Chapter 22
Dogs and Transmission of Infection to Man, "Respected Member of the Family?"

Frans van Knapen and Paul Overgaauw

Abstract Numerous reviews on dog zonoses address long-lasting lists of zoonotic infections, observed worldwide or very specifically in certain regions only. Here we describe the average family dog in the Western hemisphere owned by an average family without sufficient knowledge about potential hazards their pet might transmit to family members.

This chapter is based on semi quantitative risk analysis in order to rank potential health risk transmitted from family dogs to human. Surprisingly every day risk is different from the generally expected potential risk according to traditional ranking of hazards (zoonoses) in dogs in general. Attention is given to human behavior regarding the family dog and responsible dog ownership. Modern trends include pet travel or pet import from endemic to non-endemic areas, without sufficient knowledge amongst pet owners or public health institutes. Of great value is information provided by ESCCAP (www.esccap.org) with information for European countries (veterinarians and pet-owners) on prevalences and prevention of parasitic infections in dogs and cats in the major languages of Europe.

Eventually attention is paid to new trends in dog feed such as feeding bones and raw meat. This may have serious consequences for the spread of ordinary zoonoses like Salmonella and parasitic infections not only between dogs, but also to family members.

A last point of attention is the prevention of attracting wild life zoonoses via dogs to family members (eg. *Echinococcus multilocularis* and *Baylisascaris* spp.).

Authorities responsible for public health should be encouraged to pay more attention, not only in providing more regulations, but primary in enforcement of existing rules and stimulating responsible pet-ownership. Companion animal veterinarians and (local) public health authorities, including physicians, should contribute equally in zoonoses prevention programs ('One health' approach).

F. van Knapen (✉) · P. Overgaauw
Faculty of Veterinary Medicine, Institute of Risk Assessment Sciences, Veterinary Public Health, Utrecht University, Utrecht, The Netherlands
e-mail: f.vanknapen@uu.nl

P. Overgaauw
e-mail: p.a.m.overgaauw@uu.nl

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22.1 Introduction

Until about the turn into the twenty-first century zoonoses were regarded by the medical profession as 'just a number' of the well-known infectious diseases in the modern ('western') part of the world. As infectious diseases in that part of the world were overcome by increased public hygiene, food safety, vaccinations and proper antibiotic treatment if necessary, there seemed no need for further attention. However, a number of events has attracted public and political awareness for new and re-emerging zoonoses such as the rapid spread of SARS in 2002 (Peiris et al. 2003), West Nile virus throughout the United States (Shephard et al. 2006), the outbreaks of avian influenza in South East Asia, but also in Europe (Shortridge et al. 2003) with varying types (H5N1, H7N7) leading to human casualties which alarmed public health authorities in many countries.

In 2004 a joint WHO/FAO/OIE consultation on emerging zoonoses was held in Geneva (WHO/FHO/OIE 2004). Other incidents fostered this change such as antibiotic resistance supposed to be related with animal treatments (MRSA, ESBL) (Weese 2010; Friese et al. 2013), and the tremendous spread of ordinary grey ticks (*Ixodus ricinus*) and consequently Lyme disease in humans (Van der Giessen et al. 2010). A central question to be answered is what role do veterinarians play in public health in the twenty-first century (WHO 2002). In this chapter we will concentrate on some relevant dog zoonoses and the role of the dog owner in infection and prevention.

Dog zoonoses and public health has been addressed recently in full detail (Macpherson et al. 2013). A traditional approach to deal with zoonoses is to use a template including the biology of the germ, epidemiology, disease in humans and animals, diagnosis, and prevention or control of the disease. Often it means a mere enumeration of zoonoses found in dogs without further going into relative health risks for dog owners or the population at large through environment pollution (Tan 1997). Depending on the endemicity of particular zoonoses in certain areas of the world more attention may be paid to these (e.g. echinococcosis and toxocarosis, Carmena and Cardona 2013; Desplazes et al. 2011).

In this chapter we will concentrate on pet-ownership in an average (north) west European country without endemicity for diseases like leishmaniosis, rabies or heartworm disease. We pay attention to the average family dog in an average family with more or less awareness about potential health risks, however, enjoying having a pet.

22.2 Risk Analysis

The relative risks for human health consequences or the attribution because of having dogs for the huge variety of dog zoonoses is largely unknown or studies carried out remain to be inconclusive. This is due to failure in examining both pet owners and their pets simultaneously and comparing isolates by genotyping, serotyping or

other identification methods to suggest a one way cross infection or having a common source for infection elsewhere. There are, however, also indications that some infections may be transferred from humans to their dogs, such as MRSA (Levebvre et al. 2009) and *Giardia* spp. The zoonotic potential of *G. duodenalis* is considered as evident, based on findings of assemblages A and B in man as well as in dogs. Authors automatically concluded then a one-way transmission route to the human (Marangi et al. 2010; Dado et al. 2012). Knowing the infectious potential of the *Giardia* parasite, this does not exclude at all an interaction between owner and his dog. Evidence on the contribution and frequency of the zoonotic potential is (still) lacking (Sprong et al. 2009).

Each risk analysis starts with summing up potential biological hazards (H), in this case zoonoses, in an area and is followed by hazard characterization including prevalence figures in the reservoir (dogs), virulence for humans, transmission routes, and survival of the agent in the environment. These criteria are then weighed, mostly based on experts opinions.

The second step is exposure assessment (E). Who is exposed to the potential hazard and for how long or how often. How much of the potential pathogen is needed to become a health risk? This inevitably is directly related to human behaviour in relation to their dog.

The third step is to calculate the impact of getting infected, e.g. how serious is the disease, what is the chance for complications Disability-adjusted life years (DALY's), and what economic consequences may be expected (labour hours lost). Each of the parameters can be ranked in classes 1–5, where 1 stands for negligible and 5 for the most serious possibility. Ranking is based on literature data, own observations (measuring) or expert opinions, thus arbitrarily.

The final risk assessment can be achieved by multiplying the outcome of hazard characterization, exposure assessment and impact (H × E × I=number). The outcome is nothing more than a ranking order of the potential health hazards and has no absolute meaning. Since these figures have been estimated for a large Dutch small animal practice (Berends 2006) we shortly refer to the results. Table 22.1 provides the top five of zoonoses in dogs according to the hazard characterization ranking order. In Table 22.2 the ranking order of exposure to dog zoonoses is pro-

Table 22.1 Ranking order of biological hazard characterization in dogs

1.	*Rabies*
2.	*Capnocytophaga canimorsus*
3.	*Leptospira spp.*
4.	*Salmonella spp.*
5.	*Campylobacter spp.*

Table 22.2 Ranking order of exposure assessment

1.	*Dermatophytes*
2.	*Pasteurella mutocida, P. canis*
3.	*Staphylococcus aureus/intermedius/ pseudointermedius*
4.	*Campylobacter*
5.	*Salmonella*

Table 22.3 Ranking order of potential human health risks due to dog zoonoses

1.	*Campylobacter*
2.	*Pasteurella spp.*
3.	*Salmonella spp.*
4.	*Staphylococcus spp.*
5.	*Giardia duodenalis*

vided. Eventually in Table 22.3 the top five important dog zoonoses in an average small animal clinic are mentioned. We will use this point of departure because the intensive contact clinicians have with dogs will certainly be comparable to that of the owner with only one important exception: the duration of exposure. Since this is also subject to the owner's behaviour which will be discussed in the next paragraph.

22.2.1 Having Dog as Pet

Companion animals enhance the psychological and physiological well-being of the human because of psychological support, friendship, and even good health practices (exercising or reducing stress). Dogs play an important role in the development and in the treatment of behavioral problems of children, the well-being of the elderly, and decrease work leave through illness and visits to the doctor (Beck and Meyers 1996). Pet ownership certainly will lead to health benefits, although not all (social) studies have been based on correct methodologies (Koivulsilta and Ojantlava 2006).

Here we deal with potential biological hazards (zoonoses) that may have negative health consequences for the owner. The starting point is Table 22.3, which ranks the zoonoses with potential health risks for individuals with short but intensive contact, such as veterinarians or breeders. It may be assumed that exposure to the potential hazards mentioned will be much higher and long lasting when the owner (family) is involved. The actual top five zoonoses, however, will remain similar and concerns fecal-oral route of transmission (*Campylobacter, Salmonella, Giardia*), direct contact (*Staphylococus* spp.) and injuries as result of bites, licking, and scratching (*Pasteurella multocida, P. canis*) .

22.2.2 Human Behavior

As pets are increasingly considered as member of the family, physical contact is very common. Cuddling, stroking, and playing with the animals are all normal behaviour of dog owners and even more their kids. It is part of enjoying pet animals, but pets have become more often substitutes for childbearing and child care, sometimes leading to excessive pet care and intensive contacts (Chomel and Sun 2011).

It is remarkable that during dining of the owner, dogs are often allowed to approach, to beg for snacks, and being stroked or even worse are allowed to join the dinner. Therefore, it would be evident to at least wash hands after the fun and before a meal. The number of potential pathogens such as enterobacteriaceae (Westgarth

et al. 2008) or parasite eggs (Keegan and Holland 2010) from the fur of most animals, including dogs, is easily detectable and can be washed off by flushing water and ordinary household soap. It is self-evident behaviour to do so before sitting down for dinner or after visiting a washroom, which is part of upbringing and education.

Licking in the face, or sharing an ice cream is part of showing mutual affection and is allowed by as much as 50% households (Overgaauw et al. 2009). The idea that the tongue of a dog is clean and may even be used to clean up wounds by licking is widespread among the public and sometimes even among first aid health professionals (Verrier 1970). In literature, increasingly indications can be found that licking by a dog may lead to infections (Booij-Vrieling 2010; Haesebrouck et al. 2009); or serious health consequences in individual cases (Shewring and Rushforth 1990; Wade et al.1999; Overgaauw and Van Knapen 2012).

Allowing dogs to sleep in the bedroom (33–56%) or even to sleep in the bed of the owner (18–50%) is certainly contributing to the transmission of zoonoses including parasites (Overgaauw et al. 2009; Chomel and Sun 2011). Intensive contact with skin and nose, *Staphylococcus* spp., even when the dog is healthy and without skin lesions, may lead to contamination with antimicrobial resistant strains (MRSA) (Kempker et al. 2003; Cain 2013).

Having one or more dogs in the household means that soil from outdoors is regularly spread throughout the house. Dogs were regularly reported to have soil transmitted parasitic infections in their fur (Keegan and Holland 2010) with as yet unknown consequences for the owner however it should be kept in mind that even *Toxocara* eggs may be easily found in household dust from dog owner houses (Overgaauw and Boersema 1998).

Amongst soil transmitted diseases serious consideration must be given to toxoplasmosis, because dogs might act as active distributors of oocysts from the environment. Dogs regularly and actively roll in faeces of other animals or are eating these (Frenkel et al. 1996; Nijsse 2013).

An important role of the veterinarian is to make owners aware of the potential risks and that personal hygiene and proper cleaning of the house/kitchen is necessary, without frightening them. Awareness and responsible pet ownership are the most important issues to achieve a healthy relationship between owner and dog.

22.2.3 Responsible Pet Ownership

The benefits of pet ownership come with obligations. This is called responsible pet ownership and includes among others that owners provide preventive (e.g., vaccinations, parasite control) and therapeutic health care for the life of pet(s) (AVMA 2012) to prevent transmission of pathogens to the human. Responsible pet ownership also means that dog owners should realize that the other half of the population have no dogs or may even not like dogs. Annoyance about dog faeces in the streets or noisiness is common. Dog owners can contribute to public discussions in communities to show their attitude to regular deworming or parasite control, health certificates and to clean up the faeces of their dog while walking. It is surprising to see the differences between dog owner's attitudes in various countries in Europe. While

British dog owners are used to clean dog faeces, Dutch citizens are not sufficiently stimulated to do so. Only 39% of dog owners report to regularly clean up faeces of their dog (Overgaauw et al. 2009).

22.3 New Trends

22.3.1 Emerging Zoonoses

'Emerging zoonoses' are zoonoses that are newly recognized or newly evolved or that have occurred previously, but show an increase in incidence or expansion in the geographic, host, or vector range' (WHO/FAO/OIE 2004). A major issue of spreading zoonoses with dogs is transport from endemic areas to non-endemic areas. In the EU without borders such transports only require mandatory health certificates, signed by an official veterinarian, and proper vaccinations (e.g. rabies). Rabies, *Echinoccocus granulosus* and *Leishmania* are in many countries therefore 'imported' infections. Import of canine babesiosis (not a zoonosis) and probable settlement in Western Europe including its vector (*Dermacentor reticulatus*) are a clear sign of dragging off zoonoses (Daugschier 2001). Harmonization of parasite control in Europe has taken place by the independent organization ESCCAP (www.esccap.org) in order to enable veterinarians to inform clients about the differences of endemic diseases in the various European countries and how to prevent contracting or importing infectious diseases when traveling with dogs (holidays, animal assisted-dogs) or purchasing dogs from abroad. Obviously, this is not only of value regarding parasitic infections, but also for bacterial or viral zoonoses (e.g. brucellosis, rabies), however, comparable informative websites for veterinarians do not exist yet. Transports from dogs originating from Eastern Europe (Romania, Bulgaria) and Mediterranean countries (Spain, Italy) for commercial enterprise to the Northwest of Europe increase the spreading of unwanted and unexpected zoonoses to non-endemic areas such as cystic echinococcosis (Carnena and Cardona 2013). The shifting frontier lines from the South (e.g. *Leismania*) and Middle Europe towards Western and Northern Europe (e.g. *E. multilocularis*) also suggest changes of habitats whether or not supported by climate change. On the ESCCAP website these changes are regularly updated.

22.3.2 Feeding of Raw Meat to Dogs

Although many dog owners in the Western world feed their pets industrially processed food, an upward trend is emerging towards feeding home-made food instead of pre-prepared food, which may consist of leftovers, home-made and prepared meals, bones, raw meat, and organ meat. Outbreaks of Salmonella have been described, which could be linked to contaminated animal food. Care takers and family

members can become infected with *Salmonella*, not only when preparing food that contains raw meat, but also after being in contact with infected animals that excrete the bacteria (Finley et al. 2006; Lefebvre et al. 2008; Schlesinger 2002), and after being in contact with infected food bowls, for example when cleaning them (Weese et al. 2006). Dogs regularly lick their anus and it has been found that over half of all dog and cat owners allow their pets to lick their hands or faces. By this way, bacteria may be spread. Especially individuals with a impaired resistance are at a greater risk of becoming ill. Therefore, it is recommended that dogs living with children, elderly and those being used therapeutically in caring for people, are not allowed to eat fresh meat. As long as dogs are fed with commercially available (complete) diets, which are free from pathogens (canned, dry food), there exists no danger in getting infected through the feed chain.

22.3.3 Contact with Wildlife Zoonoses

Hunting dogs that are allowed to feed on waste of wild animals, or free ranging dogs hunting or scavenging for their own feed, are at more risk of picking up zoonoses that may have serious consequences for the owners health. In *Echinococcus multilocularis* (fox tapeworm) endemic areas (see www.esccap.org), there is a real risk that (hunting) dogs may become infected with this tapeworm. Because *E. multilocularis* easily grows in dogs the threat of spreading it to owners is also realistic. Monthly deworming in endemic areas is strongly recommended (Hegglin and Deplazes 2013). Moreover in areas with raccoons and raccoon dogs in wildlife in large parts of Europe a new threat is the appearance of *Baylisascaris* spp. in dogs, too. This emerging zoonosis, potentially leading to severe larva migrans infection in animals, humans, and particularly in children needs further attention (Okulewicz and Buńkowska 2009; Lee et al. 2010).

22.3.4 Dogs and Transmission of Human Viruses

The increasing role of influenza A virus and human disease and the threat of new pandemics of new types (hemagglutinin (H) and neuraminidase (N)) also reflects dogs and cats. So far canine influenza (H3N8) does not cause harm to humans, but human pathogenic influenza isolates are able to infect dogs and cats and these animals may play a role in interspecies transmission and spread of influenza virus (Song et al. 2008). Small animal practitioners may play an important role in early warning systems for influenza in humans and dogs (Beeler 2009).

Recently, it was shown that human noroviruses can survive in dog's gastrointestinal tract. This major source for human diarrheal disease worldwide is suggested to be transmitted from human to dog and consequently may be transferred to others (Summa et al. 2012).

Table 22.4 Additional potential health risks for dog owners depending on behaviour, travelling or import of dogs form areas endemic for zoonoses not covered by Table 22.3

1.	*Echinococcus granulosus*
2.	*Echinococcus multilocularis*
3.	*Toxocara spp.*
4.	*Bayliscascaris spp.*
5.	*(Influenza/norovirus)*
6.	*(Toxoplasma)*

Additional potential health risks for dog owners depending on behaviour, travelling or import of dogs form areas endemic for zoonoses that are not covered by Table 22.3, are presented in Table 22.4.

22.4 Authorities Involvement

With respect to emerging zoonoses, early warning and surveillance are important issues (Van der Giessen et al. 2010). Although active surveillance systems exist particularly for livestock and wildlife, no such system exists for pet animals.

Notifiable diseases from pet animals in the Netherlands include brucellosis, campylobacteriosis, echinococcosis, leptospirosis, rabies, salmonellosis, toxoplasmosis, tuberculosis and yersiniosis. Data are however scarce and undoubtedly underreporting occurs. This may be due to improper diagnosis or ignorance. Enforcement of the existing legislation should be the first goal of authorities. Community administration however is regularly confronted with complaints of citizens about dogs and dog behaviour and indirectly about dog owner behaviour. This was mentioned before and requires more attention of local authorities. Responsible pet ownership should get more attention and may be stimulated locally. Dogs enduring health certification by a veterinarian at regular intervals including proper parasite control, vaccinations, and general health checks, may be rewarded with a recognizable medal to their collar. In such way the dog owner may show (social control) his or her public responsibility. Moreover, the obligation to clean up one's own dog's faeces should be stimulated by the national government in those countries where this is not yet commonly practiced.

22.5 Conclusions

The role of the companion animal veterinarian is not only to care for animal diseases, but is increasingly becoming important in the field of veterinary public health.

Livestock veterinarians and official veterinarians have taken up this responsibility already for long. Disease detection, reporting and prevention are important issues. Companion animals, including dogs, may act as important sentinels for public

health. Veterinarians should advice more often to pet (dog) owners about health education regarding husbandry, dog behaviour and responsible pet ownership. Co-operation with community health services and the local administration should be part of the contribution of small animal practitioners in the twenty-first century 'One health' approach (Trevejo 2009)

References

AVMA (Am. Vet. Med. Ass.) (2012) Guidelines for Responsible Pet Ownership. Pet ownership brochure.

Beck AM, Meyers NM (1996) Health enhancement and companion animal ownership. Annu Rev Public Health 17:247–257

Beeler E (2009) Influenza in dogs and cats (Trevejo T Saunders (Ed), Elsevier Inc). Vet Clin Small Anim 39:251–264

Berends BR (2006) Risico inventarisatie en evaluatie van het niet-gericht werken met microbiologische agentia in de Universiteitskliniek voor Gezelschapsdieren in Utrecht. Internal report Institute for Risk Assessment Sciences (IRAS) division Veterinary Public Health. Utrecht

Booij-Vrieling HE et al (2010) Comparison of periodontal pathogens between cats and their owner. Vet Microbiol 144:147–152

Cain CL (2013) Antimicrobial resistance in *staphylococci* in small animals. Vet Clin North Am Small Anim Pract 43(1):19–40

Carmena C, Cardona GA (2013) Canine echinococcosis: global epidemiology and genotypic diversity. Acta-Trop 128(3):441–460.(Epub ahead of print)

Chome lBB, Sun B (2011) Zoonoses in the bedroom. Emerg Infect Dis 17:167–172

Dado D, Montoya A, Blanco MA, Miró G, Saugar JM, Bailo B, Fuentes I (2012) Prevalence and genotypes of *Giardia duodenalis* from dogs in Spain: possible zoonotic transmission and public health importance. Parasitol Res 111:2419–2422

Daugschier A (2001) Importation of parasites by tourism and animal trading (article in German). Dtsch Tierartzl Wochenschr 108(8):348–352

Desplazes P, Knapen F van, Schweiger A, Overgaauw PAM (2011) Role of pet dogs and cats in the transmission of helminthic zoönoses in Europe, with a focus on echinococcosis and toxocarosis. Vet Parasitol 182:41–53

Finley R, Reid-Smith R, Weese JS (2006) Human health Implications of *Salmonella*-contaminated natural pet treats and raw pet food. Clin Infect Dis 42:686–691

Frenkel JK, Dobesh M, Parker BB, Lindsay DS (1996) Xenosphilia of dogs: a habit favoring the mechanical transmission of Toxoplasma gondii and other fecal microbes. Programme guide and abstracts for the joint meeting of the American Society of Parasitologists and the Society of Protozoölogists, p 110

Friese A, Schulz J, Laube H, von Salviati C, Hartung J, Roesler U (2013) Faecal occurrence and emissions of livestock-associated methicillin-resistant *Staphylococcus aureus* (laMRSA) and ESbl/AmpC-producing *E. coli* from animal farms in Germany. Berl Munch Tierarztl Wochenschr 126:175–180

Giessen JWB van der, Giessen AW van de, Braks MAH (2010) Emerging zoönoses: early warning and surveillance in the Netherlands. RIVM report 330214002

Haesebrouck F, Pasmans F, Flahou B, Chiers K, Baele M, Meyns T, Decostere A, Ducatelle R (2009) Gastric helicobacters in domestic animals and nonhuman primates and their significance for human health. Clin Microbiol Rev 22:202–223

Hegglin D, Desplazes P (2013) Control of *Echinococcus multilocularis*: strategies, feasibility and cost-benefit analysis. Int J Parasitol 43(5):327–337

Keegan JD, Holland CV (2010) Contamination of the hair of owned dogs with the eggs of *Toxocara* spp. Vet Parasitol 173:161–164
Kempker R et al (2003) Beware of the pet dog: a case of *Staphylococcus aureus* (MRSA) in a pet dog associated with mrsa infection in household contacts. Clin Infect Dis 46:26–28
Koivusilta LK, Ojantlava A (2006) To have or not to have a pet for better health. Plos ONE 1(1):e109
Lee ACY, Schantz PM, Kazacos KR, Montgomery SP, Bowman DD (2010) Epimiologic and zoönotic aspects of ascarid infections in dogs and cats. Trends Parasitol 26:155–161
Lefebvre SL, Reid-Smith R, Boerlin P, Weese JS (2008) Evaluation of the risks of shedding Salmonellae and other potential pathogens by therapy dogs fed raw diets in Ontario and Alberta. Zoonosis Public Health 55:470–480
Lefebvre SL, Reid-Smith RJ, Waltner-Toews D, Weese JS (2009) Incidence of acquisition of methicillin-resistant *Staphylococcus aureus, Clostridium difficile*, and other health-care–associated pathogens by dogs that participate in animal-assisted interventions. J Am Vet Med Ass 234:1404–1417
Macpherson CNL, Meslin FX, Wandeler AI (eds) (2013) Dogs, zoönoses and public health. CABI, New York
Marangi M, Berrilli F, Otranto D, Giangaspero A (2010) Genotyping of Giardia duodenalis among children and dogs in a closed socially deprived community from Italy. Zoonoses Public Health 57:e54–58
Nijsse ER, Wagenaar J, Ploeger H (2013) Coprophagy interferes with coproscopical diagnosis of helminth infections in dogs. Proceedings 24th International Conference of World Association Advancement Veterinary Parasitology. Perth, p 423
Okulewicz A, Buńkowska K (2009) Baylisascaris—a new dangerous zoönosis [article in Polish]. Wiad Parazytol 55(4):329–334
Overgaauw PAM, Boersema JM (1998) Nematode infections in dog breeding kennels in the Netherlands, with special reference to Toxocara. Vet Quart 20:12–15
Overgaauw PAM, Knapen F van (2012) (in Dutch) Is being licked by dogs not dirty? Tijdschr Diergeneeskd 137(9):594–596
Overgaauw PAM, Zutphen L van, Hoek D, Yaya FO, Roelfsema J, Pinelli E, Knapen F van, Kortbeek L (2009) Zoönotic parasites in fecal samples and fur from dogs and cats in the Netherlands. Vet Par 163:115–122
Peiris JSM, Yuen KY, Osterhaus ADME, Stöhr K (2003) The severe acute respiratory syndrome. N Engl J Med 349:2431–2441
Schlesinger JDJ (2002) Preliminary assessment of the risk of Salmonella infection in dogs fed raw chicken diets. Can Vet J 43(6):441–442
Shepherd R, Aryel RM, Shaffer L (2006) Animal Health. In: Wagner MM, Moore AW, Aryel RM (eds) Handbook of biosurveillance. Elsevier Acamedic Press, Boston, pp 111–127
Shewring DJ, Rushforth GF (1990) A bizarre postoperative wound infection. Br Med J 300:1557
Shortridge KF, Peiris JS, Guan Y (2003) The next influenza pandemic: lessons from Hong Kong. J Appl Microbiol 94:70S–79S
Song D, Kang B, Lee C, Jung K, Ha G, Kang D et al (2008) Transmission of Avian Influenza Virus (H3N2) to dogs. Emerg Inf Dis 14:741–746
Sprong H, Cacciò SM, Giessen JW van der (2009) ZOOPNET network and partners. Identification of zoonotic genotypes of *Giardia duodenalis*. PLoS Negl Trop Dis 3:e558
Summa M, Bonsdorff CH von, Maunula L (2012) Pet dogs—a transmission route for human noroviruses? J Clin Vir 53:244–247
Tan JS (1997) Human zoönotic infections transmitted by dogs and cats. Arch Int med 157:1933–1943
Trevejo RT (2009) Public health for the twenty-first century: what role do veterinarians in clinical practice play? In: Trevejo T (ed) Vet Clin Small Anim 39:215–224. Saunders/Elevier Inc
Verrier L (1970) Dog licks man. Lancet 295:615
Wade T, Booy R, Teare EL, Kroll S (1999) *Pasteurella multocida* meningitis in infancy (a lick may be as bad as a bite). Eur J Pediatr 159:875–878

Weese JS, Rousseau J (2006) Survival of *Salmonella Copenhagen* in food bowls following contamination with experimentally inoculated raw meat: effects of time, cleaning, and disinfection. Can Vet J 47:887–889

Weese JS (2010) Methicillin-resistant *Staphylococcus aureus* in animals. ILAR J 51:233–244

Westgarth C, Pinckbeck GL, Bradshaw JWS, Dawson S, Gaskell RM, Christley RM (2008) Dog-human and dog-dog interactions of 260 dog owning households in a community in Cheshire. Vet Rec 162:436–442

WHO (2002) Future trends in veterinary public health. Report of a WHO studygroup. WHO technical report series, 907

WHO/FAO/OIE (2004) report of the joint consultation on emerging zoönotic diseases. Geneva Switzerland