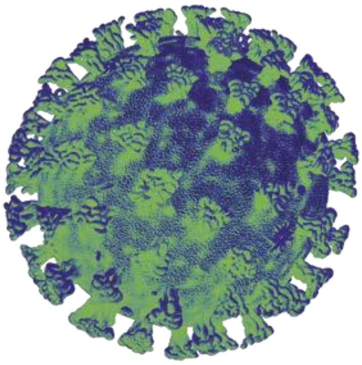
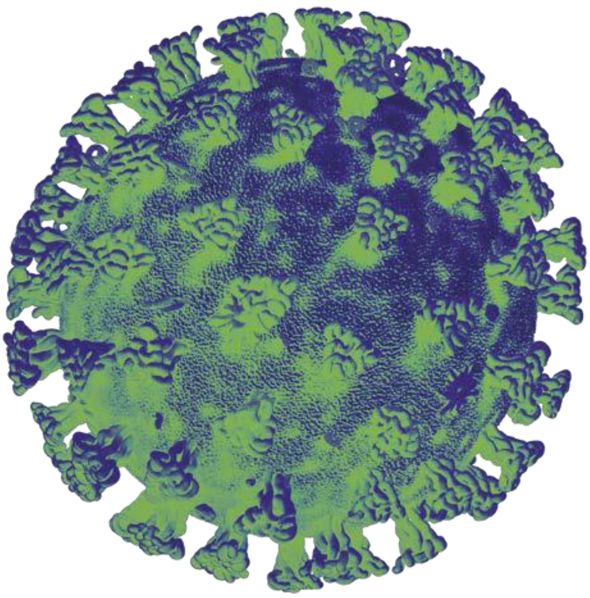
Llywodraeth Cymru
Welsh Government

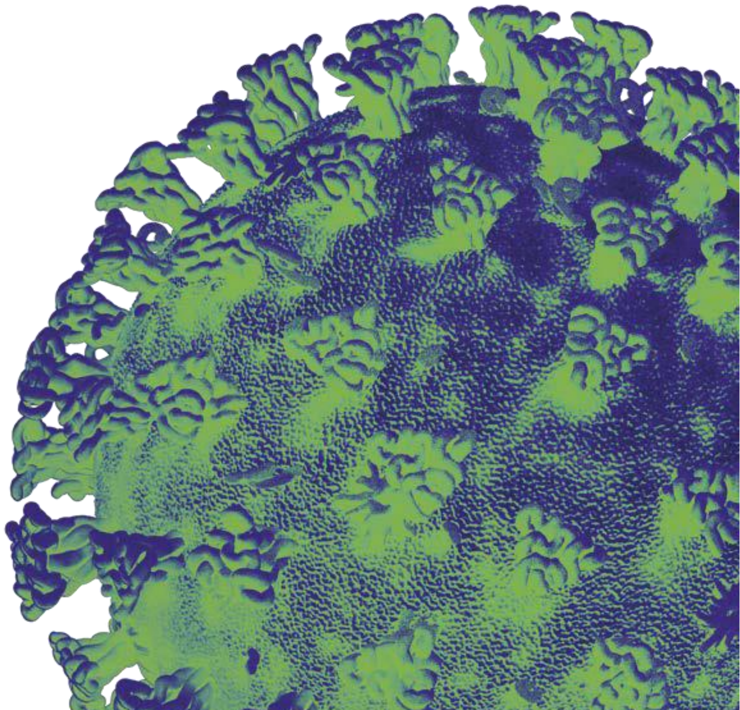
Technical Advisory Group

Review effectiveness and appropriateness of plastic screens in taxis and private hire vehicles (PHVs) for reducing transmission of COVID-19



June 2021





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Review effectiveness and appropriateness of plastic screens in taxis and private hire vehicles (PHVs) for reducing transmission of COVID-19.

June 2021

Summary

- There is strong evidence from many countries, including the UK, that occupations associated with public transport, taxis and private hire vehicles (PHVs) have a higher risk of being exposed to SARS-CoV-2 and developing COVID-19 in comparison to the other non-essential occupations.
- There is also evidence that infectious SARS-CoV-2 can persist on interior surfaces of vehicles after an infected individual has vacated the vehicle.
- Although the evidence base is weak, it appears that standard non-pharmaceutical interventions (NPIs) such as social distancing, face coverings and hand sanitizers are only partially effective at reducing the risk of exposure to SARS-CoV-2 in taxis and PHVs.
- There is good evidence that increased ventilation (opening vehicle windows, interior fans without recirculation) generally reduces the risk of the driver and passengers being exposed to SARS-CoV-2 if an infected individual is present.
- Temporary screens/partitions can be fitted to separate the driver from the passenger in taxis and PHVs with the aim of reducing the interior transmission of COVID-19. These screens/partitions come in a range of forms. Three were considered here. Our analysis suggested that all of the available options had potential drawbacks. One of the options was deemed to be of little benefit in preventing viral movement between driver and passenger. The other two options might reduce viral exposure to the driver, but subsequently increase exposure to cohorts of successive passengers.
- At present, there is no experimental or modelling evidence to validate the efficacy of screens/partitions at reducing viral movement within a vehicle.
- We therefore recommend that a combination of modelling, experimentation and behavioural studies are undertaken to provide definitive evidence on the efficacy of NPIs at preventing the spread and persistence of SARS-CoV-2 in multi-occupancy vehicles.
- Due to this high uncertainty, we therefore recommend that the available evidence does not currently support a departure from or modification of current WG guidance for taxis and PHVs.

Background – Current Guidance

- Current (since 27 Jul 2020) WG guidance for taxi and private hire vehicles (PHVs) during the COVID-19 emergency clearly specifies mandatory wearing of face coverings by passengers, unless they are exempt. Taxi and PHV drivers are advised to wear a face covering unless it affects their ability to drive safely.
- In addition, the guidance states that it is important to keep the vehicle well ventilated, and open windows when possible and not to use the recirculated air option for the car's ventilation system when carrying passengers. Provision and use of hand sanitisers, and car cleaning regimes are also specified.
- Guidance specifies that passengers should normally sit in the back seat(s) of the vehicle.
- Currently, in addition to the above, guidance states that the installation of **protective barriers or safety screens** is a decision for licensing authorities, PHV operators and firm/individual operating the vehicle to make based on their own assessment of risk. Specific guidance on safety screens for taxis and PHVs is available from the UK Dept of Transport (3 Mar 2021), but this is additional to the measures set out in guidance on Coronavirus (COVID-19): taxis and PHVs.
- Associated advice is also available for England (e.g. Local Government Association document) and Scotland (e.g. 'COVID 19 - Guidance for Holders of Taxi and Private Hire Licences', 13 May 2021)

Scope

This paper reviews in outline the effectiveness of temporary screens/partitions (not factory fitted) in taxis and private hire vehicle (PHVs) in reducing the transmission of COVID-19 between the driver and passengers in the rear of the vehicle.

It should be noted that there are a wide range of factors that will impact the likelihood of SARS-CoV-2 transmission associated with travel by taxi or PHVs, and this is an area where research is still being conducted. Therefore, the evidence and conclusions may change over time. The two main questions posed by policy colleagues were:

- How effective are temporary screens/partitions (not factory fitted) in taxis and private hire vehicle (PHVs) at reducing the transmission of COVID-19 between the driver and passengers in the rear of the vehicle? How does this advice relate to the different types of screen currently on the market (see attached note).
- A recommendation on whether the fitting of temporary screens in taxis/PHVs is an appropriate measure in reducing COVID-19 and whether it should be recommended to the taxi/PHV industry or whether the existing advice mentioned on the WG website (hand washing, effective ventilation, cleaning the vehicle etc) is sufficient.

Types of screen under consideration

Policy colleagues have asked for a review of evidence surrounding the 3 different types of screen currently on the market:

Taxi Screen options.docx

Scientific evidence

There is strong evidence from around the world that SARS-CoV-2 can pass between individuals in both public and private transportation. In some cases, it has been shown that SARS-CoV-2 can infect individuals who are socially distanced (e.g. far apart on airplanes and buses). This has necessitated the need to critically evaluate potential mitigation options to reduce the risk of transmission within vehicles.

Transmission of COVID-19 is strongly associated with proximity, duration and frequency of contact and community prevalence. The highest risks of transmission are associated with poorly ventilated and crowded indoor settings. For all transmission routes the duration of time a susceptible individual spends in an environment where virus is present will increase the probability of receiving a higher dose and hence an increased transmission risk[1]. The main routes of transmission are highlighted as aerosol, droplet, fomite and direct contact.

According to SAGE, the highest risk for transmission is when people are in close proximity (less than 2 m) which is likely for many passengers and drivers in publicly hired vehicles. This close range transmission may be due to a combination of droplets and aerosols, as well as contaminated surfaces, and it is challenging to disentangle the relative influences of each transmission pathway for transmission at close range.[2]

Vehicle sharing has been associated with transmission of COVID-19 during outbreaks in Wales. Empirical data on SARS-CoV-2 transmission dynamics within vehicles, however, is limited. Aerosol sampling of a private car driven by an individual for 15 minutes with very mild symptoms (no fever or cough) detected SARS-CoV-2 RNA copies in all particle size fractions sampled (<0.25-10 µm) and virus able to infect cell cultures from small particle size fractions (0.25-0.5 µm) during the 15 minute drive and a subsequent two hour sampling period after the vehicle was vacated [3]. A limitation of this study is that it was un-replicated. Further, and also the presence of fungal contamination of cell cultures inoculated with particulates trapped in larger (2.5-10 µm) size fractions. However, virus transmission from drivers to passengers of patient transfer vans has been proven by SARS-CoV-2 genome sequencing in instances where drivers were masked and unmasked. Subsequent airflow experiments using microspheres within the vans demonstrated airflow from the driver throughout the van

[1] https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/887618/EMG_Environmental_transmission-_02052020__1_.pdf

[2] https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/907587/s0643-nervtag-emg-role-aerosol-transmission-covid-19-sage-48.pdf

[3] Lednicky, J.A., Lauzardo, M., Alam, Md M., Elbadry, M.A., Stephenson, C.J., Gibson, J.C., Morris, J.G., 2021. Isolation of SARS-CoV-2 from the air in a car driven by a COVID patient with mild illness. Int J Infect Dis 108, 212-216.

and the authors concluded that physical distancing and face covering use were insufficient without other measures to fully mitigate the risk of transmission. Coupling the effective use of face coverings, distancing to the fullest extent possible and, critically, ensuring high rates of ventilation will be important in providing layers of protection against COVID-19 transmission within vehicles. There is high confidence that increasing ventilation rates in poorly ventilated vehicles (i.e. closed windows, interior fans on a low/off setting) will mitigate against transmission through aerosols.[4]

Taken together, current evidence suggest that taxi and PHV drivers have a higher risk of contracting COVID-19. This is supported by analyses of the incidence of COVID-19 in different occupations in Norway (Magnusson et al., 2020; Fig. 1), Sweden (Billingsley et al., 2020) and the UK (Mutambudzi et al., 2020; Fig. 2).

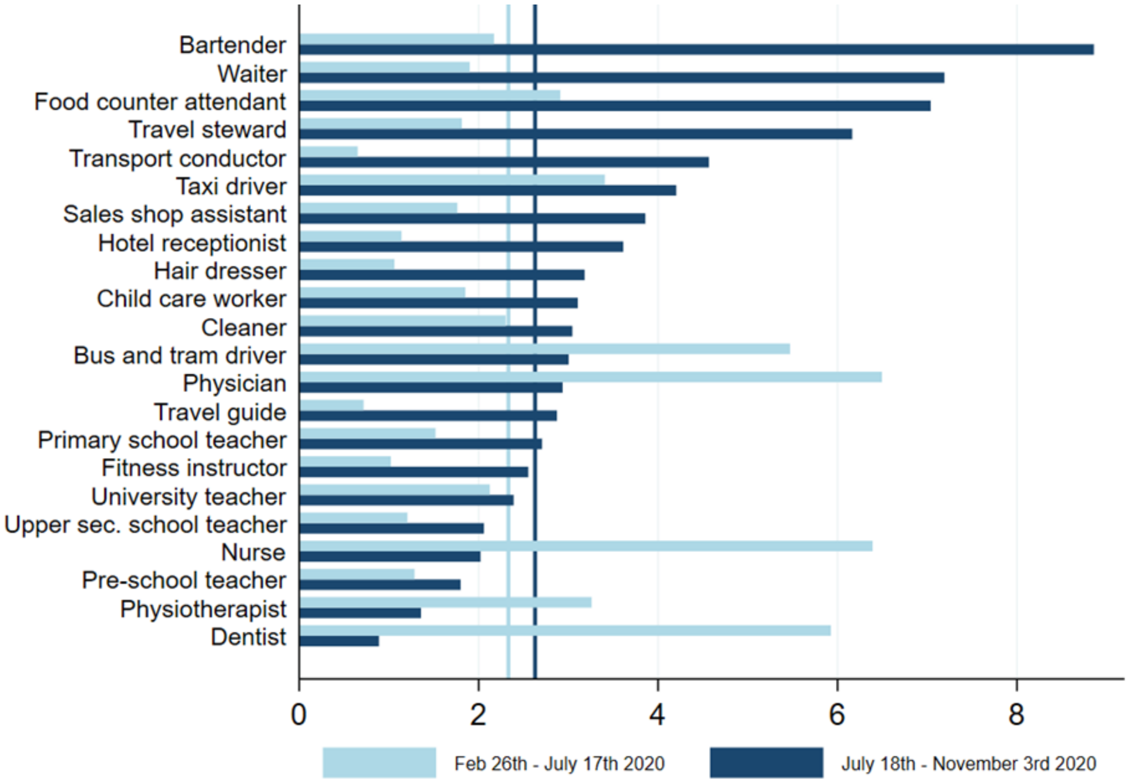


Fig. 1. The number of confirmed COVID-19 cases per 1000 working employees in Norway before and after July 18th, 2020. Vertical lines represent the proportion of confirmed cases for everyone of working age *20-70 years) for the two periods (NIPH, 2021).

[4] https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/887618/EMG_Environmental_transmission-_02052020__1_.pdf

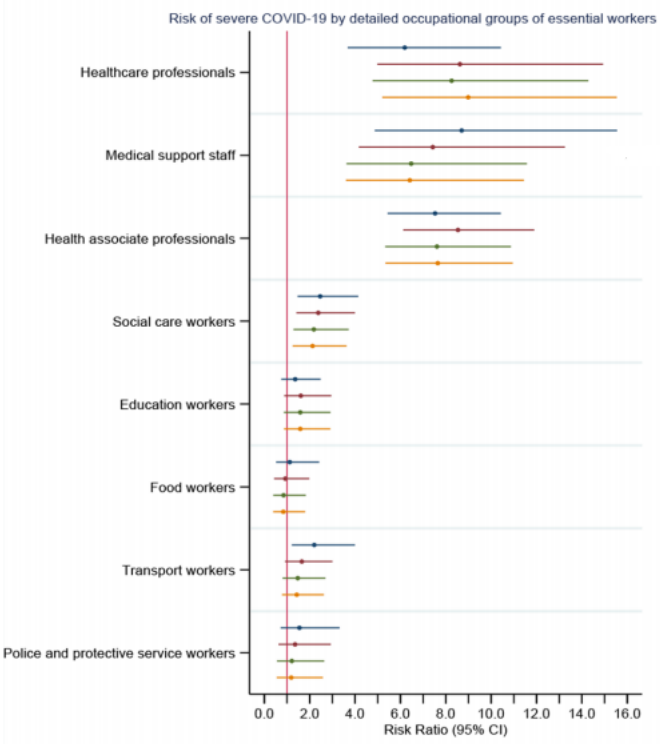
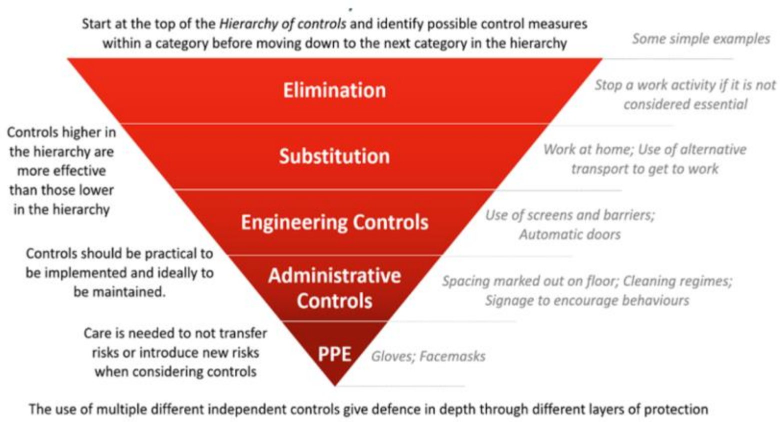


Fig. 2. Risk ratios for the association between different occupations and severe COVID-19. Transport workers had a 2-fold higher risk (Mutambudzi et al., 2020).

According to the HSE's hierarchy of risk control, whilst it would not be possible to eliminate or substitute the work of privately hired vehicles or indeed fully implement the current 2m social distancing, the next most effective layer is engineering controls. Within this context, screens and ventilation would represent engineering controls.



Use of physical barriers in the vehicle interior

Evidence for the effectiveness of screens in preventing COVID-19 transmission is very limited in spite of their ubiquity. Within US educational settings, the use of barriers was not associated with a reduction in COVID-19 incidence whereas the use of masks and ventilation were[5,6,7]. Within office settings, extensive use of plastic sheeting created very low ventilation rates within sheet-enclosed segments of an office resulting in COVID-19 transmission. Although not peer reviewed, the authors reasoned that the installation of sheeting which impedes airflow could result in a false sense of security. Considering smaller particle sizes (< 10 µm) are buoyant aerosols, entrained by their parent airflow, it is unlikely partial screens sufficiently capture these sources of infection[8].

While screens may provide a physical barrier to reinforce distancing and capture larger particle sizes, there is an urgent need to assess whether they occlude transmission from smaller particle sizes or whether their impact is a net negative by impairing airflow. In addition, the placement of physical barriers may lead to restricted airflow in the rear compartment of the vehicle. This has the potential to create a viral-enriched airspace if an infected passenger is present. While this may not pose a risk to the driver directly, it is likely to pose a heightened risk to the next passengers entering the vehicle (both from the air and the greater likelihood that droplets will have settled on surfaces). In addition, if the driver undertakes routine decontamination of surfaces in the rear compartment after the passengers exit, they will be placing themselves at greater risk of exposure.

Based on three designs screen designs for consideration (see above) and the limited evidence/research on this specific area, it is clear that none of the designs can completely mitigate against potential exposure to SARS-CoV-2. Of the three options, the rigid design (#2) is the least suitable as this has limited potential to prevent airflow between the driver and passengers. It may prevent the interior dispersal of some large droplets. Design #1 suffers from a range of drawbacks including (i) its potential to form a ‘potential viral exposure bubble’ in the rear of the vehicle, (ii) how adaptability the design is to different vehicles and the potential for air gaps, and (iii) its ability to remain undamaged over extended time periods. Design #3 is likely to offer greatest protection to the driver, but may increase the exposure risk to successive passengers in the rear compartment for the reasons highlighted above.

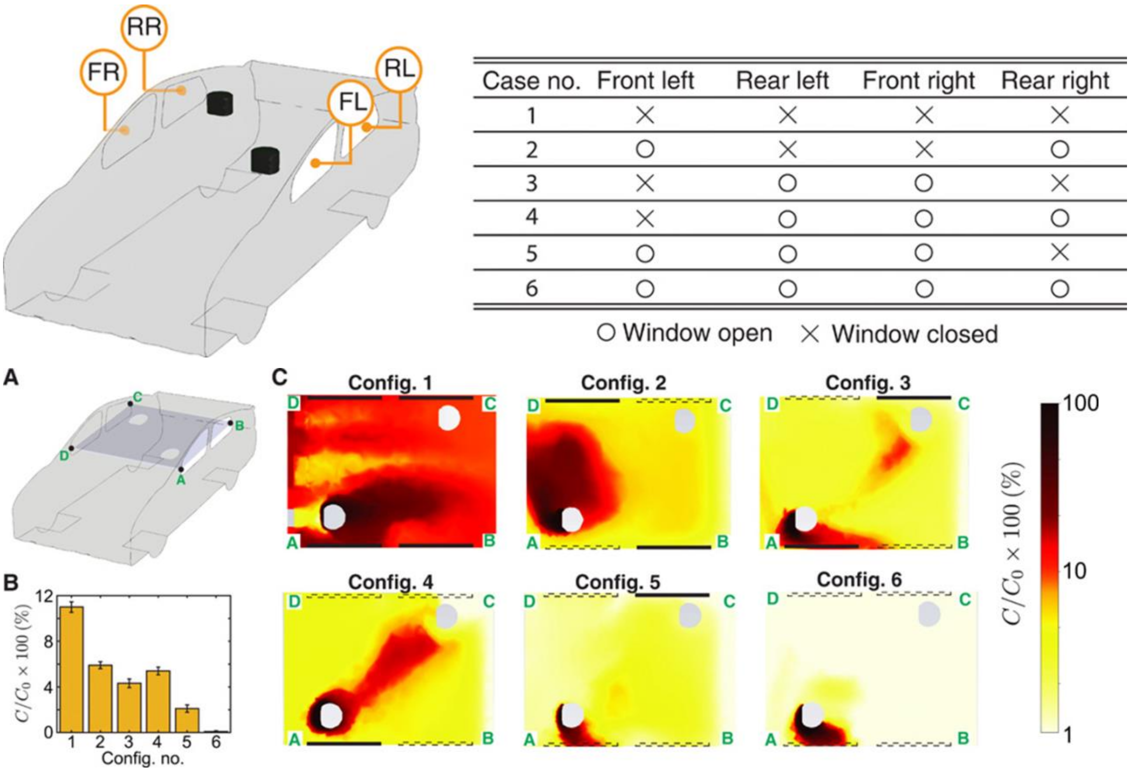
As a personal risk control, face coverings should capture the larger droplets. As an engineering control, ventilation mitigates aerosol transmission risk by dilution and dispersal of SARS-CoV-2 particles. Recirculating air conditioning within vehicles is therefore likely to increase exposure to SARS-CoV-2 aerosols whereas non-recirculating ventilation will dissipate SARS-CoV-2 aerosols to the exterior of the vehicle. This protective effect can be strongly enhanced by opening vehicle windows. Opening all windows, as might be expected, has the strongest positive impact on ventilation. However, airflows created within a vehicle with some windows opened and others closed, could also redistribute aerosols within the vehicle. This question was addressed in a recent study, where cross ventilation by opening all windows maximised the ventilation rate and reduced cross-contamination between different

[5] https://www.medrxiv.org/content/10.1101/2021.03.20.21253976v1.full
[6] https://science.sciencemag.org/content/372/6546/1092

[7] http://dx.doi.org/10.15585/mmwr.mm7021e1

[8] https://www.medrxiv.org/content/10.1101/2021.05.22.21257321v1.full.pdf

sides of a typical car. Intriguingly, while opening windows nearest occupants provided effective ventilation it was less effective than opening the windows furthest from the occupants (Figure 3)



Case no.	Front left	Rear left	Front right	Rear right
1	×	×	×	×
2	○	×	×	○
3	×	○	○	×
4	×	○	○	○
5	○	○	○	×
6	○	○	○	○

Figure 3: reproduced from Mathai et al. (2021) showing the computational fluid dynamics scenario and the relative airflows produced by each. Note the vehicle is a US design with a left-hand seated driver.

Recommendations

In summary, the scientific evidence related to the use of screens for reducing COVID-19 transmission in vehicles for public transport is scant, particularly for taxis and PHVs. **Due to this high uncertainty, we therefore advised that the available evidence does not currently support a departure from or modification of current WG guidance.**

Most of the evidence pertaining to SARS-CoV-2 transmission and persistence in vehicles mainly relates to isolated examples, most of which are not UK-based. Although it is clear from the Test, Trace, Protect programme that vehicles have been implicated in viral transmission between individuals in Wales, the relative importance of this transmission route in comparison to other scenarios (e.g. indoor transmission) remains unknown. Although modelling studies have highlighted the importance of vehicle ventilation in reducing transmission risk, this has not been validated experimentally.

The survivability of the virus in vehicle air and on surfaces also remains largely unknown. This prevents a critical assessment of safe exposure periods and the effectiveness of disinfections regimes between passenger cohorts. In addition, aspects relating to the behaviour of individuals in taxis and PHVs in relation to the adherence to NPIs remains unknown (e.g. after visiting hospitality venues).

Lastly, air flow patterns in vehicles fitted with different interior physical barriers remains untested, especially after long-term deployment. These uncertainties make it impossible to critically evaluate their ability to reduce viral transmission between the driver and passengers, and vice versa. **We therefore recommend that targeted research involving a combination of modelling, experimentation and behavioural studies be undertaken to provide definitive evidence on which to base future policy.**

Post-COVID, this would also be highly beneficial for reducing the transmission of other viral diseased transmitted by air and contaminated surfaces (e.g. Influenza, Norovirus).

Jones, L.D., et al., 2021. Transmission of SARS-CoV-2 on a patient transport van. Clinical Infectious Diseases, ciab347.

Bailey, J.A., Breuer, K., 2021. Airflows inside passenger cars and implications for airborne disease transmission. Science Advances 7, eabe0166.