



A Data-driven  
Indoor Air Quality  
Framework  
for Post-COVID19  
Workplace Re-entry

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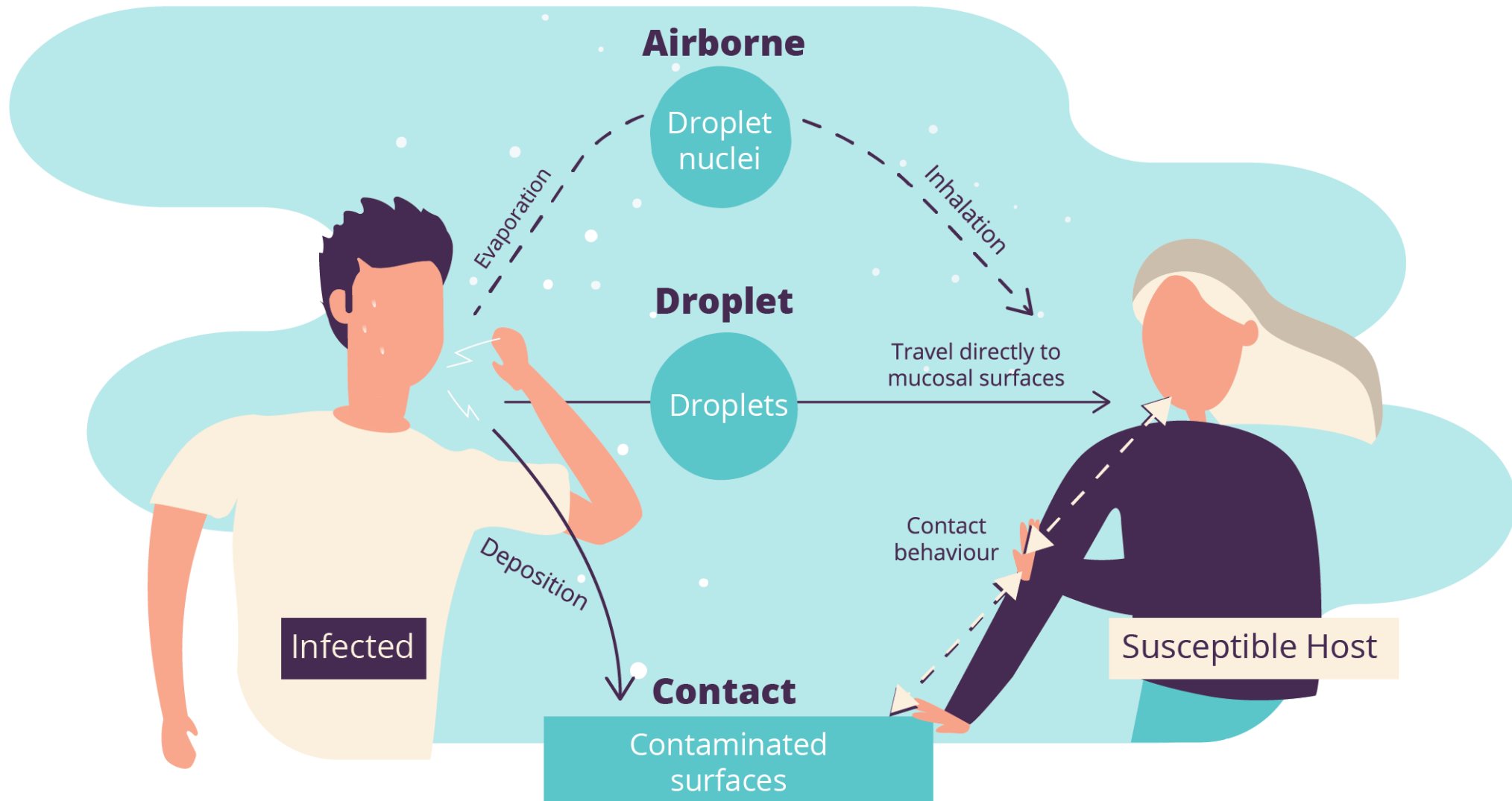


@rastopar, @arbnco

# Caveat

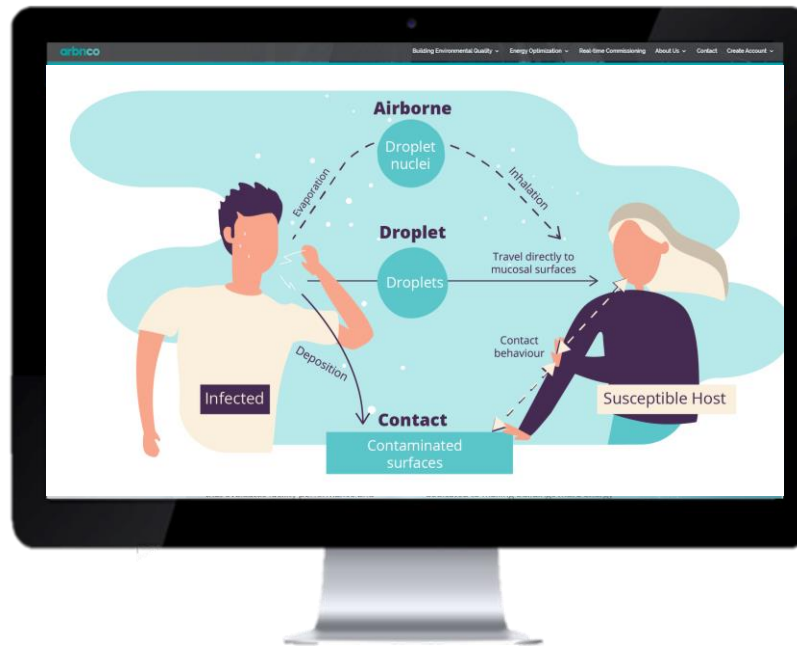
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- The authors have cited sources in good faith and as-is, meaning we assume that the reported results are correct unless proved otherwise.

# Modes of Transmission



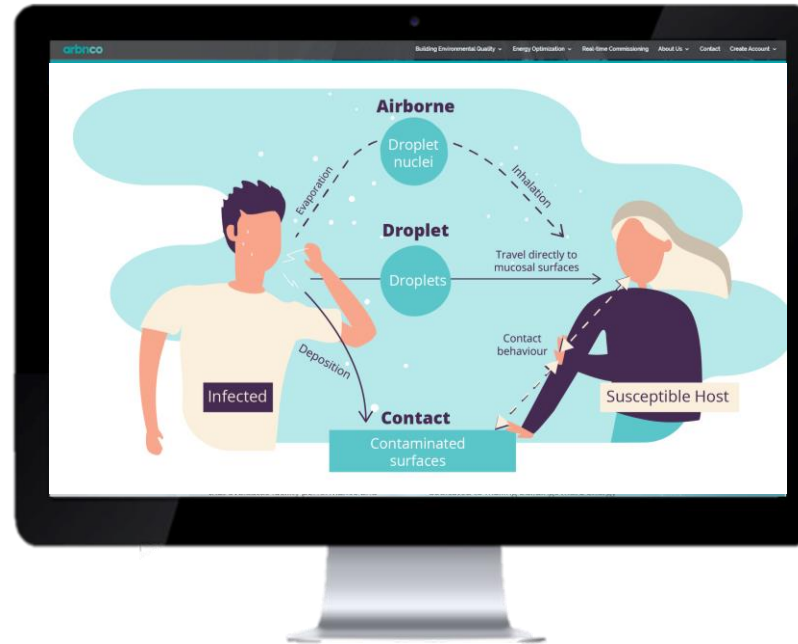
DATA REMOVED FOR DISSEMINATION

Engineering  
and  
Administrative  
Controls



Measure and  
Verify

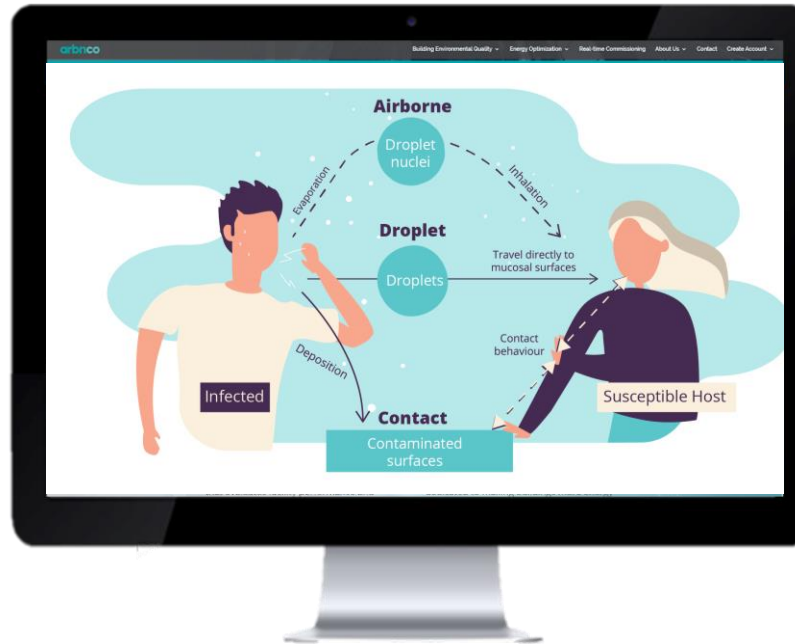
Engineering  
and  
Administrative  
Controls



Inform and  
engage  
occupants

Measure and  
Verify

Engineering  
and  
Administrative  
Controls

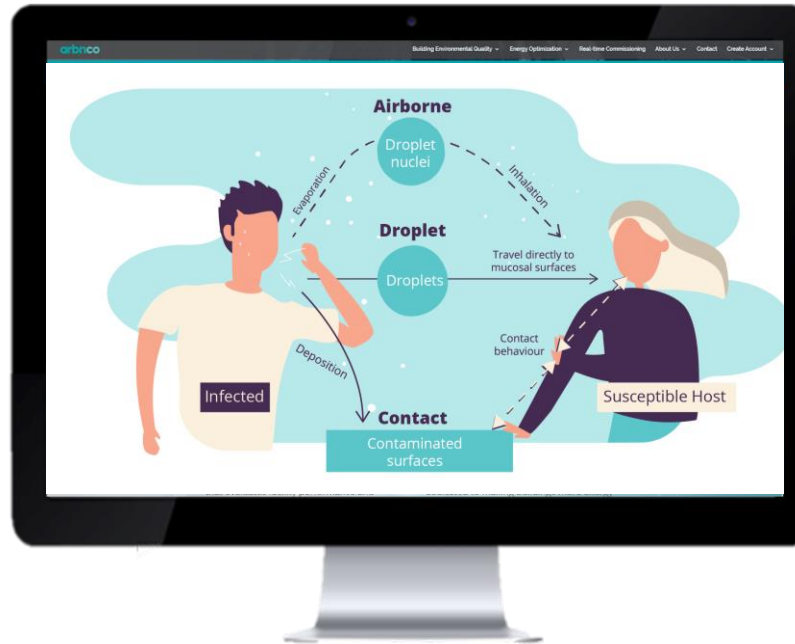


Measure and  
Verify

Inform and  
engage  
occupants

Review and  
Improve

Engineering  
and  
Administrative  
Controls





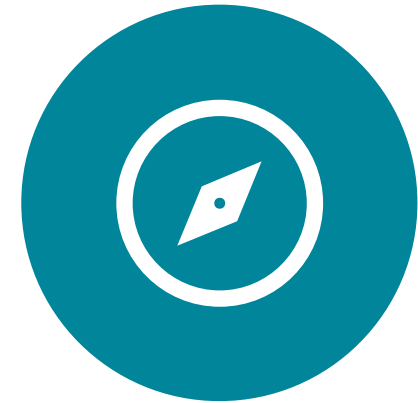
# Engineering controls



Minimum controls  
<  
Best Practice  
<  
COVID good practice



Identify gaps + TODOs



Refer to specific  
guidelines  
(CIBSE, REHVA,  
ASHRAE, etc.)

Questions

# Engineering Controls

From minimum to best practice

# General ventilation

Action	Measurable Outcomes	Unintended Consequences
1. Increase outdoor air ventilation	✓ Lower Carbon Dioxide (CO <sub>2</sub> )	× Increased outdoor PM ingress
2. Increase window ventilation	✓ Lower VOC	× Increased energy use
3. No recirculation		× Uncomfortable air speeds

**Office,  
Singapore**

**All devices**

**DATA REMOVED FOR DISSEMINATION**

Office,  
Singapore

Meeting Room

DATA REMOVED FOR DISSEMINATION

Office,  
London

All

DATA REMOVED FOR DISSEMINATION

Office,  
London

Conference Room

DATA REMOVED FOR DISSEMINATION



Office, London

Conference Room

DATA REMOVED FOR DISSEMINATION

# Air treatment / filtration\*

Action	Measurable Outcomes	Unintended Consequences
1. Improve HVAC filtration to MERV-13 or better	✓ Lower PM ✓ Lower VOC	× Energy penalty × Higher Ozone levels**
2. Upper-room or in-duct UVGI		

\*When recirculating

\*\*For certain UV equipment

Site Office,  
Central  
London

All devices

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Office,  
London

All

DATA REMOVED FOR DISSEMINATION

Office,  
London

All

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# Local air treatment

Action	Measurable Outcomes	Unintended Consequences
1. Portable room cleaners	✓ Lower VOC ✓ Lower PM	× Possibly ineffective for reducing viral load

# Source control / elimination

Action	Measurable Outcomes	Unintended Consequences
1. Toilet exhaust / extract / ventilation	✓ Lower VOC ✓ Lower RH in toilets / bathrooms	× Energy penalty × Noise
2. Toilet operation and flushing		

Office,  
London

Reception

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Office,  
London

Reception

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# General IEQ

Action	Measurable Outcomes	Unintended Consequences
1. Maintain appropriate temperature (adaptive comfort) and humidity (40-70%)	✓ Temperature ✓ RH	× Energy penalty

Office,  
Central  
Scotland  
(rural)

All devices

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Questions

Conclusion

# Why measure outcomes?



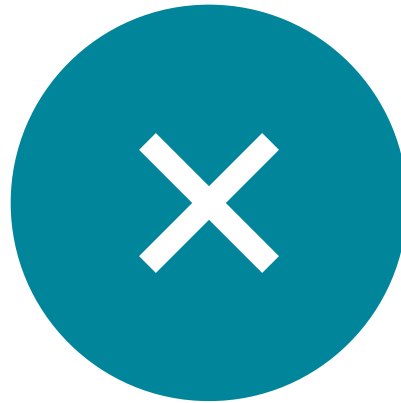
No measurement (PoE)

<

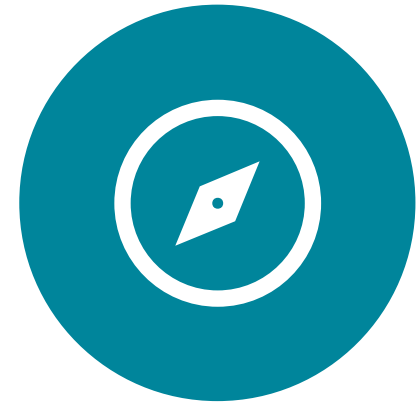
Spot checks

<

Continuous  
measurements



Improper  
implementation can  
inadvertently increase  
exposure



No visibility →  
No direction

# Coverage

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# Occupant engagement



Complaints-only

<

Signage

<

Active engagement and  
encouragement



How policies are working  
+ hazards are developing  
or being controlled  
(OSHA)



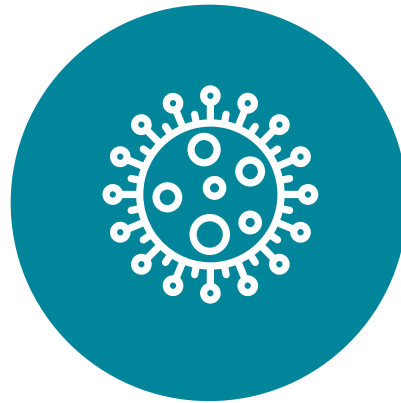
Unmeasurable  
outcomes + User  
acceptance



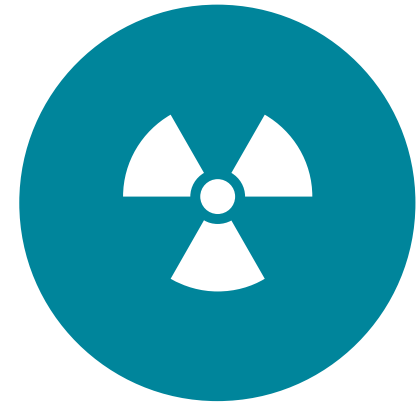
# Conclusion



Buildings impact health,  
esp. quality of indoor air



Airborne transmission  
very likely →  
building-level action



Risk  $\neq$  Zero

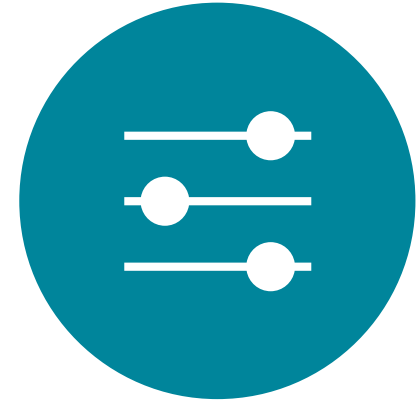
# Conclusion



Not everything applies to  
*every single building.*



Develop a plan →  
follow to the highest  
reasonable level



Review and improve

# Resources

- Rastogi, P., Sobek, O.N., Jephson, G., Allison, J. 2020. *A Data-driven Indoor Air Quality Framework for Post-COVID-19 Workplace Re-entry*. Glasgow, UK. Version 1.3, 25 May 2020.
- **ASHRAE**, 'ASHRAE Position Document on Infectious Aerosols', Atlanta, GA, USA, Apr. 2020. [Online]. Available: [https://www.ashrae.org/file%20library/about/position%20documents/pd\\_infectiousaerosols\\_2020.pdf](https://www.ashrae.org/file%20library/about/position%20documents/pd_infectiousaerosols_2020.pdf)
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- **NICE**, 'Indoor air quality at home', National Institute for Health and Care Excellence, NICE guideline NG149, Jan. 2020. Accessed: Apr. 18, 2020. [Online]. Available: <https://www.nice.org.uk/guidance/ng149/resources/indoor-air-quality-at-home-pdf-66141788215237>.
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- **REHVA**, 'COVID-19 Guidance', *REHVA: Federation of European Heating, Ventilation and Air Conditioning Associations*, Apr. 03, 2020. [https://www.rehva.eu/activities/covid-19-guidance?no\\_cache=1](https://www.rehva.eu/activities/covid-19-guidance?no_cache=1) (accessed Apr. 29, 2020).
- **SHASE and AIJ**, 'Role of Ventilation in the Control of the COVID-19 Infection', The Society of Heating, Air-Conditioning and Sanitary Engineers of Japan (SHASE), Mar. 2020.
- **BOMA**. BOMA: International's Coronavirus Resource Center. *Building Owners and Managers Association (BOMA) International* <https://www.boma.org/coronavirus> (2020).
- **NHS, CDC**, etc.

# Acknowledgements

- Alan Wegienka and the team at arbnco
- Dr Jovan Pantelic
- Dr Chris Pyke

# Aerosols and shedding

- <https://www.youtube.com/watch?v=H2azcn7MqOU>
- <https://www.youtube.com/watch?v=UASi5OUv9Pg>