UNCOVER

Usher Network for COVID-19 Evidence Reviews

Summary: What is the evidence for outdoor transmission of SARS-CoV-2?

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THE UNIVERSITY of EDINBURGH | usher institute

Title: What is the evidence for outdoor transmission of SARS-CoV-2?

Summary answer:

SARS-CoV-2 is transmissible by contact (fomites) and droplets. It can be detectable and viable in aerosols, suggesting another possible transmission route. We present the evidence in relation to outdoor transmission of SARS-CoV-2 under the following different approaches: epidemiological, microbiological, mechanistic and environmental. This update adds from three additional research articles on mechanistic studies (see below). The new key references added to this update are:
Evidence from epidemiological studies: We found very little epidemiological evidence about outdoor transmission. The quality of the evidence we found was very low. A descriptive epidemiological study of a disease cluster from China suggests that indoor transmission has a greater potential of causing outbreaks than outdoor transmission (Key reference [KR1]). Cross-sectional studies and case-reports suggest that the virus can be transmitted, directly or indirectly, by saliva and that there is a possibility of faecal-oral transmission. The latter is relevant to the issue of outdoor transmission in two ways: firstly, indirect transmission can occur if the virus is transferred from people's hands onto external surfaces such as fences, gates, petrol pump handles, pedestrian crossing buttons, etc. Secondly, those coming into contact with raw sewage may potentially be directly at risk (KR2).
Evidence from microbiological studies: A number of studies indicate that low temperatures and wet environments are most conducive to persistence of SARS-COV-2 (KR3-4); similar evidence comes from studies looking at other coronaviruses too). Two studies investigated the duration of persistence for SARS-CoV-2 on different surfaces for various time periods (KR4-5) and was found to be more stable on smooth surfaces (e.g. plastic and stainless steel). It must be stressed that these studies were laboratory-based, and therefore generalisability to real-world and outdoor contexts may be limited.
Evidence from mechanistic studies: The extent to which droplets and aerosol are dispersed is measured in laboratories. The ranges depend on temperature, humidity and environmental airflows, and this is true in both indoor and outdoor contexts. Specifically, droplets ejected by sneezes can reach 7-8 m (KR6), cough 4-6 m (KR7), aerosol more than a metre (KR7; KR8; KR9). Although there are no measurements to prove it, we can reasonably expect that the dispersion of the ejected particles would be higher outdoors because of stronger environmental airflow currents, which will more rapidly spread the particles and decrease their local concentration. Mittal et al (2020) have recently published an excellent review of flow physics and fluid dynamics in understanding the transmission of SARS-CoV-2 (KR10). We found 5 further laboratory studies that are relevant to outdoor transmission because they seek to simulate realistic conditions (windy city streets) or realistic activities (people walking or running together). Their findings suggest that infection could be transmitted by speech in the absence of coughing or sneezing.
Evidence from studies exploring correlations with environmental factors: We found four studies looking at the relationship between climatic factors (predominantly temperature and humidity) and incidence or severity of Covid-19. These were all correlation studies that need to be validated by more robust study designs. Three studies found an inverse correlation between temperature and incidence (KR11-13). Shi et al (2020) reported a biphasic relationship with temperature, suggesting that daily incidence of COVID-19 decreased at values above and below 10 degrees C (KR14).

Extended abstract:

This is the second update of a rapid review (UNCOVER 002-01 – literature search conducted 31 March 2020 and UNCOVER 002-02 – literature search conducted 30 April 2020)]. The original review had a slightly different focus (indoor vs. outdoor transmission). For update 002-02, we re-examined articles identified by the initial search, using revised screening criteria (see full review document 002-02). We adapted the original search strategy to focus explicitly on outdoor transmission. Our modified screening criteria includes articles that report data on outdoor transmission, airborne transmission, surface transmission, environmental factors affecting virus transmission (e.g. virus viability and persistence on different surfaces and at different temperatures and levels of humidity). We excluded papers exclusively about indoor transmission. We also excluded statistical modelling studies. We identified additional relevant articles by searching reference lists. T&A screening of the articles identified by the new search was conducted by one reviewer (RM, LG). Rejections were reviewed by a second reviewer (LG, RN). A third reviewer checked all abstracts identified by the new search for relevance (ET). Full text screening of each article (including reviewing those from the initial search) was conducted by one reviewer (EM, LG, RM, RN). A second reviewer then screened all excluded full texts (EM, LG, RM, RN). Conflicts were resolved by discussion. Data extraction and quality assessment for each article was conducted by a single reviewer (EM, LG, RM, RN). Data extraction was limited to a minimal set of required data items. Because of the highly heterogeneous nature of the study types identified by the search, it was not possible to assess quality using validated risk of bias tools. Instead, we critically appraised each study individually. Computational Fluid Dynamics studies were critically appraised by an expert in this field (IV). Data were synthesized narratively. Because of the heterogeneity of the evidence, a meta-analysis was not appropriate. Using the GRADE system (Guyatt et al, 2008) a single reviewer (RM) graded the certainty of the evidence overall. This update (002-03) adds in 3 additional papers from mechanistic studies, based on expert recommendation (IMV).

Link to full review and any relevant updates: https://edin.ac/transmission

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The UNCOVER network is committed to responding quickly and impartially to requests from policymakers for evidence reviews. This document has therefore been produced in a short timescale and has not been externally peer-reviewed.

Key references:

1. Qian, H., Miao, T., Liu, L., Zheng, X., Luo, D., & Li, Y. (2020). Indoor transmission of SARS-CoV-2. MedRxiv, 2020.04.04.20053058. https://doi.org/10.1101/2020.04.04.20053058
2. Yeo C., Kaushal S., Yeo D. (2020) Enteric involvement of coronaviruses: is faecal-oral transmission of SARS-CoV-2 possible? Lancet Gastroenterology and Hepatology. Volume 5, ISSUE 4, P335-337, April 01, 2020
3. Sun, Z., Cai, X., Gu, C., Zhang, R., Han, W., Qian, Y., Wang, Y., Xu, W., Wu, Y., Cheng, X., Yuan, Z., Xie, Y., & Qu, D. (2020). Stability of the COVID-19 virus under wet, dry and acidic conditions. MedRxiv, 2020.04.09.20058875. https://doi.org/10.1101/2020.04.09.20058875
4. Chin, A. W. H., Chu, J. T. S., Perera, M. R. A., Hui, K. P. Y., Yen, H.-L., Chan, M. C. W., Peiris, M., & Poon, L. L. M. (2020). Stability of SARS-CoV-2 in different environmental conditions. The Lancet Microbe, 0(0). https://doi.org/10.1016/S2666-5247(20)30003-3

5. van Doremalen, N., Bushmaker, T., Morris, D. H., Holbrook, M. G., Gamble, A., Williamson, B. N., Tamin, A., Harcourt, J. L., Thornburg, N. J., Gerber, S. I., Lloyd-Smith, J. O., Wit, E. de, & Munster, V. J. (2020, March 17). Aerosol and surface stability of sars-cov-2 as compared with sars-cov-1 (world) [Letter]. https://doi.org/10.1056/NEJMc2004973
6. Bourouiba L. (2020) JAMA. 2020 Mar 26. doi: 10.1001/jama.2020.4756. [Epub ahead of print] No abstract available. Available at: https://jamanetwork.com/journals/jama/fullarticle/2763852
7. Bourouiba, L., Dehandschoewercker, E., & Bush, J. (2014). Violent expiratory events: On coughing and sneezing. Journal of Fluid Mechanics, 745, 537-563. doi:10.1017/jfm.2014.88 https://www.cambridge.org/core/journals/journal-of-fluid-mechanics/article/violent-expiratory-events-on-coughing-and-sneezing/475FCFCBD32C7DB6C1E49476DB7A7446
8. Tang JW, Liebner TJ, Craven BA and Settles GS (2009) A schlieren optical study of the human cough with and without wearing masks for aerosol infection control. J. R. Soc. Interface (2009) 6, S727–S736. Available at: https://royalsocietypublishing.org/doi/full/10.1098/rsif.2009.0295.focus
9. Viola IM, Peterson B, Pisetta G, Pavar G, Akhtar H, Menoloascina F, Mangano E, Dunn KE, Gabl R, Nila A, Molinari E, Cummins C, Thompson G, Lo TYM, Denison FC, Digard P, Malik O, Dunn MJG, McDougall CM and Mehendale FV (2020). Face Coverings, Aerosol Dispersion and Mitigation of Virus Transmission Risk. arXiv Prepr. ArXiv2005.10720. https://arxiv.org/abs/2005.10720
10. Mittal, R., Ni, R. & Seo, J.-H. The Flow Physics of COVID-19. (2020) J. Fluid Mech. 1–14 (2020). doi:10.1017/jfm.2020.330
11. Chiyomaru, K., & Takemoto, K. (2020). Global COVID-19 transmission rate is influenced by precipitation seasonality and the speed of climate temperature warming. MedRxiv, 2020.04.10.20060459. https://doi.org/10.1101/2020.04.10.20060459
12. Pirouz, B., Golmohammadi, A., Masouleh, H. S., Violini, G., & Pirouz, B. (2020). Relationship between average daily temperature and average cumulative daily rate of confirmed cases of covid-19. MedRxiv, 2020.04.10.20059337. https://doi.org/10.1101/2020.04.10.20059337
13. Rodrigues, W., Prata, D. N., & Camargo, W. (2020). Regional determinants of the expansion of covid-19 in brazil. MedRxiv, 2020.04.13.20063925. https://doi.org/10.1101/2020.04.13.20063925
14. Shi, P., Dong, Y., Yan, H., Zhao, C., Li, X., Liu, W., He, M., Tang, S., & Xi, S. (2020). Impact of temperature on the dynamics of the COVID-19 outbreak in China. Science of The Total Environment, 728, 138890. https://doi.org/10.1016/j.scitotenv.2020.138890