SARS-CoV-2 routes of transmission and recommendations for preventing acquisition: joint British Infection Association (BIA), Healthcare Infection Society (HIS), Infection Prevention Society (IPS) and Royal College of Pathologists (RCPath) guidance.

Aggie Bak*,[1] Moira A. Mugglestone,[1] Natasha V. Ratnaraja,[2,3] Jennie A. Wilson,[4,5] Lucy Rivett,[1,6] Simon M. Stoneham,[1,7] Jennifer Bostock,[8] Samuel E. Moses,[2,9,10] James R. Price,[1,11] Michael Weinbren,[1,12] Heather P. Loveday,[4,5] Jasmin Islam,[1,7] A. Peter R. Wilson[1,13]

Affiliations:

[1]Healthcare Infection Society, [2]British Infection Association, [3]University Hospitals Coventry & Warwickshire NHS Trust, [4]Infection Prevention Society, [5]Richard Wells Research Centre, University of West London, [6]Cambridge University NHS Hospitals Foundation Trust, [7]Brighton and Sussex University Hospitals NHS Trust, [8]Lay Member, [9]Royal College of Pathologists, [10]East Kent Hospitals University NHS Foundation Trust, [11]Imperial College Healthcare NHS Trust, [12]Sherwood Forest Hospitals NHS Foundation Trust, [13]University College London Hospitals NHS Foundation Trust

* Corresponding author aggie.bak@his.org.uk

1. Executive summary

The pandemic of the coronavirus disease 2019 (COVID-19), caused by novel severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2), emerged amid uncertainty about the dynamics of transmission and the possible management options for COVID-19 patients. This resulted in confusion for healthcare workers (HCWs) and hospital managers who often received conflicting advice on how to organise care and manage infected individuals without increasing the risk of transmission to HCWs and other patients. Advice for the public has also been confusing and apparently sometimes contradictory, which sometimes resulted in overuse of Personal Protective Equipment (PPE) in the general population as well as in healthcare workers. As evidence from the first wave has emerged, we are now in a position to summarise it and provide guidance on how to prevent SARS-CoV-2 transmission whilst preserving essential resources. This article is the first in a series of guidance documents produced jointly by the Healthcare Infection Society, British Infection Association, Infection Prevention Society and Royal College of Pathologists. This guidance article describes routes of SARS-CoV-2 transmission, which will allow the public and healthcare professionals to understand how SARS-CoV-2 transmission occurs. By determining how likely transmission can occur via a given route, we can extrapolate the evidence for infection prevention and control (IPC) and apply this knowledge to optimise protection from SARS-CoV-2 infection. At the time of writing (January 2020), new variants of SARS-CoV-2 emerged, raising concerns whether the virus could make current vaccines ineffective. The evidence is still lacking, but these variants appear to be more virulent, although at the moment little is known about the transmission dynamics of these new strains. Thus, strict adherence to IPC measures is still required in breaking the chain of SARS-CoV-2 transmission. Further review may be required as more evidence about these variants becomes available.

On review of the evidence, the COVID-19 Rapid Guidance Working Party considers the different transmission routes as follows:

droplet transmission: *probable*

transmission via fomites: *possible*

airborne transmission: *possible* (in some circumstances, e.g., aerosol generating procedures (AGPs)

transmission via ocular surface: *possible*

vertical transmission: *unlikely*

transmission from different body fluids: *unlikely*

transmission from blood transfusion and transplantation organs: *unlikely*

The Working Party concludes that transmission most often occurs following close contact, especially where PPE is not worn, as reflected in high transmission rates between family members, friends, and co-workers. At the moment it is not possible to determine the distance or the duration over which transmission can occur, although these vary depending on circumstances (e.g. duration of contact will depend on the distance, but also on environmental and other factors). Transmission from COVID-19 patients to HCWs in hospitals is low, except in a small number of cases where HCWs cared for undiagnosed COVID-19 patients and did not use appropriate PPE. Even in these cases, transmission usually occurs during AGPs. Transmission in care homes appears to be very high and anecdotal evidence suggests that there were difficulties in obtaining appropriate PPE and observing social distancing during the pandemic. The published literature is not comprehensive enough to make recommendations for this setting. However, considering there is no IPC guidance specific for care homes, we suggest that staff in these institutions follow the recommendations for persons working in health and care settings listed below and that they explore aspects specific to their local institutions to address the barriers which prevent them in doing so, e.g. inability to maintain social distancing. The rationale for the above conclusions and the following recommendations is provided in section 8.

Recommendations

General recommendations which apply to all settings, including social settings:

GR1: Adhere to regulations currently imposed by your government.

GR2: Maintain the recommended minimum 2 metre distance at all times.

GR3: Use a face covering in enclosed spaces to protect yourself and others.

GR4: Reduce the time of contact with anyone outside your household to a minimum.

GR5: To avoid transmission from fomites, decontaminate your hands frequently using soap and water, and when this is not possible, use alcohol-based hand rub.

> **Good practice point:** Follow World Health Organization advice on how to handwash (https://www.who.int/gpsc/5may/How_To_HandWash_Poster.pdf) and how to handrub (https://www.who.int/gpsc/5may/How_To_HandRub_Poster.pdf)

GR6: Avoid touching your face and eyes with your hands as transmission via ocular surface is possible.

GR7: Evidence suggests that a high proportion of transmissions occur as a result of close contact between family members, friends, and co-workers. Adhere to the above recommendations when in contact with anyone outside your household or support network.

GR8: Available evidence suggests that transmission without close contact or outside is unlikely. Continue maintaining the 2m distance and using face covering in indoor settings. There is no evidence which suggests that respirator masks offer additional protection outside the healthcare settings.

> **Good practice point:** To protect yourself and others, follow WHO advice and avoid 3Cs: **C**losed spaces, **C**rowds, **C**lose contact.

Specific recommendations for persons working in health and care settings:

HR1: You must adhere to regulations imposed by your trust/employer.

HR2: Where there is ongoing transmission, for contact with patients and other healthcare staff, use a face mask, and adhere to general recommendations listed above.

HR3: For care of patients suspected or confirmed to have COVID-19, in addition to the above, use fluid resistant surgical face mask and adhere to contact and droplet precautions. No other precautions are necessary but

HR4: Risk of SARS-CoV-2 transmission from body fluids (faeces, urine, ocular excretions, and sexual body fluids) is unlikely, use contact precautions and appropriate PPE (including fluid resistant surgical face mask type IIR) and do not use additional precautions (e.g., filtering respiration mask) unless carrying out AGPs. Your employer may make a decision to provide respirator masks for procedures other than AGPs, based on local circumstances.

HR5: Whilst blood and body fluids are not a likely source of SARS-CoV-2 infection, there remains a risk of infection with other pathogens to HCWs and via them to other patients. Use PPE (gloves, plastic aprons, eye protection) as appropriate when there is a risk of exposure to blood, body fluids or any items contaminated with these products and clean your hands immediately after glove removal.

HR6: Literature suggests that most SARS-CoV-2 transmissions from patients to HCWs occurred when HCW did not use protection during AGPs on patients not suspected of having COVID-19. Use filtering respiration mask (FFP3) designed for filtering fine airborne particles for any AGPs regardless of a patient's COVID-19 status.

HR7: Vertical transmission is unlikely. Studies have reported avoiding caesarean delivery where possible and mothers being advised to use a surgical mask.

Summary of recommendations is provided in Table 1.

Recommendations for managers in health and care settings:

MR1: Adhere to current national guidelines for IPC, including those specific to COVID-19 as well as general ones for preventing infectious diseases.

MR2: Consider exploring potential factors for SARS-CoV-2 transmission specific to your setting, e.g., inability to maintain social distancing or managing apparently asymptomatic cases.

Table 1: Summary of recommendations for persons working in healthcare settings

	Casual contact – no patient care	**Care for non-COVID-19 patients**	**Care for suspected or confirmed COVID-19 patients**
Precautions	Social distancing	Standard precautions: hand hygiene, respiratory hygiene, sharps safety, environmental & equipment safety, safe injections, PPE, occupational safety, social distancing*	Standard precautions, contact precautions & droplet precautions
Patient management	Patient to wear face covering	Patient to wear face covering	Patient placed in isolation/ single room or as far away from others as possible (and at least 2m) Patient to wear fluid resistant surgical face mask when in contact with others
PPE if no contact with body fluids			
Face protection	Face covering	Fluid resistant surgical face mask	Fluid resistant surgical face mask type
Gloves	None	None	Single use
Clothes/body protection	Bare below elbow	Bare below elbow	Bare below elbow, apron tied at neck and waist
Eye protection	None	None	Face shield
Head protection	None	None	None
Foot/shoe protection	None	None	None
PPE if in contact with body fluids			
Face protection	n/a	Fluid resistant surgical face mask	Fluid resistant surgical face mask
Gloves		Single use	Single use
Clothes/body protection		Bare below elbow, apron (if risk of contamination) tied at neck and waist	Bare below elbow, apron (if risk of contamination) tied at neck and waist
Eye protection		Face shield (if risk of splashes)	Face shield (if risk of splashes)
Head protection		None	None
Foot/shoe protection		None	None
PPE if AGPs performed			
Face protection	n/a	Filtering respiration mask FFP3	Filtering respiration mask FFP3
Gloves		Single use, covering the cuffs of the gown	Single use, covering the cuffs of the gown
Clothes/body protection		Long sleeved gown	Long sleeved gown
Eye protection		Goggles	Goggles
Head protection		None	None
Foot/shoe protection		None	None

* **Note**: social distancing is now a part of standard precautions

2. Lay summary

The COVID-19 pandemic has had far reaching implications for health, economics and society. One of the many areas affected has been the ability of healthcare professionals to stop the spread of the infection in health and care settings both in hospital and in the community such as a dental surgery. With research being published since the emergence of the outbreak we now have a much better understanding of how to help prevent the spread of the infection. This document was co-produced by a multiprofessional group that includes clinicians, nurses, academics, and a member of the public. It provides the current evidence with recommendations to help frontline health professionals and managers. The timing of this guidance is important, it is vital that people are aware what has been proven to work. We are aware that new evidence will come along which may contradict or add to some of our recommendations, however this is an important start in giving health providers and managers evidence-based recommendations for limiting the spread of infection. The document contains explanation, evidence and a glossary of terms (Appendix 1). If you simply want to look at the recommendations, please see the executive summary section. Along with this document we are publishing materials for patients, carers and members of the public because it is vital that we all have access to guidance and understand our individual role in reducing COVID-19 spread in hospitals and community.

3. Introduction

The coronavirus disease 2019 (COVID-19) global pandemic, first detected in Wuhan, China has affected more than 90 million people.[1] The disease is caused by novel severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2), which together with its close relative SARS-CoV belongs to a B lineage of beta-coronaviruses. The virus is also related to MERS-CoV virus from C lineage which was responsible for the outbreaks of Middle East Respiratory syndrome (MERS).

The first wave of the pandemic occurred amid uncertainty about the dynamics of SARS-CoV-2 transmission and the possible management options for COVID-19 patients. This resulted in confusion for HCWs and hospital managers who often received conflicting advice on how to organise care and manage infected individuals without increasing the risk of transmission to HCWs and other patients. As the evidence has emerged, we are now in a position to summarise it and provide guidance to healthcare professionals on how to prevent healthcare associated COVID-19 disease when subsequent waves or localised outbreaks occur.

This guidance will be produced in a series of articles, each covering a different question relating to prevention of COVID-19 in health and care settings. This article is the first in the series and describes routes of SARS-CoV-2 transmission. Understanding the likelihood of transmission occurring via different routes is important, so individuals can take appropriate precautions to protect themselves and others.

4. Guideline Development Team

4.1. Acknowledgements

The authors would like to acknowledge the support from their employing institutions, which allowed time required for producing this guidance. We thank the National Institute for Health Research, University College London Hospitals Biomedical Research Centre, which partly supported Professor Peter Wilson's involvement in this guidance. We would also like to thank Aye Thar Aye and Bin Gao, who on behalf of HIS Guidelines Committee reviewed this document.

4.2. Source of funding

The authors received no specific funding for this work. Financial support for time required to obtain the evidence and write the manuscript was provided by the authors' respective employing institutions.

4.3. Disclosure of potential conflict of interest

- No authors reported any conflict of interest (Appendix 2)

4.4. Relationship of authors with sponsor

BIA, HIS, IPS and RCPath commissioned the authors to undertake the Working Party Report. The authors are members of the societies. Further information is provided in Appendix 2.

4.5. Responsibility for guidance

The views expressed in this publication are those of the authors and have been endorsed by BIA, HIS, IPS and RCPath, and following rapid consultation.

5. Working Party Report

5.1. What is the Working Party Report?

The report is the first in a series of guidance documents covering key aspects of preventing transmission of SARS-CoV-2 in health and care settings. The guidance also reviews the evidence for transmission dynamics of SARS-CoV-2 virus outside these settings. The diagnosis and management of COVID-19 disease in general are outside the remit of this guidance.

The Working Party recommendations have been developed systematically through multi-disciplinary discussions based on currently available evidence from published and pre-print sources. They should be used in the development of local protocols for all relevant health and care settings such as hospitals, nursing/care homes, primary care and dental practices.

5.2. Why do we need a Working Party Report for this topic?

The first wave of COVID-19 pandemic occurred amid uncertainty as to how it could be prevented and controlled. New outbreaks are still occurring, and many countries are currently experiencing subsequent waves. Concerns whether the virus has an ability to spread efficiently via certain routes still remain. We now have sufficient evidence from the first wave, which gives us an opportunity to develop an evidence-based guidance for preventing and controlling future outbreaks.

5.3. What is the purpose of the Working Party Report's recommendations?

The main purpose is to inform clinicians, managers, and policy makers about the dynamics of transmission of SARS-CoV-2 and to provide evidence-based recommendations to prevent and control its spread in health and care settings. This document highlights current gaps in knowledge, which will help to direct future areas of research.

5.4. What is the scope of the guidance?

The scope of the guidance is to provide advice for the optimal provision of an effective and safe healthcare service during the time when COVID-19 remains a health threat. This guidance was developed with acute healthcare settings in mind but may be useful in other health and care settings such as dental practices and care homes.

5.5. What is the evidence for this guidance?

Topics for this guidance were derived from the initial discussion of the Working Party and review questions were designed in accordance with the PECO (P=population, E=exposure, C=comparator, O=outcome) framework for investigating the likelihood of developing a certain condition after exposure to an event.[2] To prepare these recommendations, the Working Party collectively reviewed relevant evidence from published and pre-print sources. Methods, which were in accordance with National Institute for Health and Care Excellence (NICE) manual for developing guidelines, are described fully below.

5.6. Who developed this guidance?

The Working Party included infectious diseases/microbiology clinicians, academic IPC experts, systematic reviewers, and a lay representative.

5.7. Who is this guidance for?

Any healthcare practitioner, manager and policy maker may use this guidance and adapt it for their use. It is anticipated that users will mostly include clinical staff and IPC teams. Some parts of this guidance may also be beneficial to patients, carers and public.

5.8. How is the guidance structured?

To provide rapid advice, this guidance is produced in a series of articles, each covering a different question. Each will comprise an introduction, a summary of the evidence, and recommendations graded according to the available evidence. This article is the first in the series.

5.9. How frequently is the guidance reviewed and updated?

New evidence will be reviewed within one year to determine whether this guidance needs updating.

5.10. Aim

The aim of this guidance was to assess the current evidence for all aspects relating to dynamics and routes of transmission of SARS-COV-2 and preventing its transmission in hospitals and other care settings.

6. Methodology

6.1. Evidence search and appraisal

Topics for this guidance were derived from the initial discussions of the COVID-19 Rapid Guidance Working Party Group. In addition, HIS invited all members to propose topics. To prepare these recommendations, the Working Party collectively reviewed relevant evidence from published and pre-print sources. Methods were followed in accordance with the NICE manual for guideline development with modifications that allowed a rapid review process (described below). The modifications included systematically searching two electronic databases, including fewer members for the Working Party with one lay member, and quality assessment being conducted by one reviewer and checked by a second person.

6.2. Data sources and search strategy

Two electronic databases (Medline and EMBASE) were searched for articles published between 1st January and 11th May 2020; search terms were constructed using relevant MeSH and free text terms (Appendix 3). Additional hand searching was conducted in the following databases: WHO Chinese database, CNKI, China Biomedical Literature Service, Epistemonikos COVID-19 L·OVE platform, EPPI Centre living systematic map of the evidence, CORD-19, COVID-END, and the HIS's COVID-19 resources to identify pre-print and articles in press. Reference lists of identified reviews and included papers were scanned for additional studies. The searches were restricted to human-to-human transmission and the presence of the virus in the environment. No language restrictions were set.

6.3. Study eligibility and selection criteria

The members of the Rapid Guidance Working Party determined criteria for study inclusion. Any article presenting primary data on human-to human transmission of SARS-CoV-2 was included. Search results were downloaded to EndNote database and screened for relevance. One reviewer reviewed the title, abstracts, and full texts. A second reviewer checked at least 10% of the excluded studies at each sifting stage. Disagreements were first discussed between the two reviewers and if consensus was not reached, a third reviewer was consulted. The results are shown in the PRISMA diagram in Appendix 4.

6.4. Data extraction and quality assessment

Included epidemiological studies were appraised for quality using checklists recommended in the NICE guideline development manual. Environmental and laboratory studies were not appraised for quality. Critical appraisal and data extraction were conducted by one reviewer, and at least 10% was checked by the second. The results are available in Appendix 5. Data from the included studies were extracted to create the summary of findings, study description and data extraction tables (Appendix 6). Data were stratified into the type of transmission and either aggregated or otherwise described narratively. Where data were aggregated, meta-analyses were not conducted because the scope of this guidance was to establish whether transmission could take place via certain routes. These data should not be used as an indicator of the frequency at which these transmission events occurred because this was not the intended scope of this document. The list of the studies excluded at full text sift with a reason for this decision is provided in (Appendix 7).

6.5. Rating of evidence and recommendations

Summary of findings tables were presented to the Working Party, and recommendations were prepared according to the nature and applicability of the evidence regarding the likelihood of transmission via a certain route. The likelihood of transmission via different routes was assessed using the criteria recommended by Shah et al (2020)[3] for classifying the possibility of vertical transmission. This classification system was adapted to reflect other routes of transmission by creating five mutually exclusive categories:

- **Confirmed infection** – strong epidemiological evidence and proof that infection occurred via the route in question: e.g. the affected person had positive SARS-CoV-2 polymerase chain reaction (PCR) test AND possibility of infection via alternative routes was excluded
- **Probable infection** – strong evidence suggestive of infection, but lack of confirmatory proof that infection occurred via the route in question: e.g. the affected person had a positive PCR or symptoms suggestive of infection AND strong epidemiological evidence suggestive that the infection occurred via the route in question
- **Possible infection** – evidence that is suggestive of infection but is incomplete: e.g. the affected person had a positive PCR or symptoms suggestive of infection AND weak epidemiological evidence suggestive that the infection occurred via the route in question OR strong non-

epidemiological evidence that viable virus (i.e. virus that was shown to infect cells in culture) was detected in samples related to a route in question

- **Unlikely infection** – little evidence for infection occurring via the route in question but cannot be completely ruled out: e.g. the affected person had a positive PCR test or symptoms suggestive of infection AND weak epidemiological evidence to support that infection occurred via the route in question OR the person had negative PCR or no symptoms AND evidence for likely exposure via route in question OR weak non-epidemiological evidence that virus (viable or PCR) is detected in samples related to the route in question
- **Confirmed no infection** – strong evidence with proof that infection did not occur after exposure via the route in question: e.g. negative PCR AND strong evidence that exposure via a certain route occurred OR strong non-epidemiological evidence that virus (viable or PCR) is not detected in samples related to the route in question.

The strength of the evidence was defined by GRADE (Grading of Recommendations Assessment, Development and Evaluation) tables (Appendix 8) and using the ratings 'high', 'moderate', 'low' and 'very low' to construct the evidence statements, that reflected the Working Party Group's confidence in the evidence. The strength of recommendation was adopted from GRADE and reflects the strength of each evidence statement. In instances where no evidence was identified from searches, the statement 'No evidence was found in studies published so far…' indicates that no studies have assessed this as an outcome. Where there was no evidence or a paucity of evidence, good practice recommendations were made by expert experience and consensus via videoconferences. All disagreements were resolved by discussion and voting by members of the Working Party.

6.6. Consultation process

Feedback on draft guidance was received from the HIS Guidelines Committee and through rapid consultation with relevant stakeholders. The draft report was placed on the HIS website for 7 days along with the HIS standard comment form. The availability of the draft was advertised via email and social media. Stakeholders were invited to comment on format, content, local applicability, patient acceptability, and recommendations. The Working Party reviewed stakeholder comments, and collectively agreed revisions (Appendix 9). All reviews received from individuals with a conflict of interest or those who did not provide a declaration were excluded.

7. <u>Results</u>

The search identified a total of 1765 articles. After excluding duplicate and irrelevant studies and checking reference lists for related citations, a total of 130 were included (Appendix 4).[4-133] Due to the large number of papers being published daily, the decision was made not to update the search results before publication as this would significantly delay the guidance being available to readers. However, there were seven articles,[134-140] which were published after the search date that were felt to be of significant clinical importance. Due to the large number of articles describing SARS-CoV-2 transmission, the decision was made not to include studies which focused on SARS-CoV, MERS-CoV and other beta-coronaviruses. Any evidence from such studies, thought to be relevant to this guidance was provided as background information.

Of the included studies there were 122 case studies/series,[5-16,20-28,30-61,63,65,68-80,82-91,94-104,106-133,135,136-140] thirteen environmental surveys[4,17,18,29,62,64,66,67,81,93,105,134] and two laboratory experiments.[19,92] Nine of these studies described the possibility of SARS-CoV-2 transmission via air,[17,18,26,29,64,67,81,92,134] four via droplets,[30,51,59,82] eleven via fomites[8,17-19,29,66,67,81,92,93,134] and 32 via the vertical route.[5,10,12,14,15,22,24,31,35,39,42,46,52,54,55,56,58,71,73,75,94,97,113-115,117,119-121,124,133,136] Other studies described the presence of virus in faecal matter (n=33),[4,13,21,25,31,36,38,45,50,53,62,59,68,69,72,88-91,93,95,96,101,104,105,108,111,112,122,125,126,129-131] urine (n=11),[15,31,38,53,68,72,91,96,130,131,133] ocular secretions (n=9)[11,20,85,87,102,106, 110,127,132] and sexual body fluids (n=3).[21,44,79] Two studies also described the chance of transmission via the ocular surface[49,127] and four assessed the possibility of transmission via blood transfusion.[137-140] Lastly a total of 41 studies described clusters and outbreaks.[6,7,9,16,23,27,28,31-34,37,38,41,43,47,48,57,60,61,63,65,70,74,76-78,80,83,84,86,98-100,103,107,109,116,118,123,128] These studies did not report transmission routes, but the transmission patterns helped to determine the most likely routes via which the virus is likely to spread.

8. Review of evidence

Droplet transmission

Both, SARS-CoV and MERS-CoV viruses are predominantly transmitted via the droplet route.[141,142] The droplet route was recognized as a primary route of transmission of SARS-CoV by the scientific community, based on epidemiological evidence and the reproductive number (R_0) of approximately 3, which is consistent with close contact and therefore transmission through respiratory droplets.[143] Direct and indirect contact between respiratory droplets and the mucous membranes has been implicated as the route of transmission in some healthcare and community SARS outbreaks in Hong Kong.[141,142] Human-to-human transmission of MERS-CoV typically occurred in HCWs and family members who cared for infected persons and were therefore directly exposed to the virus by close contact with respiratory secretions.[144] The R_0 of MERS-CoV is generally considered to be <1, however for nosocomial outbreaks in Saudi Arabia and South Korea it was estimated as 2-5.[145] One study, which assessed the reproductive number for SARS-CoV-2 early in the epidemic in China, estimated that R_0

could be as high as 5.7 [CI95% 3.8-8.9] and could have been a result of travel and gatherings associated with Lunar New Year celebrations during which time a lack of awareness of the new pathogen could have facilitated its spread.[146] The authors also recognised that compared to SARS-CoV, SARS-CoV-2 has a much higher affinity to the ACE-2 receptor that both viruses use to enter the cell. Therefore SARS-CoV-2 virus is likely to be more infectious, which explains the higher reproductive number.

Epidemiological evidence for SARS-CoV-2

There was inconsistent evidence from four studies,[30,51,59,82] which investigated the possibility of droplet transmission for SARS-CoV-2 virus. Two of these studies concluded that droplet transmission was at least partially responsible for outbreaks involving choir practice attendees of whom 52/60 (86.7%) developed symptoms or tested positive for COVID-19[30] and restaurant patrons of whom 10/90 (11%) acquired infection.[59] An additional study found no SARS-CoV-2 transmission on a busy long distance flight, which authors concluded was consistent with droplet rather than airborne transmission.[82] Conversely, a different paper[51] describing the same restaurant outbreak involving 11% of restaurant patrons, concluded that the transmission via droplet route was not likely considering that close contact was not observed and the low ventilation rate of air conditioning and suggested that transmission occurred via airborne route.

*Upon the review of the above evidence, the COVID-19 Rapid Guidance Working Party considers the droplet transmission route to be **probable**.*

Airborne transmission

There is a current debate within the scientific community about the extent to which SARS-CoV-2 is able to be transmitted via the airborne route. Some confusion also exists because the term ‘aerosol’ is frequently used as a synonym of ‘airborne’. Aerosols refer to respiratory particles, which are found in the air, and their size is the predominant reason for their ability to remain suspended (airborne).[143] The generally accepted threshold for these particles to be considered airborne is <5μm.[143] Thus, the term ‘respiratory aerosol’ encompasses both the airborne particles and the larger particles which are known as droplets. It is widely accepted that humans may produce both sizes of respiratory aerosols during normal breathing, coughing, or sneezing and that larger droplets may desiccate and form smaller ‘airborne’ particles.[143] However, it is not known whether infectious SARS-CoV-2 virus is present in these small particles, and if so, how long it can stay viable in the air. As a result, it is currently not known whether this virus can be transmitted via airborne route as a result of normal breathing or coughing. One SARS outbreak in Hong Kong was suspected to be a result of airborne aerosols arising from infected faecal matter, which was distributed via the building’s drainage system.[144] The dynamics of nosocomial outbreaks in Hong Kong and Toronto suggested an airborne route was possible in some circumstances.[145] As a result, SARS-CoV virus was coined to be an 'opportunistic' airborne microorganism, meaning that while the droplets may be the main route of transmission, there may be some circumstances when airborne transmission occurs, e.g. during AGPs[145,146] or in rare circumstances when viable virus in excrement became aerosolised after flushing the toilet as reported in one outbreak.[139,147] Despite recognising SARS-CoV virus to be spread primarily via the droplet route, WHO[139] also acknowledged that airborne transmission in some circumstances was likely, mainly occurring when aerosolisation of respiratory droplets occurred, although transmission of aerosolisation of other infectious materials (e.g. faeces or urine through flushing) was also possible. Similarly, MERS-CoV is thought to have an ability to spread via airborne particles as reported during a hospital outbreak among haemodialysis and intensive care unit (ICU) patients.[148] Additionally, evidence from one study, which collected air samples from areas occupied by MERS patients, found culturable virus in rooms, toilets and the neighbouring corridor, suggesting that airborne transmission was possible.[149]

Epidemiological evidence for SARS-CoV-2

There was inconsistent evidence from four studies,[30,51,59,82] which considered the possibility of airborne transmission. Two of these studies[30,51] reported that airborne transmission was plausible, with one[30] reporting an outbreak which affected 52/60 (86.7%) of choir practice attendees and another[51] reporting 10/90 (11%) of restaurant patrons being infected from an asymptomatic index patient, some of whom had no direct contact or fomite exposure. However, another study which reported the investigation of the same restaurant outbreak concluded that there was no evidence of airborne transmission,[59] and one study[82] found no transmission on a long-distance flight, with the authors concluding that droplet transmission was more likely.

Presence of SARS-CoV-2 RNA in air

There was inconsistent evidence from seven environmental surveys,[17,18,26,29,66,81,134] which investigated the presence of viral RNA in rooms housing COVID-19 patients. Two of these studies[17,26] found no SARS-CoV-2 RNA in the collected air samples placed in the rooms of COVID-19 patients who were talking, breathing and coughing,[17,26] some of whom were also intubated.[26] One of these studies placed air samplers (n=4) in distance less than 1m from the patients[17] while the other set up four impingers (n=4) at a distance of 2-5m away from the patients.[26] In contrast, three studies[29,81,134] reported presence of SARS-CoV-2 RNA in the air surrounding COVID-19 patients. One study,[29] which distributed air samplers around the rooms and areas near COVID-19 patients found that 14/40 of air samples from ICUs and 2/16 from general wards contained SARS-CoV-2 RNA and that the virus might have travelled as far as 4m away from the patients. Another study[81] placed a total of twelve air samplers at various distances in and outside of rooms of COVID-19 patients with mild or asymptomatic infection. Seven personal air samplers were used for sampling HCWs entering the rooms wearing appropriate PPE, and who were advised to maintain at least 6ft (1.8m) distance away from the patients. The study reported that that five of the twelve samples in rooms and hallways were contaminated with SARS-CoV-2 RNA, two of which were placed at distances further than 1.8m. All seven personal air samplers were also found to contain SARS-CoV-2. Another study collected 1m^3 air samples (distance from patients not reported) and found that 14/31 of them contained SARS-CoV-2 RNA. Further, two small studies[18,66] assessing presence of SARS-CoV-2 RNA in the air in rooms of COVID-19 patients found four of six rooms which were investigated were contaminated. One of these studies placed NIOSH air samplers in three rooms[15] (n=2 per room) with 12 air changes an hour at a distance of less than 1m to 2.1m away from the patients. The authors reported that particles were of sizes >4µm as well as smaller particles of 1-4µm which can remain in the air for longer. The second study placed air samplers in the rooms and obtained swabs from air outlet fans (n=3 each), and reported that while air samples were negative, two of three air outlets were contaminated. Two of these studies[81,134] assessed the viability of the SARS-CoV-2 virus in culture (Vero E6,[81,134] Caco2[134]) and neither of them found any evidence of viable virus.

Duration of viable virus in the air

There was weak evidence from one laboratory study[92] assessing the duration that SARS-CoV-2 virus stayed viable in the air. This study used a $10^{5.25}$TCID$_{50}$ SARS-CoV-2 dose generated by three-jet nebuliser fed into a Collison drum to create an aerosolised environment, with resulting inoculum representative of upper and lower respiratory tract with 20-22 cycle threshold values. The authors reported that SARS-CoV-2 remained culturable in Vero E6 cells after 3hrs of remaining in the air with a reduction of infectious titre from $10^{3.5}$ to $10^{2.7}$ TCID$_{50}$/L.

Viral load

There was inconsistent evidence from four environmental surveys[17,18,64,134] which reported the SARS-CoV-2 viral load assessed as number of viral RNA particles per m^3 or the number of viral RNA particles/m^3/hr. One study[17] reported that no viral copies were found in the four samples collected in the rooms of COVID-19 patients who were breathing talking and coughing, while another,[18] which collected samples of less than 1m to 2.1m away from patients reported 1.84x10^3 to 3.38x10^3 copies of viral RNA present in the three samples they collected. The authors reported that these were contained in larger droplets of >4µm in size as well as droplet nuclei of 1 to 4µm. An additional study,[64] which investigated viral load as the number of viral particles/m^3/hr collected from a total of 35 samples from air samplers distributed through different locations within the hospital, reported that viral load was up to 113 in ICU, up to 42 in general wards and up to 11 in public areas. The authors reported that not only rooms and toilets were contaminated but also areas such as offices, workstations and changing rooms. The last study,[134] which collected air samples from areas housing COVID-19 patients reported that the viral load ranged from 10 to 1000 RNA copies/m^3. This was the only study that assessed the viability of the SARS-CoV-2 virus in Vero E6 and Caco2 cell cultures and it did not find any evidence of the virus being viable.

*Upon the review of the above evidence, the COVID-19 Rapid Guidance Working Party considers the airborne transmission route to be **possible**, although the group acknowledged that this may be circumstance-specific, predominantly during AGPs.*

Transmission via fomites

Fomites are inanimate objects which, when contaminated, can transfer pathogenic microorganisms from one person to another. These objects can become contaminated from person's hands, body fluids and secretions or respiratory droplets settling on their surfaces. Fomites in hospital environment are usually mentioned in the context of different objects surrounding the patient, such as toilet seats, door handles and shared equipment; other, less commonly mentioned objects include hair, clothing, bedding, and eating and drinking utensils. This route of transmission depends on the ability of the microorganism to survive outside the human body. Outbreaks of SARS in healthcare and community settings in Hong Kong[141,142] implicated fomites as the route of transmission and one MERS outbreak occurring in a hospital in South Korea was thought to involve fomites.[154]

Epidemiological evidence for SARS-CoV-2

There was weak evidence from two studies, which considered the possibility of indirect human-to-human transmission via fomites in the outbreak involving 35 cases in a shopping centre[8] and in a choir practice outbreak affecting 52 individuals.[30] Both studies concluded that fomites could have contributed to transmission of SARS-CoV-2.

The outbreak in the restaurant described in the droplet and airborne section[51,59] could also be explained by fomite spread on cutlery and crockery following contamination of the hands of the waiter serving these tables with little opportunity for hand hygiene (please see Appendix 9).

Presence of SARS-CoV-2 on surfaces

There was moderate evidence from seven environmental surveys, which assessed the presence of SARS-CoV-2 viral RNA in hospital rooms housing COVID-19 patients, with outcome measures reported either as the number of contaminated surfaces,[29,66,81,93,134] the number of contaminated rooms[15,16] or the number of contaminated PPE items.[66,67,93] One study,[29] which investigated presence of viral RNA on floors and high touch surfaces found that these were contaminated in ICUs caring for more severe cases (54/124, 44%) as well as in general wards where milder cases were present (9/114, 8%). Another study[66], which investigated toilets, floors and high touch surfaces, reported that 15/25 were contaminated and that the highest contamination was found on toilets (12/14). They found viral RNA on surfaces in three out of five patient rooms, while no contamination was found on floors. Similar findings were obtained in another study[81] which sampled common room surfaces, toilets, and personal items. Of the total of 134 samples tested, 114 (85%) were found to be contaminated with SARS-CoV-2 RNA. These included floors under beds (5/5 sampled), bedside tables or bed rails (18/24), toilets (17/21), personal phones (15/18) and remote controls (12/18). In one study,[134] where samples were collected from high touch surfaces including bed rails, sinks, computer keyboards, clinical equipment, ward telephones and other surfaces, a total of 114/218 (52.3%) surfaces were found to be contaminated with SARS-CoV-2 RNA. In contrast, one small study[93] reported no contamination of hospital surfaces including door handles, bedside tables, monitors, sinks and bedrails, although the authors reported that these results might have been confounded by frequent cleaning with 1000mg/L of chlorine (every 4hrs in ICU and 8hrs in general wards). One study[18] which reported the number of rooms contaminated with SARS-CoV-2 RNA, found that 17/30 (57%) of rooms housing COVID-19 patients were contaminated. Another study[17] sampling one room found contamination during the first but not the second episode of sampling. Studies evaluating contamination of PPE where AGPs were not undertaken,[63,64,90] found no contamination on gowns, respirators, masks, visors or goggles, while shoes were found to be contaminated only once (1/109 samples). One study attempted to assess viability of the virus obtained from the surfaces[134] in Vero E6 and Caco2 cells and reported that none of the 114 samples contaminated with SARS-CoV-2 RNA yielded culturable virus.

Survival of viable virus on different types of surfaces

There was weak evidence from two laboratory studies,[19,92] which assessed the ability of viable virus to survive on different types of surfaces (number of surfaces not provided). One study[19] used 5µl droplet of $10^{7.8}$ $TCID_{50}$/ml SARS-CoV-2 viral culture inoculated onto different types of surfaces including printing and tissue paper, wood, cloth, glass, banknote, stainless steel and plastic and maintained at room temperature (22°C) and 65% humidity. The authors reported that virus tends to survive better on smooth surfaces (glass and banknote 4 days, stainless steel and plastic 7 days), than on porous surfaces (paper less than 3hrs, wood and cloth 2 days). Another study[92] used a 10^5 $TCID_{50}$ SARS-CoV-2 virus inoculated onto plastic, stainless steel, copper and cardboard. The authors reported that SARS-CoV-2 remained viable for up to 4 hours on copper surfaces and 24 hours on cardboard. The virus was able to survive up to 48hrs and 72hrs on stainless steel and plastic surfaces respectively, although its infectious titre reduced to $10^{0.6}TICD_{50}$ on both surfaces.

*Upon the review of the above evidence, the COVID-19 Rapid Guidance Working Party considers the transmission via fomites to be **possible**.*

Vertical transmission

One meta-analysis, which evaluated the pregnancy outcomes of women infected by beta-coronaviruses[155] found that no cases of vertical transmission occurred in pregnant women affected by SARS (n=14) or MERS (n=4). Thus, vertical transmission was considered unlikely, although poor maternal, foetal, and neonatal outcomes were frequently observed.[155]

Epidemiological evidence for SARS-CoV-2

There was moderate evidence from 31 case series/study articles, which investigated the possibility of vertical transmission for SARS-CoV-2 virus.[5,10,12,14,17,22,24,31,35,39,42,46,52,54-56,58,71,73,75,94,97,113-115,117,119-121,124,133,136] The results showed that from the total of 368 babies reported by these studies, twelve (3%) were reported[5,22,39,94,117,120,121,136] to be possibly infected *in utero*. Of these babies, only one was tested (and was found positive) for the presence of SARS-CoV-2 RNA at birth, which suggests that vertical transmission is plausible.[136] The remaining eleven babies were not tested for the presence of SARS-CoV-2 RNA at birth, which raises a possibility that these babies could have been infected intrapartum or postpartum. Additionally, for three of these babies, conclusions were based on the presence of IgM antibodies at birth with no evidence of SARS-CoV-2 presence.[22,120]

Evidence for presence of SARS-CoV-2 RNA in maternal/neonatal tissues and products of conception

There was a moderate evidence from 14 case series/study articles,[10,25,31,35,42,54,71,73,94,97,113,115,117,136] which investigated the presence of SARS-CoV-2 viral RNA in different types of maternal and neonatal tissues and products of conception. The analysis of pooled results showed absence of viral RNA in samples obtained from cord blood (n=46), breast milk (n=10), vaginal secretions (n=8) and serum (n=1). Sampling of placenta revealed 4/20 (20%) positive samples, three of which were reported in one study[71] in women with severe COVID-19 disease with authors indicating that contamination from maternal tissues and fluids was likely. The remaining positive sample was reported in the study which found the neonate testing positive for SARS-CoV-2 RNA presence at birth.[136] The same study also found that amniotic fluid was contaminated with SARS-CoV-2 RNA before the rupture of the membranes whilst other studies reporting a total of 44 samples reported no presence of the viral RNA.

*Upon the review of the above evidence, the COVID-19 Rapid Guidance Working Party considers the vertical transmission route to be **unlikely**.*

Transmission of SARS-CoV-2 from different body fluids

Previous studies reported presence of SARS-CoV and MERS-CoV viral RNA in different body fluids and waste products including faeces,[156-160] urine[156,158-161] and ocular secretions,[162,163] with two further studies reporting infectious virus isolated in culture from urine and stool specimens.[164,165] Viral RNA was also found in gastrointestinal and urinary tracts of individuals affected by SARS or MERS.[166,167] This suggests that infection from exposure to body fluids is, at least theoretically, possible. Furthermore, one study describing an outbreak of SARS in residential complex in Hong Kong demonstrated a link between faeces from a symptomatic patient with diarrhoea and widespread transmission to others via the drainage system.[148] Additionally, unpublished data (being unpublished, these did not meet our criteria for inclusion in this guidance) from Chinese Center for Disease Control and Prevention suggested the possibility of SARS-CoV-2 virus in faeces becoming aerosolised after being flushed in the toilet.[151] The authors reported that the virus was deposited on surfaces (taps, showers, and sinks) of bathrooms in other apartments sharing the same sewage pipe. The data also identified individuals who later became ill with COVID-19, and who were linked to the same sewage pipe, although it is not clear whether these cases became ill as a result of exposure from infectious aerosols arising from the sewage. So far, it is unclear whether body fluids can be potential sources of SARS-CoV-2 infection, concerns also exist for blood and transplant donation recipients since it has been estimated that approximately 40% COVID-19 patients have evidence of viral RNA presence in their blood.[168]

Faecal matter

Epidemiological evidence

No evidence was found in studies published so far, that faecal matter was responsible for transmission of SARS-CoV-2 virus to other persons.

Evidence of presence of SARS-CoV-2 RNA in faecal matter

There was moderate evidence from 33 case series, case studies and environmental surveys, which assessed the presence of viral RNA in anal swabs,[21,25,36,45,72,88,101,112,126] or stools[15,31,38,50,53,68,69,89-91,95,96,101,104,108,111,122,125,129-131] of COVID-19 patients or in sewage taken during the pandemic in community settings[4,62,105] or in a hospital caring for COVID-19 patients.[93] These studies found consistent evidence for the presence of SARS-CoV-2 RNA in such specimens. Overall, SARS-CoV-2

RNA was found in anal swabs of 25/72 (35%) COVID-19 patients, in stool specimens of 215/439 (49%) patients and in 50/65 (77%) of sewage samples.

Evidence of presence of viable SARS-CoV-2 virus in faecal matter

There was weak evidence from one case series, one case study and two environmental surveys, which assessed the presence of culturable SARS-CoV-2 virus in stools[96, 129]or sewage.[4,93] One case series study,[96] which assessed virus viability in four stool samples with high SARS-CoV-2 viral load, reported that two of these samples yielded culturable virus and that the patients from whom the samples came, did not have diarrhoea. A case study[129] of one patient with severe pneumonia reported that the SARS-CoV-2 virus isolated from a faecal sample obtained 15 days after the onset of the disease was cultured in Vero E6 cells and observed under scanning electron microscope. The environmental surveys found no viable virus in six sewage samples that they tested. The first of these studies[4] collected the samples from untreated sewage from the municipal pumping station and wastewater treatment plant in the middle of the pandemic, approximately five to seven weeks after the first cases appeared in the area. Of two samples found to be positive for SARS-CoV-2 virus by PCR, neither was viable in culture. Another study[93] collected samples from hospital sewage disinfection pools with the wastewater coming from isolation rooms of COVID-19 patients. Four samples, which were previously found to contain SARS-CoV-2 RNA, yielded no viable virus cultured in Vero E6 cells.

*Upon the review of the above evidence, the COVID-19 Rapid Guidance Working Party considers SARS-CoV-2 transmission from infected faecal matter to be **unlikely**.*

Urine

Epidemiological evidence

No evidence was found in studies published so far, that urine was responsible for transmission of SARS-CoV-2 virus to other persons.

Evidence of presence of SARS-CoV-2 RNA in urine

There was moderate evidence from eleven case series and case studies, which assessed the presence of SARS-CoV-2 RNA in urine, with outcome measure defined as number of patients with positive sample[31,38,53,68,72,91,130,131,135] or number of positive urine samples.[15,96] These studies demonstrated that urine is rarely contaminated with SARS-CoV-2 viral RNA. Studies which assessed the number of patients with any positive urine sample found that in 8/150 (5.3%) urine was contaminated with SARS-CoV-2 RNA. Studies which assessed the outcome as the number of positive urine samples, found no evidence of this occurring (0/82, 0%).

Evidence of presence of viable SARS-CoV-2 virus in urine

There was weak evidence from one case study,[135] which attempted to isolate infectious virus from urine sample obtained 12 days post-infection from one COVID-19 patient. This study found evidence that the virus was culturable in Vero E6 cells, with cytopathic effects observed in cells after three days.

Upon the review of the above evidence, the COVID-19 Rapid Guidance Working Party considers SARS-CoV-2 transmission from infected urine to be ***unlikely****.*

Ocular secretions and transmission via ocular surface

Epidemiological evidence

No evidence was found in studies published so far, that ocular secretions we responsible for transmission of SARS-CoV-2 virus to other persons.

There was weak evidence from two case series and case studies,[49,127] which reported occurrence of SARS-CoV-2 transmission via ocular surface in three HCWs. These studies reported that all three cases occurred when the HCWs did not wear equipment to protect their eyes, wore it inconsistently, or touched their eyes when working with infected patients.

Evidence of presence of SARS-CoV-2 RNA in ocular secretions

There was moderate evidence from nine case series and case studies, which assessed the presence of SARS-CoV-2 RNA in ocular secretions.[11,20,85,87,102,106,110,127,132] These studies consistently demonstrated a rare presence of SARS-CoV-2 RNA in ocular secretions, with 8/194 (4%) of samples yielding positive results.

Evidence of presence of viable SARS-CoV-2 virus in ocular secretions

No evidence was found in studies published so far, that viable SARS-CoV-2 was found in ocular secretion specimens.

Upon the review of the above evidence, the COVID-19 Rapid Guidance Working Party considers SARS-CoV-2 transmission from infected ocular secretions to be ***unlikely****.*

Upon the review of the above evidence, the COVID-19 Rapid Guidance Working Party considers transmission via ocular surface to be ***possible****.*

Sexual body fluids

Epidemiological evidence

No evidence was found in studies published so far, that sexual body fluids were responsible for transmission of SARS-CoV-2 virus to other persons.

Evidence of presence of SARS-CoV-2 RNA in sexual body fluids

There was weak evidence from three case series studies, which assessed the presence of SARS-CoV-2 viral RNA in sexual body fluids.[21,44,79] One study evaluating the presence of the virus in semen[44] found 6/38 (16%) of specimens being infected while the remaining two studies[21,79] found no SARS-CoV-2 RNA in a total of 45 vaginal secretion samples.

Evidence of presence of viable SARS-CoV-2 virus in sexual body fluids

No evidence was found in studies published so far, which reported that viable SARS-CoV-2 was found in sexual body fluid samples.

*Upon the review of the above evidence, the COVID-19 Rapid Guidance Working Party considers SARS-CoV-2 transmission from infected sexual body fluids to be **unlikely**.*

Blood transfusion and organ transplantation

Epidemiological evidence

There was a weak evidence from four case studies which assessed the possibility of SARS-CoV-2 transmission via blood donation.[137-140] In these studies, a total of five recipients received blood products obtained from four donors, who at the time of donation, were not aware of their infection. None of the five recipients acquired the virus as a result of blood transfusion.

No evidence was found in studies published so far, that organ transplantation resulted in transmission of SARS-CoV-2 virus to organ recipients.

*Upon the review of the above evidence, the COVID-19 Rapid Guidance Working Party considers SARS-CoV-2 transmission from blood transfusion and organ transplantation to be **unlikely**.*

Transmission dynamics of SARS-CoV-2

The transmission dynamics for SARS-CoV and MERS-CoV were different, which may reflect their infectivity via different transmission routes. The SARS outbreak originated in southern China and it is thought that many cases were due to super-spreader index patients who infected many individuals.[169] Examples of individuals who caused such events are a fishmonger from southern China who infected 30 HCWs and eventually was implicated as the index patient in an outbreak in surrounding hospitals; a doctor from a Chinese hospital who infected 23 hotel guests and who subsequently carried the virus to other countries including Vietnam, Canada and Singapore; and a Hong Kong housing estate where one index patient with diarrhoea was responsible for transmitting the virus to over 200 estate residents.[148,169-172] Other outbreaks occurred mostly in hospitals[169] and isolated cases later occurred when researchers working with SARS-CoV in laboratory settings were infected following exposure.[173] Transmission of MERS-CoV occurs mostly from infected camels via direct contact or from consuming camel meat and milk.[144] Human-to-human transmission occurs but is thought to be relatively rare and is limited to a close contact with severely ill people.[144] The majority of secondary cases are known to be either HCWs or close family members sharing the same household. Secondary cases also tend to develop milder symptoms and be less infectious to others.[144]

Epidemiological evidence of SARS-CoV-2 transmission occurring within households

There was moderate evidence from 17 outbreak studies,[7,16,27,28,31,34,37,41,47,48,54,78,84,86,98,99,128] which investigated the possibility of SARS-CoV-2 transmission occurring between household members. The majority of the studies reported transmission which occurred at the start of the epidemic in their local areas with no restrictions put in place by local government.[7,28,31,34,37,41,48,54,82,85,128] Two studies reported that national surveillance and contact tracing were in place but that no restrictions were implemented at this point,[16,99] and further three Chinese studies reported that Wuhan was under lockdown at the time of data collection.[27,78,95] None of the studies reported the use of any mitigation measures to control transmission within the household, e.g., wearing face coverings, staying in separate rooms, or avoiding any close contact. One of the studies reported that the lockdown in Wuhan prompted many residents to return to their provinces, which resulted in the spread the disease across the country.[27] The studies collectively reported a total of 1119 cases with an overall attack rate of 25%. The attack rate varied widely from none, to all members of the household being infected.

Epidemiological evidence of SARS-CoV-2 transmission occurring between family and friends

There was moderate evidence from 14 outbreak studies, which reported a total of 179 cases of SARS-CoV-2 transmission occurring among family members[6,16,23,27,33,34,40,43,74,77,78,107,116,118] and a further five outbreak studies describing 11 cases occurring between friends.[33,40,99,107,109] These persons did not share a household with infected index cases but were reported to have close contact exposure while eating meals, visiting each other or travelling together. The overall attack rate for family contacts was 24.6%, although as with household transmission, this varied widely from 14% to all family members being infected. The overall attack rate for exposure between friends was 8%.

Epidemiological evidence of SARS-CoV-2 transmission occurring in workplaces

There was moderate evidence from six outbreak studies,[23,27,70,76,78,80] which investigated SARS-CoV-2 transmission in work environment where there was no exposure to the customers. The studies reported that a total of 122 individuals were affected with an overall 10% attack rate. One study[70] also reported that 94/97 (97%) COVID-19 individuals were working on the same floor, with many also situated on the same side of the building. Another study[76] reported that 7/94 (7%) were most likely infected because of breakout sessions and team building activities which allowed a close and sometimes physical contact between the individuals.

Epidemiological evidence of SARS-CoV-2 transmission occurring in supermarkets and shopping centres
There was weak evidence from three outbreak studies,[76,103,123] which investigated SARS-CoV-2 transmission in supermarkets and shopping centres. Two of these studies reported that national surveillance and contact tracing were in place during data collection,[76,123] but none reported specific measures for controlling transmission such as the use of face coverings or social distancing. The studies reported a total of 22 employees and 21 customers being infected, with attack rates of 12% and 0.02% respectively. However, in one study[73] where employees had close contact with infected customers, the attack rate was higher (29%).

Epidemiological evidence for SARS-CoV-2 transmission occurring during church service
There was weak evidence from three studies[76,99,116] reporting five outbreaks, where exposure during the church service affected a total of 20 cases with an attack rate of 2%. All studies reported that national surveillance and contact tracing were in place during data collection, but none reported specific measures for controlling transmission such as the use of face coverings or social distancing. Of the 20 cases, four were described as sitting very close to the index patients[76,99] and one was found to occupy the same space during a different service later that day.[99]

Epidemiological evidence for SARS-CoV-2 transmission occurring in acute healthcare settings
There was moderate evidence from eight outbreak studies,[7,16,28,32,43,83,84,100] which investigated the occurrence of SARS-CoV-2 transmission occurring in acute healthcare settings. The outbreaks showed that transmission in these settings is relatively low and affected 37 HCWs, 13 patients and seven visitors caring for their sick relatives. The attack rate for HCWs was 0.9% and mostly occurred in HCWs who reported prolonged contact with the index patients and being present during AGPs without the use of PPE (31/37, 84%);[32,83,84] in the remaining six cases the staff were reported to have worn PPE.[16] The overall attack rate for patients and visitors was not established.

Epidemiological evidence for SARS-CoV-2 transmission occurring in care homes
There was weak evidence from one outbreak study[61] describing transmission in a nursing home. This study described an outbreak which involved a total of 101 residents, 50 staff and 16 visitors. The authors did not provide a denominator, but based on the reported bed capacity of 130, the attack rate among residents was 78%.

Epidemiological evidence for SARS-CoV-2 transmission occurring in other settings

There was weak evidence from a total of 11 outbreak studies,[8,23,27,60,63,65,70,74,78,82,128] which investigated transmission occurring in other settings. They reported that the risk of acquiring the virus from these settings was low. One study[27] estimated that 6/1052 (0.6%) of infected cases acquired the virus during public gatherings and a further 5/1052 (0.5%) acquired the virus from no apparent close contact with known COVID-19 cases. Isolated incidents occurred in a public bath (n=8 cases),[57] public transport (n=14),[27,78] tour groups travelling together (n=8)[65,128] and during a flight in which a passenger sat next to an individual later diagnosed with COVID-19 (n=1).[128]

Upon the review of the above evidence, the COVID-19 Rapid Guidance Working Party conclude that it is ***probable that transmission occurs with close contact****, although at the moment it is not possible to determine the distance or the duration for transmission to occur. Transmission from COVID-19 patients to HCWs in hospitals is low, except in small number of cases where HCWs cared for undiagnosed COVID-19 patients and did not use appropriate PPE. Even in these cases, transmission usually occurred during AGPs. Transmission in care homes appears to be very high and needs particular consideration.*

9. Additional literature published after the initial search

The Working Party considered the updating the review in the light of new evidence emerging rapidly. However, the number of articles related to SARS-CoV-2, published since the original search was conducted in May 2020, has increased dramatically. The search for date range 12 May 2020 to 05 April 2021 in Embase and Medline resulted in additional 10,931 and 9132 records respectively, thus making any timely revisions unfeasible. The Working Party is aware of a number of publications which have not been included in the above evidence review, particularly those in relation to the current debate about aerosol transmission. The below evidence has not been systematically searched but was obtained from various sources, e.g., experts highlighting key research papers, Working Party members informed of the articles being published, and the articles identified from the searches ran for other COVID-19 related questions. All other methodological aspects of quality assessment and data extraction remained the same in gathering this evidence.

Droplet vs airborne route

Epidemiological evidence for SARS-CoV-2 being transmitted via droplet vs airborne route

There was inconsistent evidence from seven studies,[142,143,147,149,155,157,158] which considered the possibility of airborne vs droplet transmission. Four of these studies[143,147,155,158] concluded that airborne transmission was likely after observing the transmission patterns in outbreaks affecting 34/55 (62%) of nursing home residents and staff in the Netherlands,[143] 20/79 (25%) of early-shift employees of the meat processing plant in Germany,[147] 52/60 (86.7%) of choir practice attendees in USA[155] and 23/67 (34%) of lay Buddhists travelling on the bus to and from the worshipping event in China.[158] However, one study[157] concluded that transmission patterns were more consistent with droplet route in a small cluster where 2/132 of high and low-risk contacts were infected after one mildly symptomatic index case working as a doctor in a hospital in Germany was diagnosed early at the start of pandemic after acquiring the virus in Italy.[157] One further study[149] reported that it was not possible to confirm or exclude either droplet or airborne transmission. This study described an outbreak on a long-distance flight following which 15/183 (8.2%) of passengers and crew became infected, with majority of the passengers being within a two-metre range of the index case. Furthermore, one study describing a choir practice in France which affected 19/27 (70%) of attendees concluded that transmission was likely due to both, droplet and aerosol spread.

Presence of SARS-CoV-2 RNA in air

There was inconsistent evidence from nine environmental surveys,[141,144,145,150,152,153/154,159,160,161] which investigated the presence of SARS-CoV-2 RNA in hospital rooms, hotels and flats housing COVID-19 patients. Two of these studies[141,145] found no viral RNA in the collected air samples placed in the rooms of COVID-19 patients who were breathing normally,[141,145] talking or reading a book aloud[141,145] or singing[141] One of these studies placed their air samplers in distance less than 1m from the patients[141] while the other one set them up at a distance of 2-5m away from the patients.[145] In contrast, seven studies[144,150,152,153/154,159,160,161] reported presence of SARS-CoV-2 RNA in the air surrounding COVID-19 patients. One study found evidence of SARS-CoV-2 viral RNA in the air in all four samples taken from the room of two COVID-19 patients.[150] This study used a water vapour condensation system designed for collecting airborne particles without damage, with samples taken 2m or 4.8m away from the patients. The remaining studies reported relatively low prevalence of SARS-CoV-2-positive air samples, with one study[144] reporting 1/46 (2.2%) weakly positive sample (defined by authors as a sample with cycle threshold between 37 and 38) found in a corridor of the COVID-19 ward but not in samples taken in the rooms (at 0.5m distance from the patients) or at the nursing station, another study[152] reporting two positive samples (total number of samples not reported) taken at the distance of 1m away from the patient, one study[153/154] reporting one (1/26, 3.8%) positive sample collected from the toilet in COVID-19 ward and one study[161] reporting 3/44 (6.8%) of samples collected from high and low risk areas in hospital housing COVID-19 patients. One of these studies[150] assessed the viability of the SARS-CoV-2 virus in Vero E6 culture cells and found all four samples to contain infectious virus with 6 and 27 viral genomes/L for samples collected at 4.8m distance and 18 and 74 genomes/L for samples collected at 2m.

Duration of viable virus in the air

There was weak evidence from one laboratory study[146] assessing the duration that SARS-CoV-2 virus stayed viable in the air. The study used a custom-made drum to aerosolise and maintain suspension of the SARS-CoV-2 virus particles in the room. Authors reported that 16 hours after remaining suspended, the reproductive ability of the virus did not reach its half-life and only a minimal decrease in virus concentration was observed. They also reported that scanning electron microscope examination showed that the virus maintained its characteristics (size, shape, morphology) 16 hours after aerosolisation.

Contaminated air vents, ducts and filters

There was weak evidence from three environmental surveys[143,156,159] which reported the presence of SARS-CoV-2 RNA in swabs taken from different parts of ventilation system. Positive samples included 7/19 (37%) of vent openings and 4/19 (21%) of vents ducts taken from rooms housing COVID-19 patients[143] and from an outpatient clinic,[156] and 3/6 (50%) air exhaust outlets in negative pressure rooms with COVID-19 patients.[159] One study reported that two (1/2) filters from air conditioning units and 4/16 (25%) filters from ventilation cabinets, taken from the nursing home unit involved in the outbreak affecting 62% residents and staff, also contained SARS-CoV-2 RNA.[143] One of these studies attempted to determine the virus viability in Vero E6 cells but they reported that their results were inconclusive.[156]

Contaminated exhaled breath

There was inconsistent evidence from three environmental surveys[144,153/154,161] which investigated the presence of SARS-CoV-2 RNA in the exhaled breath of COVID-19 patients. Two of these studies,[153/154,161] both using exhaled breath collection devices (BioScreen, version I and II) to collect their samples, reported the presence of viral RNA in 14/52 (27%)[153/154] and 2/9 (22%)[161] of the collected exhaled breath condensates. Conversely, one study[161] which collected two exhaled breath samples and two expired air samples found no evidence of the SARS-CoV-2 presence. Neither of these studies attempted to determine the viability of the virus.

Faecal matter

Epidemiological evidence

There was weak evidence from one study[148] which investigated the possibility of faecal matter being responsible for transmission of SARS-CoV-2 virus to other persons. The study described an outbreak of 9 cases occurring in three vertically aligned flats with bathrooms connected via drainage system. Secondary cases occurred in families with no recent travel history and no contact with confirmed or suspected COVID-19 cases. Authors reported that no other cases occurred within the other households, some of which were in close contact with index cases in the elevator. Outbreak investigation showed presence of SARS-CoV-2 RNA in samples taken from vertically aligned flats, one of which was unoccupied while all samples taken from communal areas were negative. To further strengthen their evidence, authors released tracer gas into the toilet of the index household. Substantial tracer gas concentration was found in the flats of the two affected households and along with two other vertically connected flats. Authors concluded that drainage pipes of vertically aligned toilets probably served as transport routes of faecal aerosols between the flats and that, similarly to the SARS outbreak in Amoy Gardens in 2004, the dry drains allowed the aerosol dispersal into some but not all flats.

Transmission dynamics of SARS-CoV-2

Epidemiological evidence for SARS-CoV-2 transmission occurring in acute healthcare settings

There was moderate evidence from 23 studies[165-183,187-189,193,195] which investigated the occurrence of SARS-CoV-2 transmission affecting HCWs in acute healthcare settings. The total number of infected HCWs reported in these studies combined with the studies reported previously[7,16,28,32,83,84,100] was 2170. Seven studies[168,172-174,182,187,189] reported unprotected exposure of HCWs to undiagnosed (and not suspected) COVID-19 patients. Unprotected exposure differed between the studies but all described any contact (close or casual) with an infected patient without PPE or with PPE which was not considered sufficient. Combining the results obtained from twelve studies, which reported a total number of exposed and total number of infected HCWs,[7,16,28,32,84,168,172-174,182,187,189] the overall attack rate was 1.6% (84/5298). This included a total of 18/1138 (1.6%) HCWs who were reported to have a high-risk contact (defined in studies as prolonged, at least 10min direct contact <2m with the infected patient or being present during AGPs performed on infected patient).[84,168,173,182,187,189]

Studies which investigated the prevalence of SARS-CoV-2 infection in HCWs reported that unprotected patient-HCW contact was only one of the vectors for SARS-CoV-2 transmission. One UK study[166] reported that after the first wave of pandemic, a total of 1,128 of HCWs in one hospital (11.2% of total 10,034 staff population) tested positive either for SARS-CoV-2 RNA presence through PCR screening or for SARS-CoV-2 antibodies through serological screening test, which suggests they must have acquired an infection at some point from the start of the pandemic. The analysis of the pre-test questionnaires demonstrated that working on COVID-19 wards was one of the risk factors for SARS-CoV-2 acquisition (2.47 [CI 95% 1.99-3.08] p<0.001), although transmission still occurred in low-risk areas, which authors suggested, was due to HCW-HCW transmission. After adjusting for COVID-19 areas, exposure to a confirmed household contact was the most important risk factor with 38.5% of staff who tested positive reporting this exposure and (AOR 4.82 [CI 95% 3.45-6.73] p<0.001), and further 16.1% reporting exposure to suspected (not confirmed) household contact (AOR 1.75 [1.372.24] p<0.001). Contact with COVID-19 confirmed patients without PPE was reported by 17.0% of staff who tested positive (AOR 1.44 [1.24-1.67] p<0.001).

Another UK study,[167] which PCR screened symptomatic staff HCWs (worked in hospitals or GPs) at the start of the first wave of the pandemic in the UK between 10-31st March 2020 (national social distancing measures introduced 20th March followed by 23rd March national lockdown), reported that 240/1654 (14.5% of symptomatic staff, total number of staff not reported) tested positive during this time. Authors reported no difference in the positivity rates between three types of HCWs, i.e., those in patient-facing roles (e.g., nurses, doctors, allied professionals, porters, 128/834, 15%), those in non-patient but high-risk roles (e.g., laboratory and domestic staff, 14/86, 16%) and those in low-risk roles (e.g., administrative, secretariat, IT, 20/109, 18%). Authors suggested that nosocomial transmission from patients to staff was not an important factor. They also observed that the weekly rates of positivity in the HCWs reflected the pattern of transmission in the community rather than nosocomial spread, thus they reported that the isolation protocols and PPE provided to staff were sufficient to protect them from potentially infectious patients.

Similar conclusions were reached by another study[179] which offered asymptomatic weekly screening for staff working in one of London's NHS healthcare networks. Data were reported for five weeks starting the week of the national lockdown on 23rd March 2020. Authors reported that the rate of positivity of the asymptomatic staff who volunteered to participate in this screening programme mirrored the curve of positive cases in London area and the number of COVID-19 inpatients in the trust around this time, and that the trend represented community rather than hospital transmission to HCWs.

These findings are in line with the results of two studies which reported transmission patterns at the start of pandemic in the Netherlands.[169,178] The positivity rate in symptomatic HCWs was reported as 6% (86/1353, or 0.9% of the entire staff in two hospitals participating in the study)[169] and 6% (96/1796 or 0.8% of the entire staff in three hospitals participating in the study).[178] Only three HCWs in each study (representing 3.5%169 and 3%178) reported contact with COVID-19 positive patient before they tested positive, with a total of 21/86 positive HCWs (24%)[169] and 20/96 (21%)[178] also reporting that their roles did not involve patient contact. Other known COVID-19 exposures included fellow HCWs (18/96, 19%),[178] a household member (1/96, 1%)[178] and other contacts outside the hospital (9/96, 9%).[178] Furthermore, one of these studies[178] reported that 10 of the infected 96 HCWs (10%) declared recent foreign travel, 60 (63%) declared carnival attendance with more than 50 people present, and

31 (32%) declared attendance at other event which involved more than 50 people. Both studies concluded that the community rather than hospital transmission most likely contributed to a high prevalence of SARS-CoV-2 infection in these HCWs. Additionally, one of these studies[169] reported that 54/86 (63%) of these HCWs were working while symptomatic, which possibly contributed towards the community and nosocomial spread. Authors reported that this was due to a very narrow case definition of COVID-19 at this time with only 3/86 (3.5%) of positive staff meeting the case definition criteria.

Another study from the Netherlands[175] which described transmission dynamics in one hospital early in the pandemic (3rd April-11th May) reported a higher positivity in symptomatic HCWs (88/362, 13.9). During this time, besides the implemented PPE, staff were not allowed to work in more than one location, social distancing was implemented in break rooms and staff were asked to isolate for at least until 24hrs after symptom resolution. All infected HCWs were questioned about possible infection source and were divided into risk categories: direct patient contact, indirect patient contact, no patient contact. Whole Genome Sequencing, which analysed isolates from 30 HCWs and 20 patients, identified four clusters suggesting multiple introductions to the hospital. Authors reported that the epidemiological and WGS analysis strongly suggested transmission occurring between the healthcare workers as well as from HCWs to patients.

Another study of HCWs in a hospital, which was reported to be a hub of COVID-19 cases in Italy,[170] screened all their staff during the first wave of pandemic and also offered antibody testing to any HCW willing to participate. They identified a total of 58 of 2057 (2.7%) staff who acquired the SARS-CoV-2 infection. They reported that working on COVID-19 wards was a risk factor for acquiring an infection, although only 29/58 (50%) of positive staff had an exposure to COVID-19 +ve patient, while for 26/58 (44.8%) no exposure was traced and for 3/58 (5.2%) exposure was out of hospital. Similarly, another study from Singapore,[181] which undertook a 16-week staff symptom surveillance reported that, over the study period, 2250/9322 (24%) of staff presented to the staff clinic with symptoms and 14/2250 (0.6% of symptomatic or 0.2% of total staff) were found positive. Ten of these 14 workers did not have patient contact and were exposed in the community (71.4%) and the remaining four were infected from another HCW (three of these HCW contacts were outside the hospital).

An additional study from Philippines[180] reported the results of reactive screening (close contact or high exposure to the virus) of HCWs. A total 324 tests were performed, 97 (30%) of which were due to moderate or high-risk exposure. All infections (n=8) occurred in the group screened following the moderate/high exposure (8.2%) and most of the cases were a part of two clusters. The first cluster involved one doctor and two nurses who worked together as a TB team. It is not possible to determine how the doctor became infected, but he subsequently infected two nurses on his team either at work or in the apartment which they shared during the community quarantine; 17 days later another nurse of his team tested positive, but it was not possible to determine whether this HCW was a part of a cluster or an isolated case. Another cluster involved three laboratory technicians who were working together in HIV clinic and were exposed to an infected housemate. Authors reported that transmission may have been low due to appropriate PPE used and other measures implemented but highlighted that HCW exposure is not necessarily due to patients.

Another study from the UK,[176] reported the results of symptomatic screening of all staff combined with asymptomatic screening of staff working in areas with high-risk of exposure or working in areas for clinically vulnerable patients. Staff working in high and moderate risk areas were more likely to test positive than those working in low-risk areas (relative risk not reported). However, authors described one cluster of cases in a low-risk area on a ward with vulnerable population and suggested a potential HCW-HCW or HCW-patient transmission. In high-risk wards, where transmission was high, authors suggested patient-HCW, HCW-HCW or community transmission. Lack of behavioural data prevented the authors to form more firm conclusions.

Finally, in one study from USA[174] all HCWs, who came in close contact with patients in the emergency department, were offered a serology screening approximately a month after the peak of the first wave of pandemic. Of about 200 staff, 138 volunteered to participate in testing of whom seven (5.1%) were reported to have SARS-CoV-2 antibodies suggesting a prior infection. History of risk factors taken from all HCWs showed no significant exposure risks between staff who tested positive and negative, including number of contacts with cases in or outside work, wearing PPE, or number of hours worked. Authors acknowledged that incidence of infection in HCWs was higher than in general population and that the occupational exposure is a risk but were not able to determine whether exposure was from patients or other staff.

The remaining studies attempted to identify the source of infection for the HCWs. One study which investigated exposure to SARS-CoV-2 virus in 110 infected HCWs in Wuhan[171] reported that 17 (15.5%) worked in fever clinics/wards, 73 (66.4%) worked in other departments and 20 (18.2%) did not interact with patients. The relatively low proportion of staff from fever clinics may have been due to PPE worn in these areas, including the respirator masks. A total of 65 (59.1%) infected HCWs attributed their infection to contact with patients who were later diagnosed with COVID-19, 12 (10.9%) to contact with colleagues, 14 (12.7%) to contact with family or friends and 19 (17.3%) could not recall their exposure history. Another similar study[195] reviewed contact history of 32 nurses infected with SARS-CoV-2 in Wuhan. Authors reported that 21 of 32 (65.6%) nurses were infected in hospital (either from patient or another HCW), 5 (15.6%) were infected in community and 6 (18.8%) were unknown. Of the six nurses with no known exposure, four reported that they had no direct contact with COVID-19 patients.

Another study, which described an outbreak in Wuhan hospital at the start of the pandemic when COVID-19 pneumonia was not yet discovered,[183] identified two undiagnosed index patients who were nursed without PPE. A total of twelve confirmed and two suspected HCWs (denominator not provided) developed COVID-19, and further 13 cases were identified in other departments, although these were possibly linked to other unknown index patients. Authors reported that exposure history was available for 17 HCWs who were confirmed positive by PCR test, of whom seven (28%) were likely infected from patients, three (12%) from suspected patients, three (12%) from other HCWs, four (16%) at events and meetings, whilst for eight (32%) infected HCWs exposure was not known.

Another study,[173] which investigated the occupational exposure to SARS-CoV-2 virus in HCWs in Greece, reported that during the first wave of pandemic there were a total of 3398 HCWs were occupationally exposed, 1725 (50.8%) of which were exposures to patients and 1660 (48.9%) to another HCW, and ten (0.3%) to a visitor. In a high-risk exposure group (n=1031) patient was a risk source in 331 (32.1%) of all exposures while remaining 700 were due to another staff (67.9%). A total of 13 staff in high-risk group were subsequently found infected but the authors did not report how many of these were from exposure to patients and how many from other HCWs.

One investigation of a large hospital outbreak involving 39 patients and 80 HCWs in hospital in South Africa,[188] included a review medical records, ward visits, interviews and whole genome sequencing analysis. Phylogenetic analysis strongly suggested that the outbreak was a result from a single introduction from an index patient attending the A&E department who infected another patient. This other patient was subsequently admitted to ICU. Infection spread quickly across five wards, facilitated by frequent patient transfers. Authors suspected that this outbreak also involved a neighbouring nursing home and an outpatient dialysis unit (further 16 cases if including these two facilities). Of 1711 staff tested (approx. 86% of the total) and 80 were positive (4.7%), authors mentioned multiple exposures to patients and other HCWs as possible vectors of transmission, some cases could also have been infected in the community, although whole genome sequencing suggested one cluster. Authors also reported that a rushed intubation of one undiagnosed case involving several HCWs did not result in infection and concluded that not PPE, but hand and environmental hygiene may have been more important in mediating the transmission between staff and patients.

In one outbreak on haematology/oncology unit, where 8/106 (7.5%) HCWs and one patient were infected,[165] index case was not found. Authors identified the first case to be a nursing assistant, but it is possible that this case was infected from another case on a ward. For a total of six of the eight infected HCW (75%) and one patient (denominator not reported), it was not possible to determine how they were infected, while two HCWs (25%) acquired the virus from their colleagues.

Another nosocomial outbreak[193] in the hospital in the UK identified an index patient discharged from ICU to a medical ward. It was not possible to determine how this patient was infected, but it was likely from symptomatic or asymptomatic HCW in ICU although authors said patient-to-patient transmission from unknown case was also possible. The possibility of community transmission was excluded because the patient was in hospital for 41 days before developing symptoms and the hospital visitations stopped due to the national lockdown. Follow up identified 23 symptomatic staff (either confirmed or suspected) and 5 patients infected on a medical ward, as well as 17 ICU staff who were self-isolating around this time. It was reported that seven of the 23 HCWs (30%) were in direct contact with an index patient while others were in contact with symptomatic and pre-symptomatic staff and patients. Authors concluded that transmission was propagated by staff because close contact between staff was common.

Nosocomial transmission to patients was not well described but patients infected from other patients were described in three studies,[172,188,193] from HCWs in four studies[175,176,188,193] and in one study it was not possible to determine whether transmission occurred from HCW or another patient.[165]

Epidemiological evidence for SARS-CoV-2 transmission occurring in care homes

There was weak evidence from six outbreaks reported by eight studies[177/192,184/186,185,190,191,194] describing transmission in a nursing home. Combining the results obtained from six outbreaks, where both number of total number of residents and total number of infected residents were reported,[177/192,184/186,185,190,191,194] the overall attack rate for the residents of these facilities was 410/967 (42.4%). Only one outbreak[177/192] reported a low attack rate 3/80 (3.8%), most likely because the residents lived in the assistive care facility, which involved a minimal contact with staff and other residents. The other five outbreaks were reported to affect between 19%[190] and 64%[184/186,194] of their residents. Combining the results obtained from five outbreaks, where both number of total number of residents and total number of infected residents were reported,[177/192,184/186,190,191,194] the overall attack rate for the staff working in these facilities was 169/719 (23.5%). As with the residents, one study reported low attack rates 2/62 (3.2%) in healthcare workers due to the residents[177/192] requiring minimum staff contact. The remaining four outbreaks involved between 6%[190] and 45%[191] of staff. Of the six reported outbreaks, two implicated a resident as an index case[190,191] although it was not possible to determine how this case was infected, one suspected a transmission from the staff member[184/186] and for the remaining four the index case was not identified.[177/192,185,194] One study[191] concluded that staff in these facilities are likely vectors for SARS-CoV-2 transmission between the patients and that the part-time workers employed across multiple institutions may be responsible for cross-facility spread. The HCW-to-HCW transmission was considered likely in two outbreaks[184/186,191] and one also reported likely multiple introductions from the community via HCW route.[184/186]

Aerosols refer to respiratory particles, which are found in the air, and their size is the predominant, although not the only reason, [(Tang, 2021)] for their ability to remain suspended in the air.[143] The generally accepted threshold for these particles to be considered airborne is <5µm[143] and they are assumed to have an ability to travel further than two-metre distance within which the larger droplets are thought to fall to the ground. However, there is evidence that suggests that these larger particles can travel further than two metres.[(Tang, 2021)] Research suggests that humans may produce both sizes of respiratory aerosols during normal breathing, coughing, or sneezing and that larger droplets may desiccate and form smaller 'airborne' particles,[143] thus the distinction between the droplet and airborne route is not always clear. Both, SARS-CoV and MERS-CoV, among other respiratory viruses, were considered to be predominantly transmitted via the droplet route[141,142] However, scientists studying the behaviour of expired aerosols argue that, in the distance up to two metres, short-range airborne particles are still the main route of transmission with larger droplet route dominating only up to 0.2 metre distance or 0.5 metre during coughing.[(Chen, 2020)]

*Upon the review of the above evidence, the COVID-19 Rapid Guidance Working Party conclude that the **above conclusions to the likely routes of transmission remain the same**. Furthermore, in relation specifically to airborne/aerosol/droplet debate, the Working Party consider that this is an academic argument which is not likely to reach a consensus. The questions that are important to the potential guideline users are whether two-metre distance is sufficient and whether respiratory masks designed for filtering airborne particles are necessary to prevent SARS-CoV-2 transmission.*

10. Recommendations

Summary of findings

The above-presented evidence helps to understand the transmission dynamics and therefore allows the Working Party to make the following conclusions:

- In the community, SARS-CoV-2 transmission most commonly occurs in socially connected cases (household, relatives, friends, co-workers), which suggests close contact between the index and secondary case is required for infection to occur. Thus, the two-metre rule is usually sufficient to prevent transmission. The exceptions may be the activities with large volumes of air expired e.g., during exercise or singing (index case likely to exhale many viral particles); in crowded spaces (where more than one index case is likely or when virus is transmitted transiently between the individuals) or when virus is carried over a long distance (e.g., due to air conditioning carrying respiratory secretions further than two metres).

- Transmission mostly occurs indoors.
- Where transmission occurred, the index and secondary cases were usually present in the same space at the same time which suggests that, despite laboratory studies showing persistence of SARS-CoV-2 virus in air and on surfaces, this is not a likely route of transmission.
- In acute and nursing home care settings, patients/residents, HCWs and visitors are potential vectors for SARS-CoV-2 transmission. This may help explain the often-reported high attack rates in these facilities. This is likely due to complex dynamics involved in interaction between these individuals, where close contact is common, social distancing is difficult to maintain, many index cases may be pre-symptomatic or apparently asymptomatic and where multiple introductions may occur.

The overarching conclusion, which was reached by the members of this Working Party was that SARS-CoV-2 virus does not appear to be transmitted via the routes different to those observed in other respiratory viruses. Thus, same infection prevention mechanisms (mainly the traditional droplet and contact precautions commonly implemented in hospital settings) are considered sufficient by this Working Party to prevent SARS-CoV-2 transmission.

Rationale for recommending preventative measures:

Social distancing: since data suggest that close contact is implicated in most transmissions, social distancing remains the most important approach to prevent transmission of SARS-CoV-2 virus. This needs to include social distancing between staff in health and care settings, so that they are protected not only from patients but also from fellow HCWs. It should be the employer's responsibility to introduce appropriate social distancing policies (e.g., number of staff allowed in a staff room or changing room, seating arrangements in the office etc.) and employees' responsibility to adhere to them.

Facial and respiratory protection: data suggest that wearing fluid resistant surgical mask is sufficient to prevent SARS-CoV-2 transmission in health and care settings. This is consistent with studies which investigated the benefit of wearing respirators vs surgical masks to prevent influenza transmission(Long, 2020). However, the Working Party members understand that respirators may provide reassurance to

HCWs who are in close contact with patients and therefore conclude that the individual institutions may decide to provide them to their front-line staff. Respirators are not only more expensive but are also reported to be uncomfortable and irritating to the skin (Jefferson, 2011), thus not likely to be worn for extended period. The decision to provide respirator masks needs to be carefully balanced and consider factors such as prevalence of SARS-CoV-2 infected individuals, ventilation in the setting and the availability of the respirator masks. The studies which evaluated the risk of SARS-CoV-2 transmission specifically from AGPs found little evidence for this occurring [(Harding, 2020)], thus fluid-resistant surgical masks are likely sufficient in preventing the infection. However, since these are considered high-risk procedures, and intubation was previously shown to increase the risk of infection from other respiratory viruses, respirator masks should be recommended for AGPs. Furthermore, since the data suggest that when patient-to-HCW transmission occurs, it is usually when patient is not suspected to be infected with SARS-CoV-2 virus. Therefore, the use of respirator masks should be extended to any AGP, regardless of patient status. In community setting, if individuals adhere to social distancing, close contact is usually brief and cloth-based face covering is sufficient to prevent transmission.

Gloves and handwashing: Data suggest that fomite transmission is possible, but probably is not the major route of transmission unless combined with close contact (e.g., touching objects in the immediate surrounding of an infectious person). Appropriate hand washing is sufficient in removing respiratory pathogens, including coronaviruses, from contaminated hands[(Jefferson, 2011)]. According to the same review, gloves may not offer additional protection, which is in line with French Society for Hospital Hygiene who currently recommend wearing gloves for only some activities involving COVID-19 patients (contact with blood, body fluids or mucous membranes, contact with damaged skin or damaged skin on HCW). However, current protocols recommend the use of gloves for any activity involving a patient placed on contact precautions and therefore gloves should be recommended. For contact with blood or body fluids (excluding saliva and respiratory secretions), gloves are a part of standard precautions and should be worn regardless of patient COVID-19 status.

Other PPE: Aprons are currently recommended for all activities with patients placed on contact precautions and for activities involving the risk of contact with blood and body fluids, thus these should be recommended for any contact with COVID-19 patient. Face shields should be recommended due to a risk of SARS-CoV-2 virus entering via ocular route. Face shield is currently recommended for patients on contact precautions where there is a risk of splashes thus same should be applied to activities involving COVID-19 patients. During AGPs, where there is a risk of respiratory secretions being sprayed, long sleeved gowns should be recommended.

Recommendations:

General recommendations which apply to all settings, including social settings:

GR1: Adhere to regulations currently imposed by your government.

GR2: Maintain the recommended minimum 2 metre distance at all times.

GR3: Use a face covering in enclosed spaces to protect yourself and others.

GR4: Reduce the time of contact with anyone outside your household to a minimum.

GR5: To avoid transmission from fomites, decontaminate your hands frequently using soap and water, and when this is not possible, use alcohol-based hand rub.

> **Good practice point:** Follow World Health Organization advice on how to handwash (https://www.who.int/gpsc/5may/How_To_HandWash_Poster.pdf) and how to handrub (https://www.who.int/gpsc/5may/How_To_HandRub_Poster.pdf)

GR6: Avoid touching your face and eyes with your hands as transmission via ocular surface is possible.

GR7: Evidence suggests that a high proportion of transmissions occur as a result of close contact between family members, friends, and co-workers. Adhere to the above recommendations when in contact with anyone outside your household or support network.

GR8: Available evidence suggests that transmission without close contact or outside is unlikely. Continue maintaining the 2m distance and using face covering in indoor settings. There is no evidence which suggests that respirator masks offer additional protection outside the healthcare settings.

> **Good practice point:** To protect yourself and others, follow WHO advice and avoid 3Cs: **C**losed spaces, **C**rowds, **C**lose contact.

Specific recommendations for persons working in health and care settings:

HR1: You must adhere to regulations imposed by your trust/employer.

HR2: Where there is ongoing transmission, for contact with patients and other healthcare staff, use a face mask, and adhere to general recommendations listed above.

HR3: For care of patients suspected or confirmed to have COVID-19, in addition to the above, use fluid resistant surgical face mask and adhere to contact and droplet precautions. No other precautions are necessary but

HR4: Risk of SARS-CoV-2 transmission from body fluids (faeces, urine, ocular excretions, and sexual body fluids) is unlikely, use contact precautions and appropriate PPE (including fluid resistant surgical face mask type IIR) and do not use additional precautions (e.g., filtering respiration mask) unless carrying out AGPs. Your employer may make a decision to provide respirator masks for procedures other than AGPs, based on local circumstances.

HR5: Whilst blood and body fluids are not a likely source of SARS-CoV-2 infection, there remains a risk of infection with other pathogens to HCWs and via them to other patients. Use PPE (gloves, plastic aprons, eye protection) as appropriate when there is a risk of exposure to blood, body fluids or any items contaminated with these products and clean your hands immediately after glove removal.

HR6: Literature suggests that most SARS-CoV-2 transmissions from patients to HCWs occurred when HCW did not use protection during AGPs on patients not suspected of having COVID-19. Use filtering respiration mask (FFP3) designed for filtering fine airborne particles for any AGPs regardless of a patient's COVID-19 status.

HR7: Vertical transmission is unlikely. Studies have reported avoiding caesarean delivery where possible and mothers being advised to use a surgical mask.

Recommendations for managers in health and care settings:

MR1: Adhere to current national guidelines for IPC, including those specific to COVID-19 as well as general ones for preventing infectious diseases.

MR2: Consider exploring potential factors for SARS-CoV-2 transmission specific to your setting, e.g., inability to maintain social distancing or managing apparently asymptomatic cases.

11. Conclusions

Determining routes of infection is important because it helps to define the precautions required to stop an infection chain without using excessive PPE and other resources. SARS-CoV-2 appears to spread via the routes commonly implicated in transmission of other respiratory viruses. SARS-CoV-2 virus does not appear to have an increased ability to spread more efficiently via the traditionally defined airborne route. Other reasons, which determined its successful spread around the world and affecting so many individuals, are not related to its transmission routes but other factors such as a higher affinity for ACE2 receptors (especially observed in the new variants), a larger number of apparently asymptomatic/pauci-symptomatic individuals, pre-symptomatic transmission and the possibility of reinfection from different clades of the virus.

Mass vaccination, which already commenced in many countries, may be important in tackling the pandemic, although the impact of vaccination on transmission of the virus is yet to be determined. Emerging new strains of SARS-CoV-2 raise concerns that current vaccines may become less effective when new mutations occur. Interrupting routes of transmission by applying strict IPC measures, including social distancing, remain the most effective means of controlling the spread.[174] In this document, we summarised the evidence of the routes of SARS-CoV-2 transmission, demonstrated that it spreads via the routes commonly used by other respiratory pathogens, and we concluded that the existing recommendations for droplet and contact precautions are sufficient in preventing the transmission.

12. Further research

Research recommendations:

RR1: Outbreak studies, which thoroughly investigate the transmission dynamics of affected cases, for example, in relation to separation distances needed to sufficiently reduce the risk of human-to-human transmission.

RR2: Laboratory studies under controlled conditions to demonstrate the range of spread of droplets of different sizes that could carry potentially infectious dose of SARS-CoV-2.

RR3: Environmental sampling studies around patients newly admitted with COVID-19 to determine presence of infectious virus on different surfaces using culture techniques.

RR4: Studies on preventing COVID-19 in care home settings.

13. References

1. COVID-19 Dashboard by the Center for Systems Science and Engineering (CSSE) at Johns Hopkins University (JHU)". ArcGIS. Johns Hopkins University. Available at: https://gisanddata.maps.arcgis.com/apps/opsdashboard/index.html#/bda7594740fd40299423467b48e9ecf6. Last accessed 21October 2020.
2. Morgan R.L., Whaley P., Thayer K.A. et al. Identifying the PECO: A framework for formulating good questions to explore the association of environmental and other exposures with health outcomes. Environ Int, 2018; 121(Pt 1):1027–1031.
3. Shah P.S., Diambomba Y., Acharya G. et al. Classification system and case definition for SARS-CoV-2 infection in pregnant women, fetuses, and neonates. Acta Obstet Gynecol Scand, 2020; 99(5):565–568.
4. Ahmed W., Angel N., Edson, J. et al. First confirmed detection of SARS-CoV-2 in untreated wastewater in Australia: a proof of concept for the wastewater surveillance of COVID-19 in the community. Sci Total Environ, 2020; 728:138764.
5. Alzamora M.C., Paredes T., Caceres D. et al. Severe COVID-19 during Pregnancy and Possible Vertical Transmission. Am J Perinatol, 2020; 37(8):861-865.
6. Bai Y., Yao L., Wei T. et al. Presumed Asymptomatic Carrier Transmission of COVID-19. JAMA, 2020; 323(14):1406-1407.
7. Burke R.M., Midgley C.M., Dratch A. et al. Active Monitoring of Persons Exposed to Patients with Confirmed COVID-19 - United States, January-February 2020. MMWR, 2020; 69(9):245-246.
8. Cai J., Sun W., Huang J. et al. Indirect Virus Transmission in Cluster of COVID-19 Cases, Wenzhou, China, 2020. Emerg Infect Dis, 2020; 26(6): 1343-1345.
9. Chan J.F.W., Yuan S., Kok K.H. 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; 395(10223):514–523.
10. Chen H., Guo J., Wang C. et al. Clinical characteristics and intrauterine vertical transmission potential of COVID-19 infection in nine pregnant women: a retrospective review of medical records. Lancet, 2020; 395(10226):809-815
11. Chen L., Liu M., Zhang Z. et al. Ocular manifestations of a hospitalised patient with confirmed 2019 novel coronavirus disease. Br J Ophthalmol, 2020; 104(6):748–751
12. Chen S., Huang B., Luo D, et al. Pregnant women with new coronavirus infection: a clinical characteristics and placental pathological analysis of three cases. Chin J Pathol, 2020; 49(5): 418-423.
13. Chen S., Liao E., Cao D. et al. Clinical analysis of pregnant women with 2019 novel coronavirus pneumonia. J Med Virol, 2020; 92:1556-1561.
14. Chen Y., Chen L., Deng Q. et al. The presence of SARS-CoV-2 RNA in the feces of COVID-19 patients. J Med Virol, 2020; 92(7):833-840.
15. Chen Y., Peng H., Wang L. et al. Infants Born to Mothers With a New Coronavirus (COVID-19). Front Pediatr. 8:104.
16. Cheng H.Y., Jian S.W., Liu D.P. et al. Contact Tracing Assessment of COVID-19 Transmission Dynamics in Taiwan and Risk at Different Exposure Periods Before and After Symptom Onset. JAMA Intern Med, 2020; 180(9):1156-1163.
17. Cheng V.C.C., Wong S.-C., Chen J.H.K. 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; 41(5):493-498.
18. Chia P.Y., Coleman K.K., Tan Y.K. et al. Detection of Air and Surface Contamination by Severe Acute Respiratory Syndrome 1 Coronavirus 2 (SARS-CoV-2) in Hospital Rooms of Infected Patients. Nat Commun, 2020; 11(1):2800.
19. Chin A.W.H., Chu J.T.S., Perera M.R.A. et al. Stability of SARS-CoV-2 in different environmental conditions. Lancet Microbe, 2020; 1(1):E10.

20. Colavita F., Lapa D., Carletti F. et al. SARS-CoV-2 Isolation From Ocular Secretions of a Patient With COVID-19 in Italy With Prolonged Viral RNA Detection. Ann Intern Med, 2020; 173(3):242-243.
21. Cui P., Chen Z., Wang, T. et al. Clinical features and sexual transmission potential of SARS-CoV-2 infected female patients: a descriptive study in Wuhan, China. MedRxiv preprint, 2020
22. Dong L., Tian J., He S. et al. Possible Vertical Transmission of SARS-CoV-2 from an Infected Mother to Her Newborn. JAMA, 2020; 323(18):1846–1848
23. Dong X., Li J., Bai J. et al. Epidemiological characteristics of confirmed COVID-19 cases in Tianjin. Chin J Pathol, 2020; 41(5):638-641.
24. Fan C., Lei D., Fang C. et al. Perinatal Transmission of COVID-19 Associated SARS-CoV-2: Should We Worry? Clin Infect Dis, 2020; ciaa226.
25. Fan Q., Pan Y., Wu Q. et al. Anal swab findings in an infant with COVID-19. Pediatr Investig, 2020; 4(1):48-50.
26. Faridi S., Niazi S., Sadeghi K. et al. A field indoor air measurement of SARS-CoV-2 in the patient rooms of the largest hospital in Iran. Sci Total Environ, 2020; 725: 138401.
27. Gan H., Zhang Y., Yuan M. et al. Epidemiological analysis on 1 052 cases of COVID-19 in epidemic clusters. Chin J Pathol, 2020; 41(7): 1004-1008.
28. Ghinai I., McPherson T.D., Hunter J.C. et al. First known person-to-person transmission of severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) in the USA. Lancet, 2020; 395(10230):1137-1144
29. Guo Z.D., Wang Z.Y., Zhang S.F. et al. Aerosol and Surface Distribution of Severe Acute Respiratory Syndrome Coronavirus 2 in Hospital Wards, Wuhan, China, 2020. Emerg Infect Dis, 2020; 26(7): 1583-1591.
30. Hamner L., Dubbel, P., Capron, I. et al. High SARS-CoV-2 Attack Rate Following Exposure at a Choir Practice — Skagit County, Washington, March 2020. MMWR, 2020; 69(19):606-610.
31. Han M.S., Seong M.W., Heo E.Y. et al. Sequential analysis of viral load in a neonate and her mother infected with SARS-CoV-2. Clin Infect Dis, 2020; ciaa447(no pagination)
32. Heinzerling A., Stuckey M.J., Scheuer T. et al. Transmission of COVID-19 to Health Care Personnel During Exposures to a Hospitalized Patient - Solano County, California, February 2020. MMWR, 2020; 69(15):472-476
33. Huang L., Zhang X., Wei Z. et al. Rapid asymptomatic transmission of COVID-19 during the incubation period demonstrating strong infectivity in a cluster of youngsters aged 16-23 years outside Wuhan and characteristics of young patients with COVID-19: A prospective contact-tracing study. J Infect, 2020; 80(6):e1-e13
34. Huang R., Xia J., Chen Y. et al. A family cluster of SARS-CoV-2 infection involving 11 patients in Nanjing, China. Lancet Infect Dis, 2020; 20(5):534-535.
35. Iqbal S.N., Overcash R., Mokhtari N. et al. An uncomplicated delivery in a patient with COVID-19 in the United States. N Engl J Med, 2020; 382(16):e34.
36. Jiang X., Luo M., Zou Z. et al. Asymptomatic SARS-CoV-2 infected case with viral detection positive in stool but negative in nasopharyngeal samples lasts for 42 days. J Med Virol, 2020; 92:1807–1809.
37. Jiang X.L., Zhang X.L., Zhao X.N. et al. Transmission potential of asymptomatic and paucisymptomatic Severe Acute Respiratory Syndrome Coronavirus 2 infections: a three-family cluster study in China. J Infect Dis, 2020; 11;221(12):1948-1952.
38. Cai J., Xu J., Lin D., et al. A case series of children with 2019 novel coronavirus infection: clinical and epidemiological features. Clin Infect Dis, 2020; 71(6):1547–1551.
39. Khan S., Jun L., Nawsherwan, et al. Association of COVID-19 infection with pregnancy outcomes in healthcare workers and general women. Clin Microbiol Infect, 2020; 26(6):788-790.
40. Kong I., Park Y., Woo Y. et al. Early epidemiological and clinical characteristics of 28 cases of coronavirus disease in South Korea. Osong Public Health Res Perspect, 2020; 11(1):8-14

41. Le H.T., Nguyen L.V., Tran D.M., et al. The first infant case of COVID-19 acquired from a secondary transmission in Vietnam. Lancet Child Adolesc Health, 2020; 4(5):405-406.
42. Lee D.H., Lee J., Kim E. et al. Emergency cesarean section performed in a patient with confirmed severe acute respiratory syndrome coronavirus-2-a case report. Korean J Anesthesiol, 2020; 73(4):347-351
43. Li C., Ji F., Wang L. et al. Asymptomatic and Human-to-Human Transmission of SARS-CoV-2 in a 2-Family Cluster, Xuzhou, China. Emerg Infect Dis, 2020; 26(7): 1626-1628.
44. Li D., Jin M., Bao P. et al. Clinical Characteristics and Results of Semen Tests Among Men With Coronavirus Disease 2019. JAMA, 2020; 3(5):e208292.
45. Li J., Feng J., Liu T.H. et al. An infant with a mild SARS-CoV-2 infection detected only by anal swabs: a case report. Braz J Infect Dis, 2020; 24(3):247-249
46. Li N., Han L., Peng M. et al. Maternal and neonatal outcomes of pregnant women with COVID-19 pneumonia: a case-control study. Clin Infect Dis, 2020; ciaa352
47. Li P., Fu J.B., Li K-F. et al. Transmission of COVID-19 in the terminal stage of incubation period: a familial cluster. Int J Infect Dis, 2020; 96:452-453
48. Li W., Zhang B., Lu J. et al. The characteristics of household transmission of COVID-19. Clin Infect Dis, 2020; ciaa450
49. Li X., Wang M., Dai J. et al. Novel coronavirus disease with conjunctivitis and conjunctivitis as first symptom: two cases report. Chin J Exp Ophthalmol, 2020; 38(04):318-321
50. Li Y., Hu Y., Yu Y. et al. Positive result of Sars-Cov-2 in faeces and sputum from discharged patient with COVID-19 in Yiwu, China. J Med Virol, 2020; 92:1938-1947
51. Li Y., Qian H., Hang J. et al. Evidence for Probable Aerosol Transmission of SARS-CoV-2 in a Poorly Ventilated Restaurant. MedRxiv preprint, 2020
52. Li Y., Zhao, R., Zheng, S. et al. Lack of Vertical Transmission of Severe Acute Respiratory Syndrome Coronavirus 2, China. Emerg Infect Dis, 2020; 26(6):1335-1336
53. Ling Y., Xu S.B., Lin Y.X., et al. Persistence and clearance of viral RNA in 2019 novel coronavirus disease rehabilitation patients. Chin Med J, 2020; 133(9):1039–1043
54. Liu W., Wang J., Li W. et al. Clinical characteristics of 19 neonates born to mothers with COVID-19. Front Med, 2020; 14(2):193-198.
55. Liu W., Wang Q., Zhang Q. et al. Coronavirus disease 2019 (COVID-19) during pregnancy: a case series. Preprints, 2020; 2020020373
56. Liu Y., Chen H., Tang K. et al. Clinical manifestations and outcome of SARSeCoV-2 infection during pregnancy. J Infect, 2020; S0163-4453(20)30109-2
57. Liu Y.C., Liao C.H., Chang C.F. et al. A locally transmitted case of SARS-CoV-2 infection in Taiwan. N Engl J Med, 2020; 382(11): 1070-1072.
58. Lowe B., Bopp B. COVID-19 vaginal delivery – a case report. Aust N Z J Obstet Gynaecol, 2020; 60(3):465–466.
59. Lu J., Gu J., Li K. et al. COVID-19 Outbreak Associated with Air Conditioning in Restaurant, Guangzhou, China, 2020. Emerg Infect Dis, 2020; 26(7): 1628-1631.
60. Luo C., Yao L., Zhang L. et al. Possible Transmission of Severe Acute Respiratory Syndrome Coronavirus 2 (SARS-CoV-2) in a Public Bath Center in Huai'an, Jiangsu Province, China. JAMA Netw Open, 2020; 3(3):e204583
61. McMichael T.M., Currie D.W., Clark S. et al. Epidemiology of Covid-19 in a Long-Term Care Facility in King County, Washington. N Engl J Med, 2020; 382(21):2005-2011.
62. Medema G., Heijnen L., Elsinga, G. et al. Presence of SARSCoronavirus-2 in sewage. MedRxiv preprint, 2020
63. Ng O.T., Marimuthu K., Chia P.Y. et al. SARS-CoV-2 infection among travelers returning from Wuhan, China. N Engl J Med, 2020; 382(15):1476-1478
64. Liu Y., Ning Z., Chen Y. et al. Aerodynamic analysis of SARS-CoV-2 in two Wuhan hospitals. Nature, 2020; 582(7813):557–560

65. Okada P., Buathong R., Phuygun S. et al. Early transmission patterns of coronavirus disease 2019 (COVID-19) in travellers from Wuhan to Thailand, January 2020. Euro Surveill, 2020; 25(8):2000097.
66. Ong S.W., Tan Y.K., Chia P.Y. 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; 323(16):1610–1612
67. Ong, S.W.X., Tan, Y.K., Sutjipto, S. 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; 41(5):614-616.
68. Pan Y., Zhang D., Yang P. et al. Viral load of SARS-CoV-2 in clinical samples. Lancet Infect Dis, 2020; 20(4):411-412
69. Park J.Y., Han M.S., Park K.U. et al. First Pediatric Case of Coronavirus Disease 2019 in Korea. J Korean Med Sci, 2020; 35(11):e124
70. Park S.Y., Kim Y.M., Yi S. et al. Coronavirus Disease Outbreak in Call Center, South Korea. Emerg Infect Dis, 2020; 26(8): 1666-1670.
71. Penfield C.A., Brubaker S.G., Limaye M.A. et al. Detection of SARS-COV-2 in Placental and Fetal Membrane Samples. Am J Obstet Gynecol MFM, 2020; 2(3):100133
72. Peng L., Liu J., Xu W. et al. Novel Coronavirus can be detected in urine, blood, anal swabs and oropharyngeal swabs samples. MedRxiv preprint, 2020; 2002.2021.20026179
73. Peng Z., Wang J., Mo Y. et al. Unlikely SARS-CoV-2 vertical transmission from mother to child: A case report. J Infect Public Health, 2020; 13(5):818-820
74. Phan L.T., Nguyen T.V., Luong Q.C., et al. Importation and human-to-human transmission of novel coronavirus in Vietnam. N Engl J Med, 2020; 382(9):872-874
75. Pierce-Williams R.A.M., Burd J., Felder L. et al. Clinical course of severe and critical COVID-19 in hospitalized pregnancies: a US cohort study. Am J Obstet Gynecol MFM, 2020; 2(3):100134
76. Pung R., Chiew C.J., Young B.E. et al. Investigation of three clusters of COVID-19 in Singapore: implications for surveillance and response measures. Lancet, 2020; 395(10229):1039-1046
77. Qian G., Yang N., Ma A.H.Y. et al. A COVID-19 Transmission within a family cluster by presymptomatic infectors in China. Clin Infect Dis, 2020; 71(15):861–862
78. Qiu C., Deng Z., Xiao Q. et al. Transmission and clinical characteristics of coronavirus disease 2019 in 104 outside-Wuhan patients, China. J Med Virol, 2020; 92:2027–2035
79. Qiu L., Liu X., Xiao M. et al. SARS-CoV-2 is not detectable in the vaginal fluid of women with severe COVID-19 infection. Clin Infect Dis, 2020; 71(15):813–817
80. Rothe C., Schunk M., Sothmann P. et al. Transmission of 2019-NCOV infection from an asymptomatic contact in Germany. N Engl J Med, 2020; 382(10):970-971
81. Santarpia J., Rivera D., Herrera V. et al. Transmission Potential of SARS-CoV-2 in Viral Shedding Observed at the University of Nebraska Medical Center. MedRxiv preprint, 2020
82. Schwartz K.L., Murti M., Finkelstein M. et al. Lack of COVID-19 transmission on an international flight. Can Med Assoc J, 2020; 192(15):E410
83. Schwierzeck V., Konig J.C., Kuhn J. et al. First reported nosocomial outbreak of severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) in a pediatric dialysis unit. Clin Infect Dis, 2020; ciaa491
84. Scott S.E., Zabel K., Collins J. et al. First Mildly Ill, Non-Hospitalized Case of Coronavirus Disease 2019 (COVID-19) Without Viral Transmission in the United States - Maricopa County, Arizona, 2020. Clin Infect Dis, 2020; 71(15):807-812
85. Seah I.Y.J., Anderson D.E., Kang A.E.Z et al. Assessing viral shedding and infectivity of tears in coronavirus disease 2019 (COVID-19) patients. Ophthalmology, 2020; 127(7): 977–979
86. Song R., Han B., Song M. et al. Clinical and epidemiological features of COVID-19 family clusters in Beijing, China. J Infect, 2020; 81(2):e26–e30

87. Sun X., Zhang X., Chen X. et al. The infection evidence of SARS-COV-2 in ocular surface: a single-center cross-sectional study. MedRxiv preprint, 2020
88. Tan L., Ngoc N. That B. et al. Duration of viral detection in throat and rectum of a patient with COVID-19. MedRxiv preprint, 2020
89. Tan Y.P., Tan B.Y., Pan J. et al. Epidemiologic and clinical characteristics of 10 children with coronavirus disease 2019 in Changsha, China. J Clin Virol, 2020; 127:104353
90. Tang A., Tong Z.D., Wang H.L. et al. Detection of Novel Coronavirus by RT-PCR in Stool Specimen from Asymptomatic Child, China. Emerg Infect Dis, 2020; 26(12):1337-1339
91. To K.K.W., Tsang O.T.Y., Leung W.S. et al. Temporal profiles of viral load in posterior oropharyngeal saliva samples and serum antibody responses during infection by SARS-CoV-2: an observational cohort study. Lancet Infect Dis, 2020; 20(5):565-574
92. van Doremalen N., Bushmaker T., Morris D.H. et al. Aerosol and Surface Stability of SARS-CoV-2 as Compared with SARS-CoV-1. N Engl J Med, 2020; 382(16):1564-1567
93. Wang J., Feng H., Zhang S. et al. SARS-CoV-2 RNA detection of hospital isolation wards hygiene monitoring during the Coronavirus Disease 2019 outbreak in a Chinese hospital. Int J Infect Dis, 2020; 94:103-106
94. Wang S., Guo L., Chen L. et al. A case report of neonatal COVID-19 infection in China. Clin Infect Dis, 2020; 71(15):853–857
95. Wang S., Tu J., Sheng Y. Clinical characteristics and fecal-oral transmission potential of patients with COVID-19. MedRxiv preprint, 2020
96. Wang W., Xu Y., Gao R. et al. Detection of SARS-CoV-2 in different types of clinical specimens. JAMA, 2020; 323(18):1843-1844
97. Wang X., Zhou Z., Zhang J. et al. A case of 2019 novel coronavirus in a pregnant woman with preterm delivery. Clin Infect Dis, 2020; 71(15):844–846
98. Wang Z., Ma W., Zheng X. et al. Household transmission of SARS-CoV-2. J Infect, 2020; 81(1): 179–182
99. Wei W.E., Li Z., Chiew C.J. et al. Presymptomatic Transmission of SARS-CoV-2 - Singapore, January 23-March 16, 2020. MMWR, 2020; 69(14):411-415
100. Wei X.S., Wang X.R., Zhang J.C. et al. A cluster of health care workers with COVID-19 pneumonia caused by SARS-CoV-2. J Microbiol Immunol Infect, 2020; in press
101. Wu J., Liu J., Li S. et al. Detection and analysis of nucleic acid in various biological samples of COVID-19 patients. Travel Med Infect Dis, 2020; 101673
102. Wu P., Duan F., Luo C. et al. Characteristics of ocular findings of patients with coronavirus disease 2019 (COVID19) in Hubei province, China. JAMA Ophthalmol, 2020; 138(5): 575–578
103. Wu W.S., Li Y.G., Wei Z.F. et al. Investigation and analysis on characteristics of a cluster of COVID-19 associated with exposure in a department store in Tianjin. Zhonghua Liu Xing Bing Xue Za Zhi, 2020; 41(4):489-493
104. Wu Y., Guo C., Tang L. et al. Prolonged presence of SARS-CoV-2 viral RNA in faecal samples. Lancet Gastroenterol Hepatol, 2020; 5:434-435
105. Wurtzer, S., Marechal, V., Mouchel, J.M. et al. Time course quantitative detection of SARS-CoV-2 in Parisian wastewaters correlates with COVID-19 confirmed cases. MedRxiv preprint, 2020
106. Xia J., Tong J., Liu M. et al. Evaluation of coronavirus in tears and conjunctival secretions of patients with SARS-CoV-2 infection. J Med Virol, 2020; 92(6):589–594
107. Xia X.Y., Wu J., Liu H.L. et al. Epidemiological and initial clinical characteristics of patients with family aggregation of COVID-19. J Clin Virol, 2020; 127:104360
108. Xiao F., Tang M., Zheng X., et al. Evidence for gastrointestinal infection of SARS-CoV-2. Gastroenterol, 2020; 158(6):1831-1833.e3
109. Xiao W.J., Gao Q., Jin K. et al. Investigation of an epidemic cluster caused by COVID-19 cases in incubation period in Shanghai. Chin J Pathol, 2020; 41(9):1401-1405.

110. Xie H.T., Jiang S.Y., Xu K.K. et al. SARS-CoV-2 in the ocular surface of COVID-19 patients. Eye Vis, 2020; 7:23
111. Xing Y.H., Ni W., Wu Q., et al. Prolonged presence of SARS-CoV-2 in feces of pediatric patients during the convalescent phase. MedRxiv preprint, 2020; 2020.02.29.20027698.
112. Xu Y., Li X., Zhu B. et al. Characteristics of pediatric SARS-CoV-2 infection and potential evidence for persistent fecal viral shedding. Nat Med, 2020; 26(4):502-505
113. Yan J., Guo J., Fan C. et al. Coronavirus disease 2019 (COVID-19) in pregnant women: A report based on 116 cases. Am J Obstet Gynecol, 2020; 223(1):111.e1-111.e14
114. Yang H., Sun G., Tang F. et al. Clinical Features and Outcomes of Pregnant Women Suspected of Coronavirus Disease 2019. J Infect, 2020; 81(1):e40-e44.
115. Yang P., Wang X., Liu P. et al. Clinical characteristics and risk assessment of newborns born to mothers with COVID-19. J Clin Virol, 2020; 127:104356
116. Yong S.E.F., Anderson D.E., Wei W.E. et al. Connecting clusters of COVID-19: an epidemiological and serological investigation. Lancet Infect Dis, 2020; 20(7):809-815
117. Yu N., Li W., Kang Q. et al. Clinical features and obstetric and neonatal outcomes of pregnant patients with COVID-19 in Wuhan, China: a retrospective, single-centre, descriptive study. Lancet Infect Dis, 2020; 20(5):559-564
118. Yu P., Zhu J., Zhang Z. et al. A familial cluster of infection associated with the 2019 novel coronavirus indicating possible person-to-person transmission during the incubation period. J Infect Dis, 2020; 221(11):1757–1761
119. Zambrano L.I., Fuentes-Barahona I.C., Bejarano-Torres D.A. et al. A pregnant woman with COVID-19 in Central America. Travel Med Infect Dis, 2020; 101639.
120. Zeng H., Xu C., Fan J. et al. Antibodies in infants born to mothers with COVID-19 pneumonia. JAMA, 2020; 323(18):1848-1849
121. Zeng L.K., Xia S., Yuan W.H. et al. Neonatal Early-Onset InfectionWith SARS-CoV-2 in 33 Neonates Born to Mothers With COVID-19 inWuhan, China. JAMA, 2020; 174(7):722-725
122. Zhang J., Wang S., Xue Y. Fecal specimen diagnosis 2019 Novel Coronavirus Infected Pneumonia. J Med Virol, 2020; 92(6):680-682
123. Zhang J.Z., Zhou P., Han D.B. et al. Investigation on a cluster epidemic of COVID-19 in a supermarket in Liaocheng, Shandong province. Zhonghua Liu Xing Bing Xue Za Zhi, 2020; 41:E055
124. Zhang L., Jiang Y., Wei M. et al. Analysis of the pregnancy outcomes in pregnant women with COVID-19 in Hubei Province. Chin J Obstet Gynecol, 2020; 55(0):E009.
125. Zhang T., Cui X., Zhao X. et al. Detectable SARS-CoV-2 viral RNA in feces of three children during recovery period of COVID-19 pneumonia. J Med Virol, 2020; 92(7):909–914
126. Zhang W., Du R.H., Li B. et al. Molecular and serological investigation of 2019-nCoV infected patients: implication of multiple shedding routes. Emerg Microbes Infect, 2020; 9(1):386–389
127. Zhang X., Chen X., Chen L. et al. The evidence of SARS-CoV-2 infection on ocular surface. Ocul Surf, 2020; 18(3):360-362
128. Zhang X.A., Fan H., Qi R.Z. et al. Importing coronavirus disease 2019 (COVID-19) into China after international air travel. Travel Med Infect Dis, 2020; 35:101620.
129. Zhang Y., Chen C., Zhu S. et al. Isolation of 2019-nCoV from a stool specimen of a laboratory-confirmed case of the coronavirus disease 2019 (COVID-19). China CDC Wkly; 2020; 2(8):123–4.
130. Zhang Y., Lin D., Xiao M. et al. 2019-novel coronavirus infection in a three-month-old baby. Chin J Pediatr, 2020; 58(3):182-184.
131. Zheng S., Fan J., Yu F. et al. Viral load dynamics and disease severity in patients infected with SARS-CoV-2 in Zhejiang province, China, January-March 2020: Retrospective cohort study. BMJ, 2020; 369:m1443

132. Zhou Y.Y., Zeng Y.Y., Tong Y.Q. et al. Ophthalmologic evidence against the interpersonal transmission of 2019 novel coronavirus through conjunctiva. MedRxiv preprint, 2020
133. Zhu H., Wang L., Fang C. et al. Clinical analysis of 10 neonates born to mothers with 2019-nCoV pneumonia. Transl Pediatr, 2020; 9(1):51-60
134. Zhou J., Otter, J.A., Price, J.R. et al. Investigating SARS-CoV-2 surface and air contamination in an acute healthcare setting during the peak of the COVID-19 pandemic in London. Clin Infect Dis, 2020; ciaa905
135. Sun J., Zhu A., Li H. et al. Isolation of infectious SARS-CoV-2 from urine of a COVID-19 patient, Emerg Microbes Infect, 2020; 9(1):991-993
136. Vivanti A., Vauloup-Fellous C., Prevot S. et al. Transplacental transmission of SARS-CoV-2 infection. Nature Commun, 2020; 11:3572
137. Cho H.J., Koo J.W., Roh S.K. et al. COVID-19 transmission and blood transfusion: A case report. J Infect Public Health, 2020; 13(11):1678-1679
138. Essa M.F., Elbashir E., Batarfi K. et al. Lack of transmission of SARS-CoV-2 by platelet transfusion from a COVID-19-positive donor in a hematopoietic stem cell transplantation patient. Pediatr Blood Cancer, 2020; e28658
139. Liapis K., Papoutselis M., Vrachiolias G. et al. Blood and platelet transfusion from a donor with presymptomatic Covid-19. Ann Hematol, 2020; 13: 1–2
140. Politis C., Papadaki M., Politi L. et al. Post-donation information and haemovigilance reporting for COVID-19 in Greece: Information supporting the absence of SARS-CoV-2 possible transmission through blood components. Transfus Clin Biol, 2020; article in press
141. Lee n., Hui D., Wu A. et al. A Major Outbreak of Severe Acute Respiratory Syndrome in Hong Kong. N Engl J Med, 2003; 348(20):1986-94
142. Peiris J.S.M., Kwok D.P., Osterhaus A.D.M.E. et al. The Severe Acute Respiratory Syndrome. N Engl J Med 2003;349(25):2431-41
143. World Health Organisation. Consensus document on the epidemiology of severe acute respiratory syndrome (SARS). WHO/CDS/CSR/GAR/2003.11
144. Khan P.A., Nousheen S., Maryam N. et al. Middle East Respiratory Syndrome (MERS): a systematic review. Int J Pharm Sci, 2018; 9(7):2616-2625.
145. Choi S, Jung E., Choi B.Y et al. High reproduction number of Middle East respiratory syndrome coronavirus in nosocomial outbreaks: mathematical modelling in Saudi Arabia and South Korea. J Hosp Infect, 2018; 99(2):162–168
146. Sanche S., Lin Y.T., Xu C. et al. High Contagiousness and Rapid Spread of Severe Acute Respiratory Syndrome Coronavirus 2. Emerg Infect Dis, 2020; 26(7):1470–1477
147. Yu I.T.S., Li Y., Wong T.W. et al. Evidence of Airborne Transmission of the Severe Acute Respiratory Syndrome Virus. N Engl J Med 2004; 350(17):1731-1739
148. Fennelly, K. Particle sizes of infectious aerosols: implications for infection control. Lancet Respir Med, 2020; 8: 914–24
149. Hui D.S.C., Zumla A. Severe Acute Respiratory Syndrome: Historical, Epidemiologic, and Clinical Features. Infect Dis Clin N Am, 2019; 33(4):869–88
150. Seto W.H., Conly J.M., Pessoa-Silva C.L. et al. Infection prevention and control measures for acute respiratory infections in healthcare settings: an update. East Mediterr Health J, 2013; 19(Suppl 1): S39-S47
151. Tang S., Mao Y., Jones R.M. et al. Aerosol transmission of SARS-CoV-2? Evidence, prevention and control. Environ Int, 2020; 144:106039
152. Mutair A.A., Ambani Z. Narrative review of Middle East respiratory syndrome coronavirus (MERS-CoV) infection: updates and implications for practice. J Int Med Res, 2019; 48(1):1-6

153. Kim S.H., Chang S.Y., Sung M. et al. Extensive Viable Middle East Respiratory Syndrome (MERS) Coronavirus Contamination in Air and Surrounding Environment in MERS Isolation Wards. Clin Infect Dis, 2016; 63(3):363-369
154. Majumder M.S., Brownstein J.S. Finkelstein S.N. et al. Nosocomial amplification of MERS-coronavirus in South Korea, 2015. Trans R Soc Trop Med Hyg, 2017; 111(6):261–269
155. Di Mascio D., Khalil A., Saccone G. et al. Outcome of coronavirus spectrum infections (SARS, MERS, COVID-19) during pregnancy: a systematic review and meta-analysis. Am J Obstet Gynecol MFM, 2020; 2(2):100107
156. Memish A. Viral shedding and antibody response in MERS. Vox San, 2016; 111(Suppl 1):7-305, 4B-S20-01
157. Peiris J.S.M., Chu C.M., Cheng V.C.C. et al. Clinical progression and viral load in a community outbreak of coronavirus-associated SARS pneumonia: a prospective study. Lancet, 2003; 361(9371): 1767–1772
158. Cheng P.K.C., Wong D.A., Tong L.K.L. et al. Viral shedding patterns of coronavirus in patients with probable severe acute respiratory syndrome. Lancet, 2004; 363(9422):1699-1700
159. Corman V.M., Albarrak A.M., Omrani A.S. et al. Viral Shedding and Antibody Response in 37 Patients With Middle East Respiratory Syndrome Coronavirus Infection. Clin Infect Dis, 2016; 62(4):477-483
160. Drosten C., Seilmaier M., Corman V.M. et al. Clinical features and virological analysis of a case of Middle East respiratory syndrome coronavirus infection. Lancet Infect Dis, 2013; 13(9):745–751
161. Pacciarini F., Ghezi S., Canducci F. et al. Persistent Replication of Severe Acute Respiratory Syndrome Coronavirus in Human Tubular Kidney Cells Selects for Adaptive Mutations in the Membrane Protein. J Virol, 2008; 82(11):5137-5144
162. Belser J.A., Rota P.A., Tumpey T.M. Ocular Tropism of Respiratory Viruses. Microbiol Mol Biol R, 2013; 77(1):144-156
163. Loon S.C., Teoh S.C.B., Oon L.L.E. et al. The severe acute respiratory syndrome coronavirus in tears. Br J Ophthalmol, 2004; 88(7):861–863
164. Xu D., Zhang Z., Jin L. et al. Persistent shedding of viable SARS-CoV in urine and stool of SARS patients during the convalescent phase. Eur J Clin Microbiol Infect Dis, 2005; 24(3):165–171
165. Chan K.H., Poon L.L.L.M., Cheng V.C.C. et al. Detection of SARS Coronavirus in Patients with Suspected SARS. Emerg Infect Dis, 2004; 10(2):294-299
166. Cha R., Yang S.H., Moon K.C. et al. A Case Report of a Middle East Respiratory Syndrome Survivor with Kidney Biopsy Results. J Korean Med Sci 2016; 31(4): 635-640
167. Ding Y., He L., Zhang Q. et al. Organ distribution of severe acute respiratory syndrome (SARS) associated coronavirus (SARS-CoV) in SARS patients: implications for pathogenesis and virus transmission pathways. J Pathol, 2004; 203(2):622–630
168. Katz L.M. Is SARS-CoV-2 transfusion transmitted? Transfusion, 2020; 60(6):1111-1114.
169. McDonald L.C., Simor A.E., Su I.J. et al. SARS in Healthcare Facilities, Toronto and Taiwan. Emerg Infect Dis, 2004; 10(5):777-781
170. Stein R.A. Super-spreaders in infectious diseases. Int J Infect Dis, 2011; 15(8):e510-e513
171. Shen Z., Ning F., Zhou W. et al. Superspreading SARS Events, Beijing, 2003. Emerg Infect Dis, 2004; 10(2):256-260
172. World Health Organisation. How SARS changed the world in less than six months. Bull World Health Organ, 2003; 81(8):625-626

173. Taylor J., Wentworth D.E., Bernard A. et al. SARS Coronaviruses and Highly Pathogenic Influenza Viruses: Safety and Occupational Health for Laboratory Workers. Emerg Infect Dis, 2005; 11(4):e3
174. Wang W., Wu Q., Yang J. et al. Global, regional, and national estimates of target population sizes for covid-19 vaccination: descriptive study. BMJ, 2020;371:m4704
175. Continue with others then Tang and Chen

Appendices

Appendix 1 – glossary

Appendix 2 – guideline development and conflicts of interest

Appendix 3 – search strategy

Appendix 4 – sifting

Appendix 5 – a) QA checklist, b) QA results

Appendix 6 – evidence tables a) characteristics of included studies, b) summary of findings tables

Appendix 7 – excluded studies table

Appendix 8 – GRADE table

Appendix 9 – consultation

Appendix 1: Glossary

ACE-2 receptor: a protein, which is found on surface of many cells (including lung cells). The protein normally regulates different functions in the body such as blood pressure. Some coronaviruses such as SARS-CoV and SARS-CoV-2 have proteins which can attached the virus to ACE-2. In this case, ACE-2 acts as a receptor to allow the virus to enter the cell.

Aerosol generating procedure: a medical procedure which produces aerosols particles from the respiratory tract. The particles are small enough to be considered 'airborne' and can lead to a transmission of infection to a person who conducts a procedure (usually a healthcare worker). Some examples include intubation of a patient, suctioning, dental procedures, some surgeries where high speed devices are used and bronchoscopy.

Aggregated: grouped or linked together. In this guidance the term is used describe the event to combine the data from all available studies without conducting a formal statistical analysis.

AGP: see aerosol generating procedures

Caco2 cells: cells which were once taken from a patient with colorectal cancer. Unlike normal human cells, these cells are 'immortalised' because due to a mutation, they are able to divide indefinitely. For viruses, e.g. SARS-CoV-2, the cells are inoculated in the laboratory setting (see viral culture) to determine if the virus is able to infect other cells.

Collison drum: or Collison nebuliser, is a laboratory device used for generating aerosols from liquids. The liquid can be inoculated with micro-organisms, which can then be assessed for their ability to survive in the air, depending on the size of aerosols produced.

COVID-19: Coronavirus Disease, a respiratory disease caused by infection with SARS-CoV-2 virus, which was first identified in December 2019.

Culturable virus: a virus which was has an ability to infect other cells in viral culture. A viral sample for an experiment is usually obtained from different body tissues or environment with an aim to determine whether the virus obtained in a sample is infectious.

Denominator: a divisor – a number below a line in a fraction, in statistics the number represents a total number of samples or individuals in the experiment.

Epidemiological: relating to a study of epidemiology – a field of medicine which investigates the frequency and determinants (e.g. causes or risk factors) of health-related issues. These could be infectious and non-infectious diseases, injuries, natural disasters and other.

Fomite: inanimate objects, which are contaminated with infectious agents (e.g. viruses) and can transfer them to a person who subsequently becomes infected. Examples include clothes, door handles, toilet seats, eating utensils etc.

HCW: Healthcare Workers; the term may refer to a person who delivers care (e.g. nurse or doctor), but more broadly includes any member of staff e.g. cleaners or receptionists, including non-paid staff such as volunteers and chaplains who work in healthcare setting.

IgM: Immunoglobulin M, a type of immunoglobulin (also known as antibody), is a molecule that is produced as a response of immune system following an exposure to pathogen. IgM appears early in an infection and plays a lesser role in subsequent infections. The significance of IgM in this guidance is that this molecule is too large to be able to cross placenta, therefore IgM found in an infant at birth suggests an *in utero* exposure to pathogen; foetus is able to produce IgM from about 20 weeks. Maternal IgM can be passed to an infant via milk through breastfeeding.

Impinger: a device for collecting small particles suspended in the air e.g. dust or microorganisms. In the collection process, a pre-defined amount of air is pumped into a tube and reacts with a liquid medium inside.

Infectious dose: also minimum infectious dose, the amount of virus that is necessary to cause a disease. For example, only 10-100 viral particles are sufficient to cause norovirus infection. The infectious dose for SARS-CoV-2 is currently unknown, although it has been proposed that this is around 1000 copies.

Inoculum: a substance used for inoculation – in research or diagnostics, a process of transferring microorganisms onto a medium where they can grow and reproduce.

Intrapartum: at birth, a time period which starts with the onset of labour and ends with the delivery of the placenta.

MERS: Middle East Respiratory Syndrome, a disease caused by MERS-CoV virus.

MERS-CoV: Middle East Respiratory Syndrome Coronavirus, a beta-coronavirus causing Middle East Respiratory Syndrome, which was first discovered in Saudi Arabia. It is a close cousin of SARS-CoV and SARS-CoV-2.

MeSH: Medical Subject Headings, a set of terms, which are used to index biomedical literature. Together with keywords, MeSH terms are used for searching articles relevant to the topic of interest.

Meta-analysis: performing of an analysis by combining data from more than one study in order to determine an overall result.

Neonatal: relating to a newborn.

NIOSH: an aerosol sampler which was developed by National Institute for Occupational Safety and Health (USA). The sampler collects airborne particles, which contain bacteria, fungi and viruses. The obtained samples can then be used to assess the concentration of a given microorganism in the air and therefore to determine safety of the environment.

Ocular: relating to the eye.

PCR: polymerase chain reaction, a laboratory technique which allows taking a small sample of DNA (molecule containing a genetic material) and rapidly produce a large number of copies. This technique can also be used for diagnostic purposes, e.g. viral detection. In this instance, a primer (a small molecule that contains a DNA sequence of interest) is used and defines which part of DNA is going to be amplified. If the same DNA sequence exists in a test sample, PCR will reproduce a lot of copies which will be detectable. A variant of PCR known as RT-PCR can be used to detect RNA sequence (see RNA).

Placenta: an organ that develops in the uterus during pregnancy. The placenta delivers air and nutrients to the foetus and removes its waste products.

Postpartum: a period usually defined as six weeks from giving birth.

PRISMA diagram: a flow chart which illustrates different parts of systematic review process, in particular it maps out a number of articles which were included and excluded at each step.

Products of conception: any human tissue derived during pregnancy, e.g. placenta, umbilical cord and the cord blood.

Reproductive number: or basic reproduction number (R_0), is the number of individuals that are expected to get an infection from one infected person. If $R_0 > 1$, the infection is able to spread within the population and the higher the number, the more difficult it is to control. The reproductive number depends on many factors such as infectiousness of the organism, the length of time an infected person can spread the disease, number of people in contact with an infected person, number of immune people and different control mechanisms.

RNA: Ribonucleic acid, is a molecule which is usually derived from DNA. RNA contains a small portion of genetic material, needed for creation of a specific product. Most organisms use DNA to store their genetic material and make RNA when these products are needed. Some viruses use RNA, which gives them an additional advantage as once they enter the cell, their RNA is ready to be 'translated' into the products they encode for. Coronaviruses, including SARS-CoV-2 use RNA to store their genetic code.

SARS: Severe Acute Respiratory Syndrome, a disease caused by SARS-CoV virus.

SARS-CoV: Severe Acute Respiratory Syndrome Coronavirus. The virus was the cause of the SARS epidemic, which began in China in 2003 and spread around the world, mostly affecting East Asian countries. The virus is closely related to SARS-CoV-2 and to a slightly more distant cousin MERS-CoV.

SARS-CoV-2: Severe Acute Respiratory Syndrome Coronavirus-2. The virus is the cause of the COVID-19 pandemic, which was first identified in China in 2019 and quickly spread around the world. The virus is closely related to SARS-CoV and to a slightly more distant cousin MERS-CoV.

$TCID_{50}$: fifty percent tissue culture infective dose, is the measure of infectious virus concentration used in cell culture. It is defined as the amount of virus that is required to kill or cause pathogenic effect in 50% of the culture cells.

Vero E6 cells: immortalised cells derived from a kidney of green monkey. Unlike other cells, Vero E6 do not produce a molecule called interferon. Interferons are signalling molecules which are released from a cell after it was infected with a virus, so that the neighbouring cells can heighten their anti-virus defences. Because this molecule is not released in Vero E6 cells, they are often used for researching or detecting viable viruses.

Vertical transmission: a direct mother to child transmission that occurs before, during or shortly after birth. Transmission can occur via placenta, infected tissues during delivery or through breast milk.

Viable virus: see culturable virus

Viral culture: a laboratory technique which uses virus inoculated into cells, with the aim to test whether the virus has an ability to survive, reproduce and infect other cells.

Viral load: number of viral particles in a sample taken from an individual or environment. The amount of virus is important because the higher the number of particles in the environment, the higher the likelihood of a person becoming infected. See infectious dose.

Appendix 2: Guideline Development

a) Introduction

The need for a guideline within this area was agreed between HIS, BIA, IPS, RCPath and BSAC at the beginning of the first wave of COVID-19 affecting UK in March 2020. The need arose from the concerned healthcare workers reporting the lack of evidence in this area. Further meetings between the participating bodies confirmed the need for the establishment of a COVID-19 Rapid Guidance Working Party. Members were chosen to reflect the range of stakeholders. Feedback from the members of respective societies was used to establish a basis for review questions. The final structure of these questions in PECO format was agreed collectively during subsequent teleconference meetings. After the agreement was reached, if the need for new questions arose, these were considered for inclusion at subsequent meetings. No payment was made to anyone involved in this guideline.

b) Conflict of interest

Conflict of interest was registered from all Working Party members and during the ongoing review up until the point of completion. In the event of a potential conflict being identified, the Working Party agreed that the member should not contribute to the section affected.

Appendix 3: Search strategy

PECO Question: What are the routes of transmission of beta-coronaviruses between humans?

Note: as specified by the protocol, SARS-CoV and MERS-CoV transmission would be considered only if sufficient evidence did not exist concerning SARS-CoV-2 transmission. The review included a total of 130 primary studies describing SARS-CoV-2, without the need to include evidence from other viruses. Instead, brief information relating to SARS and MERS viruses was introduced at each introductory section.

Population: Any person at risk of exposure in the community or healthcare setting

Exposure: Exposure to the betacoronavirus via any route

Comparison: No comparison group

Outcomes: Evidence of transmission to another person

Study design: Any study reporting primary data

Literature search terms:

EMBASE/MEDLINE

1 coronavirus.mp. or exp Coronavirinae

2 exp SARS coronavirus/ or coronovirus.mp. or exp Coronavirus infection/

3 severe acute respiratory syndrome.mp. or severe acute respiratory syndrome/ or respiratory distress syndrome/

4 Severe acute respiratory syndrome coronavirus 2.mp.

5 SARS-CoV-2.mp.

6 SARSCoV-2.mp.

7 SARSCov2.mp.

8 SARS-Cov2.mp.

9 SARS-CoV9.mp.

10 COVID19.mp.

11 nCoV-2019.mp. or SARS-related coronavirus/

12 COVID-19.mp.

13 2019-nCoV.mp.

14 2019nCoV.mp. or Betacoronavirus/

15 HCoV-19.mp.

16 novel coronavirus.mp.

17 wuhan virus.mp.

18 wuhan coronavirus.mp.

19 hubei virus.mp.

20 hubei coronavirus.mp.

21 huanan virus.mp.

22 huanan coronavirus.mp.

23 wuhan pneumonia.mp.

24 hubei pneumonia.mp.

25 huanan pneumonia.mp.

26 CoV.mp.

27 2019 novel.mp.

28 Ncov.mp.

29 n-cov.mp.

30 Seafood market pneumonia.mp.

31 air/ or air.mp.

32 airway.mp. or airway/

33 airborne particle/ or airborne.mp.

34 air borne.mp.

35 airbourne.mp.

36 air bourne.mp.

37 airborn.mp.

38 air born.mp.

39 breath$.mp. or breathing/

40 talk$.mp.

41 cough$.mp. or coughing/

42 sneezing/ or sneez$.mp.

43 aerosol.mp. or aerosol/

44 droplet.mp.

45 spray.mp.

46 flush.mp. or flushing/

47 respiratory droplet.mp.

48 fecal-oral.mp.

49 faecal-oral.mp.

50 food contamination/ or foodborne.mp.

51 foodborn.mp.

52 foodbourne.mp.

53 environment.mp. or environment/

54 environmental contamination.mp.

55 surface.mp.

56 touch.mp. or touch/

57 AGP.mp.

58 aerosol generating procedure.mp.

59 droplet nuclei.mp. or disease transmission/

60 ingest.mp.

61 fomite.mp. or fomite/

62 contact.mp.

63 suction.mp. or suction/

64 inhalation/

65 airborne particle/

66 drink.mp.

67 mouth/

68 cigarette/

69 kiss.mp.

70 ventilation.mp. or air conditioning/

71 saliva/

72 body fluid.mp. or body fluid/

73 body fluid.mp.

74 spit.mp.

75 sputum.mp.

76 transmission.mp. or virus transmission/

77 transmissibility.mp.

78 spread.mp.

79 *basic reproduction number/

80 route.mp.

81 mode.mp.

82 cross infection/ or crossinfection.mp.

83 expos$.mp.

84 viral load.mp. or virus load/

85 infectivity.mp.

86 infectiousness.mp.

87 1 or 2 or 3 or 4 or 5 or 6 or 7 or 8 or 9 or 10 or 11 or 12 or 13 or 14 or 15 or 16 or 17 or 18 or 19 or 20 or 21 or 22 or 23 or 24 or 25 or 26 or 27 or 28 or 29 or 30

88 31 or 32 or 33 or 34 or 35 or 36 or 37 or 38 or 39 or 40 or 41 or 42 or 43 or 44 or 45 or 46 or 47 or 48 or 49 or 50 or 51 or 52 or 53 or 54 or 55 or 56 or 57 or 58 or 59 or 60 or 61 or 62 or 63 or 64 or 65 or 66 or 67 or 68 or 69 or 70 or 71 or 72 or 73 or 74 or 75

89 76 or 77 or 78 or 79 or 80 or 81 or 82 or 83 or 84 or 85 or 86

90 88 and 89

91 87 and 90

92 limit 91 to yr="2020 -Current"

93 limit 92 to (animals and animal studies)

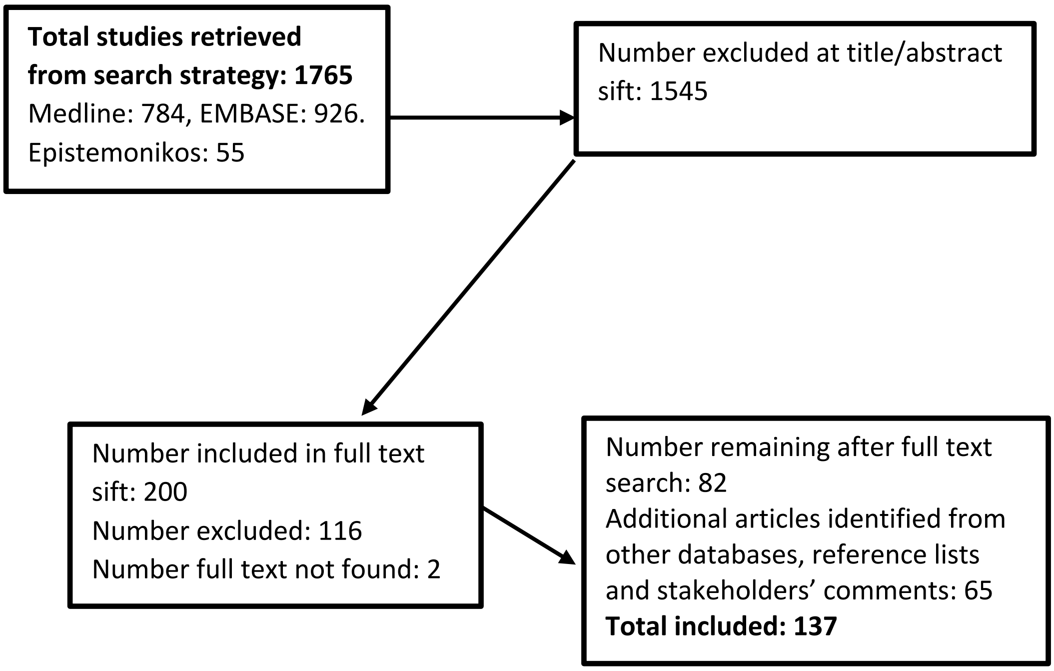
94 *in vitro study/

95 92 not 93

96 95 not 94

Appendix 4: PRISMA diagram

Summary of the data extraction and literature review process:



Appendix 5: Quality assessment

a) QA checklist

The checklist used for assessing the quality of the included case series/studies was can be found here.

b) QA results

authors	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Q10
Alzamora, 2020[5]	◆	▲	▲	◆	◆	●	●	■	▲	◆
Bai, 2020[6]	●	●	●	●	■	▲	●	●	▲	●
Burke, 2020[7]	●	●	●	▲	■	▲	▲	▲	▲	●
Cai, 2020[8]	■	■	■	▲	■	▲	▲	▲	▲	●
Chan, 2020[9]	■	●	●	■	■	▲	●	●	▲	●
Chen, 2020[10]	■	●	●	■	■	▲	●	●	▲	●
Chen, 2020b[11]	◆	●	◆	◆	◆	●	●	●	●	◆
Chen, 2020c[12]	▲	●	●	■	■	▲	▲	●	▲	●
Chen, 2020d[13]	▲	●	●	■	■	▲	●	●	▲	●
Chen, 2020e[14]	●	●	●	■	■	●	●	●	▲	●
Chen, 2020f[15]	●	●	●	■	■	●	●	●	▲	●
Cheng, 2020[16]	●	●	●	●	■	●	●	●	▲	●
Colavita, 2020[20]	◆	●	◆	◆	◆	▲	●	●	▲	◆
Cui, 2020[21]	●	●	●	■	■	●	▲	●	▲	●
Dong, 2020[22]	◆	●	◆	◆	◆	●	●	●	▲	◆
Dong, 2020b[23]	●	●	●	■	■	●	●	●	◆	●
Fan, 2020[24]	▲	●	●	▲	▲	●	●	●	▲	◆
Fan, 2020b[25]	◆	●	◆	◆	◆	●	●	●	▲	◆
Gan, 2020[27]	●	●	■	■	●	●	▲	●	●	●
Ghinai, 2020[28]	●	●	●	◆	■	●	●	●	●	◆
Hamner, 2020[30]	●	●	▲	◆	●	▲	▲	●	●	●

Han, 2020[31]	◆	●	◆	◆	◆	●	●	●	▲	◆
Heinzerling, 2020[32]	●	●	●	▲	●	▲	●	●	▲	●
Huang, 2020[33]	▲	●	●	▲	■	▲	●	●	▲	●
Huang, 2020b[34]	●	●	●	●	●	▲	▲	●	◆	●
Iqbal, 2020[35]	◆	●	◆	◆	◆	▲	●	●	▲	◆
Jiang, 2020[36]	◆	●	◆	◆	◆	●	●	●	◆	◆
Jiang, 2020b[37]	●	●	●	■	●	▲	●	●	◆	●
Jiehao, 2020[38]	●	●	●	●	●	●	●	●	▲	●
Khan, 2020[39]	●	●	●	■	■	●	●	●	▲	●
Kong, 2020[40]	●	●	●	●	●	●	●	▲	●	●
Le, 2020[41]	◆	●	◆	◆	◆	●	●	●	▲	◆
Lee, 2020[42]	◆	●	◆	◆	◆	●	●	●	◆	◆
Li, 2020[43]	▲	●	●	■	■	●	●	▲	▲	●
Li, 2020b[44]	●	●	●	●	▲	▲	▲	▲	▲	●
Li, 2020c[45]	◆	●	◆	◆	◆	●	●	●	▲	◆
Li, 2020d[46]	●	●	●	◆	●	●	●	●	▲	●
Li, 2020e[47]	●	●	●	●	●	▲	●	●	▲	●
Li, 2020f[48]	●	●	●	■	■	●	●	●	●	●
Li, 2020g[49]	◆	●	●	◆	◆	◆	●	●	●	◆
Li, 2020h[50]	●	●	●	■	■	●	■	●	▲	●
Li, 2020i[51]	●	●	●	●	●	▲	▲	●	●	●
Li, 2020j[52]	◆	●	◆	◆	◆	●	●	●	▲	◆
Ling, 2020[53]	●	●	●	◆	■	▲	●	◆	●	●
Liu, 2020[54]	●	●	●	■	■	●	●	●	▲	●
Liu, 2020b[55]	●	●	●	■	■	●	●	●	▲	●

Liu, 2020c[56]	●	●	●	●	●	●	●	●	●	●
Liu, 2020d[57]	◆	●	◆	◆	◆	●	●	●	◆	◆
Lowe, 2020[58]	◆	●	◆	◆	◆	●	●	●	▲	◆
Lu, 2020[59]	●	●	●	◆	●	▲	▲	●	●	●
Luo, 2020[60]	●	●	●	■	■	▲	▲	●	●	●
McMichael, 2020[61]	●	●	●	■	■	●	●	●	●	●
Ng, 2020[63]	●	●	●	◆	●	▲	◆	●	●	●
Okada, 2020[65]	■	●	●	■	■	●	●	●	◆	◆
Pan, 2020[68]	●	●	●	■	■	▲	●	◆	▲	●
Park, 2020[69]	◆	●	◆	◆	◆	●	●	●	●	◆
Park, 2020b[70]	●	●	●	●	●	▲	▲	●	●	●
Penfield, 2020[71]	●	●	●	●	●	●	●	▲	▲	●
Peng, 2020[72]	■	●	■	■	■	●	●	●	▲	●
Peng, 2020b[73]	◆	●	◆	◆	◆	●	●	●	◆	◆
Phan, 2020[74]	■	●	●	●	●	●	●	●	▲	◆
Pierce-Williams, 2020[75]	●	●	●	■	■	●	●	●	▲	●
Pung, 2020[76]	●	●	●	●	●	●	▲	●	●	●
Qian, 2020b[77]	■	●	●	■	■	●	●	●	▲	●
Qiu, 2020[78]	●	●	●	■	■	●	●	●	▲	●
Qiu, 2020b[79]	■	●	●	■	■	▲	▲	▲	▲	●
Rothe, 2020[80]	■	●	●	▲	▲	▲	▲	●	●	●
Schwartz, 2020[82]	●	●	●	●	●	▲	▲	●	●	●
Schwierzeck, 2020[83]	●	●	●	●	●	●	●	●	●	●
Scott, 2020[84]	●	●	●	●	●	▲	▲	●	●	●
Seah, 2020[85]	●	●	●	■	■	▲	▲	▲	▲	●

Song, 2020[86]	■	●	●	■	■	●	●	●	●	●
Sun, 2020b[87]	●	●	●	●	●	●	▲	●	▲	●
Tan, 2020[88]	◆	●	◆	◆	◆	●	●	●	▲	◆
Tan, 2020b[89]	●	●	●	■	■	●	●	●	▲	●
Tang, 2020[90]	◆	●	◆	◆	◆	●	●	●	●	◆
To, 2020[91]	●	●	●	●	▲	●	●	▲	▲	●
Wang, 2020b[94]	◆	●	◆	◆	◆	●	●	●	▲	◆
Wang, 2020c[95]	●	●	●	■	■	▲	●	▲	▲	●
Wang, 2020d[96]	▲	●	●	■	■	▲	▲	▲	▲	●
Wang, 2020e[97]	◆	●	◆	◆	◆	●	●	●	▲	◆
Wang, 2020f[98]	●	●	●	●	●	■	▲	●	▲	●
Wei, 2020[99]	●	●	●	●	●	▲	▲	▲	●	◆
Wei, 2020b[100]	●	●	●	■	■	●	●	●	●	●
Wu, 2020[101]	●	●	●	■	■	▲	▲	▲	▲	●
Wu, 2020b[102]	●	●	●	●	■	●	●	●	▲	●
Wu, 2020c[103]	●	●	●	▲	▲	●	●	●	●	●
Wu, 2020d[104]	■	●	●	■	■	▲	●	●	▲	●
Xia, 2020[106]	■	●	●	■	■	▲	▲	●	▲	●
Xia, 2020b[107]	●	●	●	■	▲	●	●	●	●	●
Xiao, 2020[108]	●	●	●	■	■	●	▲	●	▲	●
Xiao, 2020b[109]	▲	●	●	■	■	▲	●	●	●	●
Xie, 2020[110]	●	●	●	●	●	▲	▲	●	▲	●
Xing, 2020[111]	●	●	●	●	●	▲	●	●	▲	●
Xu, 2020[112]	●	●	●	●	●	●	●	●	▲	●
Yan, 2020[113]	●	●	●	●	●	●	●	●	▲	●

Yang, 2020[114]	🟢	🟢	🟢	🟨	🟨	🔺	🟢	🟢	🟢	🟢
Yang, 2020b[115]	🟢	🟢	🟢	🟨	🟨	🔺	🟢	🟢	🔴	🟢
Yong, 2020[116]	🟢	🟢	🟨	🟢	🟢	🟨	🟨	🟢	🟢	🟢
Yu, 2020[117]	🟢	🟢	🟢	🟢	🟢	🟢	🟢	🟢	🟢	🟢
Yu, 2020b[118]	🟢	🟢	🟢	🟨	🟨	🟢	🟢	🟢	🟢	🟢
Zambrano, 2020[119]	◆	🟢	◆	◆	◆	🟢	🟢	🟢	🔺	◆
Zeng, 2020[120]	🟢	🟢	🟢	◆	🟨	🔺	🟢	🟢	🔺	🟢
Zeng, 2020[121]	🟢	🟢	🟢	🟢	🟢	🟢	🟢	🟢	🔺	🟢
Zhang, 2020[122]	🟢	🟢	🟢	◆	🟨	🔺	🔺	🟢	🔺	🟢
Zhang, 2020b[123]	🟢	🟢	🟢	🟢	🟢	🔺	🔺	🟢	🟢	🟢
Zhang, 2020c[124]	🟢	🟢	🟢	🟨	🟨	🟢	🟢	🟢	🔺	🟢
Zhang, 2020d[125]	🟢	🟢	🟢	🟨	🟨	🔺	🟢	🟢	🔺	🟢
Zhang, 2020e[126]	🟢	🟢	🟢	🟨	🟨	🔺	🔺	🟢	🔺	🟢
Zhang, 2020f[127]	◆	🟢	◆	◆	◆	🟨	🟨	🟢	🟢	◆
Zhang, 2020g[128]	🟢	🟢	🟢	🟢	🟢	🔺	🟢	🟢	🟢	🟢
Zhang, 2020h[129]	◆	🟢	◆	◆	◆	🔺	🔺	🟢	🔺	◆
Zhang, 2020i[130]	◆	🟢	◆	◆	◆	🔺	🟢	🟢	🔺	◆
Zheng, 2020[131]	🟢	🟢	🟢	🟢	🟨	🟢	🟢	🟢	🟢	🟢
Zhou, 2020[132]	🟢	🟢	🟢	🟨	🟨	🟢	🟢	🟢	🔺	🟢
Zhu, 2020[133]	🟢	🟢	🟢	🟨	🟨	🟢	🟢	🟢	🔺	🟢
Sun, 2020[134]	◆	🟢	◆	◆	◆	🔺	🔺	🔺	🔺	◆
Vivanti, 2020[136]	◆	🟢	◆	◆	◆	🔺	🟢	🟢	🔺	◆
Cho, 2020[137]	◆	🟢	◆	◆	◆	🟢	🟢	🟢	◆	◆
Essa, 2020[138]	◆	🟢	◆	◆	◆	🔺	🟢	🟢	◆	◆
Liapis, 2020[139]	◆	🟢	◆	◆	◆	🔺	🟢	🟢	🔺	◆

Politis, 2020[140]	◆	●	◆	◆	◆	●	●	●	●	◆

● yes, ● unclear, ▲ no, ◆ not applicable

Appendix 6: Evidence tables

a) characteristics of included studies

Author, Year	Study Design	Country	Population	Transmission route	Comparator	Outcomes
Ahmed, 2020[4]	Environmental survey	Australia	Environment	Faecal	No comparator	Environmental contamination
Alzamora, 2020[5]	Case study	Peru	Pregnant woman + neonate	Vertical	No comparator	No of cases
Bai, 2020[6]	Case series	China	Adults in community	Not described	No comparator	No of cases
Burke, 2020[7]	Case series	USA	Contacts of COVID-19 patients	Not described	No comparator	No of cases
Cai, 2020[8]	Case series	China	Mall visitors and staff	Fomites	No comparator	No of cases
Chan, 2020[9]	Case series	China	Family	Not described	No comparator	No of cases
Chen, 2020[10]	Case series	China	Pregnant woman + neonate	Vertical	No comparator	No of cases
Chen, 2020b[11]	Case study	China	COVID-19 +ve patient	Ocular	No comparator	No of individuals with +ve samples
Chen, 2020c[12]	Case series	China	Pregnant woman + neonate	Vertical	No comparator	No of cases
Chen, 2020d[13]	Case series	China	COVID-19 +ve patient	Faecal, urine	No comparator	No of individuals with +ve samples
Chen, 2020e[14]	Case series	China	Pregnant woman + neonate	Vertical	No comparator	No of cases
Chen, 2020f[15]	Case series	China	Pregnant woman + neonate	Vertical	No comparator	No of cases

Cheng, 2020[16]	Case series	Taiwan	Contacts of COVID-19 patients	Not described	No comparator	No of cases
Cheng, 2020b[17]	Environmental survey	Hong Kong	Room of COVID-19 patient	Air	No comparator	Environmental contamination
Chia, 2020[18]	Environmental survey	Singapore	Environment	Air, fomites	No comparator	Environmental contamination
Chin, 2020[19]	Laboratory experiment	China	Different fomites	Fomites	No comparator	Virus survival
Colavita, 2020[20]	Case study	Italy	COVID-19 +ve patient	Ocular	No comparator	No of individuals with +ve samples
Cui, 2020[21]	Case series	China	Female COVID+ve patients	Faecal Sexual	No comparator	No of +ve samples
Dong, 2020[22]	Case study	China	Pregnant woman + neonate	Vertical	No comparator	No of cases
Dong, 2020b[23]	Case series	China	Contacts of COVID-19 patients	Not described	No comparator	No of cases
Fan, 2020[24]	Case series	China	Pregnant woman + neonate	Vertical	No comparator	No of cases
Fan, 2020b[25]	Case study	China	COVID-19 +ve patient	Faecal	No comparator	No of individuals with +ve samples
Faridi, 2020[26]	Environmental survey	Iran	ICU rooms with COVID-19 patients	Air	No comparator	Environmental contamination
Gan, 2020[27]	Case series	China	Contacts of COVID-19 patients	Not described	No comparator	No of cases
Ghinai, 2020[28]	Case series	USA	Contacts of COVID-19 patients	Cluster	No comparator	No of cases
Guo, 2020[29]	Environmental survey	China	ICU & general wards	Air, fomites	No comparator	Environmental contamination

Hamner, 2020[30]	Case series	USA	Adults attending choir practice	Droplet, fomites	No comparator	No of cases
Han, 2020[31]	Case series	Korea	COVID-19 patients	Faecal, urine, vertical	No comparator	No of cases
Heinzerling, 2020[32]	Case series	USA	Contacts of COVID-19 patients	Not described	No comparator	No of cases
Huang, 2020[33]	Case series	China	Contacts of COVID-19 patients	Not described	No comparator	No of cases
Huang, 2020b[34]	Case series	China	Contacts of COVID-19 patients	Not described	No comparator	No of cases
Iqbal, 2020[35]	Case study	China	Pregnant woman + neonate	Vertical	No comparator	No of cases
Jiang, 2020[36]	Case study	China	COVID-19 patients	Faecal	No comparator	No of individuals with +ve samples
Jiang, 2020b[37]	Case series	China	Contacts of COVID-19 patients	Not described	No comparator	No of cases
Jiehao, 2020[38]	Case series	China	COVID-19 children	Faecal, urine	No comparator	No of individuals with +ve samples
Khan, 2020[39]	Case series	China	Pregnant woman + neonate	Vertical	No comparator	No of cases
Kong, 2020[40]	Case series	Korea	Contacts of COVID-19 patients	Not described	No comparator	No of cases
Le, 2020[41]	Case series	Vietnam	Contacts of COVID-19 patients	Not described	No comparator	No of cases
Lee, 2020[42]	Case series	Korea	Pregnant woman + neonate	Vertical	No comparator	No of cases
Li, 2020[43]	Case series	China	Contacts of COVID-19 patients	Not described	No comparator	No of cases

Li, 2020b[44]	Case series	China	Male COVID-19 patients	Sexual	No comparator	No of +ve samples
Li, 2020c[45]	Case study	China	COVID-19 patients	Faecal	No comparator	No of individuals with +ve samples
Li, 2020d[46]	Case series	China	Pregnant woman + neonate	Vertical	No comparator	No of cases
Li, 2020e[47]	Case series	China	Contacts of COVID-19 patients	Not described	No comparator	No of cases
Li, 2020f[48]	Case series	China	Contacts of COVID-19 patients	Not described	No comparator	No of cases
Li, 2020g[49]	Case series	China	Healthcare workers	Ocular	No comparator	No of cases
Li, 2020h[50]	Case study	Korea	COVID-19 patients	Faecal	No comparator	No of individuals with +ve samples
Li, 2020i[51]	Case series	China	Restaurant guests	Droplet	No comparator	No of cases
Li, 2020j[52]	Case study	China	Pregnant woman + neonate	Vertical	No comparator	No of cases
Ling, 2020[53]	Case series	China	Convalescent COVID adult patients	Faecal, urine	No comparator	No of individuals with +ve samples
Liu, 2020[54]	Case series	China	Pregnant woman + neonate	Vertical	No comparator	No of cases
Liu, 2020b[55]	Case series	China	Pregnant woman + neonate	Vertical	No comparator	No of cases
Liu, 2020c[56]	Case series	China	Pregnant woman + neonate	Vertical	No comparator	No of cases
Liu, 2020d[57]	Case study	Taiwan	Contacts of COVID-19 patients	Not described	No comparator	No of cases

Lowe, 2020[58]	Case study	Australia	Pregnant woman + neonate	Vertical	No comparator	No of cases
Lu, 2020[59]	Case series	China	Restaurant guests	Droplet	No comparator	No of cases
Luo, 2020[60]	Case series	China	Contacts of COVID-19 patients	Not described	No comparator	No of cases
McMichael, 2020[61]	Case series	USA	Family	Not described	No comparator	No of cases
Medema, 2020[62]	Environmental survey	Netherlands	Sewage water in main cities	Faecal	No comparator	No of +ve samples
Ng, 2020[63]	Case series	Singapore	Contacts of COVID-19 patients	Not described	No comparator	No of cases
Liu, 2020[64]	Environmental survey	China	Environment	Air	2 blank controls	Environmental contamination
Okada, 2020[65]	Case series	Thailand	Contacts of COVID-19 patients	Not described	No comparator	No of cases
Ong, 2020[66]	Environmental survey	Singapore	Environment of COVID +ve patients	Air, fomites	No comparator	Environmental contamination
Ong, 2020b[67]	Environmental survey	Singapore	Environment of COVID +ve patients	Fomites	No comparator	Environmental contamination
Pan, 2020[68]	Case series	Hong Kong	COVID-19 patients	Faecal, urine	No comparator	No of individuals with +ve samples
Park, 2020[69]	Case study	Korea	Paediatric COVID-19 patient	Faecal	No comparator	No of individuals with +ve samples
Park, 2020b[70]	Case series	Korea	Contacts of COVID-19 patients	Not described	No comparator	No of cases
Penfield, 2020[71]	Case series	China	Pregnant woman + neonate	Vertical	No comparator	No of cases

Peng, 2020[72]	Case series	China	COVID +ve patients	Faecal, urine	No comparator	No of individuals with +ve samples
Peng, 2020b[73]	Case study	China	Pregnant woman + neonate	Vertical	No comparator	No of cases
Phan, 2020[74]	Case series	Vietnam	Contacts of COVID-19 patients	Not described	No comparator	No of cases
Pierce-Williams, 2020[75]	Case series	USA	Pregnant woman + neonate	Vertical	No comparator	No of cases
Pung, 2020[76]	Case series	Singapore	Contacts of COVID-19 patients	Not described	No comparator	No of cases
Qian, 2020b[77]	Case series	China	Contacts of COVID-19 patients	Not described	No comparator	No of cases
Qiu, 2020[78]	Case series	China	Contacts of COVID-19 patients	Not described	No comparator	No of cases
Qiu, 2020b[79]	Case series	China	COVID +ve patients	Sexual	No comparator	No of +ve samples
Rothe, 2020[80]	Case series	Germany	Contacts of COVID-19 patients	Not described	No comparator	No of cases
Santarpia, 2020[81]	Environmental survey	USA	Environment of COVID +ve patients	Fomites, air	No comparator	Environmental contamination
Schwartz, 2020[82]	Case series	Canada	Aircraft crew & passengers	Droplet Air	No comparator	No of cases
Schwierzeck, 2020[83]	Case series	Germany	Contacts of COVID-19 patients	Not described	No comparator	No of cases
Scott, 2020[84]	Case series	USA	Contacts of COVID-19 patients	Not described	No comparator	No of cases
Seah, 2020[85]	Case series	Singapore	COVID +ve patients	Ocular	No comparator	No of individuals with +ve samples

Song, 2020[86]	Case series	China	Contacts of COVID-19 patients	Not described	No comparator	No of cases
Sun, 2020b[87]	Case series	China	COVID +ve patients	Ocular	No comparator	No of individuals with +ve samples
Tan, 2020[88]	Case study	Vietnam	COVID +ve patient	Faecal	No comparator	No of individuals with +ve samples
Tan, 2020b[89]	Case series	China	Child COVID +ve	Faecal	No comparator	No of individuals with +ve samples
Tang, 2020[90]	Case study	China	COVID +ve patient	Faecal	No comparator	No of individuals with +ve samples
To, 2020[91]	Case series	China	COVID +ve patients	Faecal, urine	No comparator	No of individuals with +ve samples
Van Doremalen, 2020[92]	Laboratory experiment	USA	Surfaces	Fomites	SARS-CoV-2 vs SARS-CoV	Environmental contamination
Wang, 2020[93]	Environmental survey	China	Environment	Fomites, faecal	No comparator	Environmental contamination
Wang, 2020b[94]	Case study	China	Pregnant woman + neonate	Vertical	No comparator	No of cases
Wang, 2020c[95]	Case series	China	COVID +ve patients	Faecal	No comparator	No of individuals with +ve samples
Wang, 2020d[96]	Case series	China	COVID +ve patients	Faecal, urine	No comparator	No of +ve samples
Wang, 2020e[97]	Case study	China	Pregnant woman + neonate	Vertical	No comparator	No of cases
Wang, 2020f[98]	Case series	China	Household contacts of COVID-19 patients	Not described	No comparator	No of cases
Wei, 2020[99]	Case series	Singapore	Contacts of COVID-19 patients	Not described	No comparator	No of cases

Wei, 2020b[100]	Case series	China	Contacts of COVID-19 patients	Not described	No comparator	No of cases
Wu, 2020[101]	Case series	China	COVID +ve patients	Faecal	No comparator	No of +ve samples
Wu, 2020b[102]	Case series	China	COVID +ve patients	Ocular	No comparator	No of individuals with +ve samples
Wu, 2020c[103]	Case series	China	Contacts of COVID-19 patients	Not described	No comparator	No of cases
Wu, 2020d[104]	Case series	China	COVID +ve patients	Faecal	No comparator	No of individuals with +ve samples
Wurtzer, 2020[105]	Environmental survey	France	Wastewater samples during pandemic	Faecal	No comparator	No of +ve samples
Xia, 2020[106]	Case series	China	COVID +ve patients	Ocular	No comparator	No of individuals with +ve samples
Xia, 2020b[107]	Case series	China	Contacts of COVID-19 patients	Not described	No comparator	No of cases
Xiao, 2020[108]	Case series	China	COVID +ve patients	Faecal	No comparator	No of individuals with +ve samples
Xiao, 2020b[109]	Case series	China	Contacts of COVID-19 patients	Not described	No comparator	No of cases
Xie, 2020[110]	Case series	China	COVID +ve patients	Ocular	No comparator	No of individuals with +ve samples
Xing, 2020[111]	Case series	China	Paediatric COVID +ve patients	Faecal	No comparator	No of individuals with +ve samples
Xu, 2020[112]	Case series	China	COVID +ve patients	Faecal	No comparator	No of individuals with +ve samples
Yan, 2020[113]	Case series	China	Pregnant woman + neonate	Vertical	No comparator	No of cases

Yang, 2020[114]	Case series	China	Pregnant woman + neonate	Vertical	No comparator	No of cases
Yang, 2020b[115]	Case series	China	Pregnant woman + neonate	Vertical	No comparator	No of cases
Yong, 2020[116]	Case series	Singapore	Contacts of COVID-19 patients	Not described	No comparator	No of cases
Yu, 2020[117]	Case series	China	Pregnant woman + neonate	Vertical	No comparator	No of cases
Yu, 2020b[118]	Case series	China	Contacts of COVID-19 patients	Not described	No comparator	No of cases
Zambrano, 2020[119]	Case study	Honduras	Pregnant woman + neonate	Vertical	No comparator	No of cases
Zeng, 2020[120]	Case series	China	Pregnant woman + neonate	Vertical	No comparator	No of cases
Zeng, 2020[121]	Case series	China	Pregnant woman + neonate	Vertical	No comparator	No of cases
Zhang, 2020[122]	Case series	China	COVID +ve patients	Faecal	No comparator	No of individuals with +ve samples
Zhang, 2020b[123]	Case series	China	Contacts of COVID-19 patients	Not described	No comparator	No of cases
Zhang, 2020c[124]	Case series	China	Pregnant woman + neonate	Vertical	No comparator	No of cases
Zhang, 2020d[125]	Case series	China	COVID +ve children	Faecal	No comparator	No of individuals with +ve samples
Zhang, 2020e[126]	Case series	China	COVID +ve patients	Faecal	No comparator	No of individuals with +ve samples
Zhang, 2020f[127]	Case study	China	Nurse	Ocular	No comparator	No of cases

Zhang, 2020g[128]	Case series	China	Contacts of COVID-19 patients	Not described	No comparator	No of cases
Zhang, 2020h[129]	Case study	China	COVID +ve patients	Faecal	No comparator	No of individuals with +ve samples
Zhang, 2020i[130]	Case study	China	COVID +ve patients	Faecal, urine	No comparator	No of individuals with +ve samples
Zheng, 2020[131]	Case series	China	COVID +ve patients	Faecal, urine	No comparator	No of individuals with +ve samples
Zhou, 2020[132]	Case series	China	COVID +ve patients	Ocular	No comparator	No of individuals with +ve samples
Zhu, 2020[133]	Case series	China	Pregnant woman + neonate	Vertical	No comparator	No of cases
Zhou, 2020[134]	Environmental survey	United Kingdom	Environment	Air, fomites	No comparator	Environmental contamination
Sun, 2020[135]	Case study	China	COVID +ve patients	Urine	No comparator	No of individuals with +ve samples
Vivanti, 2020[136]	Case study	France	Pregnant woman + neonate	Vertical	No comparator	No of cases
Cho, 2020[137]	Case study	Korea	Blood transfusion recipients	Blood transfusion	No comparator	No of cases
Essa, 2020[138]	Case study	Germany	Blood transfusion recipients	Blood transfusion	No comparator	No of cases
Liapis, 2020[139]	Case study	Greece	Blood transfusion recipients	Blood transfusion	No comparator	No of cases
Politis, 2020[140]	Case study	Greece	Blood transfusion recipients	Blood transfusion	No comparator	No of cases

b) summary of findings tables

Droplet transmission vs airborne transmission

Author, Year	Outcome measure	No of participants		Incidence			Reviewer's comments
		Exposure	Control	No of +ves	Control	Evidence of transfer	
Hamner, 2020[30]	No of cases	60	-	52	-	Multiple opportunities for droplet and fomite transmission	Also included in surfaces
Li, 2020i[51] Lu, 2020[59]	No of cases	83 (in the same dining room)	-	9	-	**Lu:** Most probable droplet transmission facilitated by air conditioning **Li:** likely aerosol transmission, evidence for no close contact and no fomite transmission	Reported by two different studies, slightly different interpretation of results. 83 guests ate lunch in the restaurant, one guest (index) was pre-symptomatic, later diagnosed as +ve. 9 people from three families got sick, two families overlapping 53 and 73min with the family of index patient – both at neighbouring tables directly in the line of the flow of air conditioning. Airborne not likely as none of the staff and none of the guests who were not in the line of the air conditioning got sick. 20 were in direct flow, another 10 were at the tables <2m from index table but not in the flow of AC
		20 (in direct flow)	10 (not in direct flow)	9	0		
Schwartz, 2020[82]	No of cases	Approx. 340	-	0	-	Data suggest droplet rather than airborne transmission	One symptomatic (dry cough) COVID+ve individual on the 15hr flight, his wife asymptomatic and developed symptoms the next day. Both wore masks and had mild symptoms. No passengers or crew were infected. Authors suggested that airplane transmission reports may be biased with contacts sharing exposure before boarding the plane.

Presence of SARS-CoV-2 in air

Author, Year	Setting	Outcome measure	No of samples	No (%) PCR +ve	No (%) Viable in culture	Evidence of interpersonal transmission	Reviewer's comments
Contaminated samples							
Cheng, 2020b[17]	Hospital room with COVID-19 patient	No of contaminated samples	4	0	NR	NR	Air taken in 4 scenarios: normal breathing, deep breathing, speaking, coughing.
Faridi, 2020[26]	Hospital rooms with COVID+ve patients	No of contaminated impingers	4	0	NR	NR	4 impingers placed 1.5-1.8m from the floor & 2-5m away from COVID-19 patients for 1hr. Some patients coughed or were intubated
Guo, 2020[29]	Hospital rooms with COVID-19 patients	No of contaminated samples	40 ICU 16 General ward	14 (35%) ICU 2 (12.5%) General ward	NR	NR	Air samples mostly contaminated around patient areas and downstream, although upstream also observed. Virus traveling up to 4m.
Santarpia, 2020[81]	Hospital rooms with COVID-19 patients	% of contaminated samples	NR	P: 100% l H: 66.7%	0		P: Personal space – patient's isolation area; H: Hallway outside the patient's isolation area; highest load in samplers near patients Authors suggested aerosols exist even without cough and AGPs
Zhou, 2020b[134]	Hospital areas with COVID-19 patients	No of contaminated air samples	31	14 (38.7%)	0		
Contaminated rooms							
Chia, 2020[18]	Hospital rooms with COVID-19 patients	No of rooms contaminated	3	2	NR	NR	Three NIOSH samples per room (general ward) located 0.7, 0.9 and 1.2m from the floor and 1-2.1 away from COVID patients for 4hrs.
Ong, 2020[66]	Hospital rooms with COVID-19 patients	No of rooms contaminated	3	2	NR	NR	Air outlets outside the room
Viral load							

Cheng, 2020b[17]	Hospital room with COVID-19 patient	Viral particles/m^3	4	0	NR	NR	4 scenarios: normal breathing, deep breathing, speaking, coughing
Chia, 2020[18]	Hospital rooms with COVID-19 patients	Viral particles/m^3	3	$1.84x10^3$-$3.38x10^3$			Three NIOSH samples per room (general ward) located 0.7, 0.9 and 1.2m from the floor and 1-2.1 away from COVID patients for 4hrs.
Ning, 2020[64]	Hospital for COVID-19 patients, patient areas	Viral particles/m^3/hr	11	0-113	NR	NR	Highest in ICU (two samples tested, yielding 31 and 113, but these were deposits rather than aerosols)
	Hospital for COVID-19 patients, medical areas	Viral particles/m^3/hr	13	0-42	NR	NR	Possibility of airborne transmission if the areas are small, not well ventilated and overcrowded
	Public areas: inside & outside the hospital	Viral particles/m^3/hr	11	0-11	NR	NR	Possibility of airborne transmission if the areas are small, not well ventilated and overcrowded
Zhou, 2020b[134]	Hospital areas with COVID-19 patients	Viral particles/m^3	14	10-1000	0	NR	

Survival of SARS-CoV-2 in air

Author	Surface	SARS-CoV-2	SARS-CoV	Comments
Van Doremalen, 2020[92]	Time virus viable in air	>3hrs	>3hrs	Aerosol transmission plausible for both viruses. The differences in epidemiology of these viruses are probably due to other factors e.g. asymptomatic transmission, higher viral loads

Transmission via fomites

Author, Year	Setting	Surface tested	Outcome measure	No of samples	No (%) of PCR +ve	No (%) of viable in culture	No (%) of intrapersonal transmission	Reviewer's comments
Contaminated surfaces								
Guo, 2020[29]	Areas housing COVID-19 patients	Different surfaces (floors, high touch, etc.)	No of contaminated surfaces	124 ICU 114 General	54 in ICU 9 in general ward	NR	NR	Possible transmission via fomites
Ong, 2020[66]	Areas housing COVID-19 patients	Different surfaces incl. toilet, floors and high touch	No of surfaces contaminated	25	15	NR	NR	Surfaces in patient room & toilet mostly contaminated: 12/14 & 3/5; anteroom and floor no contamination
Santarpia, 2020[81]	Areas housing COVID-19 patients	Different surfaces	% of surfaces contaminated	NR	80.4%	NR	NR	76.5% personal items and 81% toilet samples contaminated, less shedding on D8 and 9 than D5-7
Wang, 2020[93]	Areas housing COVID-19 patients	Surfaces	No of surfaces contaminated	36	0	-	NR	Cleaned w/ 1000mg/L Cl 4hrs in ICU and 8hrs in general wards
Zhou, 2020b[134]	Areas housing COVID-19 patients	Surfaces	No of surfaces contaminated	218	114	0		
Contaminated PPE								
Ong, 2020[66]	Clinical areas with COVID-19 patients	PPE (gown, visor, mask, shoes)	No of items contaminated	10	1	NR	NR	Only shoes contaminated
Ong, 2020b[67]	Clinical areas with COVID-19 patients	PPE (goggles, respirators, shoes)	No of items contaminated	90	0	-	NR	Usual care, no aerosol generating procedures
Wang, 2020[93]	Clinical areas with COVID-19 patients	PPE (respirators and gloves)	No of items contaminated	9	0	-	NR	
Total			No of items contaminated	**109**	**1 (0.9%)**	**NR**	**NR**	

Contaminated rooms								
Chia, 2020[18]	Clinical areas with COVID-19 patients	Surfaces in ICU and general wards (not specified)	No of contaminated rooms	30	17	NR	NR	No differences when stratified by symptoms, but higher contamination in the first week of illness
Viral load								
Cheng, 2020b[17]	Clinical areas with COVID-19 patients	Bedside bench	Viral load on surface	2	6.5×10^2/ml once 0 once	NR	NR	
Intrapersonal transmission								
Cai, 2020[8]	Shopping centre	Surfaces (not specified)	Number of cases	NR	NR	NR	28	Lack of contact between cases suggests indirect transmission via fomites

Survival of SARS-CoV-2 on different surfaces

Author	Surface	SARS-CoV-2	SARS-CoV	Comments
Chin, 2020[19]	Paper (printing & tissue)	<3hrs	-	Except for surgical mask, virus more stable on smooth vs porous surfaces
	Wood	<2d	-	
	Cloth	<2d	-	
	Glass	<4d	-	
	Bank note	<4d	-	
	Surgical mask	<7d	-	
	Plastic	<7d	-	

Van Doremalen, 2020[92]	Copper	<4hrs	8hrs	Aerosol and fomite transmission plausible for both viruses. The differences in epidemiology of these viruses are probably due to other factors e.g. asymptomatic transmission, higher viral loads
	Cardboard	24hrs	8hrs	
	Plastic	72hrs	72hrs	
	Stainless steel	72hrs	48hrs	

Vertical transmission

Author	Number of exposed babies	Number of COVID-19 positive mothers	Number of infected babies	Types of tissues tested by PCR for COVID-19 RNA presence					
				Cord blood	Amniotic fluid	Placenta	Serum	Breast milk	Vaginal secretions
Alzamora, 2020[5]	1	1	1[i]	NR	NR	NR	NR	NR	NR
Chen, 2020[10]	9	9	0	0/6	0/6	NR	NR	0/6	NR
Chen, 2020c[12]	5	5	0	NR	NR	NR	NR	NR	NR
Chen, 2020e[14]	4	4	0	NR	NR	NR	NR	NR	NR
Chen, 2020f[15]	3	3	0	NR	NR	0/3	NR	NR	NR
Dong, 2020[22]	1	1	1[ii]	NR	NR	NR	NR	NR	NR
Fan, 2020b[25]	2	2	0	0/2	0/2	0/2	NR	0/2	0/2
Han, 2020[31]	NR	NR	NR	NR	NR	NR	NR	0/1	NR
Iqbal, 2020[35]	1	1	0	NR	0 (1)	NR	NR	NR	NR
Khan, 2020[39]	17	17	2[iii]	NR	NR	NR	NR	NR	NR
Lee, 2020[42]	4	4	0	0/1	0/1	NR	NR	NR	NR
Li, 2020d[46]	2	3	0	NR	NR	NR	NR	NR	NR
Li, 2020j[52]	1	1	0	NR	NR	NR	NR	NR	NR

Liu, 2020[54]	19	19	0	0/19	0/19	NR	NR	NR	NR
Liu, 2020b[55]	3	3	0	NR	NR	NR	NR	NR	NR
Liu, 2020c[56]	13	14	0	NR	NR	NR	NR	NR	NR
Lowe, 2020[58]	1	1	0[iv]	NR	NR	NR	NR	NR	NR
Penfield, 2020[71]	32	32	0	NR	NR	3/11[ix]	NR	NR	NR
Peng, 2020b[73]	1	1	0	0/1	NR	0/1	0/1	0/1	NR
Pierce-Williams, 2020[75]	64	65	0	NR	NR	NR	NR	NR	NR
Wang, 2020b[94]	1	1	1[v]	0/1	NR	NR	NR	NR	NR
Wang, 2020e[97]	1	1	0	0/1	0/1	0/1	NR	NR	NR
Yan, 2020[113]	86	86	0	0/10	0/10	NR	NR	NR	0/6
Yang, 2020[114]	NR	20	0	NR	NR	NR	NR	NR	NR
Yang, 2020b[115]	6	6	0	0/4	0/4	NR	NR	NR	NR
Yu, 2020[117]	7	7	1[vi]	0/1	NR	0/1	NR	NR	NR
Zambrano, 2020[119]	1	1	0	NR	NR	NR	NR	NR	NR
Zeng, 2020[120]	6	6	2[vii]	NR	NR	NR	NR	NR	NR
Zeng, 2020[121]	33	33	3[viii]	0/NR	0/NR	0/NR	NR	NR	NR

Zhang, 2020c[124]	10	10	0	NR	NR	NR	NR	NR	NR
Zhu, 2020[133]	10	10	0	NR	NR	NR	NR	NR	NR
Vivanti, 2020[136]	1	1	1	NR	1/1	1/1	NR	NR	NR
Total:	**365**	**368**	**12**	**0/46**	**1/45**	**4/20**	**0/1**	**0/10**	**0/8**
No of studies	**32**	**32**	**32**	**10**	**9**	**7**	**1**	**4**	**2**

i – baby separated from mother at birth, chest x-ray normal at this time, not tested at birth but +ve 16hrs later; ii – no tissues tested, but at 2hrs post-delivery SARS-CoV-2 antibodies were present in neonate, suggesting in utero exposure, neonate tested negative; iii – suspected vertical transmission, but authors stated that no convincing evidence of vertical transmission was found; iv – baby breastfed from the start, parents using contact precautions; v – baby tested +ve 36hrs after birth, no testing done at birth; vi - tested +ve after 36hrs, placenta and cord blood -ve, authors suggest no vertical infection; vii - two infants had elevated antibodies, but tested -ve for COVID-19; viii - 3 babies developed COVID-19: 2 of three within 2 days, the third baby septic and born w/ foetal distress but also infected Enterobacter, tested +ve for COVID-19 later. No babies were tested for COVID at birth and no samples blood cord, placenta and amniotic fluid +ve. Authors concluded vertical transmission cannot be ruled out; ix – authors suggested intrapartum exposure, although they also asserted that due to the mixing fluids and tissues during the delivery, contamination of placenta from maternal sources is also possible.

Transmission from infected body fluids – faecal matter

Author, Year	Sample	Outcome measure	No of samples	No of PCR +ve samples	No of samples viable in culture	No of documented transmissions	Reviewer's comments
Anal swab							
No of individuals							
Cui, 2020[21]	Anal swab	No of positive individuals	35	1	NR	NR	
Fan, 2020b[25]	Anal swab	No of positive individuals	1	1	NR	NR	Up to D28
Jiang, 2020[36]	Anal swab	No of positive individuals	1	1	NR	NR	Persistently +ve
Li, 2020c[45]	Anal swab	No of positive individuals	1	1	NR	NR	
Peng, 2020[72]	Anal swab	No of positive individuals	7	2	NR	NR	
Tan, 2020[88]	Anal swab	No of positive individuals	1	1	NR	NR	Up to D23
Xu, 2020[112]	Anal swab	No of positive individuals	10	8	NR	NR	Up to 1 month
Zhang, 2020e[126]	Anal swab	No of positive individuals	16	10	NR	NR	4/16 +ve on day 0, 6/16 +ve on day 5
Total:			**72**	**25 (35%)**	**NR**	**NR**	
No of samples							
Wu, 2020[101]	Anal swab	No of positive samples	120	12	NR	NR	clearance in digestive tract occurs after the OP swabs -ve
Total:			**120**	**12 (10%)**	**NR**	**NR**	
Stool							
No of individuals							

Chen, 2020f[15]	Stool	No of positive individuals	42	28	NR	NR	
Han, 2020[31]	Stool	No of positive individuals	2	2	NR	NR	
Jiehao, 2020[38]	Stool	No of positive individuals	6	5	NR	NR	
Li, 2020h[50]	Stool	No of positive individuals	13	2	NR	NR	Up to 15 days after discharge
Ling, 2020[53]	Stool	No of positive individuals	66	11	NR	NR	Convalescent patients
Pan, 2020[68]	Stool	No of positive individuals	2	0	NR	NR	
Park, 2020[69]	Stool	No of positive individuals	1	1	NR	NR	1 child known COVID-19 +ve, stool positive until D17, after symptoms resolved
Tan, 2020b[89]	Stool	No of positive individuals	10	3	NR	NR	From D16 onwards
Tang, 2020[90]	Stool	No of positive individuals	1	1	NR	NR	Multiple exposures, stool +ve 17-24 days after exposure, otherwise asymptomatic
To, 2020[91]	Stool	No of positive individuals	15	4	NR	NR	
Wang, 2020c[95]	Stool	No of positive individuals	17	11	NR	NR	Up to 40 days
Wu, 2020d[104]	Stool	No of positive individuals	74	41	NR	NR	Samples +ve up to mean 28d after symptom onset, max 47d
Xiao, 2020[108]	Stool	No of positive individuals	73	39	NR	NR	39/73 patients had +ve stool samples for up to 12d, persisted after respiratory samples -ve
Xing, 2020[111]	Stool	No of positive individuals	3	3	NR	NR	Up to 20d after NP samples _ve
Zhang, 2020[122]	Stool	No of positive individuals	14	5	NR	NR	Delay of few days after OP samples +ve
Zhang, 2020d[125]	Stool	No of positive individuals	3	3	NR	NR	OP swabs -ve but anal swabs +ve from day 10 onwards

Zhang, 2020i[130]	Stool	No of positive individuals	1	1	NR	NR	
Zheng, 2020[131]	Stool	No of positive individuals	96	55	NR	NR	Low at the onset and increasingly more prevalent up to 3 weeks from the onset
Total:			**439**	**215 (49%)**	**NR**	**NR**	
No of samples							
Wang, 2020d[96]	Stool	No of positive samples	153	44	2/4	NR	Multiple samples from patients, first +ve faecal sample on D7
Wu, 2020[101]	Stool	No of positive samples	244	24	NR	NR	clearance in digestive tract occurs after the OP swabs -ve
Zhang, 2020h[129]	Stool	No of positive samples	NR	NR	1/1	NR	Culturable virus isolated
Total:			**397**	**68 (17%)**	**3/5 (60%)**	**NR**	
Sewage							
Ahmed, 2020[3]	Sewage	No of positive samples	9	2	0/2	NR	A different assay used returned no positive samples
Medema, 2020[62]	Sewage	No of positive samples	18	15	NR	NR	Results in table 3: samples collected in Feb were before epidemic and were all -ve. Once the epidemic started 15/18 were +ve by at least one of four probes
Wang, 2020[93]	Sewage	No of positive samples	5	4	0/4	NR	PCR +ve but not viable in culture
Wurtzer, 2020[105]	Sewage – untreated	No of positive samples	23	23	NR	NR	
	Sewage – treated		8	6	NR	NR	
Total:			**65**	**50 (77%)**	**0/6**	**NR**	

Transmission from infected body fluids – ocular tissues and secretions

Author, Year	Sample	Outcome measure	No of samples	No of PCR +ve samples	No of samples viable in culture	No of documented transmissions	Reviewer's comments
Tears							
Seah, 2020[85]	Tears	No of people with positive samples	17	0	-	-	0/64 samples -ve, no patients had ocular symptoms
Xie, 2020[110]	Tears	No of people with positive samples	33	2	NR	NR	Authors speculated that low number of cases was due to most samples taken >week after symptoms started. The positive samples were collected 4 and 5 days after symptoms
Total:			**50**	**2 (4%)**			
Ocular discharge							
Zhang, 2020f[127]	Ocular discharge	No of people with positive samples	72	1	NR	NR	
Total:			**72**	**1 (1.4%)**			
Conjunctival swab							
Chen, 2020b[11]	Conjunctival swab	No of people with positive samples	1	1	NR	NR	
Sun, 2020b[87]	Conjunctival swab	No of people with positive samples	72	1	NR	NR	2/72 had conjunctivitis, 1 of 2 tested +ve, mean day eyes tested 18D
Wu, 2020b[102]	Conjunctival swab	No of people with positive samples	28	2	NR	NR	12/28 had ocular symptoms

Xia, 2020[105]	Conjunctival swab	No of people with positive samples	30	1	NR	NR	Average time from symptom to swab taken approx. 7 days
Zhou, 2020[132]	Conjunctival swab	No of people with positive samples	63	3			2/3 probable and one definite. None of 3 patients displayed ocular symptoms. 1/63 patients had ocular symptoms but tested -ve
Total:			**194**	**8 (4%)**			
Ocular swab							
Colavita, 2020[20]	Ocular swab	No of people with positive samples	1	1	NR	NR	
Total:			**1**	**1 (100%)**			

Evidence for virus entering via ocular surface

Author	Outcome measure	No exposed	No infected	Comments
Li, 2020g[49]	No of positive individuals	2	2	Two case studies: 1) anaesthetist tended to undiagnosed COVID-19 patient with routine PPE (no goggles), developed conjunctivitis on D3 and developed pneumonia days later; 2) nurse from fever clinic developed conjunctivitis and later developed pneumonia Both suspected transmission via conjunctiva, subsequently infecting respiratory tract via nasolacrimal duct system
Zhang, 2020f[127]	No of positive individuals	1	1	Occupational transmission, nurse reported wearing respirator at all times but sometimes without goggles and touching her eyes. Developed conjunctivitis (+ve for COVID) and later developed pneumonia. Not possible to determine the source of virus

Transmission from infected body fluids – sexual body fluids

Author, Year	Sample	Outcome measure	No of samples	No of PCR +ve samples	No of samples viable in culture	No of documented transmissions	Reviewer's comments
Semen							
Li, 2020b[44]	Semen	No of positive samples	38	6	NR	NR	NR
Vaginal							
Cui, 2020[21]	Vaginal swab	No of positive samples	35	0	NR	NR	NR
Qiu, 2020b[79]	Vaginal fluid	No of positive samples	10	0	NR	NR	NR

Transmission from infected body fluids – urine

Author, Year	Sample	Outcome measure	No of samples	No of PCR +ve samples	No of samples viable in culture	No of documented transmissions	Reviewer's comments
No of positive individuals							
Han, 2020[31]	Urine	No of positive individuals	2	1	NR	NR	
Jiehao, 2020[38]	Urine	No of positive individuals	2	0	n/a	n/a	
Ling, 2020[53]	Urine	No of positive individuals	58	4	NR	NR	
Pan, 2020[68]	Urine	No of positive individuals	2	0	n/a	n/a	
Peng, 2020[72]	Urine	No of positive individuals	7	1	NR	NR	
To, 2020[91]	Urine	No of positive individuals	10	0	n/a	n/a	
Zhang, 2020i[130]	Urine	No of positive individuals	1	0	NR	NR	
Zheng, 2020[131]	Urine	No of positive individuals	67	1	NR	NR	
Sun, 2020[135]	Urine	No of positive individuals	1	1	1	NR	
Total:			**150**	**8**	**1**	**NR**	
No of positive samples							
Chen, 2020f[15]	Urine	No of positive samples	10	0	n/a	n/a	
Wang, 2020d[96]	Urine	No of positive samples	72	0	n/a	NR	
Total:			**82**	**0**	**NR**	**NR**	

Blood transfusion and organ transplantation

Author	Outcome measure	No exposed	No infected	Comments
Blood transfusion				
Cho, 2020[137]	Number of cases	1	0	Donor pre-symptomatic at the time of donation, subsequently diagnosed with COVID-19 five days later
Essa, 2020[138]	Number of cases	1	0	Donor tested positive 5 days after donation, recipient (immunocompromised) had minor symptoms a day after transfusion, but these were not necessarily the result of infection. All lab tests came back with no evidence of SARS-CoV-2 acquisition.
Liapis, 2020[139]	Number of cases	2	0	Donor symptomatic and tested +ve 2 days after donation, two recipients (one older person) received blood products both with no evidence of infection
Politis, 2020[140]	Number of cases	1	0	Donor asymptomatic, tested +ve later as a part of screening strategy, blood transfused to an immunocompromised patient, recipient -ve and no evidence of antibodies later
Organ transplantation				
No studies				

Dynamics of SARS-CoV-2 transmission

Author, year	Index case(s)	Type of exposure	Number exposed	Number infected	Subsequent cases*	Comments
Bai, 2020[6]	1 family member traveling from Wuhan	Family gatherings	5	5	NR	One apparently asymptomatic patient met up with family to visit someone in hospital. No cases of COVID in the area then
Burke, 2020[7]	10 patients w/ travel history	Household	19	2	0	
		Community	104	0	n/a	Defined as at least 10min contact at 6 feet or less

		Healthcare	100	0	n/a	defined as at least 10min contact at 6 feet or less in the shared room or up 2 two hrs in the same airspace (e.g. examination room after COVID patient was seen)
		Healthcare workers	222	0	n/a	Anyone who came to contact with patient or their infectious material
Cheng, 2020[16]	100 COVID +ve patients	Household	151	10	NR	
		Family gatherings	76	5	NR	
		Healthcare	698	6	NR	
		Other	1836	1	NR	
Dong, 2020b[23]	Multiple index cases	Exposure from family	NR	59	NR	A total of 101 cases with no exposure to Wuhan or other endemic areas, infected locally. Cases stratified into the type of exposure.
		Exposure in public places	NR	28	NR	
		Exposure at work	NR	12	NR	
		Exposure not identified	NR	2	NR	
Gan, 2020[27]	NR	Household	NR	914	NR	Not possible to determine index cases and no of exposed individuals. This is a breakdown of 1052 cases where it was possible to determine their source of infection.
		Family gatherings		12		
		Public transport		7		
		Other gatherings		6		
		Public spaces		5		
		Work		2		
Ghinai, 2020[28]	1 returning from China	Household	1	1	0	Community and healthcare contacts were those of the wife or the husband she infected
		Community	152	0	n/a	
		Healthcare	195	0	n/a	
Han, 2020[31]	1 family member	Household	6	4	NR	One family member infected others, not possible to determine who was the index case and where the infection came from

Heinzerling, 2020[32]	1 undiagnosed patient	Healthcare	121	3	NR	Patient not suspected of COVID, managed with standard precautions, underwent multiple AGPs. Those infected spent more time w/ patient, performed physical examinations and were present during AGPs
Huang, 2020[33]	1 patient travelling from Wuhan	Family gathering	7	1	NR	One who got sick stayed with index patient for approx. 30 min; in a poorly ventilated room with doors and windows closed
		Gatherings with friends	15	6	NR	Those who got sick were sitting in a direct flow of the air conditioning in the restaurant where they had dinner
Huang, 2020b[34]	1 family member, returning from Wuhan	Household	2	2	n/a	Three cases infected at dinner transmitted the virus to one household member and 3 relatives at another family dinner
		Family gatherings	8	3	4	
Jiang, 2020b[37]	2 patients travelling from Wuhan	Household	4	2	4	The infected household contacts further infected 2 family members from another household 2/4 and one member of the third household (who went on and infected 1 of 4 of his household)
Kong, 2020[40]	16 patients	Household or family gathering	NR	7	NR	Not possible to determine the exact number of household and family contacts
		Gathering with friends	NR	3	NR	
Le, 2020[41]	1 patient in contact w/ Wuhan	Household	6	1	NR	One grandmother living with husband and two children, infected neonate who stayed with them for few days, parents of the neonate not infected
Li, 2020[44]	1 patient changing trains at Wuhan station	Family gatherings	2	2	NR	One patient travelled via Wuhan station where he most likely was infected. He infected his two daughters, a son-in-law he was caring for in hospital and the neighbouring patient. The neighbouring patient infected
		Caring for family in hospital	1	1	0	
		Neighbouring patient	1	1	1	
Li, 2020e[47]	1 patient	Household	5	4	NR	index patient travelled to his home where he infected 4/5 household members
Li, 2020f[48]	105 patients	Household	392	64	NR	Other exposure routes not explored
Liu, 2020[54]	Wife returning from Wuhan	Household	1	1	0	

Luo, 2020[60]	1 patient returning from Wuhan	Public bath	NR	8	NR	Index patient showered in a public bath centre (already symptomatic w/ cough), patients who were infected visited the centre 1-6 days after the index patient. Authors suggest the survival of virus in hot, humid environments
McMichael, 2020[61]	Not identified	Residents in facility A	Approx. 130 (118 tested)	101		One care home resident found infected, had no travel history or contact w/ known COVID case. By the time COVID suspected, at least 45 staff and residents displayed symptoms. Not possible to determine the index case or who infected whom.
		Staff in facility A	NR	50		
		Visitors to facility A	NR	16		
Ng, 2020[63]	2 patients on a flight from Wuhan to Singapore	Passengers on the flight	92	2	0	Everyone wore masks, one tested positive and one inconclusive (tested +ve for one gene but not another), both on D3
Okada, 2020[65]	2 patients on 2 flights from Wuhan	Travel with the same tour group	34	0	n/a	Index patients not symptomatic at the time of boarding, so no PPE used, flights approx. 4hrs
		Passengers on flight 2 rows before and after	30	0	n/a	
		Crew members	18	0	n/a	
		Airport health officer	2	0	n/a	
Park, 2020b[70]	Not identified	11th floor employees	216	94		Outbreak in a call centre on 11th floor. Commercial/residential building. Commercial: floors 1-11 (call centre with outbreak 7-9 &11), residential floors 12-19. Most of the infected people from the 11th floor were on the same side of the building. 225 household contacts of 97 patients followed up, 34/225 +ve. Residents and employees had frequent contact in the lobby and elevators.
		Employees on other floors	706	3		
		Residents	201	0		
		Visitors	20	0		
Phan, 2020[74]	1 patient returning from Wuhan	Family sharing hotel room	2	1	NR	The family travels to four cities in Vietnam, close contacts were those on a plane, train and taxis
		Close contacts	28	0	n/a	

Pung, 2020[76]	A tour group from China	Shop assistants	17	5	3	At least 5/20 in the tour group symptomatic. Shop assistants reported assisting the tourists, 4/5 applying medicinal oil to their hands (30min visit), 1/5 assisting in a jewellery store (1hr visit).
	17 conference attendees from China	Conference attendees	94	7	13	Internal conference for an international company: 17 attendees were from China and at least 1 from Wuhan – not possible to determine the index case. Close interactions with cases during dining, breakout sessions and team building activities (with physical contact). Other close contacts (e.g. hotel staff) monitored but did not develop symptoms
	Chinese couple from Wuhan attending church	Attended the same church service	140	3	0	Two +ve cases attended the service as the index couple, another +ve case attended the church later but sat in the seat occupied by one of the index cases
Qian, 2020b[77]	2 infected in a temple	Family gatherings	4	3	3	Four cases exposed via family visit later had a family dinner with 3 relatives – all three subsequently infected
Qiu, 2020[78]	29 index cases	household	NR	31	5	Total of 24 clusters. Family gatherings: 2/4 infected family members later infected 2 of their household contacts. Work: infected the colleague who later infected 3 of his household members. Public transport: One of the passengers later transmitted the virus to his sister over dinner
		Family gatherings	NR	4	2	
		Work	NR	1	3	
		Public transport	NR	7	1	
Rothe, 2020[80]	Pre-symptomatic business partner from China	Work	NR	2	2	Pre-symptomatic index case infected two people, two other people had no contact with index, thus infected by the cases
Schwierzeck, 2020[83]	1 index patient	Nosocomial	NR	47		28 HCWs, 12 patients and 7 accompanying persons infected. Type of exposure was either cumulative 15-minutes face-to-face contact without usage of PPE (patients or their carers) or HCWs exposed during treatment or nursing in a distance of ≤ 2 meters, without PPE (HCWs)
Scott, 2020[84]	1 index, returned from Wuhan	Sharing the car to/from work	5	0	n/a	No cases infected despite close contact. Authors concluded it may have been due to mild symptoms (non-productive cough only)
		HCWs	3	0	n/a	
		Household	2	0	n/a	
		Intimate contact	1	0	n/a	
		HCWs, medium risk exposure	5	0	n/a	

Song, 2020[86]	4 index cases with direct or indirect contact with Wuhan	Household	20	19		Not possible to determine if index cases infected others
Wang, 2020f[98]	85 index patients	Household	155	47		85 index patients distributed among 76 households
Wei, 2020[99]	6 index patients (6 clusters)	Singing practice	NR	1	NR	Six clusters, cluster A excluded from data extraction as already included in Pung, 2020. Household included three separate clusters, each with one index and one infected case. In the church cluster, infected cases sat one row behind the index patient
		Household	NR	3	NR	
		Church service	NR	2	NR	
		Gathering with friends	NR	1	NR	
Wei, 2020b[100]	Two surgical patients	Hospital environment	NR	14 some infected via contact with staff, not possible to determine		Staff had either direct or indirect contact with patients, no staff wore PPE as patients were pre-symptomatic and not suspected COVID-19 +ve
Wu, 2020c[103]	Not determined	Department store	NR	25	15	There were 6 employees affected – not possible to determine whether there was only one index case between them. The areas where they worked were on the same floor and close to each other. There were further 19 cases of customers infected. These 25 further infected 15 cases
Xia, 2020b[107]	Index case with travel history to Wuhan	Family gathering	15	7	2	Multiple exposures for the family, having meals together, sometimes staying in the house, one case with whom index had dinner a few times infected 2 of her household members
		Friends gathering	60	0	0	
Xiao, 2020b[109]	2 index cases, infected at the gym	Friends gathering	NR	3		Two cases had multiple exposures at the gym (COVID cases were linked to the gym later), both had contact with one case, and the three of them travelled together to another city. On arrival, one index case had dinner with four friends, 2/4 were later found infected – 3hr exposure with possibilities for transmission via droplets and direct contact when touching each other's hands.
Yong, 2020[116]	2 index cases from Wuhan	1. Church A service	NR	5 (or 4)	0 (or 1)	Five people infected. One case – not possible to determine whether infected from index cases or another infected person. One case responsible for outbreak 2
		2. Family gathering	NR	6	1	One case responsible for infecting their family member and also for starting outbreak 3

		2. Church B service	NR	9	7	Nine cases infected in the church who then infected another 7 cases
Yu, 2020b[118]	2 family members travelled from Wuhan	Family gatherings	2	2	n/a	Two pre-symptomatic patients travelled from Wuhan and stayed with the family,
Zhang, 2020b[123]	Not identified	Supermarket employees	120	11	12	8,437 people screened, 120 employees (full time and temporary), 8,224 customers and 93 close family contacts of the infected cases.
		Customers	8224	2	NR	
Zhang, 2020g[128]	Index patient returning to China	Household	2	1	n/a	One woman returning from Singapore to China found +ve. All close contacts isolated. Passengers included those in the same row or up to 2 rows from patient. Flight attendant served the patient on a plane. Retrospective tracing revealed index had contact with COVID+ve cases in China before traveling to Singapore
		Passengers on a plane	5	0	n/a	
		Flight attendant	1	0	n/a	
	5 Wuhan passengers	Non-Wuhan passengers	220	1	n/a	110 Wuhan passengers travelled together as a part of a tour group to Singapore and Malaysia (10hr + 4 hr flights). 5 were found +ve and probable index cases. The non-Wuhan passenger sat next to infected case on a returning flight.
		Flight attendants	11	0	n/a	
		Wuhan passengers	105	6	NR	

* Defined as those with no exposure to index case, infected from the person infected by index case

Household – living at the same property, family gathering – meeting with other family members, e.g. family meals (in or out), family visits, traveling together

Appendix 7: Excluded studies table

Citation	reason
Abduljalil J.M., Abduljalil B.M. Epidemiology, genome, and clinical features of the pandemic SARS-CoV-2: a recent view. New Microbes New Infect, 2020; 35:no pagination	no primary data
Acuna-Zegarra M.A., Santana-Cibrian M., Velasco-Hernandez J.X. Modeling behavioral change and COVID-19 containment in Mexico: A trade-off between lockdown and compliance. Math Biosci, 2020; 108370.	no primary data
Adekunle I.A., Onanuga A.T., Akinola O.O. et al. Modelling spatial variations of coronavirus disease (COVID-19) in Africa. Sci Total Environ, 2020; 729:no pagination	no primary data
Advani S.D., Smith B.A., Lewis S.S. et al. Universal masking in hospitals in the COVID-19 era: Is it time to consider shielding? Infect Control Hosp Epidemiol, 2020; 1-2	no primary data
Agalar C., Ozturk Engin D. Protective measures for covid-19 for healthcare providers and laboratory personnel. Turk J Med Sci, 2020; 50(SI-1):578-584	no primary data
Ali Y., Alradhawi M., Shubber N. et al. Personal protective equipment in the response to the SARS-CoV-2 outbreak - A letter to the editor on World Health Organization declares global emergency: A review of the 2019 novel coronavirus (COVID-19). Int J Surg, 2020; 76:71-6	no primary data
Amirian E.S. Potential Fecal Transmission of SARS-CoV-2: Current Evidence and Implications for Public Health. Int J Infect Dis, 2020; no pagination	no primary data
Anderson E.L., Turnham P., Griffin J.R. et al. Consideration of the Aerosol Transmission for COVID-19 and Public Health. Risk Anal, 2020; 40(5):902-907	no primary data
Anderson R.M., Heesterbeek H., Klinkenberg D. et al. How will country-based mitigation measures influence the course of the COVID-19 epidemic? Lancet, 2020; 395(10228):931-934	no primary data
Arons M.M., Hatfield K.M., Reddy S.C. et al. Presymptomatic SARS-CoV-2 Infections and Transmission in a Skilled Nursing Facility. N Eng J Med, 2020	no data on transmission
Au Yong P.S., Chen X. Reducing droplet spread during airway manipulation: lessons from the COVID-19 pandemic in Singapore. Brit J Anaesth, 2020; no pagination	no data on transmission
Auler A.C., Cassaro F.A.M., da Silva V.O. et al. Evidence that high temperatures and intermediate relative humidity might favor the spread of COVID-19 in tropical climate: A case study for the most affected Brazilian cities. Sci Total Environ, 2020; 731:139178	no primary data
Azap A., Erdinc F.S. Medical mask or N95 respirator: When and how to use? Turk J Med Sci, 2020; no pagination	no primary data
Baettig S.J., Parini A., Cardona I. et al. Morand GB. Case series of coronavirus (SARS-CoV-2) in a military recruit school: clinical, sanitary and logistical implications. BMJ Mil Health, 2020	no data on transmission
Bahl P., Doolan C., de Silva C. et al. Airborne or droplet precautions for health workers treating COVID-19? J Infect Dis, 2020	no primary data
Balachandar V., Mahalaxmi I., Kaavya J. et al. COVID-19: Emerging protective measures. Eur Rev Med Pharmacol Sci, 2020; 24(6):3422-3425	no primary data
Balachandar V., Mahalaxmi I., Subramaniam M. et al. Follow-up studies in COVID-19 recovered patients - is it mandatory? Sci Total Environ, 2020; 729:139021	no primary data
Banik R.K., Ulrich A.K. Evidence of short-range aerosol transmission of SARS-CoV-2 and call for universal airborne precautions for anesthesiologists during the COVID-19 pandemic. Anesth Analg, 2020	no primary data
Bi Q., Mei S., Ye C. et al. Epidemiology and transmission of COVID-19 in 391 cases and 1286 of their close contacts in Shenzhen, China: a retrospective cohort study. Lancet Infect Dis, 2020; no pagination	no data on transmission
Bonato G., Dioscoridi L., Mutignani M. Faecal-oral transmission of SARS-COV-2: practical implications. Gastroenterology, 2020	no primary data
Britton P.N., Marais B.J. Questions raised by COVID-19 case descriptions. J Paediatr Child Health, 2020; 56(4): 652	no primary data
Briz-Redon A., Serrano-Aroca A. A spatio-temporal analysis for exploring the effect of temperature on COVID-19 early evolution in Spain. Sci Total Environ, 2020; 728:138811	no primary data
Broderick D., Kyzas P., Sanders K. et al. Surgical tracheostomies in Covid-19 patients: important considerations and the "5Ts" of safety. Br J Oral Maxillofac Surg, 2020; 58(5): 585–589	no data on transmission
Brown J, Pope C. Personal protective equipment and possible routes of airborne spread during the COVID-19 pandemic. Anaesthesia, 2020; 75(8):1116-1117.	no primary data
Bulut C, Kato Y. Epidemiology of COVID-19. Turk J Med Sci, 2020; 50(SI-1):563-570	no primary data
Cabrini L., Landoni G., Zangrillo A. Minimise nosocomial spread of 2019-nCoV when treating acute respiratory failure. Lancet, 2020; 395(10225):685	no primary data

Cai S.J., Wu L.L., Chen D.F. et al. Analysis of bronchoscope-guided tracheal intubation in 12 cases with COVID-19 under the personal protective equipment with positive pressure protective hood. Chinese Chin J Tuberc Resp Dis, 2020; 43(0):E033	no data on transmission
Canova V., Lederer Schlapfer H., Piso R.J. et al. Transmission risk of SARS-CoV-2 to healthcare workers - observational results of a primary care hospital contact tracing. Swiss Med Wkly, 2020; 150:w20257	not possible to retrieve
Cao Q., Chen Y.-C., Chen C.-L. SARS-CoV-2 infection in children: Transmission dynamics and clinical characteristics. J Formos Med Assoc, 2020; 119(3):670-673	no primary data
Carducci A., Federigi I., Liu D. et al. Making waves: Coronavirus detection, presence and persistence in the water environment: State of the art and knowledge needs for public health. Water Res, 2020; 179:115907	no primary data
Celik I., Saatci E., Eyuboglu F.O. Emerging and reemerging respiratory viral infections up to covid-19. Turk J Med Sci, 2020; 50(SI-1):557-562	no primary data
Chang D., Lin M., Wei L. et al. Epidemiologic and Clinical Characteristics of Novel Coronavirus Infections Involving 13 Patients Outside Wuhan, China. JAMA, 2020; 323(11):1092-1093	no data on transmission
Chang D., Xu H., Rebaza A. et al. Protecting health-care workers from subclinical coronavirus infection. Lancet Respir Med, 2020; 8(3):e13	no primary data
Chen C, Gao G, Xu Y, et al. SARS-CoV-2-positive sputum and feces after conversion of pharyngeal samples in patients with COVID-19. Ann Intern Med, 2020; M20-0991	no data on transmission
Chen D, Xu W, Lei Z, et al. Recurrence of positive SARS-CoV-2 RNA in COVID-19: a case report. Int J Infect Dis, 2020; 93:297-299	no data on transmission
Chen M.-J., Chang K.-J., Hsu C.-C. et al. Precaution and Prevention of Coronavirus Disease 2019 (COVID-19) Infection in the Eye. J Chin Med Assoc, 2020; no pagination	no primary data
Chen P., Zhang Y., Wen Y. et al. Epidemiological and clinical characteristics of 136 cases of COVID-19 in main district of Chongqing. J Formos Med Assoc, 2020; 119(7):1180-1184	no data on transmission
Chen X., Tian J., Li G. Initiation of a new infection control system for the COVID-19 outbreak. Lancet Infect Dis, 2020; 20(4):397-398	no data on transmission
Chen X., Liu Y., Gong Y. et al. Perioperative Management of Patients Infected with the Novel Coronavirus: Recommendation from the Joint Task Force of the Chinese Society of Anesthesiology and the Chinese Association of Anesthesiologists. Anesthesiology, 2020; 132(6): no pagination	no primary data
Chen Y, Li L. SARS-CoV-2: virus dynamics and host response. Lancet Infect Dis, 2020; 20(5):515-516	no primary data
Cheng V.C.-C., Wong S.-C., Chuang V.W.-M. et al. The role of community-wide wearing of face mask for control of coronavirus disease 2019 (COVID-19) epidemic due to SARS-CoV-2. J Infect, 2020; 81(1):107–114	no data on transmission
Cheung J.C., Ho L.T., Cheng J.V. et al. Staff safety during emergency airway management for COVID-19 in Hong Kong. Lancet Respir Med, 2020; 8(4):e19	no primary data
Choi S.-H., Kim H.W., Kang J.-M. et al. Epidemiology and clinical features of coronavirus disease 2019 in children. Korean J Pediatr, 2020; 63(4):125-132	no primary data
Chou R., Dana T., Buckley D.I. et al. Epidemiology of and Risk Factors for Coronavirus Infection in Health Care Workers: A Living Rapid Review. Ann Intern Med, 2020; 173(2):120-136	no primary data
Chow V.L.Y., Chan J.Y.W., Ho V.W.Y. et al. Tracheostomy during COVID-19 pandemic-Novel approach. Head Neck, 2020; 1-7	no data on transmission
Cook T.M. Personal protective equipment during the coronavirus disease (COVID) 2019 pandemic - a narrative review. Anaesthesia, 2020; 75(7):920-927	no primary data
Cordier P.-Y., De La Villeon B., Martin E. et al. Health workers' safety during tracheostomy in COVID-19 patients: Homemade protective screen. Head Neck, 2020; 42(7):1361-1362	no data on transmission
Corman V.M., Rabenau H.F., Adams O. et al. SARS-CoV-2 asymptomatic and symptomatic patients and risk for transfusion transmission. Transfusion, 2020; 60(6):1119-1122	no primary data
Correia G., Rodrigues L., Gameiro da Silva M. et al. Airborne route and bad use of ventilation systems as non-negligible factors in SARS-CoV-2 transmission. Med Hypotheses, 2020; 141:(no pagination)	no primary data
Couper K., Taylor-Phillips S., Grove A. COVID-19 in cardiac arrest and infection risk to rescuers: A systematic review. Resuscitation, 2020; 151:59-66	no primary data
David A.P., Jiam N.T., Reither J.M. et al. Endoscopic Skull Base and Transoral Surgery During the COVID-19 Pandemic: Minimizing Droplet Spread with a Negative-Pressure Otolaryngology Viral Isolation Drape (NOVID). Head Neck, 2020; 1577-1582	no data on transmission
Day A.T., Sher D.J., Lee R.C. et al. Head and neck oncology during the COVID-19 pandemic: Reconsidering traditional treatment paradigms in light of new surgical and other multilevel risks. Oral Oncology, 2020; 105:104684	no primary data

De Simone B., Chouillard E., Di Saverio S. et al. Emergency surgery during the COVID-19 pandemic: what you need to know for practice. Ann R Coll Surg Engl, 2020; 102(5):323-332	no primary data
Desai A.N., Patel P. Stopping the Spread of COVID-19. JAMA, 2020; 323(15):1516	no primary data
Dexter F., Parra M.C., Brown J.R. et al. Perioperative COVID-19 Defense: An Evidence-Based Approach for Optimization of Infection Control and Operating Room Management. Anesth Analg, 2020;20:10.1213	no primary data
Dexter F., Elhakim M., Loftus R.W. et al. Strategies for daily operating room management of ambulatory surgery centers following resolution of the acute phase of the COVID-19 pandemic. J Clin Anesth, 2020; 64:109854	no primary data
Di Mascio D., Khalil A., Saccone G. et al. Outcome of Coronavirus spectrum infections (SARS, MERS, COVID 1 -19) during pregnancy: a systematic review and meta-analysis. Am J Obstet Gynecol, 2020; 100107	no primary data
Diaz-Quijano F.A., Rodriguez-Morales A.J., Waldman E.A. Translating transmissibility measures into recommendations for coronavirus prevention. Rev Saude Publica, 2020; 54:43	no primary data
Dietz L., Horve P.F., Coil D.A. et al. 2019 Novel coronavirus (CoviD-19) pandemic: Built environment considerations to reduce transmission. mSystems, 2020; 5(2):e00245-20	no primary data
Ding J., Fu H., Liu Y. Prevention and control measures in radiology department for COVID-19. Eur Radiol, 2020; 30(7): 3603–3608	no primary data
Ding S, Liang TJ. Is SARS-CoV-2 Also an Enteric Pathogen with Potential Fecal-Oral Transmission: A COVID-19 Virological and Clinical Review. Gastroenterology, 2020; 159(1):53–61	no primary data
Dona D., Minotti C., Costenaro P. et al. Fecal-oral transmission of sars-cov-2 in children: is it time to change our approach? Pediatr Infect Dis J, 2020; 39(7):e133-e134	no primary data
Dong Y., Mo X., Hu Y. et al. Epidemiology of COVID-19 among children in China. Pediatrics, 2020; 145(4):e20200702	no data on transmission
Duran P., Berman S., Niermeyer S. et al. COVID-19 and newborn health: systematic review. Rev Panam Salud Pública, 2020; 44:e54	no primary data
Eissenberg T., Kanj S.S., Shihadeh A.L. Treat COVID-19 as Though It Is Airborne: It May Be. AANA J, 2020; 88(3):29-30	no primary data
El Kassas M., Al Shafie A., Abdel Hameed A.S. et al. Emergency endoscopic variceal band ligation in a COVID-19 patient presented with hematemesis while on mechanical ventilation. Dig Endosc, 2020; 32(5):812-815	no data on transmission
Elli L., Rimondi A., Scaramella L. et al. Endoscopy during the Covid-19 outbreak: experience and recommendations from a single center in a high-incidence scenario. Dig Liver Dis, 2020; 52(6):606–612	no primary data
Fathizadeh H., Maroufi P., Momen-Heravi M. et al. Protection and disinfection policies against SARS-CoV-2 (COVID-19). Infez Med, 2020; 28(2):185-191	no primary data
Fattorini D, Regoli F. Role of the chronic air pollution levels in the Covid-19 outbreak risk in Italy. Environ Pollut, 2020; 264:114732	no data on transmission
Ferioli M., Cisternino C., Leo V. et al. Protecting healthcare workers from sars-cov-2 infection: Practical indications. Eur Respir J, 2020; 29(155):1-10	no primary data
Fiorillo L., Cervino G., Matarese M. et al. COVID-19 surface persistence: A recent data summary and its importance for medical and dental settings. Int J Environ Res Public Health, 2020; 17(9):3132	no primary data
Firstenberg M.S., Libby M., Ochs M. et al. et al. Isolation protocol for a COVID-2019 patient requiring emergent surgical intervention: case presentation. Patient Saf Surg, 2020; 14:15	no data on transmission
Francom C.R., Javia L.R., Wolter N.E. et al. Pediatric laryngoscopy and bronchoscopy during the COVID-19 pandemic: A four-center collaborative protocol to improve safety with perioperative management strategies and creation of a surgical tent with disposable drapes. Int J Pediatr Otorhinolaryngol, 2020; 134:110059	no primary data
Fusco P., Petroni G.M., Di Carlo S. et al. Use of a modified system for manual ventilation of the patient for in-hospital and extra hospital transport to avoid aerosolizing spread of droplets during covid-19 outbreak. Anesth Analg, 2020; 4:10.1213	no data on transmission
Galbadage T., Peterson B.M., Gunasekera R.S. Does COVID-19 Spread Through Droplets Alone? Front Public Health, 2020; 8:163	no primary data
Gandhi M., Havlir D. The time for universal masking of the public for coronavirus disease 2019 is now. Open Forum Infect Dis, 2020;7 (4):ofaa131.	no primary data
Gatto M., Bertuzzo E., Mari L. et al. Spread and dynamics of the COVID-19 epidemic in Italy: Effects of emergency containment measures. PNAS, 2020; 117(19):10484-10491	no primary data
Ge Z.-Y., Yang L.-M., Xia J.-J. et al. Possible aerosol transmission of COVID-19 and special precautions in dentistry. J Zhejiang Univ Sci B, 2020; 21(5): 361–368	no primary data
Georgiades F., Summers D.M., Butler A.J. et al. Renal transplantation during the SARS-CoV-2 pandemic in the UK: experience from a large volume centre. Clin Transplant, 2020; e14150	Compares outcome pre

	and post-COVID-19
Giordano G., Blanchini F., Bruno R. et al. Modelling the COVID-19 epidemic and implementation of population-wide interventions in Italy. Nat Med, 2020; 26(6):1-6	no primary data
Givi B., Schiff B.A., Chinn S.B. et al. Safety Recommendations for Evaluation and Surgery of the Head and Neck during the COVID-19 Pandemic. JAMA Otolaryngol Head Neck Surg, 2020; 146(6):579-584	no primary data
Giwa A.L, Desai A., Duca A. Novel 2019 coronavirus SARS-CoV-2 (COVID-19): An updated overview for emergency clinicians. Emerg Med Pract, 2020; 22(5):1-28	no primary data
Goh G.K., Dunker A.K., Foster J.A. et al. Shell disorder analysis predicts greater resilience of the SARS-CoV-2 (COVID-19) outside the body and in body fluids. Microb Pathog, 2020; 144:104177	no primary data
Goldman R.A., Swendseid B., Chan J.Y.K. et al. Tracheostomy Management during the COVID-19 Pandemic. Otolaryngol Head Neck Surg, 2020;163(1):67-69	no primary data
Goldust M., Abdelmaksoud A., Navarini A.A. Hand disinfection in the combat against Covid-19. J Eur Acad Dermatol Venereol, 2020; 10.1111	no primary data
Gormley M., Aspray T.J., Kelly D.A. COVID-19: mitigating transmission via wastewater plumbing systems. Lancet Glob Health, 2020; 8(5):e643	no primary data
Gu J., Han B., Wang J. COVID-19: Gastrointestinal Manifestations and Potential Fecal-Oral Transmission. Gastroenterology, 2020; 158(6):1518-1519	no primary data
Guan L., Zhou L., Zhang J. et al. More awareness is needed for severe acute respiratory syndrome coronavirus 2019 transmission through exhaled air during non-invasive respiratory support: Experience from China. Eur Respir J, 2020; 55(3):no pagination	no primary data
Guo D., Xia J., Shen Y. et al. SARS-CoV-2 may be related to conjunctivitis but not necessarily spread through the conjunctiva SARS-CoV-2 and conjunctiva. J Med Virol, 2020; 10;10.1002	no primary data
Guo Y.-R., Cao Q.-D., Hong Z.-S. et al. The origin, transmission and clinical therapies on coronavirus disease 2019 (COVID-19) outbreak- An update on the status. Mil Med Res, 2020; 7(1):11	no primary data
Guo Y., Huang Y.M., Huang J. et al. Global Health Governance Working Group for COVID-19 Outbreak, Institute for Global Health and School of Public Health. COVID-19 Pandemic: global epidemiological trends and China's subsequent preparedness and responses. Chin J Epidemiol, 2020; 41(5):643-648	no primary data
Gupta M.K., Lipner S.R. Personal Protective Equipment Recommendations Based on COVID-19 Route of Transmission. J Am Acad Dermatol, 2020; 83(1):e45–e46	no primary data
Haines S., Caccamo A., Chan F. et al. Practical Considerations When Performing Neurodiagnostic Studies on Patients with COVID-19 and Other Highly Virulent Diseases. Neurodiagn J, 2020; 1–18	no data on transmission
Ham S. Prevention of exposure and dispersion of COVID-19 using air purifiers: challenges and concerns. Epidemiol Health, 2020; 42:e202002	no primary data
Han Y., Yang H. The transmission and diagnosis of 2019 novel coronavirus infection disease (COVID-19): A Chinese perspective. J Med Virol, 2020; 92(6):pp 639-644	no primary data
Hara T., Yamamoto C., Sawada R. et al. Infection risk in a gastroenterological ward during a nosocomial COVID-19 infection event. J Med Virol, 2020; 10.1002	no data on transmission
He D., Zhao S., Lin Q. et al. The relative transmissibility of asymptomatic COVID-19 infections among close contacts. International J Infect Dis, 2020; 94:145-147	no primary data
He X., Lau E.H.Y., Wu P., et al. Temporal dynamics in viral shedding and transmissibility of COVID-19. Nat Med, 2020; 26:672–675	no primary data
He Y., Wang Z., Li F. et al. Public health might be endangered by possible prolonged discharge of SARS-CoV-2 in stool. J Infect, 2020; 80(5):e18-e19.	no primary data
He Y., Zheng C. Replication and transmission mechanisms of highly pathogenic human coronaviruses. J Zhejiang Univ Med Sci, 2020; 49(1)	no primary data
Heffernan D.S., Evans H.L., Huston J.M. et al. Surgical Infection Society Guidance for Operative and Peri-Operative Care of Adult Patients Infected by the Severe Acute Respiratory Syndrome Coronavirus-2 (SARS-CoV-2). Surg Infect, 2020; 21(4):301-308	no primary data
Heller L., Mota C.R., Greco D.B. COVID-19 faecal-oral transmission: Are we asking the right questions? Sci Total Environ, 2020; 729:138919	no primary data
Hellewell J., Abbott S., Gimma A. et al. Feasibility of controlling COVID-19 outbreaks by isolation of cases and contacts. Lancet Glob Health, 2020; 8(4):e488-e496	no primary data
Helmy Y.A., Fawzy M., Elaswad A. et al. The COVID-19 pandemic: A comprehensive review of taxonomy, genetics, epidemiology, diagnosis, treatment, and control. J Clin Med, 2020; 9(4):no pagination	no primary data

Hindson J. COVID-19: faecal-oral transmission? Nat Rev Gastroenterol Hepatol, 2020; 17(5):259	no primary data
Hirschmann M.T., Hart A., Henckel J. et al. COVID-19 coronavirus: recommended personal protective equipment for the orthopaedic and trauma surgeon. Knee Surg Sports Traumatol Arthrosc, 2020; 28(6):1690-1698	no primary data
Hodcroft EB. Preliminary case report on the SARS-CoV-2 cluster in the UK, France, and Spain. Swiss Med Wkly, 2020; 150(9-10):no pagination	not possible to retrieve
Holshue M.L., DeBolt C., Lindquist S. et al. First case of 2019 novel coronavirus in the United States. N Eng J Med. 382(10):929-936	no data on transmission
Hsih W.-H., Cheng M.-Y., Ho M.-W. et al. Featuring COVID-19 cases via screening symptomatic patients with epidemiologic link during flu season in a medical center of central Taiwan. J Microbiol Immunol Infect, 2020; 53(3):459–466	no data on transmission
Hu Z., Song C., Xu C. et al. Clinical characteristics of 24 asymptomatic infections with COVID-19 screened among close contacts in Nanjing, China. Sci China Life Sci, 2020; 63(5):706-711	no data on transmission
Huang J., Hu Y., Wang J. et al. Recommendation about the perioperative prevention of infection to healthcare workers and the anesthesia management of children with SARS-CoV-2 infection. WJPS, 2020; 3(1):e000126	no primary data
Huang X., Wei F., Hu L. et al. Epidemiology and Clinical Characteristics of COVID-19. Arch Iran Med, 2020;. 23(4):268-271	no primary data
Ierardi A.M., Wood B.J., Gaudino C. et al. How to Handle a COVID-19 Patient in the Angiographic Suite. Cardiovasc Intervent Radiol, 2020; 1–7	no primary data
Jia J., Hu X., Yang F. et al. Epidemiological Characteristics on the Clustering Nature of COVID-19 in Qingdao City, 2020: A Descriptive Analysis. Disaster Med Public Health Prep, 2020; 1–5	no data on transmission
Jin Y., Yang H., Ji W. et al. Virology, epidemiology, pathogenesis, and control of covid-19. Viruses, 2020; 12(4):372	no primary data
Jin, X., Lian, J.S., Hu, J.H. et al. Epidemiological, clinical and virological characteristics of 74 cases of coronavirus-infected disease 2019 (COVID-19) with gastrointestinal symptoms. Gut, 2020; 69(6):1002-1009	no data on transmission
Jung F., Krieger V., Hufert F.T. et al. How we should respond to the Coronavirus SARS-CoV-2 outbreak: A German perspective. Clin Hemorheol Microcirc. 2020; 74(4): 363–372	no primary data
Kabesch M., Roth S., Brandstetter S. et al. Successful containment of COVID-19 outbreak in a large maternity and perinatal center while continuing clinical service. Pediatr Allergy Immunol, 2020; 31(5):560-564	no data on transmission
Kampf G. Potential role of inanimate surfaces for the spread of coronaviruses and their inactivation with disinfectant agents. IPIP, 2020; 2(2):100044.	no primary data
Kampf G., Todt D., Pfaender S. et al. Persistence of coronaviruses on inanimate surfaces and their inactivation with biocidal agents. J Hosp Infect, 2020; 104(3)246-251	no primary data
Kang Y., Xu S. Comprehensive overview of COVID-19 based on current evidence. Dermatol Ther, 2020; e13525	no primary data
Katz L.M. Is SARS-CoV-2 transfusion transmitted? Transfusion, 2020; 60(6):1111-1114.	no primary data
Kaul D. An overview of coronaviruses including the SARS-2 coronavirus - Molecular biology, epidemiology and clinical implications. Curr Med Res Pract, 2020; 10(2):54-64	no primary data
Khajji B., Kada D., Balatif O. et al. A multi-region discrete time mathematical modeling of the dynamics of Covid-19 virus propagation using optimal control. J Appl Math Comput, 2020; 1-27	no primary data
Khan M.M., Parab S.R. Safety Guidelines for Sterility of Face Shields During COVID 19 Pandemic. Indian J Otolaryngol Head Neck Surg, 2020; 1–2.	no primary data
Killerby M.E., Biggs H.M., Midgley C.M. et al. Middle East Respiratory Syndrome Coronavirus Transmission. Emerg Infect Dis, 2020; 26(2):191-198	not COVID-19
Kim G.U., Kim M.J., Ra S.H. et al. Clinical characteristics of asymptomatic and symptomatic patients with mild COVID-19. Clin Microbiol Infect, 2020; 26(7):948.e1-948.e3	no data on transmission
Kimball A., Hatfield K.M., Arons M. et al. Asymptomatic and Presymptomatic SARS-CoV-2 Infections in Residents of a Long-Term Care Skilled Nursing Facility - King County, Washington, March 2020. MMWR, 2020;69(13):377-381	no data on transmission
Kiykac Altinbas S., Tapisiz O.L., Ustun Y. Gynecological laparoscopic surgery in the shade of COVID-19 pandemic. Turk J Med Sci, 2020; 30;50(4):659-663	no primary data
Koenig K.L., Bey C.K., McDonald E.C. 2019-nCoV: The Identify-Isolate-Inform (3I) Tool Applied to novel Emerging Coronavirus. West J Emerg Med, 2020; 21(2):184-190	no primary data
Kowalski L.P., Sanabria A., Ridge J.A. et al. COVID-19 pandemic: Effects and evidence-based recommendations for otolaryngology and head and neck surgery practice. Head Neck, 2020; 42(6):1259-1267	no primary data
La Rosa G., Bonadonna L., Lucentini L. et al. Coronavirus in water environments: Occurrence, persistence and concentration methods - A scoping review. Water Res, 2020; 179:115899	no primary data

Lai T.H.T., Tang E.W.H., Fung K.S.C. et al. Reply to "Does hand hygiene reduce SARS-CoV-2 transmission?". Graefes Arch Clin Exp Ophthalmol, 2020; 258(5):1135	no primary data
Lamouroux A., Attie-Bitach T., Martinovic J. et al. Evidence for and against vertical transmission for SARS-CoV-2 (COVID-19). Am J Obstet Gynecol, 2020; 223(1): 91.e1–91.e4	no primary data
Lan L., Xu D., Ye G. et al. Positive RT-PCR Test Results in Patients Recovered from COVID-19. JAMA, 2020; 323(15):1502-1503	no data on transmission
Lance C.G. PAP therapy increases the risk of transmission of COVID-19. Cleve Clin J Med, 2020; in press	no primary data
Lee H., Heo J.W., Kim S.W. et al. Lesson from Temporary Closing of a Single University-affiliated Hospital owing to In-Hospital Transmission of Coronavirus Disease 2019. J Korean Med Sci, 2020; 35(13):e145.	no data on transmission
Lee-Archer P., von Ungern-Sternberg B.S. Pediatric anesthetic implications of COVID-19-A review of current literature. Paediatr Anaesth, 2020; 10.1111	no primary data
Leung K., Wu J.T., Liu D. et al. First-wave COVID-19 transmissibility and severity in China outside Hubei after control measures, and second-wave scenario planning: a modelling impact assessment. Lancet, 2020; 395(10233):1382-1393	no primary data
Li L.Y., Wu W., Chen S. et al. Digestive system involvement of novel coronavirus infection: prevention and control infection from a gastroenterology perspective. J Dig Dis, 2020; 21(4):199-204	no primary data
Li R.-L., Chu S.-G., Luo Y. et al. Atypical presentation of SARS-CoV-2 infection: A case report. World J Clin Cases, 2020; 8(7):1265-1270	no data on transmission
Li X., Wang X., Liu J. et al. Epidemiological characteristics of confirmed COVID-19 in Guizhou province, China. Disaster Med Public Health Prep, 2020; 1-19	no data on transmission
Li Y., Ren B., Peng X. et al. Saliva is a non-negligible factor in the spread of COVID-19. Mol Oral Microbiol, 2020; 35(4):141-145	no primary data
Lieberman J.A., Mays J.A., Wells C. Expedited SARS-CoV-2 screening of donors and recipients supports continued solid organ transplantation. Am J Transplant, 2020; 20(11):3106-3112	Donors not +ve at donation
Lillie P.J., Samson A., Li A. et al. Novel coronavirus disease (Covid-19): The first two patients in the UK with person to person transmission. J Infect, 2020; 80(5):578-606	no data on transmission
Liu D., Li L., Wu X., et al. Pregnancy and perinatal outcomes of women with COVID-19 pneumonia: a preliminary analysis. Am J Roentgenol, 2020; 215(1):127-132	no data on transmission
Liu Y., Eggo R.M., Kucharski A.J. Secondary attack rate and superspreading events for SARS-CoV-2. Lancet, 2020; 395(10227):e47	no primary data
Liu Z., Sun C.-B. Conjunctiva is not a preferred gateway of entry for SARS-CoV-2 to infect respiratory tract. J Med Virol, 2020; 10:10.1002	no primary data
Liu, M., He, P., Liu, H. et al. Clinical characteristics of 30 medical workers infected with new coronavirus pneumonia. Chin J Tuberc Respir Dis, 2020; 43:E016.	no data on transmission
Lu C.-W., Liu X.-F., Jia Z.-F. 2019-nCoV transmission through the ocular surface must not be ignored. Lancet, 2020; 395(10224):e39	no primary data
Lu D., Wang H., Yu R. et al. Integrated infection control strategy to minimize nosocomial infection of coronavirus disease 2019 among ENT healthcare workers. J Hosp Infect, 2020; 104(4):454-455	no data on transmission
Luan R.-S., Wang X., Sun X. et al. Epidemiology, Treatment, and Epidemic Prevention and Control of the Coronavirus Disease 2019: a Review. J Sichuan Univer Med Sci, 2020; 51(2):31-138	no primary data
Lucchini A., Giani M., Isgro S. et al. The "helmet bundle" in COVID-19 patients undergoing non invasive ventilation. Intensive Crit Care Nurs, 2020; 58:102859	no primary data
Lynch R.M., Goring R. Practical Steps to Improve Air Flow in Long-Term Care Resident Rooms to Reduce COVID-19 Infection Risk. J Am Med Dir Assoc, 2020; 21(7):893-894	no primary data
Ma Q.-X., Shan H., Zhang H.-L. et al. Potential utilities of mask-wearing and instant hand hygiene for fighting SARS-CoV-2. J Med Virol, 2020; 10.1002	no primary data
Malik J.S., Jenner C., Ward P.A. Maximising application of the Aerosol Box in protecting healthcare workers during the covid-19 pandemic. Anaesthesia, 2020; 75(7):974-975	no data on transmission
Mao, Y. et al. Epidemiological and clinical characteristics of SARS-CoV-2 and SARS-CoV: a system review. medRxiv preprint, 2020	no primary data
Marcel S., Christian A.L., Richard N. et al. COVID-19 epidemic in Switzerland: On the importance of testing, contact tracing and isolation. Swiss Med Wkly, 2020; 150(11-12):e20225	no primary data
Marchese M., Capannolo A., Lombardi L. et al. Use of a modified ventilation mask to avoid aerosolizing spread of droplets for short endoscopic procedures during coronavirus COVID-19 outbreak. Gastrointest Endosc, 2020; 92(2): 439–440	no data on transmission

Matrajt L., Leung T. Evaluating the Effectiveness of Social Distancing Interventions to Delay or Flatten the Epidemic Curve of Coronavirus Disease. Emerg Infect Dis, 2020; 26(8)	no primary data
McCloskey B., Zumla A., Ippolito G. et al. Mass gathering events and reducing further global spread of COVID-19: a political and public health dilemma. Lancet, 2020; 395(10230):1096-1099	no primary data
McDermott C.V., Alicic R.Z., Harden N. et al. Put a lid on it: Are faecal bio-aerosols a route of transmission for SARS-CoV-2? J Hosp Infect, 2020; 105(3):397–398	no primary data
Mizumoto K., Chowell G. Transmission potential of the novel coronavirus (COVID-19) onboard the diamond Princess Cruises Ship, 2020. Infect Dis Model, 2020;5:264-270	no primary data
Mol M.P.G., Caldas S. Can the human coronavirus epidemic also spread through solid waste? Waste Manag Res, 2020; 38(5):485-486	no primary data
Morawska L., Cao J. Airborne transmission of SARS-CoV-2: The world should face the reality. Environ Int, 2020; 139:105730	no primary data
Mullins, E., Evans D., Viner R.M. et al. Coronavirus in pregnancy and delivery: rapid review. Ultrasound Obstet Gynecol, 2020; 55(5): 586-592.	no primary data
Musa S. Hepatic and gastrointestinal involvement in coronavirus disease 2019 (COVID-19): What do we know till now? Arab J Gastroenterol, 2020; 21(1):3-8	no primary data
Nan, Y., Che S., Zhang J. et al. Breastfeeding of Infants Born to Mothers with COVID-19: A Rapid Review. medRxiv preprint, 2020	no primary data
Napoli P.E., Nioi M., d'Aloja E. et al. The Ocular Surface and the Coronavirus Disease 2019: Does a Dual 'Ocular Route' Exist? J Clin Med, 2020; 9(5)	no primary data
Neidlinger N.A., Smith J.A., D'Alessandro A.M. et al. Organ recovery from deceased donors with prior COVID-19: a case series. Transpl Infect Dis, 2020; 00:e13503	Donors not +ve at donation
Ng Y., Li Z., Chua Y.X. et al. Evaluation of the Effectiveness of Surveillance and Containment Measures for the First 100 Patients with COVID-19 in Singapore - January 2-February 29, 2020. MMWR, 2020; 69(11);307-311	no data on transmission
Ng, P. C., Leung C.W., Chiu W.K. et al. SARS in newborns and children. Biol Neonate, 2004; 85(4): 293-298.	no primary data
Nicastri E., D'Abramo A., Faggioni G. et al. Coronavirus disease (COVID-19) in a paucisymptomatic patient: Epidemiological and clinical challenge in settings with limited community transmission, Italy, February 2020. Euro Surveill, 2020; 25(11):2000230	no data on transmission
Nikhat S., Fazil M. Overview of Covid-19, its prevention and management in the light of Unani medicine. Sci Total Environ, 2020; 728:138859	no primary data
Ningthoujam R. COVID 19 can spread through breathing, talking, study estimates. Curr Med Res Pract, 2020; 10(3):132-133	no primary data
Niu F.-L., Ku N.-N., Sun Y. Investiagation of possible mechanism of eye transmission of SARS-CoV-2 based on SARS-CoV. Int Eye Sci, 2020; 20(4):729-732	no primary data
Nunez-Delgado A. What do we know about the SARS-CoV-2 coronavirus in the environment? Sci Total Environ, 2020; 727:138647	no primary data
Odor P.M., Neun M., Bampoe S. et al. Anaesthesia and COVID-19: infection control. Brit J Anaesth. 2020; 125(1):16–24	no primary data
Oraby T., Tyshenko M.G., Balkhy H.H. et al. Analysis of the healthcare mers-cov outbreak in king abdulaziz medical center, riyadh, saudi arabia, june-august 2015 using a seir ward transmission model. Int J Environ Res Public Health, 2020; 17(8):no pagination	not COVID-19
Ozaslan M., Safdar M., Halil Kilic I. et al. Practical measures to prevent COVID-19: A mini-review. J Biol Sci, 2020; 20(2):pp 100-102	no primary data
Ozma M.A., Maroufi P., Khodadadi E. et al. Clinical manifestation, diagnosis, prevention and control of SARS-CoV-2 (COVID-19) during the outbreak period. Le Infez Med, 2020; 28(2):153-165	no primary data
Ozturk C.N., Kuruoglu D., Ozturk C. et al. Plastic surgery and the covid-19 pandemic: a review of clinical guidelines. Ann Plast Surg, 2020; 10.1097	no primary data
Pan L., Mu M., Yang P., et al. Clinical characteristics of COVID-19 patients with digestive symptoms in Hubei, China: a descriptive, cross-sectional, multicenter study. Am J Gastroenterol, 2020; 115(5):766-773	no data on transmission
Panahi, L., Amiri M., Pouy S. et al. Risks of Novel Coronavirus Disease (COVID-19) in Pregnancy, a Narrative Review. Arch Acad Emerg Med, 2020; 8(1):e34	no primary data
Panuganti B.A., Pang J., Califano J. et al. Procedural precautions and personal protective equipment during head and neck instrumentation in the COVID-19 era. Head Neck, 2020; 10.1002	no primary data
Parhar H.S., Tasche K., Brody R.M. et al. Topical preparations to reduce SARS-CoV-2 aerosolisation in head and neck mucosal surgery. Head Neck, 2020; 42(6):1268-1272	no primary data

Park H.C., Lee S.-H., Kim J. et al. Effect of isolation practice on the transmission of middle east respiratory syndrome coronavirus among hemodialysis patients: A 2-year prospective cohort study. Medicine, 2020; 99(3):no pagination	not COVID-19
Park J., Yoo S.Y., Ko J.-H. et al. Infection Prevention Measures for Surgical Procedures during a Middle East Respiratory Syndrome Outbreak in a Tertiary Care Hospital in South Korea. Sci Rep, 2020; 10(1):325	no primary data
Park O., Park Y.J., Park S.Y. et al. Contact transmission of Covid-19 in South Korea: Novel investigation techniques for tracing contacts. Osong Public Health Res Perspect, 2020; 11(1):60-63	no primary data
Park S.E. Epidemiology, virology, and clinical features of severe acute respiratory syndrome-coronavirus-2 (SARS-COV-2, Coronavirus Disease-19). Korean J Pediatr, 2020; 63(4):119-124	no primary data
Parodi S.M., Liu V.X. From Containment to Mitigation of COVID-19 in the US. JAMA, 2020; 323(15):1441-1442	no primary data
Patel K.P., Patel P.A., Vunnam R.R. et al. Gastrointestinal, hepatobiliary, and pancreatic manifestations of COVID-19. J Clin Virol, 2020; 128:104386	no primary data
Patel Z.M., Fernandez-Miranda J., Hwang P.H. et al. Letter: Precautions for Endoscopic Transnasal Skull Base Surgery During the COVID-19 Pandemic. Neurosurgery, 2020; 87(1):E66-E67	no primary data
Patino Montoya M., Chitilian H.V. Extubation barrier drape to minimise droplet spread. Br J Anaesth, 2020; 125(1):e195–e196	no data on transmission
Pattanshetty S., Narayana A., Radhakrishnan R. Povidone-iodine gargle as a prophylactic intervention to interrupt the transmission of SARS-CoV-2. Oral Dis, 2020; 10.1111	no primary data
Pawar T., Pokharkar A., Gori J. et al. The Technique and Justification for Minimally Invasive Surgery in COVID-19 Pandemic: Laparoscopic Anterior Resection for Near Obstructed Rectal Carcinoma. J Laparoendosc Adv Surg Tech A, 2020; 30(5):485-487	no data on transmission
Peng P.W.H., Ho P.L., Hota S.S. Outbreak of a new coronavirus: what anaesthetists should know. Brit J Anaesth, 2020; 124(5):497-501	no primary data
Peng X., Xu X., Li Y. et al. Transmission routes of 2019-nCoV and controls in dental practice. Int J Oral Sci, 2020; 12(1):9	no primary data
Perisetti A., Gajendran M., Boregowda U. et al. COVID-19 and gastrointestinal endoscopies: current insights and emergent strategies. Dig Endosc, 2020; 32(5):715-722	no primary data
Petersen E., Memish Z.A., Zumla A. et al. Transmission of respiratory tract infections at mass gathering events. Curr Opin Pulm Med, 2020; 26(3):197-202	no primary data
Pleil J.D., Beauchamp J.D., Risby T.H. et al. The scientific rationale for the use of simple masks or improvised facial coverings to trap exhaled aerosols and possibly reduce the breathborne spread of COVID-19. J Breath Res, 2020; 14(3):030201	no primary data
Portugal L.G., Adams D.R., Baroody F.M. et al. A Surgical Safety Checklist for Performing Tracheotomy in Patients with Coronavirus Disease 19. Otolaryngol Head Neck Surg, 2020;194599820922981	no primary data
Prata D.N., Rodrigues W., Bermejo P.H. Temperature significantly changes COVID-19 transmission in (sub)tropical cities of Brazil. Sci Total Environ, 2020; 729:no pagination	no primary data
Prem K., Liu Y., Russell T.W. et al. The effect of control strategies to reduce social mixing on outcomes of the COVID-19 epidemic in Wuhan, China: a modelling study. Lancet Public Health, 2020; 5(5):e261-e270	no primary data
Qian G.-Q., Yang N.-B., Ding F. et al. Epidemiologic and Clinical Characteristics of 91 Hospitalized Patients with COVID-19 in Zhejiang, China: A retrospective, multi-centre case series. QJM, 2020; 113(7): 474–481	no data on transmission
Qing H., Li Z., Yang Z. et al. The possibility of COVID-19 transmission from eye to nose. Acta Ophthalmol, 2020; 98(3):e388	no primary data
Qing H., Yang Z., Shi M. et al. New evidence of SARS-CoV-2 transmission through the ocular surface. Graefes Arch Clin Exp Ophthalmol, 2020; 1–2	no primary data
Qiu H., Wu J., Hong L. et al. Clinical and epidemiological features of 36 children with coronavirus disease 2019 (COVID-19) in Zhejiang, China: an observational cohort study. Lancet Infect Dis, 2020; 20(6):89-696	no data on transmission
Rahimi F., Abadi T.B.A. Challenges of managing the asymptomatic carriers of SARS-CoV-2. Travel Med Infect Dis, 2020; 37:101677	no primary data
Rahul, G., Deepak M., Mahale S. et al. Pregnancy outcomes, Newborn complications and Maternal-Fetal Transmission of SARS-CoV-2 in women with COVID-19: A systematic review. medRxiv preprint, 2020	no primary data
Ren S.Y., Wang W.B., Hao Y.G. et al. Stability and infectivity of coronaviruses in inanimate environments. World J Clin Cases, 2020; 8(8):1391-1399	no primary data
Reusken C.B., Buiting A., Bleeker-Rovers C. et al. Rapid assessment of regional SARS-CoV-2 community transmission through a convenience sample of healthcare workers, the Netherlands, March 2020. Euro Surv, 2020; 25(12):no pagination	no data on transmission

Rocklov J., Sjodin H., Wilder-Smith A. COVID-19 outbreak on the Diamond Princess cruise ship: estimating the epidemic potential and effectiveness of public health countermeasures. J Travel Med, 2020; 18;27(3):taaa030	no primary data
Sadhu S., Agrawal R., Pyare R. et al. COVID-19: Limiting the Risks for Eye Care Professionals. Ocul Immunol Inflamm, 2020; 28(5):714-720	no primary data
Sanche S., Lin Y.T., Xu C. et al. High Contagiousness and Rapid Spread of Severe Acute Respiratory Syndrome Coronavirus 2. Emerg Infect Dis, 2020; 26(7):no pagination	no data on transmission
Sardar T., Ghosh I., Rodo X. et al. A realistic two-strain model for MERS-CoV infection uncovers the high risk for epidemic propagation. PLoS Negl Trop Dis, 2020; 14(2):e0008065	no primary data
Satheesan M.K., Mui K.W., Wong L.T. A numerical study of ventilation strategies for infection risk mitigation in general inpatient wards. Build Simul, 2020; 1-10	no primary data
Schwartz D.A., Graham A.L. Potential maternal and infant outcomes from coronavirus 2019-NCOV (SARS-CoV-2) infecting pregnant women: Lessons from SARS, MERS, and other human coronavirus infections. Viruses, 2020; 12(2):194	no primary data
Sciomer S., Moscucci F., Magri D. et al. SARS-CoV-2 spread in Northern Italy: what about the pollution role? Environ Monit Assess, 2020; 192(6):325	no primary data
Service R.F. NAS letter suggests 'normal breathing' can expel corona. Science, 2020; 368(6487):119	no primary data
Setti L., Passarini F., De Gennaro G. et al. Airborne Transmission Route of COVID-19: Why 2 Meters/6 Feet of Inter-Personal Distance Could Not Be Enough. Int J Environ Res Public Health, 2020; 17(8): no pagination	no primary data
Shalish W., Lakshminrusimha S., Manzoni P. et al. COVID-19 and Neonatal Respiratory Care: Current Evidence and Practical Approach. Am J Perinatol, 2020; 37(8):780-791	no primary data
She J., Jiang J., Ye L. et al. 2019 novel coronavirus of pneumonia in Wuhan, China: emerging attack and management strategies. Clin Transl Med, 2020; 9:19	no primary data
Sina, A., Vaseghi G., Heidari Z. et al. Clinical characteristics of COVID-19 infection in pregnant women: a systematic review and meta-analysis. medRxiv preprint, 2020	no primary data
Sivaraman D., Pradeep P.S., Sundar Manoharan S. et al. Current strategies and approaches in combating SARS-CoV-2 virus that causes COVID-19. Lett Drug Des Discov, 2020; 17(5):pp 670-672	no primary data
Song J.-X., Xing Y.-X., Wu J. et al. Caution of coronavirus transmission through ocular surface. Int Eye Sci, 2020; 20(4):726-728	no primary data
Sun C.B., Wang Y.Y., Liu G.H. et al. Role of the Eye in Transmitting Human Coronavirus: What We Know and What We Do Not Know. Front Public Health, 2020; 8:155	no primary data
Sun K., Viboud C. Impact of contact tracing on SARS-CoV-2 transmission. Lancet Infect Dis, 2020; 20(8):876-877	no primary data
Sun Y., Koh V., Marimuthu K. et al. Epidemiological and Clinical Predictors of COVID-19. Clin Infect Dis, 2020; 71(15):786-792	no data on transmission
Gupta S., Parker J., Underwood S. et al. Persistent viral shedding of SARS-CoV-2 in faeces - a rapid review. Colorectal Dis, 2020; 22(6):611-620	no primary data
Takhar A., Walker A., Tricklebank S. et al. Recommendation of a practical guideline for safe tracheostomy during the COVID-19 pandemic. Eur Arch Otorhinolaryngol, 2020; 277(8): 2173–2184	no primary data
Tang B., Bragazzi N.L., Li Q. et al. An updated estimation of the risk of transmission of the novel coronavirus (2019-nCov). Infect Dis Model, 2020; 5:248-255	no primary data
Tang L.Y., Wang J. Anesthesia and COVID-19: What We Should Know and What We Should Do. Semin Cardiothorac Vasc Anesth, 2020; 24(2):127-137	no primary data
Tatu A.L., Nadasdy T., Nwabudike L.C. Observations about sexual and other routes of SARS-CoV-2 transmission and its prevention. Clin Exp Dermatol, 2020; 45(6):761-762	no primary data
Tham W.Y., Tong A.K.T., Loke K.S.H. et al. Divide and conquer: strategies to manage a nuclear medicine department during COVID-19. J Nucl Med Technol, 2020; 48(2):98-101	no primary data
Tian Y., Rong L., Nian W. et al. Review article: gastrointestinal features in COVID-19 and the possibility of faecal transmission. Aliment Pharmacol Ther, 2020; 51(9):843-851	no primary data
To K.K.-W., Tsang O.T.-Y., Chik-Yan Yip C. et al. Consistent detection of 2019 novel coronavirus in saliva. Clin Infect Dis, 2020; 71(15):841–843	no data on transmission
Tong Z.-D., Tang A., Li K.-F. et al. Potential Presymptomatic Transmission of SARS-CoV-2, Zhejiang Province, China, 2020. Emerg Infect Dis, 2020; 26(5):1052-1054	no data on transmission
Verbeek J.H., Rajamaki B., Ijaz S. et al. Personal protective equipment for preventing highly infectious diseases due to exposure to contaminated body fluids in healthcare staff. Cochrane Database Syst. Rev, 2020; 4:CD011621	no primary data

Wahidi M.M., Shojaee S., Lamb C.R. et al. The Use of Bronchoscopy during the COVID-19 Pandemic: CHEST/AABIP Guideline and Expert Panel Report. Chest, 2020; 158(3):1268-1281	no primary data
Wan R., Mao Z.-Q., He L.-Y. et al. Evidence from two cases of asymptomatic infection with SARS-CoV-2: Are 14 days of isolation sufficient? Int J Infect Dis, 2020; 95:174-175	no data on transmission
Wang L., Duan Y., Zhang W. et al. Epidemiologic and clinical characteristics of 26 cases of covid-19 arising from patient-to-patient transmission in Liaocheng, China. Clin Epidemiol, 2020; 12:387-391	no data on transmission
Wang R., Liao C., He H. et al. COVID-19 in Hemodialysis Patients: A Report of 5 Cases. Am J Kidney Dis, 2020; 76(1):141-143	no data on transmission
Wang Y., Li X., Liu W. et al. Discovery of a subgenotype of human coronavirus NL63 associated with severe lower respiratory tract infection in China, 2018. Emerg Microbes Infect, 2020; 9(1):246-255	Not COVID-19
Wang Y., Liu Y., Liu L. et al. Clinical outcome of 55 asymptomatic cases at the time of hospital admission infected with SARS-Coronavirus-2 in Shenzhen, China. J Infect Dis, 2020; 221(11):1770–1774	no data on transmission
Wang, L., Shi Y., Xiao T. et al. Chinese expert consensus on the perinatal and neonatal management for the prevention and control of the 2019 novel coronavirus infection. Ann Transl Med, 2020; 8(3):47	no primary data
Williams M., Blake S., Matthews H. Mitigating the risk of aerosol generation from power tools during the COVID-19 pandemic. Ann R Coll Surg Engl, 2020; 102(5):393-394	no primary data
Wilson M.E., Chen L.H. Travellers give wings to novel coronavirus (2019-nCoV). J Travel Med, 2020; 27(2):taaa015	no primary data
Wilson N.M., Norton A., Young F.P. et al. Airborne transmission of severe acute respiratory syndrome coronavirus-2 to healthcare workers: a narrative review. Anaesthesia, 2020; 75(8):1086-1095	no primary data
Wolfel R., Corman V.M., Guggemos W. et al. Virological assessment of hospitalized patients with COVID-2019. Nature, 2020; 581(7809):465-469	no primary data
Wong D.H.T., Mak S.T., Yip N.K.F. et al. Protective shields for ophthalmic equipment to minimise droplet transmission of COVID-19. Graefes Arch Clin Exp Ophthalmol, 2020; 258(7):1571-1573	no primary data
Wong S.C.-Y., Kwong R.T.-S., Wu T.C. et al. Risk of nosocomial transmission of coronavirus disease 2019: an experience in a general ward setting in Hong Kong. J Hosp Infect, 2020; 105(2): 119–127	no data on transmission
Wu Y.C., Chen C.S., Chan Y.J. Overview of The 2019 Novel Coronavirus (2019-nCoV): The Pathogen of Severe Specific Contagious Pneumonia (SSCP). J Chin Med Assoc, 2020; 83(3):217-220	no primary data
Wu, F., Xiao, A., Zhang, J. et al. SARS-CoV-2 titers in wastewater are higher than expected from clinically confirmed cases. medRxiv preprint, 2020	no data on transmission
Xia J., Liao C., Li Y. et al. Transmission of corona virus disease 2019 during the incubation period may lead to a quarantine loophole. medRxiv preprint, 2020	no data on transmission
Xu R., Cui B., Duan X. et al. Saliva: potential diagnostic value and transmission of 2019-nCoV. Int J Oral Sci, 2020; 12(1):11	no primary data
Xu T., Zhu Z., Cui M. et al. Clinical features and dynamics of viral load in imported and non-imported patients with COVID-19. Int J Infect Dis, 2020; 94:68-71	no data on transmission
Yang C. Does hand hygiene reduce SARS-CoV-2 transmission? Graefes Arch Clin Exp Ophthalmol, 2020; 258(5):1133-1134	no primary data
Yang C., Ma Q.Y., Zheng Y.H. et al. Transmission routes of 2019-novel coronavirus (2019-nCoV). CJPM, 2020; 54(4):374-377	no primary data
Yang C.H., Jung H. Topological dynamics of the 2015 South Korea MERS-CoV spread-on-contact networks. Sci Rep, 2020; 10(1):4327	not COVID-19
Yang H.Y., Duan G.C. Analysis on the epidemic factors for the Corona Virus Disease. CJPM, 2020; 54(0):E021	no primary data
Yang H.Y., Xu J., Li Y. et al. The preliminary analysis on the characteristics of the cluster for the Corona Virus Disease. Chin J Epidemiol, 2020; 10;41(5):623-628	no primary data
Yang R., Gui X., Xiong Y. Patients with respiratory symptoms are at greater risk of COVID-19 transmission. Respir Med, 2020; 165:105935	no data on transmission
Yang Y., Soh H.Y., Cai Z.G. et al. Experience of Diagnosing and Managing Patients in Oral Maxillofacial Surgery during the Prevention and Control Period of the New Coronavirus Pneumonia. Chin J Dent Res, 2020; 23(1):57-62	no data on transmission
Yang Z., Wang M., Zhu Z. et al. Coronavirus disease 2019 (COVID-19) and pregnancy: a systematic review. J Matern Fetal Neonatal Med, 2020; 1-4	no primary data
Yao M., Zhang L., Ma J. et al. On airborne transmission and control of SARS-Cov-2. Sci Total Environ, 2020; 731:139178	no primary data

Yao Y., Tian Y., Zhou J. et al. Epidemiological characteristics of SARS-CoV-2 infections in Shaanxi, China by 8 February 2020. Eur Respir J, 2020; 55(4): no pagination	no data on transmission
Ye F., Xu S., Rong Z. et al. Delivery of infection from asymptomatic carriers of COVID-19 in a familial cluster. Int J Infect Dis, 2020; 94:133-138	no data on transmission
Ye Q., Wang B., Mao J. et al. Epidemiological analysis of COVID-19 and practical experience from China. J Med Virol, 2020; 10.1002	no primary data
Yen M.-Y., Schwartz J., Chen S.-Y. et al. Interrupting COVID-19 transmission by implementing enhanced traffic control bundling: Implications for global prevention and control efforts. J Microbiol Immunol Infect, 2020; 53(3):377–380	no primary data
Yen M.Y., Schwartz J., King C.C. et al. Recommendations for protecting against and mitigating the COVID-19 pandemic in long-term care facilities. J Microbiol Immunol Infect, 2020; 53(3):447-453	no primary data
Yeo C., Kaushal S., Yeo D. Enteric involvement of coronaviruses: is faecal-oral transmission of SARS-CoV-2 possible? Lancet Gastroenterol Hepatol, 2020; 5(4):335-337	no primary data
Yin S., Peng Y., Ren Y. et al. The implications of preliminary screening and diagnosis: Clinical characteristics of 33 mild patients with SARS-CoV-2 infection in Hunan, China. J Clin Virol, 2020; 128:104397	no data on transmission
Yoo J.H., Hong S.T. The outbreak cases with the novel coronavirus suggest upgraded quarantine and isolation in Korea. J Korean Med Sci, 2020; 35(5):e62	no data on transmission
Yu G.Y., Lou Z., Zhang W. Several suggestion of operation for colorectal cancer under the outbreak of Corona Virus Disease 19 in China. Chin J Gastrointest Surg, 2020; 23(3):9-11	no primary data
Yu X., Sun S., Shi Y. et al. SARS-CoV-2 viral load in sputum correlates with risk of COVID-19 progression. Crit Care, 2020; 24(1):170	no data on transmission
Yu Y.X., Sun L., Yao K. et al. Consideration and prevention for the aerosol transmission of 2019 novel coronavirus. Chin J Ophthalmol, 2020; 56:E008	no primary data
Zaigham M., Andersson O. Maternal and perinatal outcomes with COVID-19: A systematic review of 108 pregnancies. Acta Obstet Gynecol Scand, 2020; 99(7):823-829	no primary data
Zeng L.K., Tao X.W., Yuan W.H. et al. First case of neonate infected with novel coronavirus pneumonia in China. Chin J Pediater, 2020; 58:E009 .	no data on transmission
Zhang H. Early lessons from the frontline of the 2019-nCoV outbreak. Lancet, 2020; 395(10225):687	no primary data
Zhang J., Tian S., Lou J. et al. Familial cluster of COVID-19 infection from an asymptomatic. Crit Care, 2020; 24(1):119	no data on transmission
Zhang J.-F., Yan K., Ye H.-H. et al. SARS-CoV-2 turned positive in a discharged patient with COVID-19 arouses concern regarding the present standard for discharge. Int J Infect Dis, 2020; 97:212-214	no data on transmission
Zhang M.-Z. New coronavirus pneumonia COVID-19 and ocular surface transmission. Int Eye Sci, 2020; 20(3)401-403	no primary data
Zhang Z., Zhang L., Wang Y. COVID-19 indirect contact transmission through the oral mucosa must not be ignored. J Oral Pathol Med, 2020; 49(5):450-451	no primary data
Zhang R., Li Y., Zhang A.L. et al. Identifying airborne transmission as the dominant route for the spread of COVID-19," by Renyi Zhang, Yixin. Proc Natl Acad Sc. U.S.A, 2020; 117, 14857–14863	major flaws in data collection & analysis
Zhao C., Viana A. Jr., Wang Y. et al. Otolaryngology during COVID-19: Preventive care and precautionary measures. Am J Otolaryngol, 2020; 102508	no primary data
Zhao S., Ling K., Yan H. et al. Anesthetic Management of Patients with COVID 19 Infections during Emergency Procedures. J Cardiothorac Vasc Anesth, 2020; 34(5):1125-1131	no data on transmission
Zhao Z., Li X., Liu F. et al. Prediction of the COVID-19 spread in African countries and implications for prevention and control: A case study in South Africa, Egypt, Algeria, Nigeria, Senegal and Kenya. Sci Total Environ, 2020; 729:138959	no primary data
Zheng Y., Xiong C., Liu Y. et al. Epidemiological and clinical characteristics analysis of COVID-19 in the surrounding areas of Wuhan, Hubei Province in 2020. Pharmacol Res, 2020; 157:104821	no data on transmission
Zimmermann M., Nkenke E. Approaches to the management of patients in oral and maxillofacial surgery during COVID-19 pandemic. J Craniomaxillofac Surg, 2020; 48(5):521-526	no primary data
Zimmermann P., Curtis N. Coronavirus infections in children including COVID-19: An overview of the epidemiology, clinical features, diagnosis, treatment and prevention options in children. Pediatr Infect Dis J, 2020; 39(5):355-368	no primary data

Appendix 8: GRADE table

Outcome	Type of outcome	No of studies	No of participants/ samples	Quality of studies	Overall classification of evidence	Overall effect	Overall decision for likelihood of transmission
Droplet transmission							
Epidemiological evidence for droplet transmission of SARS-CoV-2	Primary outcome	4	60[30] 90[51,59] ~340[82]	Low quality[i]	Inconsistent	3 of 4 studies provide some evidence for droplet transmission. Based on evidence from SARS and MERS this is considered a primary route	Probable
Airborne transmission							
Epidemiological evidence for airborne transmission of SARS-CoV-2	Primary outcome	4	60[30] 90[51,59] ~340[82]	Low quality[i]	Inconsistent	2 of 4 studies provide some evidence for airborne transmission.	Possible
Presence of SARS-CoV-2 in air	Secondary (surrogate) outcome	7	No of samples: 4,[17] 4,[26] 56,[29] NR,[81] 31[134] No of rooms: 3,[18] 3,[66]	Not assessed[ii]	Inconsistent	3 of 5 studies found presence of viral RNA in air samples. 2 of 2 studies found presence of viral RNA in rooms.	
Presence of viable SARS-CoV-2 in air	Secondary (surrogate) outcome	2	NR,[81] 31[134]	Not assessed[ii]	Weak	0 of 2 studies found presence of viral RNA in air samples.	
Duration of viable SARS-CoV-2 in air	Secondary (surrogate) outcome	1	NR[92]	Not assessed[ii]	Weak	1 of 1 studies found evidence that virus can survive in air for up to 3hrs	

SARS-CoV-2 load in the air	Secondary (surrogate) outcome	4	4,[15] 3,[18] 35,[64] 14[134]	Not assessed[ii]	Inconsistent	3 of 4 studies found evidence of viral RNA with up to 1000 copies/m^3	
Fomite transmission							
Epidemiological evidence for transmission of SARS-CoV-2 via fomites	Primary outcome	2	NR,[8] 60[30]	Low quality[i]	Weak	2 of 2 studies provide some evidence for transmission via fomites	Possible
Presence of SARS-CoV-2 on surfaces	Secondary (surrogate) outcome	7	Contaminated surfaces: 238,[29] 25,[66] NR,[81] 36,[93] 218[134] Contaminated PPE: 10,[66] 90,[67] 9[93] Contaminated rooms: 30[18] Viral load: 2[17]	Not assessed[ii]	Moderate[iii]	4 of 5 studies found evidence of viral RNA on surfaces, one study showed no results but also reported frequent cleaning 1 of 3 studies found evidence of viral RNA on PPE. Only 1/109 samples contaminated with virus 1 of 1 studies found evidence of viral RNA in rooms 1 of 1 studies found evidence of viral RNA $6.5x10^{2}$/ml once and 0 next time	
Presence of viable SARS-CoV-2 on surfaces	Secondary (surrogate) outcome	1	114[134]	Not assessed[ii]	Weak	1 of 1 studies found no evidence of viable virus on surfaces	
Survival of viable SARS-CoV-2 on surfaces	Secondary (surrogate) outcome	2	NR,[19] NR[92]	Not assessed[ii]	Weak	2 of 2 studies found evidence that virus can survive on different	

						surfaces. The time of survival depends on type of surface	
Epidemiological evidence for vertical transmission of SARS-CoV-2	Primary outcome	32	Total 368[2,7,9,11,12,19,21,28,32,36,39,43,49,51,52,53,55,68,70,72,91,94,110-112,114,116-118,121,130,136]	Low quality[i]	Moderate[iii]	8/30 studies found 12/368 babies infected. However, except in one study, these studies did not test for COVID-19 at birth, so there is a high risk that transmission occurred peripartum. One study provided evidence that vertical transmission was plausible	
Evidence for presence of SARS-CoV-2 RNA in maternal/neonatal tissues and products of conception	Secondary (surrogate) outcome	14	Total 467 for cord blood[22,39,51,70,91,94,110,112,114] Total 45 for amniotic fluid[7,22,32,39,51,94,110,112,118,136] Total 20 for placenta[12,22,68,70,94,114,118,136] Total 1 for serum[70] Total 10 for breast milk[7,22,28,70]	Low quality[i]	Moderate[iii]	2 of 13 studies found evidence for virus presence in these tissues. One study found 3 placentas with viral RNA but also reported that contamination could have occurred during delivery. One study reported viral RNA found in amniotic fluid prior to the rupture of the membranes and in placenta which appeared to be damaged as a result of infection	

			Total 8 for vaginal secretions[22,110]				
Transmission from body fluids							
Epidemiological evidence for transmission of SARS-CoV-2 from faecal matter	Primary outcome	0	n/a	n/a	No evidence	No evidence	Unlikely
Evidence of presence of SARS-CoV-2 RNA in faecal matter	Secondary (surrogate) outcome	32	No of individuals with positive anal swabs: total 72[21,25,36,45,72,88,112,126] No of positive anal swabs: 120[101] No of individuals with positive stool: total 439[15,31,38,50,53,68,69,89-91,95,104,108,111,121,125,130,131] No of positive stool samples: total 397[96,101,129] No of positive sewage samples: total 65[4,62,93,105]	All studies low quality[i] except,[4,62,93,105] which were not assessed[ii]	Moderate[iii]	31 of 32 studies found evidence of virus in anal swabs, stools or sewage. One study which did not find evidence of this was conducted on stool samples of two patients.	
Evidence of presence of viable SARS-CoV-2 virus in faecal matter	Secondary (surrogate) outcome	4	No of stool samples with viable virus: total 5[96,129] No of sewage samples with viable virus: total 6[4,93]	Low quality[i], [96,129] not assessed[ii] [4,93]	Weak	2 of 2 studies found evidence of viable virus in stool 0 of 2 studies found evidence of viable virus in sewage	

Epidemiological evidence for transmission of SARS-CoV-2 from urine	Primary outcome	0	n/a	n/a	No evidence	No evidence	Unlikely
Evidence of presence of SARS-CoV-2 RNA in urine	Secondary (surrogate) outcome	11	No of individuals with positive urine sample: total 150[31, 38,53,68,72,91,130,131,135] No of positive samples: total 82[15,96]	Low quality[i]	Moderate[iii]	5 of 9 studies found evidence of viral RNA in urine of 8/150 individuals 0 of 2 studies found evidence of viral RNA in urine samples (0/82)	
Evidence of presence of viable SARS-CoV-2 virus in urine	Secondary (surrogate) outcome	1	1[135]	Low quality[i]	Weak	1 of 1 studies found evidence for viable virus in one individual	
Epidemiological evidence for transmission of SARS-CoV-2 via ocular surface	Primary outcome	2	2,[49] 1[127]	Low quality[i]	Weak	2 of 2 studies found evidence for transmission via ocular surface in 3/3 individuals	Possible
Epidemiological evidence for transmission of SARS-CoV-2 from ocular secretions	Primary outcome	0	n/a	n/a	No evidence	No evidence	Unlikely
Evidence of presence of SARS-CoV-2 RNA in ocular secretions	Secondary (surrogate) outcome	9	No of individuals with positive tear samples: total 50[82, 110] No of individuals with positive ocular discharge samples: 72[127] No of individuals with positive	Low quality[i]	Moderate[iii]	1 of 2 studies found evidence for viral RNA in tears of 2/50 individuals 1 of 1 studies found evidence for viral RNA in ocular discharge of 1/72 individuals 5 of 5 studies found evidence for viral RNA in tears of 8/194 individuals	

			conjunctival swab samples: total 194[11,87,102,106,132] No of individuals with positive ocular swabs: total 1[20]			1 of 1 studies found evidence for viral RNA in tears of 1/1 individuals	
Evidence of presence of viable SARS-CoV-2 virus in ocular secretions	Secondary (surrogate) outcome	0	n/a	n/a	No evidence	No evidence	
Epidemiological evidence for transmission of SARS-CoV-2 from sexual body fluids	Primary outcome	0	n/a	n/a	No evidence	No evidence	Unlikely
Evidence of presence of SARS-CoV-2 RNA in sexual body fluids	Secondary (surrogate) outcome	3	Semen: 38[44] Vaginal fluid: 35[21] Vaginal swab: 10[79]	Low quality[i]	Weak	1 of 1 studies found evidence for viral RNA in semen of 6/38 of men 0 of 2 studies found evidence for viral RNA in vaginal fluid or swabs of 45 women	
Evidence of presence of viable SARS-CoV-2 virus in sexual body fluids	Secondary (surrogate) outcome	0	n/a	n/a	No evidence	No evidence	
Blood transfusion and organ transplant							

Epidemiological evidence for transmission of SARS-CoV-2 via blood transfusion	Primary outcome	4	0/5 persons infected[137-140]	Low quality	Weak	No evidence of transmisison	
Epidemiological evidence for transmission of SARS-CoV-2 via organ donation	Primary outcome	0	n/a	n/a	No evidence	No evidence	
Transmission dynamics							
Epidemiological evidence of SARS-CoV-2 transmission occurring within households	Secondary (surrogate) outcome	17	1119[7,16,27,28,31,34,37,41,47,48,52,78,84,86,98,99,128]	Low quality[i]	Moderate[iii]	Evidence shows that transmission usually occurs with close contact, although distance and duration has not been established. Transmission in healthcare settings is low and is usually due to no or inappropriate wear of PPE. Transmission in care homes high.	Suggest close contact transmission
Epidemiological evidence of SARS-CoV-2 transmission occurring between family and friends	Secondary (surrogate) outcome	14	179[6,16,23,27,33,34,40,43,74,77,78,107,116,118]	Low quality[i]	Moderate[iii]		
Epidemiological evidence of SARS-CoV-2 transmission occurring in workplaces	Secondary (surrogate) outcome	6	122[23,27,70,76,78,80]	Low quality[i]	Moderate[iii]		
Epidemiological evidence of SARS-CoV-2 transmission occurring in supermarkets and shopping centres	Secondary (surrogate) outcome	3	22[76,103,123]	Low quality[i]	Weak		
Epidemiological evidence for SARS-CoV-2 transmission occurring during church service	Secondary (surrogate) outcome	3	NR[76,99,116]	Low quality[i]	Weak		
Epidemiological evidence for SARS-CoV-2 transmission occurring in acute healthcare settings	Secondary (surrogate) outcome	8	NR[7,16,28,32,43,83,84,100]	Low quality[i]	Moderate[iii]		
Epidemiological evidence for SARS-CoV-2 transmission occurring in care homes	Secondary (surrogate) outcome	1	NR[61]	Low quality[i]	Weak		

Epidemiological evidence for SARS-CoV-2 transmission occurring in other settings	Secondary (surrogate) outcome	11	NR[8,23,27,60,63,65,70,74,78,82,128]	Low quality[i]	Weak		

[I] – low quality due to study design – case studies/series
[II] – studies not assessed for quality (environmental surveys and experiments in laboratory settings)
[III] – low quality studies, but a relatively large number and show consistent results

Classification of the evidence	
Strong	Further research unlikely to change confidence in the estimate of the effect
Moderate	Further research may impact the estimate of the effect and may change its strength
Weak	Further research very likely to impact the estimate of the effect and change its strength
Inconsistent	Current studies show conflicting evidence, further research will very likely change the estimate of the effect

Appendix 9: Consultation

Section	Comments	Working party response
Dr. Bin GAO, Tianjin 4th Centre Hospital, Tianjin, China		
Page3, Line13, Page23, Line26	To avoid touching your face and eyes with hands is difficult and to do so with clean hands is safe from transmission.	We appreciate that it may be hard at times to avoid touching face and eyes. However, it is known that this may be a common entry route for respiratory pathogens, and we follow opinion of many infection prevention professionals who advise that this should be avoided.
Page4, Line14	To be more clear (suggested change: except around aerosol generating procedures (AGPs).	This was added
Page4, Line16	Per needs of editing (suggested change: remove aerosol generating procedures and insert AGP	This was changed
Page6, Line22	May be more clear (suggested change: replace healthcare settings with health and care settings)	This was changed
Page11, Line3	An error? The 4th to 133rd references marked here according to total 130 references had been cited.	This was changed
Page13, Line15	Per needs of editing (suggested change: add ICU in brackets)	This was changed
Page17, Line1	Per requirement of syntax	This was changed
Professor Philip Carling, Boston University School of Medicine, United States		
General	Thank you very much for providing me with the opportunity to review this document. This guidance is timely, thoroughly researched and the results are thoughtfully and clearly stated.	We thank you for your generous comment
Executive summary, Droplet Transmission	Would consider the word “established” rather than “probable” since this mode of transmission is clearly the primary mode of COVID transmission	We agree with the comment that droplet transmission is likely the predominant route via which the SARS-CoV-2 virus is transmitted. However, whilst the clinical experience tells us this is likely the case, we feel that the current evidence does not establish this beyond doubt.

Section	Comments	Working party response
		Please also note that in the scarcity of evidence for the airborne transmission, this Working Party made recommendations for droplet rather than airborne precautions.
Executive summary, Airborne Transmission	While an area of ongoing debate, this reviewer would suggest the term “probable” more accurately reflects the current science than “possible”. Furthermore, the use of the term “probable” better distinguishes its relevance in comparison to the category “transmission via fomites” which is very likely epidemiologically less relevant than “airborne transmission”	Considering the lack of strong epidemiological evidence, we think that airborne transmission better fits the ‘possible’ category described as: ‘weak epidemiological evidence suggestive that the infection occurred via the route in question OR strong non-epidemiological evidence that viable virus (i.e. virus that was shown to infect cells in culture) was detected in samples related to a route in question’
Executive summary, Transmission via fomites (p. 15)	As my primary area of research interest, I found that the section related to transmission via fomites extremely thorough and particularly well analysed. Although it is likely that there will never be ideally clear quantification of the risk of transmission of COVID from surfaces, it is likely a mode of transmission if the contamination is of high density, the surface is non-porous and the transmission contact occurs shortly after contamination.	Thank you for your comment, we think that our classification as ‘possible’ reflects your opinion
Concluding Comment	Given the importance of the subject and the amount of work that went into developing this document, it is hoped that the authors will consider establishing a structure to allow for regular update based on the peer reviewed scientific literature which continues to evolve at an extremely rapid rate.	We agree with your suggestion and as per section 5.9, we plan to review the evidence and, if need arises, updating the guidance.
This responder wishes to remain anonymous, United Kingdom		

Section	Comments	Working party response
General	The lay element and the sections that have more general relevance aren't as well separated out as they could be, which means that overall it's not easy to skim read and find the sections you would want the 'non expert' reader to know about.	We will be producing the lay member materials which will be published along this guidance. We hope that this will make it easier for lay members to access the guidance.
Executive Summary, Lines 25-26 P24, HR6, Line 15 P19, Line 1 General	The helpful and positive aspects of the guidance were: "Transmission from COVID-19 patients to HCWs in hospitals appears to be low, unless HCWs do not use appropriate Personal Protective Equipment (PPE)." – helpful "Use respirators designed for filtering airborne particles for any AGPs regardless of a patient's COVID-19 status."- hard to do with all the NIV, even for NON COVID and inadequate side rooms, but it is good that it's a strong statement. "COVID-19 Rapid Guidance Working Party consider SARS-CoV-2 transmission from infected faecal matter to be unlikely." - helpful It is a good summary of the publications, and a good place to start.	Thank you for your generous comments
Pg24, HR3, Lines 3-9	For care of patients not suspected or confirmed to have COVID-19 - there is no mention of facemasks as part of standard PPE.	This is now addressed
Exec Summary Pg2, Line 17	The group justifies their categorisation of transmission via different routes using a new 2020 bespoke classification for intrauterine transmission, which led them to conclude that droplet transmission is probable.	Unfortunately, there is no other framework (neither for this virus nor for other infectious microorganisms), which could be used to capture the probability of transmission via different routes. The existing frameworks either mention the likelihood that infection occurred (but do not mention the route by which exposure occurred) or

Section	Comments	Working party response
	Probable...billions lost from economy, facemasks throughout society, tens of thousands of deaths both directly and indirectly...and the best explanation for this is that it is probable droplet transmission. The guidance uses a 2020 classification. There must already be established classifications for infection transmission. How can there still not be definitive answer to this question? It would be preferable to say either droplet transmission is confirmed or change the categorisation so the document can say something stronger. To the layperson - probable is slightly better than 50:50 or we do not really know. It needs to be clearer what the purpose of the guidance is. Who their audience is? To stop anyone getting infected - body armour approach. To keep R number in society (universities) under 1 - a pragmatic approach. A different approach / advice is needed. e.g., yes, someone may have got infected by sitting on the same seat as someone previously who had COVID. But this becomes non-significant to the R number. So in society one may not disinfect every chair, but in hospital, where zero nosocomial spread is expected - you might.	are limited to vertical transmission. The adapted system was derived from 'Neonatal infection acquired intrapartum' section of the cited document, although we note that we used the term 'intrauterine transmission' erroneously. As per response to another reviewer, we think that the current epidemiological evidence did not establish beyond doubt that transmission occurred via droplet route. Whilst the general opinion is that this is most likely the predominant route of transmission, which we also reflect in our recommendations, we cannot with all confidence state that we found a definitive proof of this occurring in current literature. This fact is true regardless whether we do or do not use the above-mentioned framework. The comment to lay member was passed on and was considered when structuring the accompanying materials for the public. As mentioned in section 5.3 the purpose was to evaluate different routes by which the SARS-CoV-2 virus can be transmitted and to identify the gaps in the literature. Section 5.7 clarifies that the guidance was intended for any healthcare professional but that it may be useful to others, including the public. As such, we provided general comments which should be observed by everyone at all times. These emphasise the importance of hand hygiene and maintaining adequate distance and discourage the use of unnecessary PPE. We feel these are sufficient to prevent transmission in general situations. The more comprehensive recommendations for persons working in health and care settings are listed separately.
Exec Summary, Pg2, Line 26	"Transmission in care homes appears to be very high and needs particular considerations"- what sort of	This section was rephrased. Unfortunately, the reasons for high transmission in this setting have not been addressed in the literature.

Section	Comments	Working party response
	consideration? How can your advice help? This enormously important area should be addressed in the guidance.	We also note that these institutions are different from each other and we cannot comment on specific barriers to maintaining appropriate IPC. We therefore recommend that care homes follow our guidance and that they explore and address their individual issues which prevent them from doing so.
General	The guidance concentrates on blood and bodily fluid PPE advice, yet that is not how you think the virus is spread. The noise to signal ratio in this document is high. Rather than having an updated infection control manual, we need advice for this pandemic.	We rephrased the wording in recommendations to make some of the points we were trying to make clearer: Whilst we think that body fluids do not present the risk to HCWs due to SARS-CoV-2, we need to stress that gloves need to be worn for protection from blood and body fluids in general. This is the principle of standard precautions to ensure healthcare workers do not become infected by pathogens other than SARS-CoV-2 Similarly, we need to stress the importance of general IPC because our experience and anecdotal evidence suggest that infection prevention so far was one-directional, focusing on HCWs protecting themselves. As a result, the rate of infections due to common nosocomial pathogens increased in general hospital patients as well as those being cared on COVID wards
Exec Summary, Pg2, Line 23	Close contact conclusion - it is probable that transmission occurs with close contact. Is this really the best you can say?	Although this seems a little bit obvious, we think it is an important statement to make, especially considering that so many transmissions occur between family members and friends. We rephrased it to make it clearer
Recommendations	The document is an evidence-based focus on causes of virus transmission but the recommendations - wear a facemask here, medical mask there, respirator here - do not have the same attempt at rigour.	We hope that the statement added in the executive summary makes it clearer that by determining the routes of transmission we can determine appropriate ways of protecting everyone

Section	Comments	Working party response
	On what basis are the PPE /infection control recommendations made? How does it link to the evidence? Especially given you cannot confidently say how the virus is transmitted. This should either be a pure science rigorous paper that makes no recommendations and leaves that to others or it should seek to be something useful that makes recommendations.	
Dr Sadia Shakoor, Aga Khan University & Hospitals, Pakistan		
Page 3 line 15 GR8	I agree with the guidance for the general public that airborne respiratory protection is not required, especially if other guidance is followed (or enforced in public places). However, I feel that it is important to further explain that airborne transmission potential is present in rare circumstances, especially in closed spaces without adequate ventilation and with infectious persons in close quarters. Such circumstances may exist in crowded settings or work environments that constitute 'public spaces' – such as shops and malls, gyms/ other community congregate settings etc. I would suggest that the guidance be rephrased as: *Do not use masks and respirators specifically designed for protection against airborne organisms.* ***Available evidence suggests that transmission via the airborne***	This was changed as suggested

Section	Comments	Working party response
	route is inefficient and highly unlikely in well-ventilated, open spaces. The good practice point that follows also supports this further.	
Page 4 lines 4-19 (HR4-6)	Please consider the following: 1. Patient placement is an extremely important feature of droplet precautions, and as such should be outlines here for all healthcare staff (including administrators) and especially for re-purposed healthcare facilities in the event of COVID surge. Therefore, suggest updated recommendation with this aspect highlighted: *For care of patients suspected or confirmed to have COVID-19, use contact and droplet precautions* ***(single room, or isolation ward with proper bed distance and with closed doors)*** 2. The PPE outlined is the minimal recommended, therefore please highlight this: *For care of patients suspected or confirmed to have COVID-19, use contact and droplet precautions (single room, or isolation ward with proper bed distance and with closed doors) , and adhere to using following* ***minimal*** *PPE for all activities* 3. It would be helpful to describe eye protection in some detail for the guidance to be as discerning as possible: c. Eye protection ***(face shield or goggles)***	1. This was changed as suggested 2. We wanted to highlight that no other PPE is necessary, and we think the word 'minimal' may be taken as an invitation for HCWs to wear other PPE, which would be inappropriate 3. This was changed as suggested 4. The evidence search found that there is a weak epidemiological evidence for airborne transmission in community settings and no evidence for healthcare settings (unless AGPs are performed). At the moment, it is also not possible to determine whether the virus found in the rooms of COVID-19 patients is viable. In the light of this, we have recommended respirator use should be limited to performing AGPs. 5. This was changed as suggested

Section	Comments	Working party response
	4. As with community settings transmission modes may vary; studies showing longer viability in air are available and this should be considered when recommending medical mask alone which can compromise healthcare worker safety especially in patients who are coughing excessively (not common, but possible) and in patients housed in poorly ventilated rooms or wards. Additionally, should hospital space or housing patients become problematic the 3 feet droplet precaution rule may become compromised, increasing the likelihood of airborne transmission due to closed spaces (especially in winters in facilities lacking HVAC) and therefore a recommendation of FFP2 should be made with the condition that at a minimum a face mask with a face shield must always be used if FFP2/ N95 are not available. Therefore, the following should be added to the recommendation: ***Where available it is preferable to use an N95/FFP2 or higher grade respirator is preferable to a medical mask for routine care of confirmed COVID-19 patients*** 5. While body fluids listed in HR6 are indeed those with low viral loads if at all of SARS-CoV-2, the guidance oversimplifies the issue of recommended protection as AGPs may still require N95 in patients who tested positive especially for ocular procedures (the list includes ‘ocular excretions’). In keeping with earlier	

Section	Comments	Working party response
	comments regarding a preference for FFP2 where available, and in keeping with possibility of transmission from a positive patient in whom a procedure cannot be avoided (e.g. emergency procedures such as removal of intraocular foreign body), a provision should be made for avoidance of unnecessary additional protection in non-AGPs. Please consider: *Risk of SARS-CoV-2 transmission from body fluids (faeces, urine, ocular excretions and sexual body fluids) is unlikely, use contact precautions and appropriate PPE and refrain from using additional precautions (e.g. respirator masks)* ***when exposed to non-aerosol generating procedures involving these body fluids****.*	
	As an editing note, HR6 guidance should appear before HR5	The recommendations have changed order following this and other feedback
Dr Giuseppe E Bignardi, Retired Microbiology Consultant, United Kingdom		
Section 8	Epidemiological evidence of SARS-CoV-2 transmission occurring within households. An overall attack rate of 25% is reported. Would have been useful to know if this was the unmitigated attack rate (with no control measures) or the attack rate in countries at a time when infection control precautions had been issued to household members (minimising time in same rooms, separate bedrooms, and	This information is now included in the report. However, as mentioned in section 6.4, we did not attempt a meta-analysis, therefore the attack rates presented here should only be used as approximate estimations of the frequency at which these transmission events occurred. We thought it was important to highlight that the majority of cases seemed to occur in household within the households and between family/friends

Section	Comments	Working party response
	bathrooms when possible, face coverings when in the same room, hand hygiene).	
Section 8	Epidemiological evidence of SARS-CoV-2 transmission occurring in supermarkets and shopping centres. & Epidemiological evidence for SARS-CoV-2 transmission occurring during church service. Again, would have been helpful to know whether the reported attack rates were unmitigated attack rates or the attack rates experienced after the introduction of control measures (reduced crowding, recommended distance, use of face coverings). Would be useful to know if the reported attack rates were in communities with a high uptake of Covid-19 national apps: in the absence of mobile phone apps under-ascertainment might be significant.	This information is now included in the report, please also see the comment above.
Julie McNally, Royal Orthopaedic Hospital NHS Trust, United Kingdom		
	Document is well designed with valuable information. No alterations necessary.	Thank you for your generous comments
Dr Jeorge Orendi, University Hospitals of North Midlands NHS Trust, United Kingdom		
General	I have enclosed the MS-Word file with name “HIS Consultation SARS-CoV-2 routes of transmission” provided with the consultation, with suggested changes tracked and visible in the ‘Show Markup’ mode	Thank you, the comments within the document were addressed

Section	Comments	Working party response
General	The authors have completed an excellent and extensive manuscript with a review of routes of transmission as well as recommendations on prevention of transmission in healthcare settings and in the general community	Thank you for your generous comment
Title	The paper provides guidance on prevention of transmission as well as a review of routes of transmission; both should be referred to in the title	This was addressed
Executive Summary	As reviewed in Richman-D et al. in: Clinical Virology, 4th Ed., 2017, ASM Press, Chapter 52. Coronaviruses, the enforcement of droplet an contact precautions was strongly associated with protection against SARS-CoV-1 and MERS-CoV, and the unusual stability of the virus likely predisposed it to spread via direct or indirect contact. Risk factors associated with SARS outbreaks in hospital wards were narrow space between beds, lack of availability of washing or changing facilities for staff, performance of resuscitation on the ward, and the use of oxygen therapy or BIPEP (bilevel positive-airway-pressure ventilation); (YU-I et al. 2007; Clin Infect Dis 44:1017-25). Similar to SARS-CoV-1, SARS-CoV-2 is a betacoronavirus that via a spike protein binds specifically to a metalloprotease expressed on many human cell types: angiotensin-converting enzyme 2 (ACE2). Hence, the modes of transmission is likely to be similar. Modes of transmission were also studied in experimental animal models using mammals	These are excellent points, although we still think that strong epidemiological evidence for fomite transmission is lacking. Therefore, we think that fomite transmission better fits the 'possible' category described as: 'weak epidemiological evidence suggestive that the infection occurred via the route in question OR strong non-epidemiological evidence that viable virus (i.e. virus that was shown to infect cells in culture) was detected in samples related to a route in question' However, we still acknowledge the importance of fomites as a possible route of transmission and we make specific recommendations to prevent transmission via this route.

Section	Comments	Working party response
	susceptible to severe disease caused by the same coronavirus strains, such as cynomolgus macaques, African green monkeys, common marmosets and transgenic mice. The authors of the current manuscript reviewed the literature of reports providing compelling evidence of the likely role of fomite transmission. Taken together with the unusual stability of the virus, I believe that the transmission route of fomites should be characterised as "likely" instead of "possible".	
Executive Summary	On page 2 I have suggested ordering the different transmission routes by likelihood of occurrence/frequency, and added a further one (blood transfusion and organ transplant). Suggested change re hospital transmission: Similar to the virulent coronavirus strains responsible for SARS and MERS in humans, SARS-CoV-2 has been merciless in exploiting lapses in infection control measures within healthcare settings, relating to the use of Personal Protective Equipment (PPE), hand hygiene, and environmental cleaning.	This was re-ordered as suggested We acknowledge in the guidelines that increased risk of transmission of SARS-CoV-2 has been seen in such situations, e.g., where optimal PPE has not been used
HR3	I have suggested some changes, as shown in MS-Word file. Suggested addition: *) When residents in the region with symptoms suspect for COVID-19 are offered testing for COVID-19, and the incidence per 100,000 is higher than XX, or the test positivity rate is higher than	We have not reviewed the evidence for this and therefore we would not be able to make this recommendation.

Section	Comments	Working party response
	YY %, then treat all patients as suspected for COVID-19 irrespective of symptoms (see HR4).	
HR4	I have suggested some changes, as shown in MS-Word file. Suggested changes a. For aerosol generating procedures (AGP): Protective long-sleeved gown, which is tied around your neck and waist b. For AGP: Gloves with cuffs covering the cuffs of the gown c. For AGP: FFP-3 mask or equivalent d. For non-AGP care/procedure: apron, which is tied around your neck and waist, and bare below the elbow to facilitate good hand hygiene and prevention of transmission of multi-drug resistant bacteria e. For non-AGP care/procedure: Gloves; change gloves and apron and apply hand hygiene between patients f. Eye protection: visor or goggles; remove after a session; spectacles provide insufficient protection g. For non-AGP care/procedure: Medical-grade mask; remove after a session. h. Adherence to the recommended procedure for donning and doffing PPE, with hand hygiene applied before and after	We think these points are now addressed in the table
Survival of viable virus on diffe rent types of surfaces (page 1 6-17)	I have suggested some changes, as shown in MS-Word file. Suggested change: change from 'possible' to 'likely'	As per comment in executive summary, we do not think we can classify fomite transmission as 'probable'

Section	Comments	Working party response
Conclusions	Whilst SARS-CoV-1 also binds to the ACE2 receptor, MERS-CoV binds to dipeptidyl peptidase-4 (DPP4; CD26). The level of infectiousness of a virus depends on many virus, host and environmental factors; a higher affinity for a receptor does not necessarily make a virus more infectious as compared to another virus.	This issue was addressed
Miss Sally Welham, British Thoracic Society, United Kingdom		
HR4	We note that it clashes with PHE guidance as HR4 recommends healthcare workers to wear long sleeved gowns (sleeves covered by gloves) for routine care of all COVID positive patients, whereas in PHE guidance healthcare workers are advised that disposable aprons are sufficient. PHE say gowns required only for AGPs.	This recommendation was revised to better fit with PHE guidance
Mrs Ellie Wishart, Ecolab, United Kingdom		
Page 3, line 9 Page 3, line 27 Page 23, line 15 Page 24, line 5	Recommend to replace the term ‘hand sanitizer’ with alcohol-based hand rub (ABHR), bringing in line with WHO terminology also. Sanitisers are considered to achieve a 3-log reduction and therefore this is not an appropriate term. ABHR are classified as disinfectants and are registered as biocides under Biocide Product Regulations (BPR) in Europe. Disinfectants are considered as achieving a 4-log reduction in microorganisms.	This issue was addressed
Professor Philip Howard, OBE, British Society for Antimicrobial Chemotherapy (BSAC)		

Section	Comments	Working party response
Specific Recommendations	HR5 – Should the list of bodily fluids also include saliva?	We considered your suggestion for including saliva as a separate body fluid, but we think takes part in droplet transmission as it is a part of mouth/nose secretions which are ejected during exhalation
Mrs Maria Cann, MRSA Action, United Kingdom		
Executive Summary	Row 8 Insert 'the' to read 'Advice for the public...' Row 9 Delete 'now' and replace with 'subsequently'. Delete erroneous 'to' at end of line, so it reads 'provide the guidance on how'	These were addressed
Executive Summary	Row 21 Change transmission from different body fluids to 'possible' as effective standard precautions would be necessary to prevent transmission via carers/HCWs, the consultation document makes reference to airborne aerosols arising from infected faecal matter. Furthermore, the consultation document makes reference to the flushing of toilets being involved in transmission, therefore guidance should advise on the closing of toilet lids for carers/HCWs and the public. Flushing the toilet as reported in an outbreak. (Reference 138, 146) Despite recognising 4 SARS-CoV virus to be spread primarily via the droplet route, the WHO study acknowledges that airborne transmission in some circumstances was likely, mainly occurring when aerosolisation of respiratory droplets occurred, although transmission of aerosolisation of other infectious materials (e.g. faeces or urine through flushing) was also possible.	Whilst the opening section mentions that this route is theoretically possible, an assumption which is based on one outbreak of SARS and the unpublished data from SARS-CoV-2, we found little evidence from the published studies that this is happening. Considering the lack of epidemiological evidence for this route of transmission and the weak evidence for the presence of viable virus in body fluids we consider that this route, if possible, is not very efficient and therefore occurs rarely and in certain circumstances. This explains our reasoning for ‘unlikely’ category. Based on the current evidence, we do not know whether closing the lid of the toilet for flushing could reduce the SARS-CoV-2 transmission. The situations described for SARS-CoV and SARS-CoV-2 did not mention this issue but instead described the waste matter travelling vertically via wastewater systems to other flats/apartments situated in the same building.

Section	Comments	Working party response
	138. World Health Organisation. Consensus document on the epidemiology of severe acute respiratory syndrome (SARS). WHO/CDS/CSR/GAR/2003.11 146. Tang S., Mao R.M. et al. Aerosol transmission of SARS-CoV-2? Evidence, prevention and control. Environ Int, 2020; 144:106039	
General	Should vaccination and the potential effects of reducing transmission be cited in the document? If it is outside of the scope of the document MRSA Action UK feel that there should be a statement to this effect and further guidance issued when more is known about the impact of vaccination on prevention of transmission.	We do not think that vaccination is within the scope of this guidance. However, as recommended, we included some reflections about the impact of vaccine.
General	MRSA Action UK welcomes the guidance on routes of transmission and acknowledges the need to provide information for the public and healthcare / key workers. Information needs to be produced in a wide range of accessible formats to ensure the whole population can understand the risks and actions needed to mitigate risks.	Thank you, we agree with this, we will be producing materials for the public which will be published on the Societies' websites together with the guidance for healthcare professionals
Dr Sara Romano-Bertrand, French Society for Hospital Hygiene (SF2H), France		
Line 7 p4	HR4 - Gloves with cuffs covering the cuffs of the gown: SF2H guidelines for glove's use are the same as standard precautions for COVID patient (please see: https://www.sf2h.net/wp-content/uploads/2020/06/Avis-SF2H-gants-5juin2020.pdf). Currently, French recommendations of	Thank you for your comments. However, as this guidance has been written by UK based societies, it is important that we follow our national PHE guidance which states that gloves should be warn as part of standard PPE when looking after COVID-19 patients. We do accept that the use of gloves should be in combination with maintaining good hand hygiene.

Section	Comments	Working party response
	Contact Precautions do not include systematic gloves wearing (https://www.sf2h.net/wp-content/uploads/2009/01/SF2H_prevention-transmission-croisee-2009.pdf) For the specific case of SARS-CoV-2, we consider that: - Hydroalcoholic solution is efficient against SARS-CoV-2, - gloves over-use increases environmental contamination (doi: 10.1016/j.jhin.2004.03.010, https://www.oralhealthgroup.com/features/gloves-spread-disease-and-have-created-an-infection-control-dilemma/…) - gloves overuse increases risk of dermatitis and induce difficulties on application of hand hygiene guideline: 10.1080/10937404.2017.1304741 , https://infectioncontrol2019.co.uk/wp-content/uploads/2017/08/Helen-Dunn-Gloves-and-Hand-Hygiene.pdf) - Glove disposal induces environmental contamination (DOI: 10.1016/j.jhin.2018.10.015 DOI:https://doi.org/10.1016/j.ajic.2010.06.007) Thus for glove's use, SF2H defends that it is more efficient to strictly respect standard precautions regardless of a patient’s COVID-19 status, as proposed in HR3 recommendation page 3 of the current document: “Gloves for all activities where there is a risk of exposure to blood or body fluids or when handling 25 contaminated devices. Immediately remove the gloves at the end of activity and decontaminate 26 your hands using soap and water or alcohol gel before the	

Section	Comments	Working party response
	gloves are worn and immediately 27 after they are removed”	
Dr. Abdullah Yusuf National Institute of Neurosciences & Hospital, Bangladesh		
Page 12, Line 19	Airborne transmission is not possible if it is in open air, well ventilated air. In our Institute, we have collected Covid19 Samples more than 8000 cases. Some of our lab staffs stand beside the patients without full PPE with coverall, gloves and so one, but only 3 pcs of surgical masks and a hand sanitizer which does not cause any infection to them.	Thank you for your comment, we believe your results are in line with our findings from other studies on airborne transmission. Our conclusions based on these findings were that whilst viral RNA was found in air samples of COVID-19 patients, there was no evidence of the viable virus and that epidemiological evidence is inconsistent.
Page 19, Line 22	I have handled a conjunctivitis patient and have found no transmission of COvid19 to the other family members though the family members do not take proper protection.	We believe that this also is in line with our findings. We found no evidence that ocular secretions, regardless whether ocular symptoms were present, were not contaminated with viral RNA and therefore we considered this route of transmission unlikely. On the other hand, we noted that SARS-CoV-2 virus can use ocular surface as a point of entry. This route via ocular surface, which we considered possible, would not require ocular secretions to be contaminated. Instead, the most likely vector for the virus entering this route would be contaminated hands or splashes/aerosols in contact with an eye surface.
Prof Jon Cohen, Brighton and Sussex Medical School, United Kingdom		
Page 15 line 11 et seq	I suggest that the section on fomites is not sufficiently clear about the relative risk, in particular in respect of common domestic fomites (plates, cutlery etc) which is still a concern to some people. I completely accept the evidence, which has been expertly summarised here,	Thank you for your comment. We included a definition of fomites which we hope will make it clearer for the readers that the items mentioned in this comment are included. We believe that ‘possible’ category better fits the description of fomite transmission, since we have found evidence that viable virus was present on surfaces. Since the majority of

Section	Comments	Working party response
	that virus can be detected on, and recovered from some fomites. However, I would respectfully suggest that what is completely lacking is any evidence that, outside of experimental conditions, the infection can actually be acquired from these routes. This is of some economic consequence as well if these recommendations were to be interpreted as needing a slavish adherence to "disinfection" despite essentially no evidence of risk. I would respectfully submit that the recommendation in this section be downgraded to unlikely, and that some specific advice be included in respect of domestic situations.	the cases occurred with close contact, we believe that epidemiological evidence, whilst inconclusive also does not let us to distinguish whether contact occurred via droplet or fomite route. Therefore, as a result, we are not able to exclude fomites are a potential route of transmission. We would also like to draw your attention to the new paragraph included in the epidemiological evidence section, which was included following the feedback from one of the respondents.
Dr Toney Thomas Poovelikunnel, Beaumont Hospital & RCSI, Republic of Ireland		
Title	Routes of transmission of SARS-CoV-2, prevention of transmission and acquisition: joint … (As the guidance suggests how to prevent transmission).	Thank you, this was addressed.
Ex summary, P3, L26-28 P24, L4-6	Conjoined sentence that may not appropriately convey the intended meaning. Suggestion to split it to two parts. Immediately remove the gloves at the end of activity and decontaminate your hands using soap and water or alcohol gel. Decontaminate hands before the gloves are worn and immediately after they are removed.	Thank you, the recommendations was rephrased and this is no longer an issue
P4, L9-d P24, L15-d	Medical grade mask.	This was addressed in the recommendations

<table>
<tr><th>Section</th><th>Comments</th><th>Working party response</th></tr>
<tr><td></td><td>Specify EN 14683:2019, Type IIR and the equivalent UK (BSI), FDA standard.</td><td></td></tr>
<tr><td>Results, P10</td><td>Suggest a PRISMA type flow diagram to account for inclusions and exclusions</td><td>The PRISMA diagram was included in appendix 4 with the reference in section 6.3. Following your comment, we also included the reference to appendix 4 in section 7.</td></tr>
<tr><td colspan="3">Royal College of Physicians</td></tr>
<tr><td></td><td>The document also references full length gowns for all COVID-19 patients, yet our current PHE guidance refers to aprons unless risk of bodily fluid contact. Perhaps the reality is that the PPE recommended by PHE is inadequate to protect frontline workers including care home staff.</td><td>Thank you for your comment, this has been acknowledged and recommendation was changed so that it is now in line with PHE guidance.</td></tr>
<tr><td></td><td>Our experts have some concern about the conclusion that if a health care worker develops COVID-19 its due to non-compliance with PPE. Or exposure via AGPs in undiagnosed patients where FFP masks and other mitigation is not in place. This is not chiming with the reality of front-line staff.</td><td rowspan="2">Our intention was not to criticize the non-compliance of healthcare staff. Instead, we intended to highlight the circumstances when undiagnosed COVID-19 patients were cared for as we think this is the time staff are most vulnerable and likely to acquire the infection. We have changed the wording of the statement to reflect this. Additionally, we recognise that at the start of pandemic healthcare workers may have been inadequately protected due to PPE shortages.
We have been reviewing the evidence for staff screening and management and we believe the data presented in this guidance are accurate and represent what has been discussed in the literature. We appreciate that many front-line staff feel that the risk from patients to healthcare workers is higher. However, we would like to draw your attention to the fact that healthcare workers could be infected from each other as well as within the community. The literature reviewed</td></tr>
<tr><td></td><td>Published guidance has clearly been reviewed but our experts' question whether feedback from colleagues has been reviewed. Our experts noted one of the acute medics had noted infection rates in colleagues in a survey at 63%. Our experts would like to challenge the implication this is poor infection control compliance.</td></tr>
</table>

Section	Comments	Working party response
		suggests that these are significant factors that are usually not considered.
Anonymous		
	The elimination of “fomite” transmission in both these publications on the same incident is poorly described, essentially “no evidence was identified”. What they do not consider is the role of waiters’ hands, collecting used items and then distributing food, cutlery, and crockery. Some used items could be highly contaminated with saliva, particularly if shellfish or shell crab were eaten. It is reasonable that the same waiter(s) attended all three tables and attending to a group of tables in a line one after another is a reasonable thing to do. Contamination of waiters’ hands seems likely; hand hygiene between collecting used items and distributing new items seems unlikely.”	The Working Party would like to acknowledge that this hypothesis is plausible and could only be confirmed or rejected by observing the closed-circuit TV recording from the restaurant, which is not available for public view. The Working Party decided to include this statement as a potential evidence in support of fomite transmission