

EPIDEMIOLOGY OF CANICOLA FEVER

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Since the first case of human canicola fever was diagnosed as such in Holland in 1931 the disease has been reported from many different countries. While the number of known cases has been steadily increasing, the total is not large. Thus in England, according to Broom (1951*a*), seventy human cases of canicola fever were diagnosed during 1947–50 inclusive while, so far, in Scotland only three occurrences have been published (Joe & Sangster, 1951).

It is surprising, as the dog is believed to be the main source of infection in man, that more cases have not been recognized. Surveys (Stuart, 1946; Broom & MacIntyre, 1948) have shown that 25–40% of dogs reveal evidence of past infection with *Leptospira canicola*, and, as the carrier state in dogs may last as long as 4½ years, the potential sources of infection must be considerable in most areas. It is estimated, for instance, that in Edinburgh there are at least 19,000 dogs, or approximately one dog to every seven families, so that between 5000 and 8000 dogs in the city should show evidence of past or present leptospiral infection. This means that the members of, at least, one in every thirty families in the city have been or are exposed to risk.

Several explanations have been advanced for the small number of reported human cases in relation to the high rate of dog infection. It has been argued, for example, that *L. canicola* has a low virulence for man, and that for human infection to occur very close contact with the dejecta of infective dogs is necessary. On the other hand, it has been suggested that the incidence in man is higher than is realized, and that many cases of human disease go unrecognized. Thus Broom (1951*b*) found eight missed cases of canicola fever among 642 cases of aseptic meningitis, and as investigations on *L. icterohaemorrhagiae* have revealed evidence of that disease which had not been suspected clinically, mild infections with *L. canicola* probably occur but are undiagnosed. To test this possibility, the present investigation was undertaken.

Only two surveys on these lines have been reported in the literature. Tiffany & Martorana (1942) in America tested the agglutination reaction against *L. canicola* of blood from fifty-four persons employed in animal hospitals and dog shelters, while Campbell, Macrae, Manderson, Sumner & Broom (1950) examined forty-nine inmates of a camp in England where canicola fever had occurred. The results were negative, but in neither investigation was information available as to the actual degree of contact, if any, between infected dogs and the persons examined. Furthermore, only adults were included, no children being presented for examination.

METHOD OF INVESTIGATION

When the present investigation was first considered it was appreciated that there might be some difficulty in obtaining samples of blood for examination. A possible line of approach was to examine for *L. canicola* agglutinins samples of blood taken routinely from women, who were known to keep dogs, attending ante-natal clinics in the city. Any cases with positive sera could be followed up to their homes and their dogs could be examined. Twenty-five women were examined in this way with negative results, so that this line of investigation seemed likely to be unproductive. Accordingly, it was decided to approach the problem through the dogs, by making inquiries and carrying out examinations amongst human contacts of dogs known to be infected with *L. canicola*.

During 1951, therefore, all cases of canine leptospirosis which had been fully investigated at the Royal (Dick) Veterinary College were used as the basis for the inquiry.

The owners of dogs which had been recently ill, or which were attending for 'follow up' after infection in earlier years, were asked to co-operate and, if they were willing to do so, to give the name of their family doctor. After consultation with the general practitioners concerned the families were visited. An inquiry into the home circumstances surrounding the illness of the dog was made, particularly in relation to soiling of the floor of the house by urine and other dejecta. The history of illness among human household contacts was also obtained and the contacts were asked to agree to serological examination and to submit a sample of urine for analysis.

It is a pleasure to record the willing co-operation of most of the householders and of all the general practitioners.

DISEASE IN DOGS

Forty-six homes were visited but, as in one household two dogs had suffered from the disease, a total of forty-seven dogs with a history of leptospirosis is included in the investigation. They represent, of course, only a sample of the dogs with leptospirosis attending for treatment or 'follow up', but there was no intentional selection of owners on social, housing or hygienic grounds.

There is no available information concerning social or other circumstances of dog owners in general with which to make a comparison, but an attempt has been made in Tables 1-3 to compare the social circumstances of the owners of dogs in the present survey with those of the population in Edinburgh as a whole.

While a rather high proportion of the dog owners in the present survey belonged to the upper social groups and lived under favourable housing conditions, they were on the whole a fair cross-section of the population.

All the dogs but one were males. The terrier breed was most common, there being 28 pure bred or mongrel terriers. Of the remainder, 8 were pure or cross-bred collies; 3 Labradors; 2 Cocker spaniels; 2 Dalmatians; 1 Alsatian; 1 Boxer; 1 Dandie Dimont and 1 not stated. The ages varied from 4 months to 7 years, 15 dogs being under 1 year; 11 between 1 and 2 years; 8 between 2 and 3 years; 6 between 3 and 5 years; and 6 over 5 years, while in 1 the age was unknown.

Table 1. *Dog owners, arranged according to condition of house occupied and compared with city as a whole*

Condition of house	No. of dog owners	Percentage of total	Percentage in city as a whole
Fit	29	63.0	61.9
Sub-standard	14	30.5	32.5
Unfit	3	6.5	5.6
Total	46	100.0	100.0

Table 2. *Dog owners—arranged according to type of house occupied and compared with those of city as a whole*

Type of house	No. of dog owners	Percentage of total	Percentage in city as a whole
Tenements and flatted dwellings	28	60.9	78.5
Bungalows and villas	18	39.1	21.0
Others	—	—	0.5
Total	46	100.0	100.0

Table 3. *Dog owners—arranged according to occupational classification of registrar general*

Class	No.	Percentage
1. Professional and financially independent	3	6.5
2. Class between 1 and 3	8	17.4
3. Skilled artisan and analogous workers	17	37.0
4. Class between 3 and 5	11	23.9
5. Labourers and other unskilled workers	7	15.2
Total	46	100.0

When first examined all the dogs save one (case 29) were found to be in the primary stage of nephritis due to *L. canicola* infection. The symptoms varied with the severity of the renal lesion, but all were sufficiently ill to stimulate the owner to seek veterinary advice. Thirst and polyuria were the commonest symptoms, with intermittent anorexia and occasionally emesis. In severe cases there was an intense thirst followed by emesis, oliguria and sometimes extensive buccal ulceration. Such dogs became prostrate and died or were destroyed in an advanced state of uraemia.

The diagnosis of leptospirosis was confirmed in every case by serological test. All the dogs, save case 29, showed agglutination against *L. canicola* in titres of 1:3000 or higher. Twenty-two showed titres of 1:30,000 and seventeen titres of 1:10,000. Case 29, with a titre of 1:300, was a typical secondary or chronic case of leptospirosis and was presumed to have its primary attack at least 6 months previously.

Amongst thirteen chronic or recovered cases, examined 2–4 years after the original illness, ten showed a titre of 1:300 or higher, two a titre of 1:100, and in the remaining case a titre of 1:30 was obtained. Altogether thirty-four of the forty-seven dogs showed leptospiruria when first examined.

TREATMENT OF DOGS

When a dog was found to be voiding leptospirae in the urine it was the practice at the Royal (Dick) Veterinary College to admit the animal to the hospital in order to remove it from contact with the owner and to initiate penicillin therapy—100,000 units of the sodium salt and latterly the procaine salt being injected subcutaneously daily for at least 5 days in the mild cases and longer in the more severe. Before the animal was returned to its owner it was ascertained that no leptospirae could be demonstrated in the urine by dark field examination.

Although these measures were taken to eliminate leptospirae from each case it has been shown that penicillin therapy does not destroy all the leptospirae in the dog's kidney. According to McIntyre & Montgomery (1952) foci of spirochaetes can be found at post-mortem examination of the kidneys of dogs known to have been infected and treated with penicillin 3 years earlier. They have demonstrated the spirochaetes within the lumina of renal tubules. Those organisms must find their way into the urine, and although too few to be demonstrated by microscopical examination must act as a potential source of infection for the remainder of the dog's life.

At this point we would like to raise the question of what happens to humans who have recovered from the primary attack of canicola fever. The woman associated with case A (*vide infra*) showed an agglutination titre of 1/150 against *L. canicola* 3 years after her original infection. In the dog, so high a titre is invariably associated with a renal lesion of widely varying intensity but always active.

HOUSEHOLD CONTACTS

The homes of all diseased dogs were visited and inquiries made of the epidemiological circumstances surrounding the dogs' illness. A study was made, in particular, of any illness among human contacts and of the method, and by whom, any dog dejecta were dealt with. An attempt was also made to obtain blood from the various human contacts for serological examination.

There were 137 household contacts associated with the diseased dogs, the average period of contact being 16 months, with extremes of 2 weeks and 4 years 2 months. The age and sex distribution and the number whose blood was examined for *L. canicola* agglutinins is shown in Table 4.

Table 4. *Household contacts*

Age group (years)	No. of contacts		
	Male	Female	Total
Under 1	1	3	4
1-4	1 (1)	2 (1)	3 (2)
5-9	5 (3)	—	5 (3)
10-14	6 (5)	2 (2)	8 (7)
15-19	5 (5)	5 (3)	10 (8)
20 and over	51 (40)	56 (39)	107 (79)
	69 (54)	68 (45)	137 (99)

(Figures in brackets refer to household contacts whose blood was submitted for agglutination examination against *L. canicola*).

HISTORY OF ILLNESS AMONG CONTACTS

As was to be expected, histories of a wide variety of illness were found in the households visited. Four contacts had suffered over a period from gastric ulcer; three from bronchitis or pleurisy; two from nasal sinusitis; two from chronic rheumatism; one from mitral stenosis with decompensation; one from coronary thrombosis; one from varicose ulceration; one from psychoneurosis and one had had a breast recently removed for cancer.

'Colds' were a common complaint. Eleven household contacts gave a history of 'influenza' which had occurred in 5, 1 or 2 years after the dog's initial illness, but in the other six within a few weeks of the onset of disease in the dog. The account of illness in four of these six cases was indefinite, but the history in the other two is of some interest.

An adult female associated with case 20 complained for a few days of headache, sore throat, shivering and generalized pains, 2 weeks after the onset of leptospirosis in the dog, and an adult female associated with case 35 had a rise in temperature, with sore throat, vomiting and generalized pains, again about 2 weeks after the dog in the house had sickened. The first woman had mopped up dog urine but the other had had no contact of this nature. The agglutination reaction against *L. canicola* in both cases was negative 3 and 4 weeks later.

RELATION OF HOUSE CONTACTS TO DOGS' DEJECTA

Thirty-six dogs passed urine or faeces or vomited matter on the floor of the house during the initial stages of the illness, and fifty-two household contacts, or 37·4% of all those included in the investigation, were associated with removal of dejecta. Details are given in Table 5.

Table 5.

Nature of dejecta	No. of dogs	Household contacts associated with removal of dejecta			Agglutination reaction	
		Male	Female	Total	Examined	Not examined
Urine only	26	15	26	41	36	5
Urine and vomit	2	2	1	3	3	—
Vomit only	7	—	7	7	6	1
Faeces only	1	—	1	1	—	1
Total	36	17	35	52	45	7

Most of those engaged in the removal of urine, faeces or vomit took no special precautions. Usually a floor cloth was used for the purpose. This was rinsed under the tap and the hands were thereafter washed perfunctorily. Only six of the household contacts had taken more care. A mop with disinfectant was used by two, and a third removed faeces passed on the floor with a shovel. The hands of these six, therefore, did not come into direct contact with the dejecta. Disinfectant was used with a floor cloth in two other cases, and another, while not using disinfectant, stated that he was particularly careful in washing his hands and always destroyed the cloth used in the operation.

CUTS AND SORES ON HANDS WHEN REMOVING DEJECTA

As a number of the dogs were taken ill some years before the inquiry, an accurate history of cuts and sores on the hands when removing dejecta was not possible in all cases, although the nature of employment of some made it not unlikely that cuts were present. There were, however, five definite examples of mopping up taking place with cuts or other lesions on the hands or arms and without any special precautions being taken. Female contacts of cases 43 and 46 had cuts, one on a right thumb, and the other on a forefinger, covered only by cotton bandages, and a woman associated with case 18 had a septic cut on the back of the right hand, resulting from injury by a 'prickly pear' plant. Another woman having to remove vomit from the floor had many scratches on the arms caused by the teeth of the ill dog. The most outstanding example, however, was that of a female contact of case 5. This woman suffered from occupational dermatitis and there were sores and cuts on the back of the hands and between the fingers on the frequent occasions when she removed urine from the floor of the house.

GARDEN VEGETABLES

A garden was attached to sixteen houses where dogs were kept, and in twelve vegetables and fruit were grown. Although the garden produce in two was fenced off, and the dogs had no means of access, in the others the animals were free to roam over the garden and there was, therefore, a possibility of contamination of vegetables and fruit with infected urine or other dejecta.

RATS, MICE AND OTHER ANIMALS

In only two houses was there a complaint of mice. Rats had been found in the garden in another case and the dog, immediately before sickening, had killed rats on a number of occasions. Cats were kept by seven families; canaries and guinea-pigs by two others, but in no instance was there any illness amongst these animals, although the dogs and cats were always closely associated.

SEROLOGICAL EXAMINATION

Samples of blood were obtained from 99 or 72·3% of the 137 household contacts and submitted for agglutination against *L. canicola*, the serological examination being made by Dr P. M. Edmunds of the Department of Bacteriology, University of Edinburgh. The sera in all cases failed to agglutinate *L. canicola* (Berlin) in the lowest dilution tested, 1/30. One of the contacts of case 16 gave a doubtful reaction in a dilution of 1/30, but a specimen of blood taken 2 weeks later was negative. It is of interest that of the fifty-two contacts who were closely associated with dejecta from diseased dogs, blood samples were obtained in forty-five or 86·5%, and all gave a negative result.

Chemical examination of specimens of urine from most of the contacts was undertaken, and in a proportion centrifugalized urine was examined for leptospirae. None showed evidence of leptospiruria and all were negative for albumen.

DISCUSSION

The relationship of canine disease to canicola fever in man is obviously of public health importance, and it is desirable that the preventive aspect should receive attention.

There are many reported instances of the human disease where the history would seem to leave little doubt that infection was transmitted from a dog suffering from leptospirosis, but others reveal epidemiological features difficult to explain. Several human cases, for example, have occurred where, despite careful inquiry, no direct contact with dogs could be discovered. Analysis of the fifteen British cases, details of which have been published (Baber & Stuart, 1946; Laurent, Norris, Starks, Broom & Alston, 1948; Weetch, Colquhoun & Broom, 1949; Campbell *et al*, 1950; Joe & Sangster, 1951), shows that only six had evidence of contact with a dog in which leptospirosis was definitely established; four were in contact with dogs which had been ill, but the diagnosis of leptospirosis was only presumptive. In one case the household dog was well, although no serological examination was made, while in four there was no evidence of contact with dogs. Moreover, results of the present investigation show that even close and continued contact with diseased dogs and their dejecta does not necessarily lead to infection. The absence of infection under what may be considered optimum conditions is perhaps best exemplified by a female contact who, when her dog fell ill and a veterinary surgeon requested urine for examination, obtained a sample by soaking the urine subsequently shown to contain leptospira with cotton-wool and then squeezing the urine into a bottle.

Males have been found to be more often affected, while it is clear that females are more commonly associated with the removal of infected canine excreta. Thus in the present inquiry there were thirty-five females against seventeen males so engaged.

Further, few cases of canicola fever have occurred in children where the relationship with canine pets is close and intimate. Lastly, very few multiple cases in the same household have been reported. It has been suggested that this is due to the fact that duties of removing dejecta are usually undertaken by only one member of the family. The findings of the present investigation, however, do not bear out this theory because in 12 or 25% of the households more than one individual was responsible for mopping urine or other dejecta from the floor of the house.

Some of the epidemiological difficulties mentioned are brought out in the following notes of three cases of human canicola fever which were brought to light during the course of the investigation and which have not so far been published. The details are given with the permission of the doctors who attended them.

Patient A. Female, aged 44 years. Sickened 21 August 1948 with shivering, severe headache and generalized pains, particularly severe at the back of the neck. The following day temperature was 105° F. On treatment with penicillin the symptoms abated after some 5 days. A tentative diagnosis of 'influenza' was made. However, a newly acquired puppy dog had sickened some days earlier and at the Royal (Dick) Veterinary College was found to be suffering from leptospirosis. Blood from the patient was strongly positive for *L. canicola*. An agglutination test 3 years later showed a titre of 1:150.

The patient was in constant attention on the dog during its illness and frequently mopped up urine and vomit from the floor. A floor cloth was used but no special precautions were taken. The other contacts were the husband, two sons—16 and 12 years—and a daughter of 3 years of age. None suffered any symptoms of illness, and serum agglutination against *L. canicola* 4 years later was negative in all cases. The history of this case appears to point to infection from the dog; yet the husband and the two sons also undertook the removal of urine and the daughter was intimately associated with the dog all the time. In fact, except that the patient had more to do with the dog, careful inquiry showed little difference in the handling of the dog by the patient and the other members of the family. She had no cuts or sores on the body and her own explanation was that she had a particularly 'sensitive skin' as skin reactions had occurred with the exhibition of aureomycin for rheumatoid arthritis.

Patient B. Male, aged 20 years. Admitted to hospital 11 October 1950. Illness commenced on 6 October 1950 with headache, rigor, generalized pains and very severe pain in the lumbar region. The diagnosis on admission was for some days in doubt until on 21 October 1950 his serum was found to agglutinate *L. canicola* in a dilution of 1/500. Four days later the titre was 1/10,000.

The patient worked on a large piggery owned by his father. There were two dogs—an Alsatian and a Collie bitch. Both dogs were tethered in the yard and never entered the house. While neither had shown any suggestion of illness, their sera were positive for *L. canicola* in low titre. The other contacts consisted of father, mother, three brothers and one sister. None of the family gave any history of illness, but unfortunately blood examination was refused. Inquiry showed that the patient at no time paid any attention to the dogs and never handled them in any way. The care of the dogs was the duty of the only other brother working on the piggery.

Patient C. Male, aged 30 years. Sickened on 19 December 1951 and was removed to hospital where the diagnosis of canicola fever was established after serum agglutination. Treated with penicillin and discharged on 29 January 1952.

The dog in the patient's household had been acquired in October 1951, when 7 weeks old. It was never house-trained and urine had frequently to be mopped up from the floor. Towards the end of November the puppy was noticed to be 'off colour', very thirsty, with loss of appetite and difficulty in walking. It seemed to pass more urine on the floor than usual but little notice was taken because of past experience. On 22 December it grew worse with weakness and loss of power in the legs. On examination the serum agglutinated *L. canicola* in a dilution of 1/10,000. The dog was under treatment for some weeks but was ultimately destroyed on 31 January 1952.

The family consisted of the patient, his wife, father and mother-in-law, all residing together. None of the other inmates complained of any recent illness and the sera of all failed to agglutinate *L. canicola*. The patient, his wife and mother-in-law all undertook the removal of urine from the floor and no special precautions were taken by any of them. There was, in fact, no difference in the handling of the dog by any of the household contacts. The patient's wife had more to do with the

nursing of the dog and the removal of dejecta than the other members. The patient was a maintenance worker with the Gas Board and his work entailed frequent contact with drains. He stated that on occasion his hands were soiled with human excreta in the course of his employment and that there were many rats at his work-place. The skin between his thumb and forefinger was frequently cut by chisels and other tools and was in this state when he was engaged in mopping up the urine of the sick dog. On the other hand, his wife when playing with the puppy often received scratches on the hands and arms from the animal's teeth, and when nursing the dog or engaged in the removal of its dejecta, her hands and arms were covered with scratches and were bleeding on at least one occasion.

The histories of patients A and C suggest that the source of infection was the household dog, but it is strange that other members of the family who were as intimate, if not more so, with the dog remained unaffected. It is especially surprising that the wife of patient C should have escaped infection.

Patient B and his parents, in careful cross-examination, denied that he had been in close contact with the dogs in the piggery.

These three cases and the survey itself show a great variation in the risk of infection to owners and others living in the same house. There may be some other unknown source of infection common to dog and man, but since the possibility of infection from diseased dogs exists, it is highly desirable that all possible care should be taken to prevent the transmission of the disease from dogs to humans.

To this end, propaganda is necessary. Dog owners should be made aware of the possibilities of infection, should be advised to be careful at all times in dealing with dog's dejecta and should avoid all unnecessary contact with sick dogs. A case might even be made out for the notification of canine leptospirosis so that households could be visited immediately and advice given on precautions which should be taken to prevent any spread of disease. Difficulties are the wide distribution of the disease among dogs and the fact that many which recover remain carriers over a long period. The discovery of some more potent agent for the cure of the disease and the termination of the carrier state would be a profitable advance in dealing with the problem. Also, the vaccination of dogs against this disease needs to be more widely used.

SUMMARY

The results of an investigation into the incidence of canicola fever amongst owners of dogs infected with *L. canicola* is described.

Visits were made to forty-six households in which infected dogs lived. Altogether 137 household contacts were examined and blood samples from 99 or 72.3% were tested for agglutination against *L. canicola*. All the sera proved negative.

A detailed classification of the kinds and conditions of housing and of householders is given.

Some of the difficulties in explaining the relationship between the disease in dogs and man are discussed; the results of the present survey and the experience with some reported cases of human canicola fever show that there is great variation in the risk of infection to owners and others living in the same house with diseased dogs.

Some other source of infection common to man and dog is possible.

It is recommended that in the light of present knowledge greater attention should be paid to the preventive aspect and that more propaganda should be directed to make dog owners aware of the possibilities of infection and of the importance of observing hygienic principles when handling dogs and particularly when dealing with dejecta.

Grateful acknowledgement is made to many general practitioners for their co-operation, without which the Survey could not have been carried out, to Drs E. V. Kuenssberg, D. A. MacKinnon and H. Maitland Moir for permission to give details of the three unpublished cases of canicola fever; to Dr P. M. Edmunds of the Department of Bacteriology, University of Edinburgh, for carrying out the human serological examinations and to Mr J. B. Boyce, F.I.M.L.T., for much technical assistance in connexion with the examination of dogs.

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