# Understanding the Risks of Virus Transmission on London's Public Transport Vehicles

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# UCL VIRAL

- https://bit.ly/uclviral
- @UclViral


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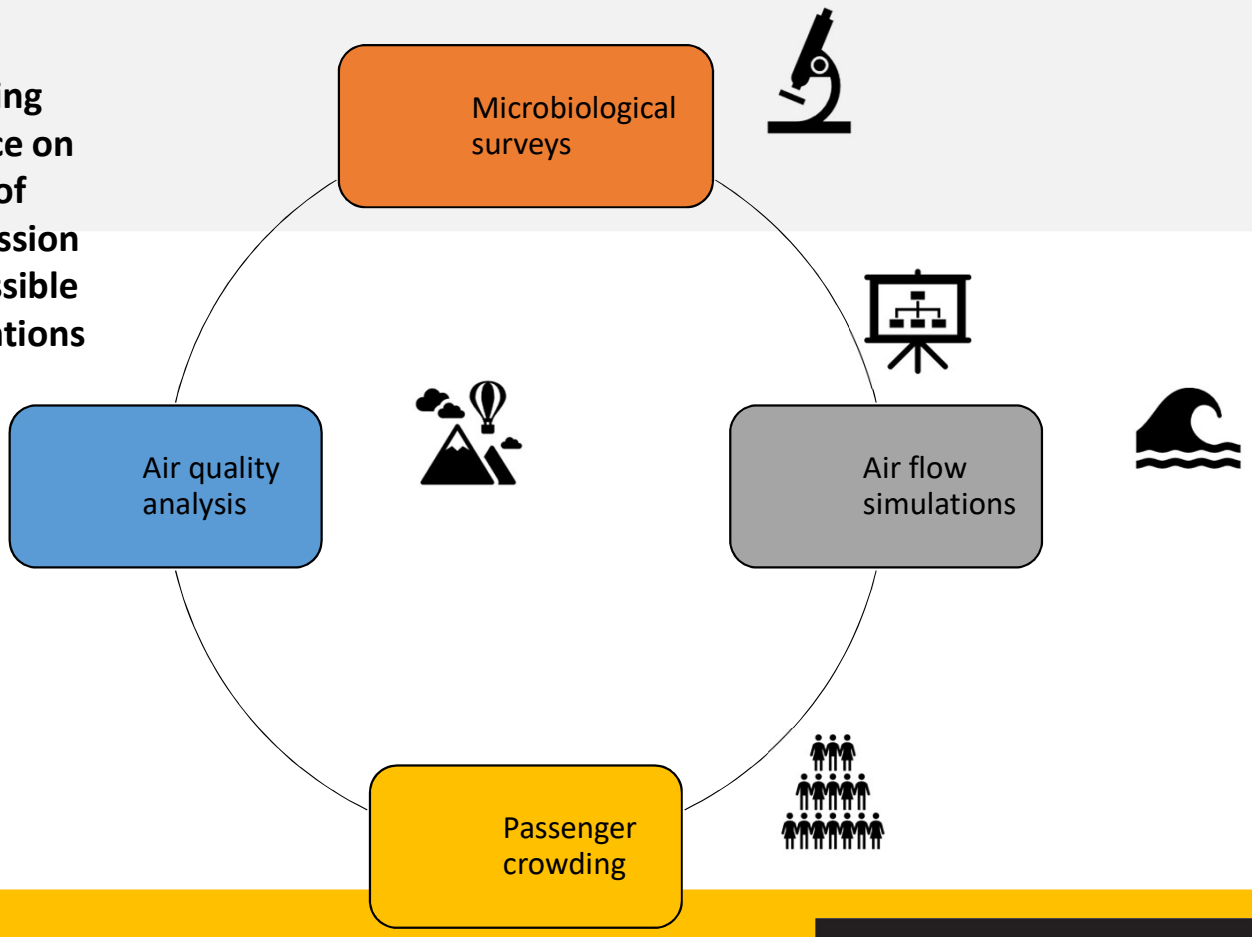
**Building evidence on risk of transmission and possible interventions**

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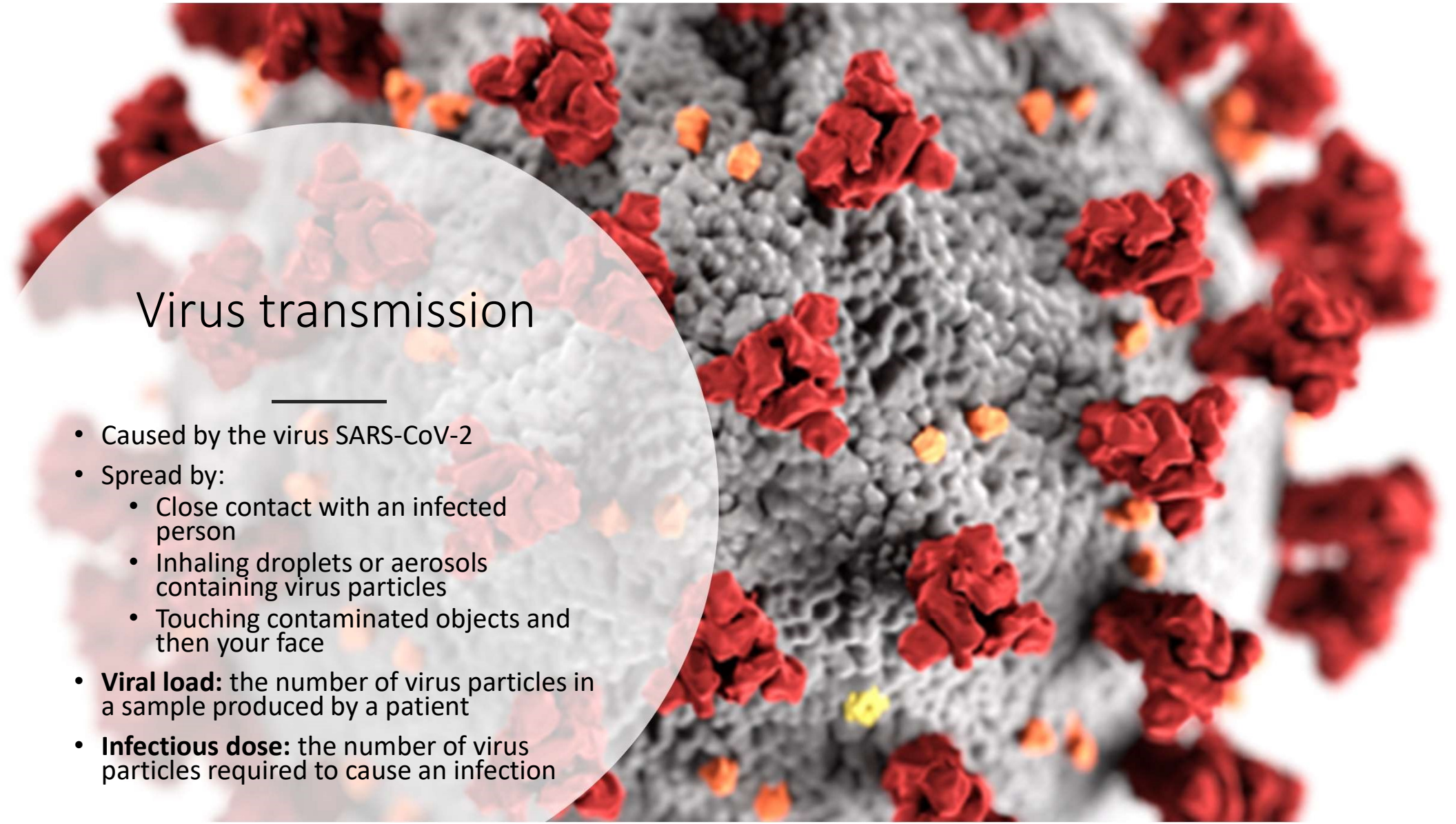


# Virus transmission

- Caused by the virus SARS-CoV-2
- Spread by:
  - Close contact with an infected person
  - Inhaling droplets or aerosols containing virus particles
  - Touching contaminated objects and then your face
- **Viral load:** the number of virus particles in a sample produced by a patient
- **Infectious dose:** the number of virus particles required to cause an infection


How can passengers remain protected in this environment? With their cooperation

# Air quality

- For the first few months of the pandemic, a debate between aerosol scientists and environmental fluid mechanics experts and the WHO on the importance of inhaling aerosols as a route of transmission
- Recognition by the CDC and PHE after several months that COVID-19 can be airborne indoors
- Indoor air quality and high standards of ventilation may play a crucial part in enabling society to adapt to a “new normal” safely
- This applies in all indoor spaces: in residential and non-residential buildings, theatres, shops, schools, and public transport

THE 100 MOST INFLUENTIAL PEOPLE OF 2021

← BACK TO HOME

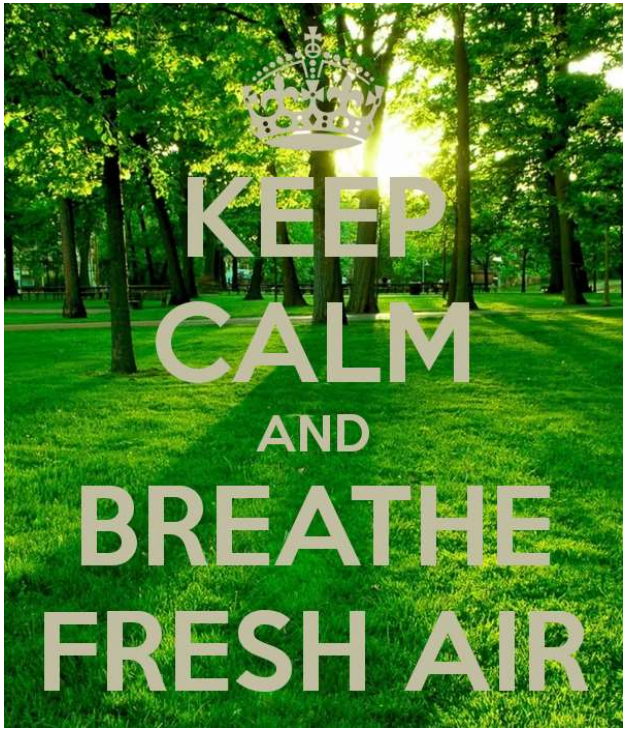
Lidia Morawska

Anthony Weate/QUT

“She assembled a team of more than 200 scientists and public-health authorities to recognize the role of aerosols in spreading SARS-CoV-2 and change how we measure and lessen our risk of contracting the virus. Her advocacy helped change practices everywhere from schools to workplaces, making these environments safer for more people around the world.” - TIME Magazine

# Air quality

- The infectious dose for SARS-CoV-2 is unknown at present and may change with time due to variants
- With early evidence that the initial dose of exposure may affect the severity of the disease, mitigations to reduce the exposure dose can be helpful:
  - Increasing fresh and clean air to lower the concentration of exhaled breath in indoor air
  - Reducing exposure duration
  - Wearing face coverings – ***the more people wear these, the more effective they are***



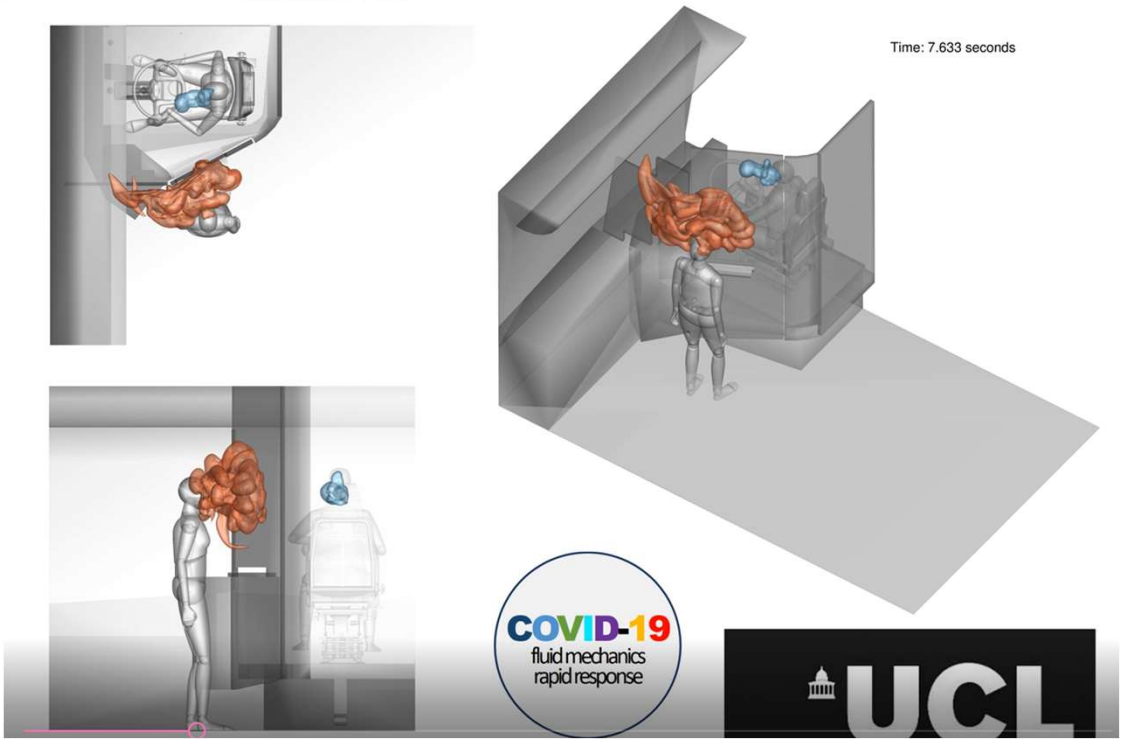
# Computational Fluid Dynamics (CFD) Simulations

**PURPOSE**

- To understand details of airflows and aerosol transport on vehicles/busses/trains
- To investigate interventions to reduce driver and passenger's exposure to virus-laden aerosols

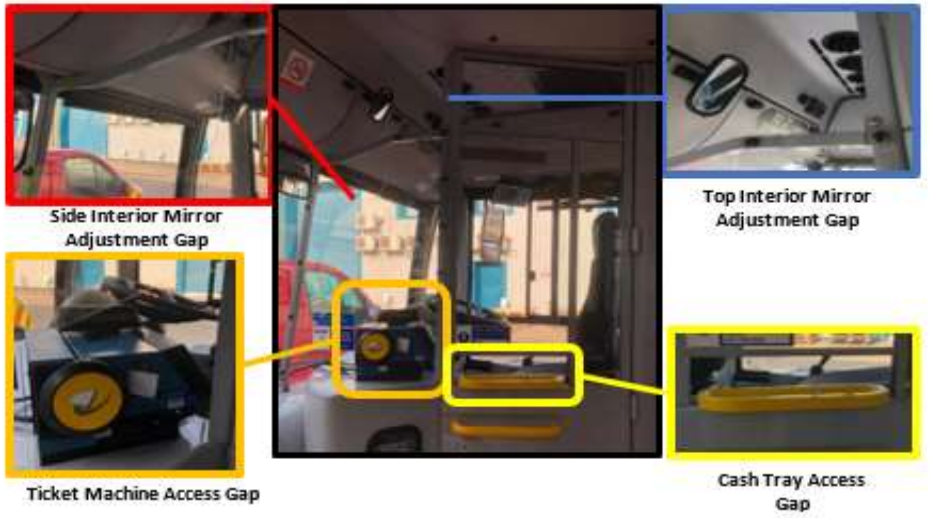
**TOOLS**

- Computational Fluid Dynamics
- High-resolution Large-Eddy Simulations to calculate detailed airflows and concentrations of exhaled breath
- Run on supercomputers

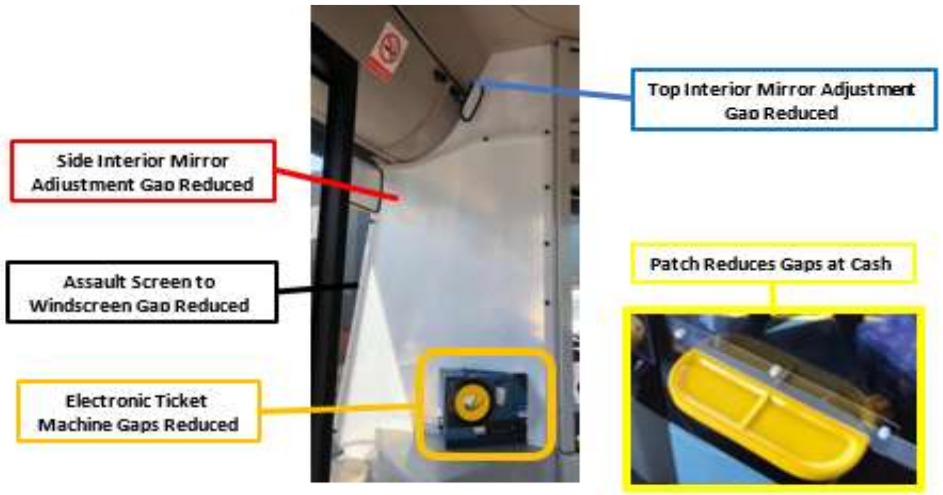


# Modified TfL Assault screens

Following many simulations run over a few months on the Met Office Supercomputer, UCL demonstrated that these modifications would substantially increase the driver's safety on the job




Original assault screen on a bus




Modified assault screen on a bus

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# Studying air quality of bus drivers

**Air flow simulations to test the improved protective assault screen developed by TfL under different conditions**

| Case # | Description | Front Door | Middle Door | Cab Window | Screen Gaps | Speech holes |
|---|---|---|---|---|---|---|
| 1 | Pre-COVID19 | Open | Closed | Closed | Large | Open |
| 2 | Initial Intervention: Seal speech holes | Open | Closed | Closed | Large | Sealed |
| 3 | Middle door boarding | Closed | Open | Closed | Large | Sealed |
| 4 | Middle door boarding and physical distancing (passenger standing 2m back) | Closed | Open | Closed | Large | Sealed |
| 5 | Middle door boarding and cab window open | Closed | Open | Open | Large | Sealed |
| 6 | Modified Screen Design – front door boarding | Open | Closed | Closed | Small | Sealed |
| 7 | Modified Screen Design – middle door boarding | Closed | Open | Closed | Small | Sealed |
| 8 | Modified Screen Design – both doors open for boarding and alighting | Open | Open | Closed | Small | Sealed |
| 9 | **Modified Screen Design – both doors open for boarding and alighting and cab window open** | **Open** | **Open** | **Open** | **Small** | **Sealed** |

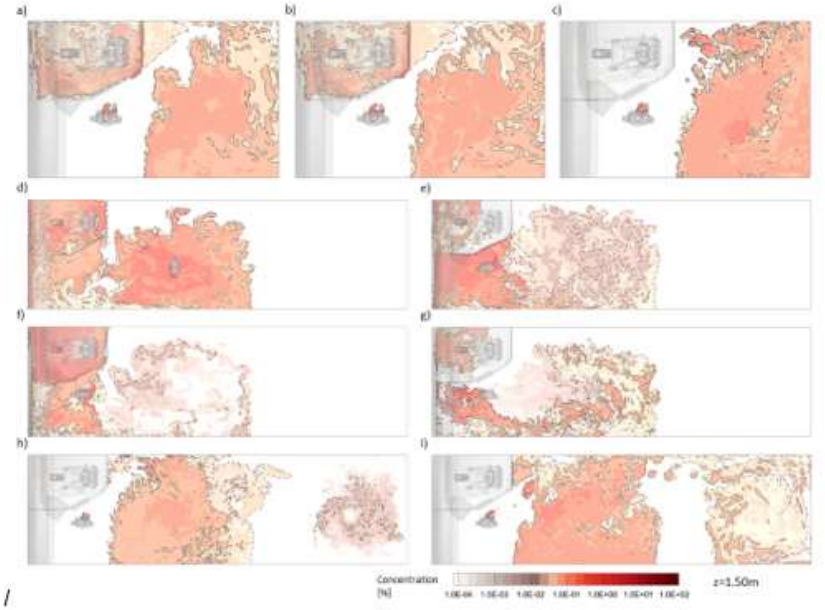

*Figure 14: Scalar Comparison Panel: Scalar concentration plots at z=1.50m for all cases, in a clockwise direction starting at the top left-hand corner, a) S1, b) S2, c) S6, d) S4, e) S5, f) S3, g) S7, h) S8, i) S9.*

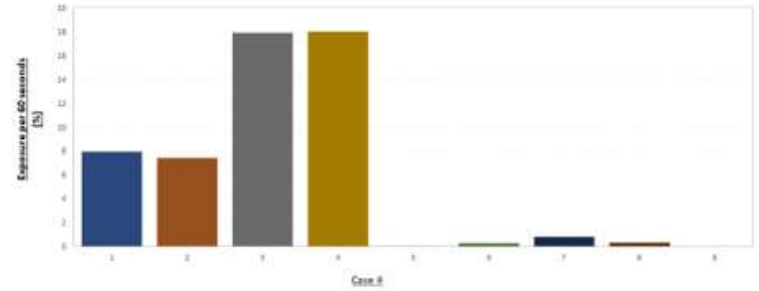

*Figure 15: Total exposure to EB per minute (%) for all cases; EB concentration results taken within the cabin area 5 cm in front of the driver's mouth*

# Air Quality and CFD analysis: Recommendations to TfL


AFP via Getty Images

- Modifications to the assault screens
- Opening the windows in the driver's cab until the ventilation systems could be adapted
- Improve the cab ventilation system to provide high standards of indoor air quality for the driver
- Return to front door boarding and operate boarding procedures such that both front and middle door are opened to increase ventilation on the bus.
- Open windows in the passenger saloon
- Encourage face covering use by passengers

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# Air quality and CFD analysis: Implementation


- Early recommendations on internal air quality and ventilation were implemented by Transport for London
- 1200 buses* were fitted with additional separate ventilation systems for the bus drivers
- Increased protection for bus drivers, improvement in ventilation standards, opening windows, maintenance of ventilation systems, testing and research


* The rest of the fleet already had the required ventilation system

## Current Challenges

- Focus on reducing crowding and increasing fresh air
- Evaluating vehicle performance

## Future Challenges

- Improving vehicle design
- Improving ventilation standards for vehicles

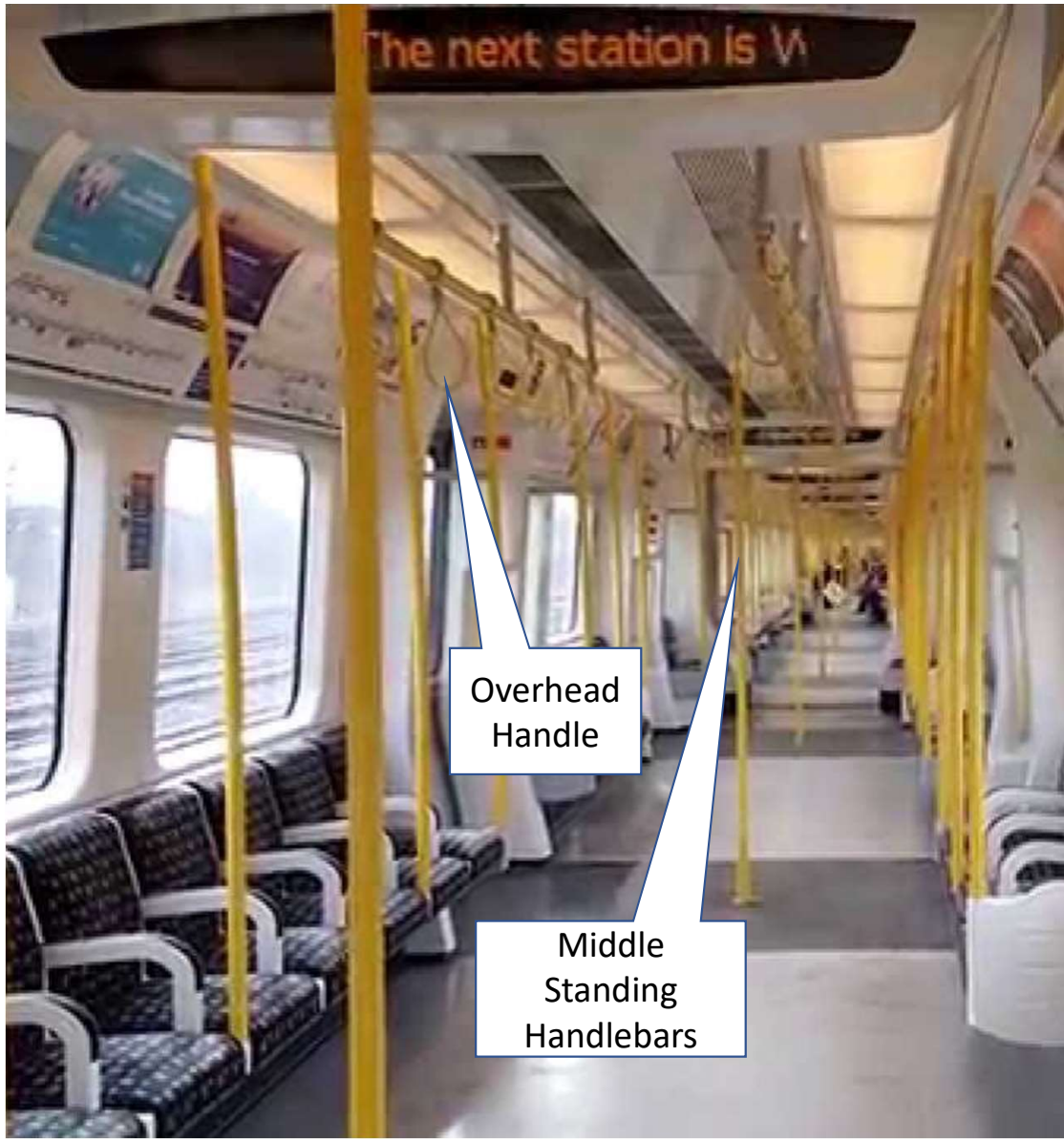
# Surface Sampling

- We are taking samples from surfaces of transport vehicles
- No SARS-CoV-2 has been found*. We are also using the amount of bacteria on surfaces as an indicator
- Some factors behind it would be vehicle crowding: the usage of public transport has been low


* Between Nov 2020 and Apr 2021. Note that the number of cases were low in this period, too.

# Surface Touches

- Although people were already conscious, touches were still made
- Different types of interiors have different patters of touches by passengers. Understanding this would improve vehicle cleaning protocols.
- Level of crowding may affect surface touches



# Risk Assessment framework

- We are integrating our results into our Risk Assessment Framework.

- For example, we are calculating the risk each travelling individual would be exposed to, as well as the risk present at key transport links. This may depend on a range of factors including the duration of travel, congestion of vehicles, etc.

- We hope that our framework would help practitioners.


Thank you for listening.

Any question?