Impacts of Ventilation and Building Airflows on Indoor Aerosol Transport

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Outline

Which airflows and their magnitudes
Reducing aerosol exposure with airflow
Ventilation suggestions to reduce viral exposure
Summary
Some Key Concepts

Ventilation (ASHRAE Standard 62.1) the process of supplying air to or removing air from a space for the purpose of controlling air contaminant levels, humidity, or temperature within the space.

Every building is different.

Buildings not tight unless built that way.

Air moves based on physics, not design intent.

Airflow has been studied in very, very few buildings.

Outdoor air isn’t necessarily fresh air.

1 air change per hour doesn’t mean all the air in a building is replaced in 1 hour.
Which Airflows

- Mechanical ventilation (filtration)
- Natural ventilation (windows, designed systems)
- Infiltration
- Outdoor air intake
- Mechanical system (HVAC)
- Local filtration
- Portable air cleaners
- Local exhaust

VENTILATED/OCCUPIED SPACE
Magnitudes

Mechanical/Commercial
Outdoor air: ~1 h⁻¹, highly variable, up to ~5 h⁻¹
Supply air: ~ 3 to 5 h⁻¹, higher in healthcare

Mechanical/Residential
OA: ~0.1 to 0.5 h⁻¹

Infiltration
~0.1 to 1.0 h⁻¹
~5 to 1 variation in individual building

Natural ventilation
>1 h⁻¹, hard to measure and predict

Local exhaust
(Residential, 25 L/s to 50 L/s, ~1/4 to 1/2 h⁻¹)

Local filtration
CADR ratings (~Local exhaust flows)
Interzone airflows
Magnitudes similar to airflows from outdoors

Residential
Crawl spaces, basements, attics, ...

Commercial
Return air plenums, plumbing chases, mechanical rooms, ...

![Diagram of residential and commercial buildings with airflow pathways]
Buildings are diverse
USA: 100 million dwellings; 6 million commercial

Building systems vary and matter
Layout, design & controls, occupant activities, operation & maintenance (O&M), …

Ventilation has been studied in very few buildings
Impacts of HVAC & ventilation on aerosol transport in even less
Reducing Aerosol Exposure with Airflow

Build tight, ventilate (filter) right

Overpressure buildings (careful with moisture)

Airflow/pressure from clean spaces to dirty

Commissioning, Operations & Maintenance

Ventilation limited for strong, local sources
“Primum non nocere”
First, do no harm!
- Hippocrates
Some suggestions to reduce viral exposure

**Increase outdoor air ventilation rates**
- System capacity
- Outdoor air quality
- Moisture management
- Assuming good HVAC control

**More efficient filtration**
- System capacity
- Sealing
- Maintenance
Some suggestions to reduce viral exposure

Change relative humidity
Do we know the right number?
System capacity
Condensation potential/microbial growth

Open windows
Outdoor air quality
Moisture
Direction, magnitude, distribution

Change air distribution
System configuration
Options may be limited
Summary

Do no harm

Good ventilation is good practice

Excellent time to check system, review O&M practice (Schoen 2020 and ASHRAE guidance)

https://www.ashrae.org/technical-resources/resources

NIST on-line tool for comparing impacts of ventilation, filtration, etc. on indoor aerosols

https://www.nist.gov/services-resources/software/fatima