



# Companion Animals as a Source of Viruses for Human Beings and Food Production Animals

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## Summary

Companion animals comprise a wide variety of species, including dogs, cats, horses, ferrets, guinea pigs, reptiles, birds and ornamental fish, as well as food production animal species, such as domestic pigs, kept as companion animals. Despite their prominent place in human society, little is known about the role of companion animals as sources of viruses for people and food production animals. Therefore, we reviewed the literature for accounts of infections of companion animals by zoonotic viruses and viruses of food production animals, and prioritized these viruses in terms of human health and economic importance. In total, 138 virus species reportedly capable of infecting companion animals were of concern for human and food production animal health: 59 of these viruses were infectious for human beings, 135 were infectious for food production mammals and birds, and 22 were infectious for food production fishes. Viruses of highest concern for human health included hantaviruses, Tahyna virus, rabies virus, West Nile virus, tick-borne encephalitis virus, Crimean–Congo haemorrhagic fever virus, Aichi virus, European bat lyssavirus, hepatitis E virus, cowpox virus, G5 rotavirus, influenza A virus and lymphocytic choriomeningitis virus. Viruses of highest concern for food production mammals and birds included bluetongue virus, African swine fever virus, foot-and-mouth disease virus, lumpy skin disease virus, Rift Valley fever virus, porcine circovirus, classical swine fever virus, equine herpesvirus 9, peste des petits ruminants virus and equine infectious anaemia virus. Viruses of highest concern for food production fishes included cyprinid herpesvirus 3 (koi herpesvirus), viral haemorrhagic septicaemia virus and infectious pancreatic necrosis virus. Of particular concern as sources of zoonotic or food production animal viruses were domestic carnivores, rodents and food production animals kept as companion animals. The current list of viruses provides an objective basis for more in-depth analysis of the risk of companion animals as sources of viruses for human and food production animal health.

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*Keywords:* companion animal; livestock; virus; zoonosis

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## Introduction

Little is known about the role of companion animals in the transmission of pathogens, in particular viruses, to man or to livestock. A plethora of viruses have zoonotic potential (Gortazar *et al.*, 2014) or are of economic importance as they infect food production animals (Morgan and Prakash, 2006). Studies aiming at inventorying viruses with zoonotic potential have revealed their expanding diversity with an average of three to four new zoonotic pathogens identified each year (Woolhouse *et al.*, 2012). Wild animal species commonly are the source of these novel or newly identified pathogens. New virus species, and sometimes even new virus genera, have been reported increasingly in wild animal species, such as bats or rodents (Drexler *et al.*, 2012, 2013).

Viruses of economic importance, because of their ability to infect and cause disease in food production animal species (and therefore their ability to undergo transboundary spread), have long been listed by international organizations, such as the Office International des Epizooties (OIE; World Organisation for Animal Health; [www.oie.int](http://www.oie.int)), with associated regulatory phytosanitary measures. In addition, as for zoonotic pathogens, new pathogens are recognized occasionally to infect food production animals. Wild animal species are likewise often implicated in the transmission of such newly discovered pathogens, both to human beings and to livestock species (Field *et al.*, 2007; Raj *et al.*, 2014).

Companion animals, in particular domestic carnivores, also are hosts of an expanding diversity of viruses. For example, canine parvovirus, now a major pathogen of domestic dogs worldwide, emerged in the 1970s (Parrish, 1999). Influenza A viruses that appear to be maintained in domestic dog populations have only recently emerged (Dubovi, 2010). However, populations of companion animal species are expanding both in size and diversity, in particular in industrialized countries. In this review, companion animals are defined as any domesticated, domestic-bred or wild-caught animals, permanently living in human communities and kept by people for company, amusement, work (e.g. support for blind or deaf people, police or military dogs) or psychological support. These include dogs, cats, horses, rabbits, ferrets,

guinea pigs, reptiles, birds and ornamental fish, but also food production animals, such as domestic pigs, kept as companion animals. These changes in populations of companion animals have so far not been matched with an assessment of the role of these animals as a source of zoonotic viruses and viruses of economic importance in livestock. Here, we review the literature on the occurrence of infections of companion animal species by zoonotic viruses and viruses of food production animals in order to establish a complete list of viruses that could possibly be transmitted from companion animals to man or livestock, based on published records of cross-species transmission. We further prioritize these viruses semiquantitatively, in terms of health and economic importance, by ranking the likelihood that companion animals act as relevant sources for the cross-species transmission of the listed viruses, and associated potential impact, with a special focus on Europe.

## Materials and Methods

### *Literature Search*

We retrieved articles published before 1st July 2012 in PubMed to identify and list mammalian, avian and fish viruses that have proven ability to cross the species barriers between companion animals and man or between companion animals and food production animals. To this end, PubMed was searched for combinations of terms belonging to the following general categories: ‘virus’ AND ‘companion animal’ AND ‘food production animal’ OR ‘human’ (Supplementary Tables 1a and 1b). Viruses of food production animals (without report of infection in companion animals) were also included, to account for the risk posed by viruses transmitted from ruminants, pigs and poultry kept as companion animals to people or food production animals. Zoonotic viruses and viruses of food production animals were considered capable of infecting companion animals, based on published positive polymerase chain reaction (PCR) data, viral isolation or serology in the latter. Accordingly, a total of 170 viruses or virus groups at or below genus level were included (Supplementary Table 2).

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