NIPH
Norwegian Institute of Public Health

memo

COVID-19-EPIDEMIC :

Contact based transmission of SARS-CoV-2 – a rapid review

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Key messages

The findings in this memo are based on rapid searches in the PubMed. One researcher went through all search records, selected and summarised the findings. In the current situation, there is an urgent need for identifying the most important evidence quickly. Hence, we opted for this rapid approach despite an inherent risk of overlooking key evidence or making misguided judgements.

We identified four eligible systematic reviews and ten eligible primary studies. Eligible studies are summarised in text and tables.

Systematic reviews conclude that viruses that resembles SARS-CoV-2, i.e. SARS-CoV and MERS-CoV, are likely to transmit through a combination of paths. Currently available evidence suggests this is the case also for SARS-CoV-2. The virus seems to transmit between people staying in close proximity to each other, but indirect transmission through inanimate surfaces (fomites) may also occur. Current evidence is not sufficient to conclude about the relative importance of different ways of transmission in different settings.

Hovedfunn (Norwegian)

Funnene i denne hurtigoversikten baserer seg på raske søk i PubMed. Én forsker har gått gjennom søketreff, valgt ut og oppsummert resultatene. Ettersom det har vært viktig å få fram forskningsresultatene raskt, har vi valgt denne framgangsmåten, selv om det innebærer risiko for at vi kan ha oversett viktig dokumentasjon og kan ha gjort feilvurderinger underveis.

Vi identifiserte fire systematiske oversikter og ti enkeltstudier som på ulike måter kunne bidra til å belyse spørsmålet om viktigheten av dråpe-og/eller kontaktsmitte i spredningen av SARS-CoV-2. De inkluderte studiene er oppsummert i tekst og i tabeller.

Systematiske oversikter konkluderer med at virus som ligner på SARS-CoV-2, det vil si SARS-CoV og MERS-CoV, kan smitte gjennom en kombinasjon av ulike smitteveier. Foreløpig dokumentasjon tyder på at dette er tilfelle også for SARS-CoV-2. Viruset ser i stor grad ut til å smitte mellom mennesker som befinner seg hverandres fysiske nærhet, men indirekte kontaktsmitte via overflater (fomites) kan også forekomme. Eksisterende dokumentasjon er ikke tilstrekkelig til å konkludere om den relative viktigheten av ulike smitteveier i ulike omgivelser.

Content

Introduction

Updated evidence on possible transmission routes is essential in order to give appropriate advice on infection control measures. As a part of the Norwegian Institute of Public Health's role in handling the COVID-19 epidemic, we have been asked to prepare a rapid summary of the available research on the role of droplet and contact in the transmission of SARS-CoV-2.

Methods

We conducted two simple searches for literature in the PubMed. One of the searches aimed at identifying systematic reviews about transmission of SARS-CoV-2, MERS-CoV and SARS-CoV (Appendix A), and the other search aimed at identifying primary studies about transmission of SARS-CoV-2 via droplets and close contact (Appendix B). We also went through reference lists of relevant studies in order to identify studies not retrieved in the main searches.

We summarised the findings reported in the systematic review. Primary studies were categorised and briefly summarised in tables. We excluded modelling and animal studies.

One researcher (Kjetil Brurberg) assessed the relevance of each reference and summarized the findings.

Elisabet Hafstad (Information Specialist) prepared the literature searches. Atle Fretheim (Research Director, Norwegian Institute of Public Health), Hanne-Merete Eriksen-Volle (Acting Department Director, Norwegian Institute of Public Health) and Oliver Kacelnik (MD, Norwegian Institute of Public Health) read swiftly through a draft of this document before publication.

Results

Included studies

Systematic reviews

The search returned eight unique records, of which two systematic reviews were considered relevant. We identified two further systematic reviews by snowballing, i.e. manual searches in reference lists of relevant studies. Ultimately, four systematic reviews were included. The quality of the included reviews was impaired by limitations in search strategies and that the methodology used in the included studies was not systematically appraised.

Primary studies

The search for primary studies returned 77 unique records. We included ten studies with some potential to inform knowledge about transmission via contact. The available studies could be categorised into two main categories: 1) Studies aimed at tracing SARS-CoV-2 transmission, and 2) Studies aimed at detecting SARS-CoV-2 on surfaces.

Summary of systematic reviews

Kramer and co-workers summarized studies about the persistence of different pathogens (1). This systematic review does not include evidence on the persistence of MERS-CoV or SARS-CoV-2, but it cites one publication on the SARS-CoV virus (2). The study measured the infectivity of the virus after deposition in clinical specimens and on different household surfaces, e.g. wood, glass and paper. The infectivity of the virus was measured by inoculating the virus into cultured cells. In brief, the study showed that SARS-CoV can survive on inanimate surfaces and remain infectious for several days. The infectivity of the virus was strongly reduced following heating or UV irradiation (2).

In January 2020, Kampf and co-workers reviewed literature about the persistence of coronaviruses (3). The authors included 22 studies. None of the included studies investigated SARS-CoV-2, but data from SARS-CoV, MERS-CoV and other coronaviruses suggests these viruses can persist on inanimate surfaces (metal, glass or

plastic) for up to nine days. However, the viruses seem to be efficiently removed following some standard disinfection procedures (3).

Dawson and colleagues have published a thorough systematic review about MERS-CoV in which they also summarise evidence on possible transmission routes (4). Transmission between patients seems to be associated with close contact, for example in crowded emergency rooms, but some studies suggest direct contact can only explain ten percent of the cases. A South Korean study confirms the existence of MERS-CoV viral RNA on environmental surfaces on patient rooms, which may suggest a risk of fomite transmission. On the other hand, there are few known incidences of transmission to hospital laundry or maintenance workers, and the review authors point out this may indicate the risk of such transmission is low.

Otter and colleagues published a systematic review based on simple searches in PubMed (5). The authors aimed to assess the role of dry surface contamination in transmission of SARS-CoV and MERS-CoV. There are methodological differences between the available primary studies, but in-vitro studies suggest MERS-Cov and SARS-CoV can survive on dry surfaces for a longer period of time than influenza virus and other human coronaviruses (days vs. hours) (5). Survival time depends on the surface material, and more concentrated viral suspensions seem to survive longer. The review authors further state that "*…two studies have detected environmental reservoirs of SARS-CoV RNA by PCR, but no viable virus by culture*." The authors conclude that SARS-CoV may transmit by direct contact, indirect contact, droplets and aerosols, but that the relative importance of these routes is difficult to determine.

Primary studies about SARS-CoV-2

Transmission tracking

Five of the included primary studies traced transmission in clusters of patients infected with SARS-CoV-2 (Table 1). The studies show that transmission usually occur between people who are in close contact, but there were some cases where spread may have been by indirect transmission through contaminated inanimate surfaces (fomites). Even though these studies are not designed to differentiate between various routes of transmission, the results indicate that SARS-CoV-2 can be transmitted in the community by a combination of droplets, direct and indirect contact.

Table 1 *Studies tracing transmission between humans*

Authors	Material	Conclusion
Chan et al. (6) China	Investigating family cluster of SARS-CoV-2 infection	Transmission between people in close contact
Cai et al. (7) China	Investigation of relationship and points of contact between people (n=35) in a cluster of COVID-19-cases in a shopping mall	Cases on floor 7 had been in direct contact, but no evident direct link between cases on floor 7 and cases on the other floors. Workers on all floors share elevators and restrooms, and may indicate indirect transmission (fomites)
Li et al. (8) China	425 patient with SARS-CoV-2 acquired pneumonia	Transmission between humans is most likely to occur by the means of direct physical contacts
Liu et al. (9) China	115 patients with SARS-CoV-2	Transmission between humans is most likely to occur by the means of direct physical contacts
Pung et al. (10) Singapore	Analyse contact between 36 patients with COVID-19 within three clusters comprising 6, 11, and 20 individuals	People who were infected did not always know each other, but transmission is usually traced to direct physical contact

SARS-CoV-2 contamination on surfaces

Included studies are listed in table 2. One in vitro study demonstrated that viable SARS-CoV-2 may survive on inanimate surfaces for several days, but the virus' ability to survive differs between materials (15). SARS-CoV-2 RNA is also detected on inanimate surfaces near patients with COVID-19 (11, 13), but not all studies confirm surface contamination with SARS-CoV-2 is a real problem (11,14). Importantly, a study from Italy, showed that it is possible to confine contamination to patient rooms (12).

Table 2 *Studies searching for SARS-CoV-2 on inanimate surfaces*

Authors	Material	Conclusion
Cheng et al. (11) Hong Kong	Samples taken from 13 surfaces in a COVID-19 patient room	One of the 13 samples positive for SARS-CoV-2 RNA
Colaneri et al. (12) Italy	16 surfaces in areas considered virus free were swabbed to search for COVID-19 RNA	Anteroom, corridor and post-cleaning samples negative for SARS-CoV-2 RNA despite possible contamination in patient rooms
Ong et al. (13) Singapore	Environmental samples from 26 sites at a SARS-CoV-2 outbreak centre. Samples Analysed using RT-PCR	Detected environmental contamination by patient through droplets indicating that environment is a potential medium of transmission
Ong et al. (14) Singapore	Samples (n=90) from health care workers' (n=30) protective equipment in COVID-19 department. Typical activities: medication administration, cleaning, physical examination and collection of respiratory samples[A]	All 90 samples were negative
van Doremalen et al. (15) US	Comparison of surface stability of SARS-CoV and SARS-CoV-2 on copper, cardboard, stainless steel and plastic. In vitro study	SARS-CoV-2 and SARS-CoV show similar stability. Both viruses decay more slowly on plastic and stainless steel than on copper and cardboard

[A] No aerosol generating procedures were performed prior to or during sampling

Discussion and conclusion

Systematic reviews conclude that viruses that resembles SARS-CoV-2, i.e. SARS-CoV and MERS-CoV, are likely to transmit through a combination of different transmission paths. Currently available evidence suggests this is the case also for SARS-CoV-2. The virus seems to transmit between closely related individuals, but indirect transmission through inanimate surfaces (fomites) may also occur. It is very challenging, however, to acquire evidence regarding the relative importance of different transmission paths. People in close relations and people staying in close proximity to each other are likely to be exposed to multiple potential ways of transmission.

References

1. Kramer A, Schwebke I, Kampf G.How long do nosocomial pathogens persist on inanimate surfaces? A systematic review. *BMC Infect Dis*. 2006, 16;6:130. PMID:16914034
2. Duan SM, Zhao XS, Wen RF et al. Stability of SARS coronavirus in human specimens and environment and its sensitivity to heating and UV irradiation. *Biomedical and Environmental Sciences* 2003, 16:246-255.
3. Kampf G, Todt D, Pfaender S, Steinmann E. Persistence of coronaviruses on inanimate surfaces and their inactivation with biocidal agents. *J Hosp Infect*. 2020;104:246-251. doi: 10.1016/j.jhin.2020.01.022.
4. Dawson P, Malik MR, Parvez F, Morse SS. What Have We Learned About Middle East Respiratory Syndrome Coronavirus Emergence in Humans? A systematic Literature Review. *Vector Borne Zoonotic Dis*. 2019, 19:174-192. doi: 10.1089/vbz.2017.2191.
5. Otter JA, Donskey C, Yezli S, Douthwaite S et al. Transmission of SARS and MERS coronaviruses and influenza virus in healthcare settings: the possible role of dry surface contamination. *J Hosp Infect* 2016, 92:235–250. Doi: 10.1016/j.jhin.2015.08.027.
6. Chan JF, Yuan S, Kok KH, To KK et al. A familial cluster of pneumonia associated with the 2019 novel coronavirus indicating person-to-person transmission: a study of a family cluster. *Lancet*. 2020, 15;395(10223):514-523. Doi 10.1016/S0140-6736(20)30154-9.
7. Cai J, Sun W, Huang J, Gamber M et al. Indirect Virus Transmission in Cluster of COVID-19 Cases, Wenzhou, China, 2020. *Emerg Infect Dis*. 2020, 26. doi: 10.3201/eid2606.200412.
8. Li Q, Guan X, Wu P, Wang X et al. Early transmission dynamics in Wuhan, China, of novel coronavirus-infected pneumonia. *N Engl J Med* 2020 [Epub ahead of print]. doi: 10.1056/NEJMoa2001316
9. Liu YF, Li JM, Zhou PH, Liu J et al. [Analysis on cluster cases of COVID-19 in Tianjin]. *Zhonghua Liu Xing Bing Xue Za Zhi*. 2020, 41:654-657. doi: 10.3760/cma.j.cn112338-20200225-00165. [Epub ahead of print]
10. Pung R, Chiew CJ, Young BE, Chin S et al. Investigation of three clusters of COVID-19 in Singapore: implications for surveillance and response measures. *Lancet*. 2020, 395(10229):1039-1046. doi: 10.1016/S0140-6736(20)30528-6.
11. Cheng VCC, Wong SC, Chen JHK, et al. Escalating infection control response to the rapidly evolving epidemiology of the Coronavirus disease 2019 (COVID-19)

due to SARS-CoV-2 in Hong Kong. *Infect Control Hosp Epidemiol*. 2020, 1-24. doi: 10.1017/ice.2020.58. [Epub ahead of print]

12. Colaneri M, Seminari E, Piralla A, Zuccaro V et al. Lack of SARS-CoV-2 RNA environmental contamination in a tertiary referral hospital for infectious diseases in Northern Italy. *J Hosp Infect*. 2020, pii:S0195-6701:30117-1. doi: 10.1016/j.jhin.2020.03.018. [Epub ahead of print]
13. Ong SWX, Tan YK, Chia PY, Lee TH et al. Air, Surface Environmental, and Personal Protective Equipment Contamination by Severe Acute Respiratory Syndrome Coronavirus 2 (SARS-CoV-2) From a Symptomatic Patient. *JAMA*. 2020, doi: 10.1001/jama.2020.3227. [Epub ahead of print]
14. Ong SWX, Tan YK, Sutjipto S, Chia PY et al. Absence of contamination of personal protective equipment (PPE) by Severe Acute Respiratory Syndrome Coronavirus 2 (SARS-CoV-2). *Infect Control Hosp Epidemiol*. 2020, 1-6. doi: 10.1017/ice.2020.91. [Epub ahead of print]
15. van Doremalen N, Bushmaker T, Morris DH, Holbrook MG et al. Aerosol and Surface Stability of SARS-CoV-2 as Compared with SARS-CoV-1. *N Engl J Med*. 2020, doi: 10.1056/NEJMc2004973. [Epub ahead of print]

Attachment

Search strategies

A) Search for systematic reviews (conducted 1. April 2020).

((Coronavirus[mh] OR "Coronavirus Infections"[mh] OR "SARS virus"[mh] OR "Severe Acute Respiratory Syndrome"[mh] OR "Middle East Respiratory Syndrome Coronavirus"[mh] OR "covid-19"[nm] OR "severe acute respiratory syndrome coronavirus 2"[nm] OR "corona virus"[tw] OR coronavirus[tw] OR coronovirus[tw] OR "COVID-19"[tw] OR COVID19[tw] OR CORVID-19[tw] OR CORVID19 OR nCoV[tw] OR 2019nCoV[tw] OR "SARS-CoV-2"[tw] OR "SARS-CoV2"[tw] OR SARSCoV19[tw] OR HCoV-19[tw] OR WN-CoV[tw] OR SARS[tw] OR "Severe Acute Respiratory Syndrome"[tw] OR MERS[tw] OR "Middle East Respiratory Syndrome"[tw]) AND ("Equipment Contamination"[mh] OR vehicle*[tw] OR contaminat*[tw] OR "direct contact"[tw] OR fomite*[tw] OR fomes[tw] OR hand[tw] OR hands[tw] OR skin[tw] OR surface*[tw]) AND systematic[sb])

B) Search for primary studies (conducted 1. April 2020)

Restricted to SARS-CoV-2 and studies published after 1. December 2019.

((((Coronavirus[mh] OR "Coronavirus Infections"[mh] OR "corona virus"[tw] OR coronavirus*[tw] OR coronovirus*[tw]) AND (novel[tw]OR 2019[tw] OR Wuhan[tw] OR Huanan[tw])) OR "covid-19"[nm] OR "severe acute respiratory syndrome coronavirus 2"[nm] OR "COVID-19"[tw] OR COVID19[tw] OR CORVID-19[tw] OR CORVID19[tw] OR "coronavirus 2"[tw] OR "corona virus 2"[tw] OR nCoV[tw] OR 2019nCoV[tw] OR "SARS-CoV-2"[tw] OR "SARS-CoV2"[tw] OR SARSCoV19[tw] OR SARS-CoV19[tw] OR SARS-CoV-19[tw] OR HCoV-19[tw] OR WN-CoV[tw]) AND ("Equipment Contamination"[mh] OR vehicle*[tw] OR contaminat*[tw] OR "direct contact"[tw] OR fomite*[tw] OR fomes[tw] OR hand[tw] OR hands[tw] OR skin[tw] OR surface*[tw]) AND (2019/12/01:2030/12/31[edat]))

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