EXPERIMENTAL STUDY

Do dogs and cats present a risk of transmission of salmonellosis to humans?

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Abstract

Examination of rectal swabs from 187 dogs and 13 cats showed that Salmonella spp. was present in only one dog, a 4-month old mongrel puppy, weighing 3.5 kg. It was identified as S. dublin, a species specific serovar of cattle. The animal exhibited no signs of disease during clinical examination. Of the total number of examined animals this positive dog represents only 0.5 %. Within the group of patients included in our monitoring in none of those with gastrointestinal problems it was possible to isolate Salmonella spp. This indicates that the risk of transmission of salmonellosis from dogs and cats in the region of Košice seems to be rather low. On the basis of literature and our own observations we identified the potential sources and the possible ways of the transfer of this disease. The most common appears to be the oral infection by infected feed of various types, particularly by direct contamination of feed with either animal or human contaminants. In dogs and cats salmonellosis occurs most frequently in a latent form. The clinical findings vary with regard to the number of pathogens, immune status of the host, occurrence of health complications and the form of associated disease units. There are suitable isolation and diagnostic methods for diagnostics of salmonellosis. Due to the need for continuous protection of health of humans and animals, screening of occurrence of zoonotic pathogens appears topical. (Tab. 3, Fig. 1, Ref. 35.)

Key words: occurrence, Salmonella spp., risk of transmission, dogs, cats.

The role and position of veterinarians in the society becomes more and more demanding. Their responsibilities include not only care about the animal health but, through the healthy animals, protection of the health of animal owners, children, and the wide public.

The relationship between humans and small or companion animals has been subjected to long-term investigations. It brings many emotional and health benefits and enjoyment to the people. However, also certain health risks are associated with this relationship because under certain conditions, due to some unfavourable factors, these animals may become a source of transmission of some diseases, particularly the zoonotic ones.

Considerable risk is associated particularly with the possible transmission of some pathogens from dogs and cats to immunosuppressed persons. Green (1995) included in this group the following disease agents: *Toxoplazma gondii, Cryptosporidium spp., Salmonella sp., Campylobacter spp., Giardia lamblia, Bartonella spp., Rhodococcus equi, Mycobacterium marinum, Bordetella bronchiseptica, Chlamidophylla psittaci* and dermatomycosis agents.

The present study investigated actively one of them – salmonellosis in dogs and partially in cats. Besides the well-known and traditionally monitored sources of human infections, particularly contaminated food, an increased attention has been paid recently to additional potential sources of human salmonellosis that also include pet or companion animals which live in close contact with humans. Dogs and cats can become infected in the same way as humans and can become temporal carriers of salmonella infection. In this respect the most exposed group are children, the younger they are the higher the risk. High variability of results obtained by screening studies

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in different parts of the world, concerned with the carrier status of dogs and cats with regard to salmonellosis, induced our two-year study of salmonellae shedding by dogs and cats in Košice and the surrounding area.

The high number of human salmonella infections in SR (18 143 cases in the year 2000) and particularly of symptom-free cases – carriers (500 cases annually) indicate the need for close collaboration between veterinarians and human health organizations (Saladiová et al, 2001).

According to the reports of physicians and veterinarians, salmonellosis rates as the second (after toxoplasmosis) most serious zoonotic disease and poses considerable risk to children and immunosuppressed humans (Grant, 1999; Čisláková et al, 2001). Sufficient communication between veterinarians and physicians and the animal owners on all professional and social levels (Švrček et al, 1998) is the basic precondition for respecting the needs for protection, particularly against zoonoses. Monitoring of the occurrence of pathogens in human and animal populations should become more thorough and intensive.

The aim of this paper is to contribute, at least to a small degree, to the protection of health of animals and owners of companion animals through screening of the occurrence of *Salmonella spp.* in dogs and cats. At the same time it confirms or contradicts the opinions about the risk of transfer of salmonellae from dogs to the human population.

Material and methods

The basic set of samples consisted of 200 rectal swabs from 187 dogs and 13 cats that were examined clinically in the office of the Ist Internal clinic of the University of Veterinary Medicine in Košice in the period of 2001-2002. The samples were taken systematically from patients with digestive disorders of varying character (i.e. regardless of breed, age, weight category or sex).

The rectal swabs were examined at the State Veterinary Diagnostic Institute in Košice, Slovakia. The methods used corresponded to the standard procedure recommended by O.I.E.:

1. Cultivation and isolation of suspect colonies.

2. Biochemical identification of suspect colonies using the following method:

BBL ENTEROTUBE II preceded by the **test of catalase activity, oxidase test and the proof of production of indole.** The BBL ENTEROTUBE II method and its computer coding and identification system (CCIS) is designed especially for identification of the family *Enterobacteriacae* – aerobic and facultative anaerobic, gram-negative and oxidase-negative rod-shaped bacteria. A diagram demonstrates how the oxidase test and BBL ENTEROTUBE II can be used to distinguish the family *Enterobacteriacae* from other gram-negative bacteria..

3. Individual *Salmonella spp. serovars were also determined by means of a slide agglutination method* (Holoda et al, 2001). The slide agglutination was employed to diagnose bacteria on the basis of their antigenic structure using known antibodies.

Tab. 1. Number of examined animals and the positivity according to species.

Species	Number of examined animals	Number of positive animals
Dog	187	1
Cat	13	0

Results

The screening of occurrence of salmonellae provided the following results.

Altogether 200 animals, 187 dogs and 13 cats, were examined in the period of 2001 and 2002. They belonged to various breeds and age categories. We recorded anamnestic data of these animals and examined them clinically.

Of the total number of examined samples (200) only one sample was positive which corresponded to 0.5 %. Of 187 dogs 0.53 % were positive. No presence of the agent was detected in rectal swabs of cats.

The age of the animals examined ranged from 4 months to 13 years. Salmonella organisms were isolated only from one 4-month old mongrel male puppy, weighing 3.5 kg.

When recording the anamnestic data, we tried to determine the character of their feed rations. On the basis of our observations and considerations about the possible source of the infection the examined animals were divided into 4 groups.

Group A. This group included service dogs the feed rations of which contained besides commercial dog-food also a supplement in the form of raw meat.

Group B. This group consisted of animals (dogs and cats) which were besides the granulated feed supplied also with food thermally treated in the respective households, or residua of food intended for human consumption..

Group C. It consisted of dogs fed exclusively with the commercial dog food.

Group D. Dogs from this group received also other types of food accessible to cats and rodents that could transfer the disease.

As it was already mentioned, salmonella was isolated only from one 4-month old mongrel male puppy, weighing 3.5 kg.

Tab. 2. The number of animals included in groups A, B, C, D and the number of positive cases.

Group	Number of animals	Number of positive animals
A	44	0
B	116	1
C	19	0
D	8	0

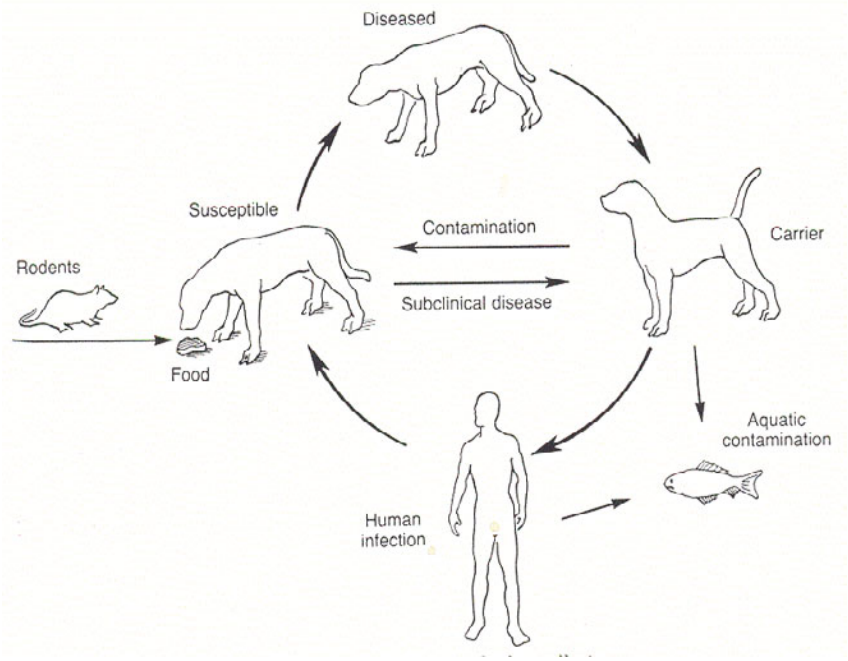

Fig. 1. Pathways of *Salmonella spp.* Transmission (Green, 1998).

According to the division of animals to groups (Tab. 1), the positive dog was included in the Group B. Besides the loss of appetite no signs of diarrhoeic disease were recorded or reported by the owner.

Agglutination methods confirmed the presence of *S. dublin* serovar (1, 9, 12 [Vi]: g, p:-).

Discussion

The representatives of the genus *Salmonella* belong to the family *Enterobacteriacae*. They are nonsporeforming, gram-negative, motile, rod-shaped micro-organisms (*S. gallinarum* and *S. pullorum* are nonmotile). They cause gastroenteritis and also system diseases in humans and animals.

Salmonellosis is a zoonotic disease affecting both humans and animals. It is an infection that spreads directly from one vertebrate to another (Švrček et al, 1996; Čisláková et al, 2001).

On the basis of antigenic properties we distinguish today 2375 salmonella serovars (O.I.E., 1996). They are classified according to the Kauffman-White diagnostic scheme. Salmonellae as ubiquitous parasites are very easily transmitted in the environment between humans and animals (Fig. 1). The most frequent way of contamination is the contact with infected food, water or equipment. Respiratory infections can also occur (Rodriguez et al, 1993).

Dogs and cats can become infected when they drink contaminated water but this way of transmission is scarce in the areas where potable water is disinfected with chlorine. Another source of infection, very frequent in the past, is the consumption of raw and untreated food (Green, 1998).

For example, in the USA salmonellosis poses a serious threat to race-greyhounds and dog-team animals that are fed raw meat (Chengappa et al, 1993). Even the commercial dog food can become a source of infection if it is inadequately sterilised, improperly stored or exposed to secondary contamination by insects, rodents or reptiles.

Willis (2001) examined 2369 dog food products imported to England and Wales between January 1998 and January 2000 and isolated the agent from 184 samples, i.e. 7.8 %. The most frequent isolates were *Salmonella binza* and *Salmonella havana.*

The disease can also be transmitted from humans to animals, e.g. in cases in which small children infect the companion animals (Becker et al, 1992).

Foley et al (1999) described a case of fatal salmonellosis in kittens that was recorded after administration of vaccine containing live virus of feline panleukopenia. The virus caused transient immunosuppression and activated subclinical salmonella infection from an unknown source.

Clinical manifestations in humans and animals are generally caused by an infectious dose ranging between 106 to 109 microorganisms. In the individuals with decreased resistance 103 bacteria suffice to induce the disease (Havlík, 1990).

Salmonella is a facultatively intracellular micro-organism. With regard to the pathogenicity of salmonellae, we recognise the following three types:

– the first group causes septic diseases (e.g. *Salmonella typhi* which causes typhoid fever in humans) and includes also salmonellae that induce diseases resembling typhoid fever – the paratyphoid fever,

– the second group also includes invasive salmonellae but they cause suppurative processes in joints, on meninges and in bones (*S. choleraesuis, S. dublin, S. panama, S. wirchov)*,

– the majority of other salmonellae cause enterocolitis in humans and animals (*S. typhimurium, S. enteritidis)*.

This division is not strict and any salmonella can, although sporadically, cause for example a disease with local manifestations (Topley and Wilson, 1990).

The clinical findings associated with salmonellosis vary in dependence on the infective dose, immunostatus of the host, complicating factors, and accompanying diseases. Only small proportion of infected dogs and cats (less than 10 %) shows acute clinical symptoms of salmonellosis (Green, 1998).

Clinical forms of the disease in small animals were described by Niemand and Suter (1996) as follows:

1. dormant infection with immunisation or persistent agent with the risk of reactivation,

2. secretory or haemorrhagic enteritis with or without occurrence of general symptoms,

3. acute sepsis or *endotoxaemia* with serious general symptoms, ileus and eventually exitus in shock,

4. transient enteritis with prolonged bacteraemia and organ infection with necrotic foci, abscesses, polyarthritis, pneumonia, and CNS disorders.

Green (1998) performed clinical observations of dogs and cats and distinguished the following: gastroenteritis, bacteraemia and endotoxemia, organ localisation or other syndromes.

Clinical symptoms associated with gastroenteritis are variable. Marked symptoms appear 3 to 5 days after the exposure of animals or after overcoming the stress in carriers. The symptoms are more serious in very young or old dogs and cats. Fever (40.0—41.1 °C), apathy and anorexia are accompanied by vomitus, abdominal pain and watery diarrhoea with the presence of mucus and fresh blood (Green, 1998).

According to Cantor et al (1997), there is no association between the type of diarrhoea (watery, mucous, bloody) and isolation of *Salmonella spp.*

Dow (1989) described 6 cases of clinical salmonellosis in cats of which only the animals marked 1, 4, and 5 manifested signs of gastroeneteritis. In the cat 1 with necrotic colitis the agent multiplied extensively which resulted in massive organ infection and septic shock. The cats marked 2 and 3 showed nonspecific symptoms and bacteraemia and acted as carriers. The cat No. 6 exhibited mixed infection with *Klebsiella pneumoniae.*

Fatal, salmonella-associated septicaemia that occurred after vaccination with a modified virus of feline panleukopenia was described by Dow (1989) and Foley (1999). Characteristic manifestations included dehydration, enlargement of spleen and mesenteric lymph nodes, weakness, and inadequate response to external stimuli.

Organ or metastatic infections follow the clinical or subclinical bacteraemia. The symptoms vary according to localisation, for example abscesses, meningitis, osteomyelitis, cellulitis, and so on (Topley, 1990).

Caldow and Graham (1998) described abortions in greyhounds caused by *S. montevideo*. Its serovar caused abortions in ewes and was isolated also from cattle in the northern Scotland. The agent was present in the stomach content and in foetal tissues. Similar to sheep, no significant clinical changes were observed in canine foetuses (Annon, 1994).

According to a number of authors, the seasonal migration of birds in the northeastern part of the USA is associated with *S. typhimurium* and acute febrile disease in cats characterised by depression, anorexia, vomitus, and diarrhoea and lasting 2 to 7 days. The mortality exceeds 10 % (Green, 1998).

Tauni and Osterlund (2000) described a similar disease in Sweden caused by *S. typhimurium.* Wild birds were the reservoir for cats. Of 62 anorectic and lethargic cats 57 % vomited and 31 % were affected by diarrhoea. In several cases the infection was transmitted also to humans.

Dahlinger et al (1997) made an effort to explain localisation of individual species of pathogenic bacteria that crossed the intestinal barrier. For this purpose they cultivated (aerobically and anaerobically) tissues from mesenteric lymphatic nodes of 50 healthy dogs. The nodes were obtained during hysterectomy. They examined also samples of peripheral and portal blood to eliminate haematogenic organisms as a source of contamination of lymphatic nodes. Bacteria were isolated from lymphatic nodes of 26 dogs (52 %). Three dogs were positive for *Salmonella spp.*.

The preferential locations of the long-term occurrence of salmonella agent in chronically infected individuals include spleen, liver, gallbladder, biliary ducts and in gallinaceous birds the oviducts. Recovery from any form of infection may result in a non-sterile immune status when the affected organism shows no signs of infection but eliminates fully virulent salmonellae in its excreta (The Merck Veterinary Manual, 1998).

Dogs and cats with experimentally-induced latent infection shed the agent irregularly for the subsequent 3 to 4 weeks. In rare cases this shedding continues for up to 100 days (We bber et al, 1995).

Green (1990) reported that dogs recovering from clinical salmonellosis may eliminate the agent in their faeces for 4 to 6 weeks. The excretion may be reactivated by stress or recurrent infections. Human carriers may act as a source of non-typhoid salmonella serovars and cause the so-called *reverse zoonoses.* This possibility should be considered particularly in those animal populations in which recurrent infections may become a problem.

Very dangerous are the highly resistant strains, such as *S. typhimurium* DT 104. This strain is resistant to ampicillin, chloramphenicol, streptomycin, (spectinomycin), sulphonamides and tetracyclin. It endangers the inhabitants of USA, Great Britain and Scotland due to the possible transfer of this agent from cattle, as described by Calvert et al (1998). The agent was also isolated (Gay, 1999) from clinically healthy dogs and cats that lived in the proximity of infected cattle herds which may become a potential source of infection also for children.

Kallo and Hasso (2001) examined 150 rectal swabs from dogs in Bagdad. They isolated 7 different salmonella serovars. The most frequent was *S. typhimurium* (29.4 %), followed by *S. give* (17.6 %) and *S. enteritidis* (17.6 %). In vitro examination showed that all isolates were 100 % sensitive to gentamycin and 97.1 % of them to chloramphenicol.

According to the studies mentioned the incidence of salmonella infection varies greatly among individual countries.

Our screening showed a 0.5 % positivity when 200 dogs and cats were examined for the presence of *Salmonella spp.* and 0.53 % positivity in dogs alone (187 animals) while no positive cat was found among the 13 examined. Our results are comparable with those of other studies carried out in this field.

Kwaga et al (1985) examined 303 dogs, out of that 198 females and 105 males. The group of examined animals included 93 puppies. Diarrhoea was observed in 11 animals. *Salmonela spp.* was isolated from 3 dogs, i.e. 1.0 % of examined animals was affected. The authors detected 3 salmonella serovars: *S. kofandoka, S. colindale* and *S. tamberma.*

From 1975 till 1994 Weber et al (1995) examined 5009 samples of excrements of dogs and cats in North Bavaria. They determined the presence of representatives of the genus *Salmonella spp.* in dogs and cats. The pathogen was present in 103 (3.45 %) out of 2985 dogs and in 39 (1.92 %) out of 2024 cats. The number of serovars isolated from dogs reached 32 and from cats 17. *S. typhimurium var. copenhagen* was the agent most frequently isolated from both dogs (33 %) and cats (49 %).

Hill and Cheney (2000) studied the prevalence of enteric zoonotic micro-organisms in cats. Eighty seven of them had diarrhoea, 106 showed no signs of gastrointestinal disorders and in 12 cats the consistence of excrements was unknown. Examination of faeces and serum samples proved the presence of *S. typhimurium* only in 1 % of these animals.

Cave et al (2000) used routine diagnostic tests in 260 dogs and detected *Salmonella spp*. in 3 of them. They failed to prove the presence of this pathogen in the additional 177 dogs with unchanged consistence of excrements.

The variability of occurrence of *Salmonella spp.* in the cases mentioned is associated with the ability of this pathogen to persist in the lymphatic nodes which also results in its intermittent excretion (Burnie et al, 1983).

The factors playing an important role in the occurrence of salmonellosis include coprophagia in dogs and the ability of the pathogen to survive in various environments. Saladiová et al (2001) summarised the survival of salmonellae in various environments (Tab. 3).

Exposure of gravid animals to salmonella micro-organisms can result in abortions, postnatal mortality or low viability of the young (Caldow, 1998).

In case of systemic salmonellosis the agent can be proved in body fluids, such as blood, urine, saliva, synovial fluid, tracheal lavage, cerebrospinal fluid, and also in bone marrow. Samples for cultural examination may be taken from the liver, bile duct and gallbladder, spleen, lungs, mesenteric lymphatic nodes and from intestinal bioptate during the post-mortem examination (Green, 1998).

The serovar isolated in our study is host-adapted to the cattle. It causes septicaemia or enteritis and diarrhoea in calves. In adult cattle it is manifested as diarrhoea, abortions and only occasionally as chronic enteritis or mastitis (Kováč et al, 2000).

According to Webber (1995), naturally infected dogs eliminated from 7 to 300 *Salmonella spp.* organisms (80 on average) per 1 g of excrements. Because of that only serious hygiene shortcomings may result in human infections (105 dose is the minimum needed to cause infection in humans).

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