SAGE meeting paper: Cover sheet

Please complete this cover sheet for each substantive and non-routine paper being discussed at SAGE, unless these details are clearly provided in the paper itself.

SAGE meeting date:	14/05/2020
Paper title:	Transmission and Control of SARS-CoV-2 on Public Transport
Paper ID:	To be completed by SAGE Secretariat
Author(s):	Cath Noakes and EMG members
Supporting papers: (for storage in the repository)	Evidence for transmission of SARS-COV-2 on ground public transport and potential effectiveness of mitigation measures Application of UV disinfection, visible light, local air filtration and fumigation technologies to microbial control
Handling instructions:	No specific instructions
Suitable for publication: (please include reason if not for immediate publication)	Immediately Choose an item. Click or tap here to enter text.
Written on:	18/05/2020
Considered at:	SPI-M ☐ SPI-B ☐ NERVTAG ☐ Nosocomial working group ☐ Environmental and Modelling group ☒ Children sub-group ☐ [Other] ☐ Click or tap here to enter text.
Word count:	Click or tap here to enter text.

<u>Summary of paper</u>

1. <u>Reason for bringing to SAGE (include links to any commissions from SAGE or elsewhere); how does this build on previous SAGE discussions?</u>
   Paper provides evidence for approaches to assess and mitigate risk from SARS-CoV-2 on public transport

2. <u>What are the key conclusions of the paper (and confidence in these)?</u>

   Summarised in the paper

3. <u>What are the key questions to be considered at SAGE?</u>
   Is SAGE happy to endorse this paper

4. <u>Are there any proposed next steps?</u>
   Share with DfT and other relevant government departments

Transmission and Control of SARS-CoV-2 on Public Transport

SAGE – Environmental and Modelling Group 18052020

Key Points

- There is evidence that there is an enhanced risk of transmission of SARS-CoV-2 for both transport workers and passengers on public transport.
- While not covered within this paper, minimising short-range person-to-person transmission using strategies including physical distancing and encouraging public wearing of face coverings remains a key mitigation measure.
- Environmental mitigation measures to minimise transmission during transport operation should focus on high frequency cleaning of touch sites as a high priority. Enhancing ventilation should also be considered where ventilation rates are low.
- It is likely that surfaces within public transport will be contaminated so hygiene measures to enable greater frequency of hand washing/sanitizing should be a high priority.
- Use of UV-C light may be beneficial as a decontamination approach at the end of a day. HPV fumigation may also be effective but it is unlikely to be viable as a daily cleaning approach.

Summary of Evidence

1. We have considered published literature, initial modelling and published statistics relating to transmission of COVID-19 on transport focusing on specific questions on evidence for risk of transmission, evidence for surface contamination and cleaning and evidence for ventilation as a control. This paper is based on evidence up to 16th May 2020.

Evidence for close contact transmission - is there any evidence that people who do very close contact (e.g. body searches) or who do roles such as ticket checks are at a higher risk?

2. There is currently very little data to indicate which specific roles and activities are the highest risk for transmission for SARS-CoV-2. While there is good evidence to suggest that transport workers are at a higher risk of infection, the specific rates among different groups of workers and the mechanisms for transmission are not clear.

3. There is very little evidence from other diseases on transmission risks associated with specific roles within the transport sector. A small number of studies highlight drivers (buses, taxis) to be at higher risk which is consistent with that seen so far for SARS-CoV-2.

4. Overall there is high confidence that transport workers are at enhanced risk of infection, but low confidence in the specific reasons why this is the case.

Public transport as a transmission route - is there evidence that people have been infected on transport (for this and other diseases), is there evidence that transport moves the disease regionally?

5. There is a good body of evidence to associate public transport with transmission of respiratory infections from a mixture of epidemiological studies and modelling studies. While some studies show no association between public transport and risk, the overall weight of evidence is towards an increased risk of infection among public transport users. Contact tracing studies generally show transmission only in cases of long exposure over many hours, but this may be a result of the evidential threshold required to demonstrate a causal relation.

6. There is emerging evidence from analysis of COVID-19 outbreaks that public transport is one of the environments where SARS-CoV-2 transmission is more frequently reported.

7. Risk factors for transmission of respiratory infections on transport include proximity to the source and duration of exposure, which is consistent with evidence already presented by EMG for transmission in other indoor environments.

8. Evidence for ground public transport being a factor facilitating regional transmission of infection is limited. While cases of infection in different regions are clearly initiated by people travelling, the relative importance of transmission during travel itself, compared to the activities that people participate in at either end of their journey, is unclear.

9. Overall there is high confidence that some users of public transport have been infected with SARS-CoV-2 while travelling. However there is not yet evidence to understanding how this transmission occurred or to be able to determine the proportion of cases that are associated with transmission on public transport.

How to clean transport - evidence for survival on surfaces including fabrics as well as metal, evidence for methods and frequency of cleaning applied in a transport context. Is there potential for application of enhanced light (visible or Ultra Violet (UV)) and technologies such as Hydrogen Peroxide Vapour (HPV) fogging?

10. The evidence to date indicates with high confidence that SARS-CoV-2 is highly likely to survive for several hours, and probably several days on typical surfaces within public transport. Cleaning of surfaces, particularly those that are frequently touched is likely to be a very important mechanism for reducing transmission. Continuing to promote good hand hygiene and providing additional facilities to enable people to clean their hands more frequently are also important actions.

11. There is good evidence that standard cleaning techniques will be effective at reducing surface contamination by the virus. The details of the relationship between surface contamination levels and viral spread remains unclear. It is also not clear how quickly surfaces become re-contaminated after cleaning.

12. There is high confidence that both UV-C and HPV fumigation technologies will be effective against SARS-CoV-2. There is low confidence that they can be currently be applied effectively in public transport but they may be feasible with appropriate testing to validate the methods in a transport context. UV-C is widely used as a decontamination technology in hospitals, but there is very little evidence for application in transport. There is evidence that HPV or other fumigation techniques are better able to disinfect complex spaces than UV-C. The length of time required and may make both approaches difficult in practice.

13. Both UV-C and HPV have specific safety challenges. HPV is not suitable for use in occupied spaces, and UV-C is only suitable for occupied spaces when occupants are appropriately shielded. Both approaches have potential application as part of a terminal cleaning strategy but only if the right safety precautions are taken.

14. There is weak evidence to support the use of visible light or blue/violet (high-intensity narrow-spectrum (HINS)) light as a decontamination technology that is viable in a transport

setting. Far-UV is a promising technology but is still at an early research stage. There may be benefits in enhancing daylighting in vehicles and transport hubs where this is easy to do, but there is currently insufficient evidence to show that this will have a significant enough effect to merit substantial investment.

Ventilation on transport - is there evidence to link ventilation design/use to infection risk on public transport, including aircraft.

15. Of the three transmission mechanisms (airborne, short range and surface contact), there is medium confidence that short range and surface transmission are the most important for SARS-CoV-2. Ventilation within transport environments is not believed to affect these two mechanisms, and therefore is only considered to affect the airborne route. The relationship between ventilation and exposure to aerosols generally is well understood. However, the uncertainties over the generation of virus-containing small aerosol and infectious dose make it difficult to quantify the importance of airborne transmission.

16. Epidemiological evidence shows an association between poor ventilation on public transport and infection risk for other respiratory disease, including for transmission of tuberculosis and influenza. The risk of infection is higher for multi-hour exposures. Studies of transmission on aircraft indicate that ventilation flows may have played a role in transmission of SARS.

17. There are several modelling studies that examine the mechanisms for airborne transmission including studies that assess the role of ventilation, and preliminary calculations from computational fluid dynamics models show the potential influence of infector location and ventilation scenarios on risk to a bus driver.

18. A small number of studies suggest that increasing ventilation rates will reduce exposure to exhaled pathogens, and one study shows that simple actions such as opening 2 or more windows on a minibus can substantially increase ventilation rates.

19. As risk of transmission is associated with the duration of exposure, improved ventilation is most likely to be of greatest benefit to those who spend the most time on-board vehicles including transport workers and long distance passengers.

20. There is high confidence that increasing ventilation rates in poorly ventilated vehicles will mitigate against transmission through aerosols. There is some evidence that ventilation flow patterns also have an effect, but this is not as strong as the evidence for ventilation rate.

21. While there are not explicit guidelines for what constitutes good ventilation in public transport vehicles, it would be reasonable to assume that the guidance for buildings holds, which recommends 8-10 l/s/person of fresh air, avoiding recirculation of air. In general, most public transport vehicles have high air change rates because they are designed for high occupancy.