic diagnoses were placed in one of 14 agent categories. The 14 categories corresponding most closely to individual base reports were roundworms, hookworms, heartworms, tapeworms, fleas, ticks, sarcoptic mites, protozoa, dermatophytes, deep systemic fungi, yeasts, Gram-positive bacteria, Gram-negative bacteria, and viruses. A few diagnoses were not specific (e.g., bacterial dermatitis) or did not match a category (e.g., chlamydial conjunctivitis). Such reports were few and were not included in this study.

The number of rabies vaccinations was selected as the denominator for calculation of these zoonosis ratios. Dog and cat rabies vaccinations are required by military regulation and usually by local civilian law. Pet birds, rabbits, and rodents are not vaccinated against rabies. Normally, dogs and cats do not receive more than one rabies vaccination annually. Therefore, the number of rabies vaccinations was the best available "count" of the pet population served and the only comparable statistic reported by all base veterinary services. Eighty-seven per cent of the Air Force pet owners have at least one dog, and 76–81 per cent of these animals have current rabies vaccinations.**

*Infestations and infections transmitted between lower vertebrates and humans.

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**Warner RD: Mather AFB pet ownership survey. Unpublished data, 1980.

TABLE 1—Zoonoses Reported Most Frequently from Pet Dogs and Cats at 30 Air Force Bases in the US: 1980 and 1981 (Cases per 100 Rabies Vaccinations)*

Zoonoses	1980 (23 bases)	1981 (27 bases)
Hookworms	4.5	6.2
Roundworms	4.7	5.3
Tapeworms	3.3	5.4
Fleas	1.1	5.7
Dermatophytes	0.8	0.8
Ticks	0.7	0.7
Heartworms	0.5	0.5
Gram-positive bacteria	0.4	1.1
Scabies	0.3	0.2
Gram-negative bacteria	0.3	0.5

*Mean number of rabies vaccinations per base: 1,398 (in 1980) and 1,435 (1981).

For this study, bases were grouped into nine state and regional areas to eliminate single-base bias and to compare geographic differences. Occurrence of each zoonotic disease (agent category) was calculated as the annual nationwide and regional number of reported cases per 100 rabies vaccinations (cs/Crv)*** and quarterly cs/Crv for each region during 1980 and 1981. Mean quarterly ratios were used to construct listings of the five most frequent zoonoses in pet dogs and cats for each calendar quarter in nine regions of the United States during 1980 and 1981.

Results

Although their relative rankings changed slightly from 1980 to 1981, the four most frequent zoonoses in dogs and cats (Air Force mean) were hookworms, roundworms, tapeworms, and fleas. Hookworms were the second most frequently reported (4.5 cs/Crv) zoonoses in pets during 1980 and became the most frequent (6.2 cs/Crv) in 1981. The fifth through the tenth most frequently reported zoonoses were dermatomycoses, ticks, heartworms, Gram-positive bacteria, scabies, and Gram-negative bacteria (Table 1).

Annual pet dog and cat zoonoses ratios varied considerably from region to region. The occurrence of hookworms ranged from 12.3 cs/Crv in the southeast to 0.5 cs/Crv in California; roundworms from 11.6 cs/Crv in Illinois to 1.1 cs/Crv in Arizona; tapeworms from 11.9 cs/Crv in California to 0.5 cs/Crv in Alaska; dog and cat dermatomycoses from 1.4 cs/Crv in Illinois to 0.2 cs/Crv in Alaska.

Quarterly (seasonal) variations were also noted (Table 2). Data from Texas and the southeast reflect an increase in the occurrence of fleas from January through October. In contrast, bases in Virginia and Maryland reported fleas as the most frequent zoonoses in dogs and cats every quarter. In Alaska, roundworms were the most frequent and hookworms were the second most frequent pet animal zoonoses reported each quarter. New England experienced the least variation in relative seasonal occurrence of zoonoses in pet dogs and cats.†

***Computer programs derived from those discussed in Statistical Package for the Social Sciences, 2d Ed, Nie NH, Hull CH, Jenkins JG, et al. New York: McGraw-Hill, 1975.

†Details of annual regional zoonoses ratios (cs/Crv) available on request to author.

Dog or Cat Associated Zoonoses in Humans

Table 3 displays the reported dog and cat associated zoonoses in humans at bases which supplied full data for both 1980 and 1981. Although hookworms and roundworms were the most frequent pet animal zoonoses in these 1980–1981 reports, only one case of "ground itch" or cutaneous larva migrans in humans was reported. *Ancylostoma caninum* and *A. braziliense* are rarely responsible for intestinal infestations in humans, but their larvae can penetrate human skin to cause cutaneous larve migrans.[1,4]

Toxocara in man produce visceral and ocular larva migrans.[11,12] The most reliable diagnostic test is an enzyme-linked immunosorbent assay.[13] Only one case of visceral larva migrans was reported in this study.

Fleas were the most frequently reported external zoonotic parasites, and *Dipylidium caninum* was the most common zoonotic tapeworm reported in this study. These two infestations can be related. Mature *D. caninum* live in dog or cat small intestines; proglottids are passed; flea larvae ingest tapeworm eggs; tapeworm larvae develop in fleas; pets swallow fleas as they groom; and tapeworm cysts mature inside pets.

Flea infestation and, consequently, flea-bite dermatitis can become serious problems in households.[4] The dog flea, *Ctenocephalides canis,* and the cat flea, *C. felis,* were the only species reported in this study, and there were 87 reported cases of human infestation. Although most cases were reported during warm, humid seasons, infestations can occur during the winter. The veterinarian at Pease Air Force Base, New Hampshire reported a severe infestation involving three households during December 1980 and January 1981.

Dipylidium caninum was the tapeworm reported almost exclusively in this study. There was one report of human infestation with *D. caninum,* resulting from ingestion of infested fleas.

The most common animal mite that infested humans was *Sarcoptes scabiei* var *canis*. Forty-six known cases of human zoonotic scabies were associated with 67 canine cases. One hundred forty-two cases of animal scabies were reported. Children are most often infested from contact with young pups. Most human scabies cases are due to the human scabies mite, not to "var *canis*".[14]

The fungus reported most frequently from dogs and cats was *Microsporum canis*. The second most frequently reported agent was *Microsporum gypseum;* no human cases were associated with *M. gypseum. Trichophyton spp.* were reported only twice from animal cases; one report indicated human involvement.

Ringworm fungi were the most frequently reported zoonotic agents among people in the Air Force communities. One hundred six cases of human ringworm were associated with 202 animal dermatomycoses in this study; cats were the source in 77 per cent of the human cases. *Microsporum canis* causes most zoonotic ringworm in man, and kittens are primary sources.[15]

Reports in this study indicated that *Microsporum canis* was very communicable. Although not nearly as common as animal-to-man transmission, man-to-animal transmission was reported. Two dependent children on vacation in North Carolina acquired *M. canis* ringworm from an infected kitten. When they returned to Williams AFB, Arizona, the family dog (kept in Arizona) contracted ringworm from the children.

Twenty of 30 Air Force veterinary clinics reported 248

TABLE 2—Five Most Frequent Pet Animal Zoonoses, by Quarter (mean, cases per 100 rabies vaccinations), Reported from US Air Force Bases, 1980 and 1981

	January–March		April–June		July–September		October–December	
California	Tapeworms	6.3		7.7*		8.0		13.6
(3 bases)	Roundworms	4.0		4.4		4.9		5.7
	Hookworms	1.4	Fleas	2.1		1.1		1.5
	Fleas	1.4	Hookworms	0.5		0.4		0.6
	Gm-positive bacteria	0.4	Gm-negative bacteria	0.5	Gm-positive bacteria	0.3		0.6
Texas	Hookworms	7.1		5.7	Fleas	6.7	Hookworms	6.4
(6 bases)	Roundworms	3.0		2.6	Hookworms	5.8	Tapeworms	5.6
	Tapeworms	2.6	Fleas	2.6	Ticks	4.4	Fleas	5.0
	Fleas	1.8	Ticks	2.6	Tapeworms	3.4	Roundworms	3.5
	Ticks	0.8	Tapeworms	2.2	Roundworms	2.7	Dermatophytes	1.2
N. Great Plains	Roundworms	3.1		4.6		5.2		3.1
(4 bases)	Tapeworms	1.2	Hookworms	0.8		1.0		0.8
	Hookworms	0.7	Tapeworms	0.7		0.9		0.6
	Dermatophytes	0.7		0.5	Rabies	0.4	Dermatophytes	0.3
	Gm-positive bacteria	0.2		0.4	Dermatophytes	0.3	Scabies	0.2
Southeast	Hookworms	11.2		8.5		12.2		11.7
(6 bases)	Tapeworms	9.5		5.5	Fleas	8.0		9.3
	Roundworms	4.8	Fleas	3.8	Tapeworms	6.9		8.7
	Fleas	3.8	Roundworms	3.1		5.1		7.0
	Gm-positive bacteria	0.8	Heartworms	1.6		2.3	Gm-positive bacteria	1.2

*Same diagnosis as previous quarter.

cases of Gram-positive bacterial zoonoses in animals (including 201 cases of *Staphylococcus spp.* and 40 cases of *Streptococcus spp.*) in 1980 and 1981. Thirty-four human infections were reported as causally related to these animal diagnoses.

The most common zoonotic Gram-positive bacterium isolated from infections of pets was *Staphylococcus aureus*. One reported case of human involvement is noteworthy. A young canine with severe moist pyoderma on both sides of its face was examined at the veterinary clinic at Maxwell AFB, Alabama. Cultures from the lesions yielded coagulase-positive *Staphylococcus aureus*. The pup had close daily contact with a six-month-old child suffering from acute, severe "impetigo." No cultures were taken from the child, but both the child and the pet responded to appropriate antibiotics.

Household pets have been identified as reservoirs of persistent or recurring streptococcal throat infections in children.[16] Reports in this study associated 16 isolations of Beta-hemolytic, Gp A, *Streptococcus* from dogs and cats with 30 human cases, either family members or household visitors. Pets of 29 other human "strep" cases were culture-negative for this bacterium, and seven animal isolates were not associated with any known human cases.

Fifteen cases of giardiasis in pets were reported: nine from California, and six from Colorado. Three cases of human giardiasis reported from Lowry AFB, Colorado, were associated with one canine case.

Table 4 lists zoonotic Gram-negative bacteria diagnosed at 11 of the 30 base veterinary clinics during 1980 and 1981. Since few human infections were reported, the risks of these zoonoses to Air Force families appeared small in comparison to dermatomycoses, fleas, animal scabies, and Gram-positive bacterial infections. Human infections from *Pasteurella multocida* and *Campylobacter fetus* var *jejuni* were mentioned in the reports.

The bacterium *Campylobacter fetus* var *jejuni* (formerly a *Vibrio spp.*) is increasingly recognized as an enteric zoonotic pathogen.[17] Veterinarians have long recognized *Campylobacter spp.* as agents that cause abortion in cows and ewes, and enteritis in pigs and calves. Spread of the agent within households has been traced to contacts with poultry (live and processed), certified raw milk, contaminated water, and various domesticated animals.[18] The following case history illustrates several possible routes of spread.

A 21-year-old Air Force female suffering from fever, chills, diarrhea, nausea, and abdominal cramps was admitted to the military hospital at Vandenberg AFB, California, in May 1980. Identification of *Campylobacter fetus* var *jejuni* in stool cultures and treatment with tetracycline led to recovery. The patient and her family had recently moved to a dairy farm. Calves on the farm had a chronic history of diarrhea; untreated drinking water came from a well. The patient's husband worked on the farm and the family drank raw milk from the herd. The family's pet pup had exhibited diarrhea just prior to her illness.

Among domestic animals, cats present a significant rabies threat.[19] When a dependent child was bitten by a stray

TABLE 3—Dog or Cat Associated Zoonoses in Humans Reported from 30 Air Force Bases* in the US, 1980 and 1981

Zoonoses	Human Cases 1980 (23 bases)	Human Cases 1981 (27 bases)
Dermatophytes	48	58
Fleas	24	63
Scabies; animal variety	21	25
Gm-positive bacteria	12	22
Exposure to rabid cats	2	36
Giardiasis	3	0
Pasteurellosis	1	0
Visceral larva migrans	1	0
Tapeworm	1	0
Ticks	1	0
Campylobacterosis	0	1
Cutaneous larva migrans	0	1
Cat scratch fever	0	1

*Mean population of active-duty military assigned to those bases: 6,074 (in 1980); 6,047 (1981).

TABLE 4—Zoonotic Gram-Negative Bacteria Reports from 11 Air Force Veterinary Clinics, 1980 and 1981

21 cases	*Pseudomonas spp.*	
	Pseudomonas aeruginosa	(18 cases)
16 cases	*Proteus spp.*	
	Proteus vulgaris	(8 cases)
	Proteus mirabilis	(5 cases)
8 cases	*Escherichia coli*	
8 cases	*Pasteurella spp.*	
	Pasteurella multocida	(4 cases)
7 cases	*Klebsiella spp.*	
	Klebsiella pneumonia	(4 cases)
	Klebsiella oxytoca	(1 case)
6 cases	*Campylobacter fetus* var *jejuni*	
4 cases	*Shigella boydii*	
2 cases	*Salmonella newport* and *Salmonella enteritidis* (one each)	
2 cases	*Yersinia pestis*	
4 cases (one each)	*Brucella spp.*	
	Enterobacter aerogenes	
	Haemophilus spp.	
	Serratia rubidea	

female cat at Ellsworth AFB, South Dakota, a state laboratory reported the animal's brain positive for rabies. An investigation revealed the cat had six kittens, adopted by various families in the neighborhood. A door-to-door survey located the kittens and identified 85 people with possible exposures; one kitten was positive for rabies. Health care providers administered rabies-immune globulin and human diploid cell vaccine (RIG and HDCV)†† to 36 people. Fifteen people were exposed by scratches; six had other open wounds; three had been licked on the face; and nine others had questionable or uncertain exposures. These post-exposure protocols were valued at over $15,000 in biologicals and other medical material.

Discussion

In general, the occurrence of several zoonoses declined from higher cs/Crv in the east, southeast, or midwest to lower cs/Crv in the west, southwest, and Alaska. Climatic and other influencing variables were not measured in this study. Much of the change was probably due to absolute shifts in disease incidence within regions, but some of the change was undoubtedly due to the data-base. In 1981, more bases reported from Arizona, the southeast, Virginia/Maryland and New England; fewer bases reported from California and the northern Great Plains.

Many ecological variables not measured in this study are known to influence parasites, soil saprophytes, vector populations, and hosts. Hookworms, roundworms, tapeworms, and fleas were the zoonoses reported most frequently from pet dogs and cats. Abstracts of human cases reported in this study suggested that dermatomycoses, fleas, scabies, Gram-positive bacterial infections, and rabies present the most acute zoonotic threats to people in these communities.

Other animal zoonoses diagnosed at base veterinary clinics were not discussed because there were no reported associated cases of human involvement, or they were not diagnosed in dogs or cats. However, many of these diseases (e.g., salmonellosis,[20] shigellosis, and toxoplasmosis[21,22]) cause significant morbidity and mortality in humans and animals. Cryptococcosis[23] and psittacosis[24] pose unique risks to bird fanciers. Other less frequently diagnosed diseases in humans (e.g., babesiosis, cryptosporidiosis, echinococcosis,[25] and dirofilariasis[26]) appear to be "emerging" zoonoses that justify the attention and concern[27] of health care providers.

Base veterinarians were probably not aware of every local zoonotic diagnosis in humans and, conversely, physicians were probably not informed of all zoonoses in animals. However, in the author's experience military veterinarians and physicians exchange this information more often than their civilian counterparts. Our data have illustrated the importance of such exchange.

††RIG given on a bodyweight basis during initial treatment, and HDCV given as a series of vaccinations; per product inserts.

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