Schweizerische Eidgenossenschaft
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Tiergesundheit und Zoonosen **One Health**

Importance of SARS-CoV-2 Infections in Animals of COVID-19 Affected Households and Influence of Hygiene Standards

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Key words
SARS-CoV-2, One Health, COVID-19 households, interspecies transmission, infection prevention and control, hygiene measures, risk factors, prevalence, immune response, phylodynamic analysis, virus reservoir

Aim of the study
This study was performed (i) to investigate the prevalence and importance as well as the clinical presentation, and geographic and demographic distribution of SARS-CoV-2 infections in companion animals living in COVID-19 affected households by RT-qPCR to monitor active infections and by serology to determine exposure rates, (ii) to assess hygiene standards and animal-human interactions via a query of the household members through a standardized questionnaire in order to identify possible risk factors for the infection of companion animals, and (iii) to investigate sources as well as transmission routes of animal infections by including sequence analysis of viruses from humans and animals and phylogenetic and dynamic analyses.

Material and methods
Companion animals from COVID-19 affected Swiss households were tested for SARS-CoV-2 infection after the animal owners had been informed and had consented to the study. For each animal sampling was performed for RT-qPCR at five different locations: mouth, nose, feces, fur, and animal bed. Two follow-up samplings were performed at 7-day intervals or at shorter intervals, when the animal tested positive. If possible, blood samples were taken from the animals after the infection and tested for antibodies. In addition, data on standard hygiene and animal-human interactions in the household were collected via a questionnaire to assess potential risk factors for within–household transmission of SARS-CoV-2.

Results and significance
In total 302 animals, including 214 cats, 78 dogs and 10 other animals, from 171 COVID-19 affected households were sampled for the study. The participating households were located in 16 different Swiss cantons. Positive/Questionable positive RT-qPCR results were confirmed in 35 cats (15%) and 24 dogs (31%) by the Institute of Virology and Immunology. Serologically, 21 of 54 animals (39%), from which blood samples were available (33 cats and 21 dogs), tested positive for SARS-CoV-2 antibodies; this included six dogs (29%) and 15 cats (45%).

A special focus in our research has been set on the SARS-CoV-2 delta variant positive households: eleven cats and three dogs in nine COVID-19-positive households were RT-qPCR and/or serologically positive for the SARS-CoV-2 Delta variant. Using next generation sequencing, four different pangolin lineages were recognized in the infected animals, including two lineages (AY.129, AY.4) that had not been reported previously in animals. We determined a low number of differences in the viral sequences obtained from animals or owners. This indicates that in most households, direct transmission between owners and animals is most likely, while in the multi-pet households animal-to-animal transmission could not be excluded. Exclusive differences in the SNP and similarities among different animal sequences may indicate an adaptation of the virus to the animal hosts.

A completed questionnaire has been analyzed from 122 (71.3%) COVID-19 affected households. The presence of minors in the household increased the risk of animals to be infected. For cats, the infection risk was decreased if they had outdoor access or their litter box was emptied less frequently. Environmental samples (fur, animal bedding) tested positive significantly more often when the animals in the household tested also positive. Due to only zero to three single-nucleotide polymorphisms differences SNPs between owner and animal sequences, this study confirms the importance of within–household transmission as the main route of SARS-CoV-2 transmission between owners and their animals. It supports the importance of monitoring infection transmission and dynamics in humans and companion animals using a One Health approach.

Publications, posters and presentations

Chan, T. Presentation of the poster: “Importance of SARS-CoV-2 Infection in Animals of COVID-19 Affected Households and Influence of Hygiene Standards auf dem 4th Poster and Networking Day der Vetsuisse Faculty (23. September 2021)

Chan, T., et al., SARS-CoV-2 Infektion bei Katzen, Hunden und anderen Tieren: Erkenntnisse zur Infektion und Daten aus der Schweiz. Schweizer Archiv für Tierheilkunde, 2021

Kuhlmeier, E. Presentation of the poster: “Detection, Molecular Characterisation of the SARS-CoV 2 Delta Variant and Specific Immune Response in Companion Animals” und “Risk factor analysis for SARS CoV 2 infection in companion animals living in SARS CoV 2 affected households in Switzerland” auf dem ISCAID Kongress, Glasgow, (4.- 7. September 2022)

Kuhlmeier, E. Presentation of the poster: “Risk factor analysis for SARS CoV 2 infection in companion animals living in SARS CoV 2 affected households in Switzerland” auf dem 5th Poster and Networking Day der Vetsuisse Faculty (29. September 2022)

Further publications in preparation:

Kuhlmeier, E.; Chan, T.; Valenzuela Agüí, C.; et al. Detection and Molecular Characterization of the SARS-CoV-2 Delta Variant and the Specific Immune Response in Companion Animals in Switzerland; Kuhlmeier E. et al., Risk factor analysis for SARS-CoV-2 infection of animals in COVID-19 affected households

Project *1.21.14*

Project duration *April 2021 - December 2022*