What Covid-19 can Teach us about TB Transmission Control – *and vice-versa*

Edward A. Nardell, MD

Professor, Harvard Medical school, Harvard T.H. Chan School of Public Health

Brigham & Women's Hospital

TB vs Covid-19 spread:

TB

- Spread predominantly indoors
- *Mtb* must reach *alveolar macrophage* – 1-5 µm particles
- Environmentally adapted, stable in air
  - Can traverse ventilation systems
- Infectious *dose* can be low (1 – few)
- Chronically infectious
- Mostly symptomatic spread

Covid-19

- Also spreads mostly indoors
- SARS-CoV-2 virus target is *ACE receptors* in respiratory tract, and elsewhere in the body
  - Mucosa of mouth, eyes, nose, airways – 1 to > 100 µm particles
  - Envelope RNA viruses fragile in environment
    - No evidence of ventilation duct transmission yet reported
- Infectious *dose* very high (300-1000 viruses)
- Asymptomatic spread – 48 hrs infectious period

Submitted to *Indoor Air* 15 June 2020

Transmission of SARS-CoV-2 by inhalation of respiratory aerosol in the Skagit Valley Chorale superspreading event

Shelly L. Miller[1], William W Nazaroff[2], Jose L. Jimenez[3], Atze Boerstra[4], Giorgio Buonanno[5], Stephanie J. Dancer[6], Jarek Kurnitski[7], Linsey C. Marr[8], Lidia Morawska[9], Catherine Noakes[10]

[1] Mechanical Engineering, University of Colorado Boulder

Summary:

March 10, 2020, **2.5 hour** choir rehearsal in a church

No one had symptoms

53 of 61 persons present had proven or clinically diagnosed Covid-19

2 people died

Strict social distancing and hand sanitizing

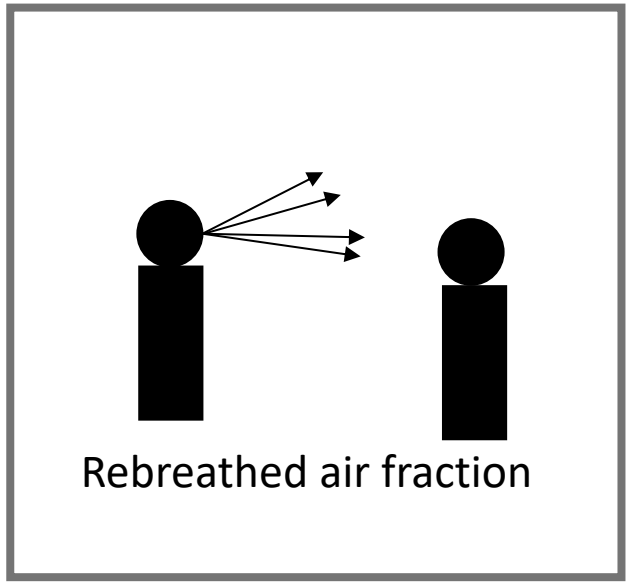
Large droplet and surface spread highly unlikely to account for the extent of transmission

Estimated production of infectious aerosol:

1000 doses per hour (possibly more than one asymptomatic source)

Where is most Covid-19 transmission occurring?

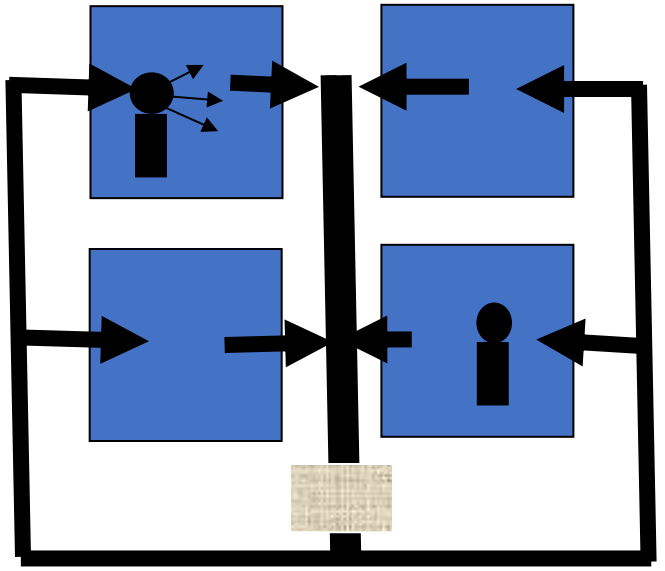
- In the room?



High volume ventilation, Room air cleaners
<u>Upper room germicidal UV (GUV) air disinfection</u>

- Throughout the ventilation circuit?

Dilution and viral damage in return air

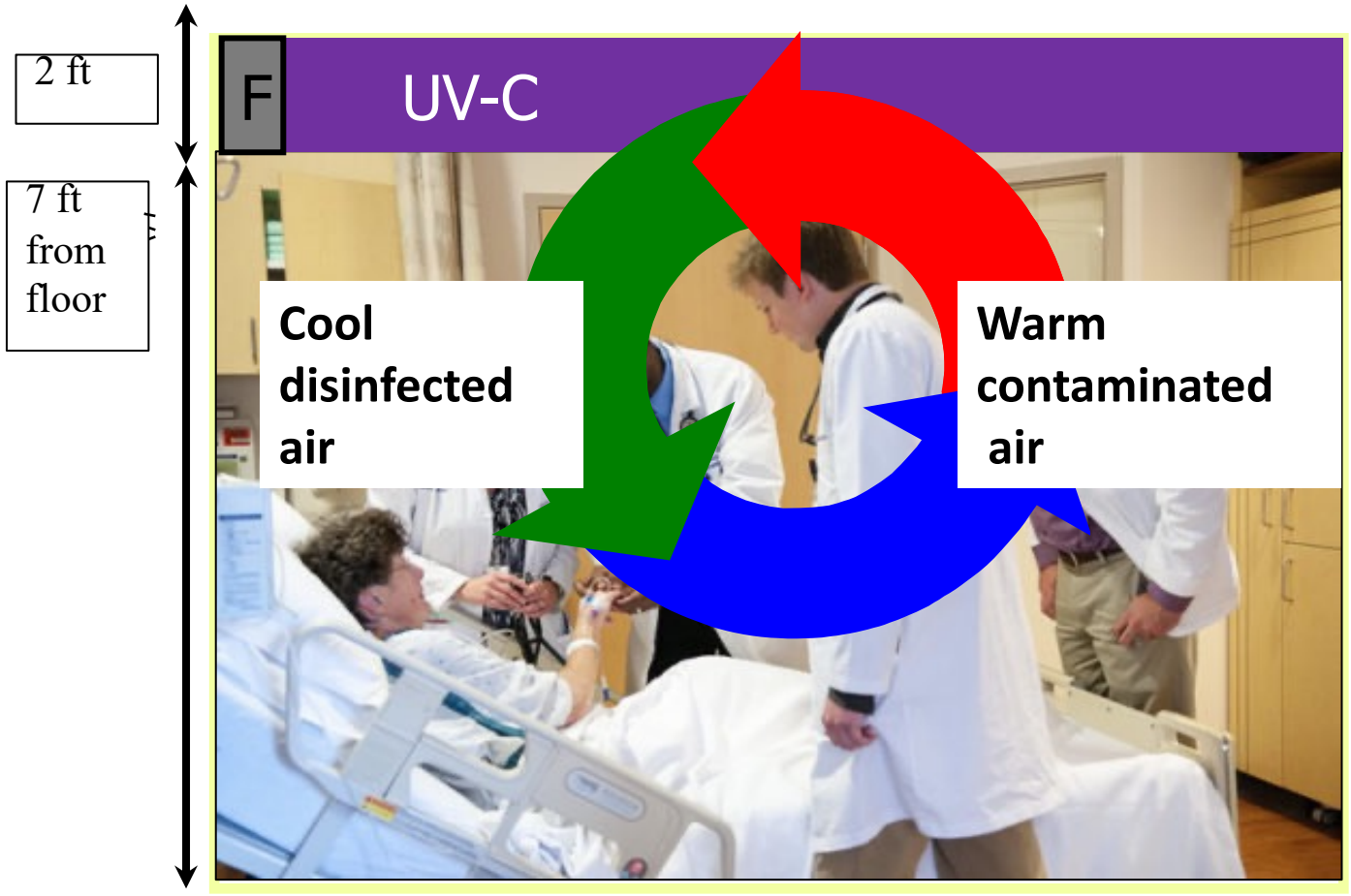


Air filter or UV in return duct

Air Disinfection

1. Natural Ventilation – *variable (and threatened)*
2. Mechanical ventilation – *flow limited*
3. Room air cleaners – *flow limited*
4. Upper room germicidal ultraviolet (GUV) air disinfection
   - Not flow limited – treats large volume of air at once
   - Most economical
   - Safe for room occupants
   - Highly effective against TB and SARS-CoV-2 virus
     - Influenza, measles, etc.
5. New technologies stimulated by Covid-19:
   - 222 nm ”Far UV” – can be used directly around room occupants – currently too expensive but will get cheaper
   - Ion generators (not so new)

Upper Room GUV Disinfects a Large Volume of Air at Once



Low velocity ceiling fans assure good air mixing

Upper Room UVC effectively prevented measles transmission in schools

Wells and Wells Am J Hyg 1942;35:97-121.

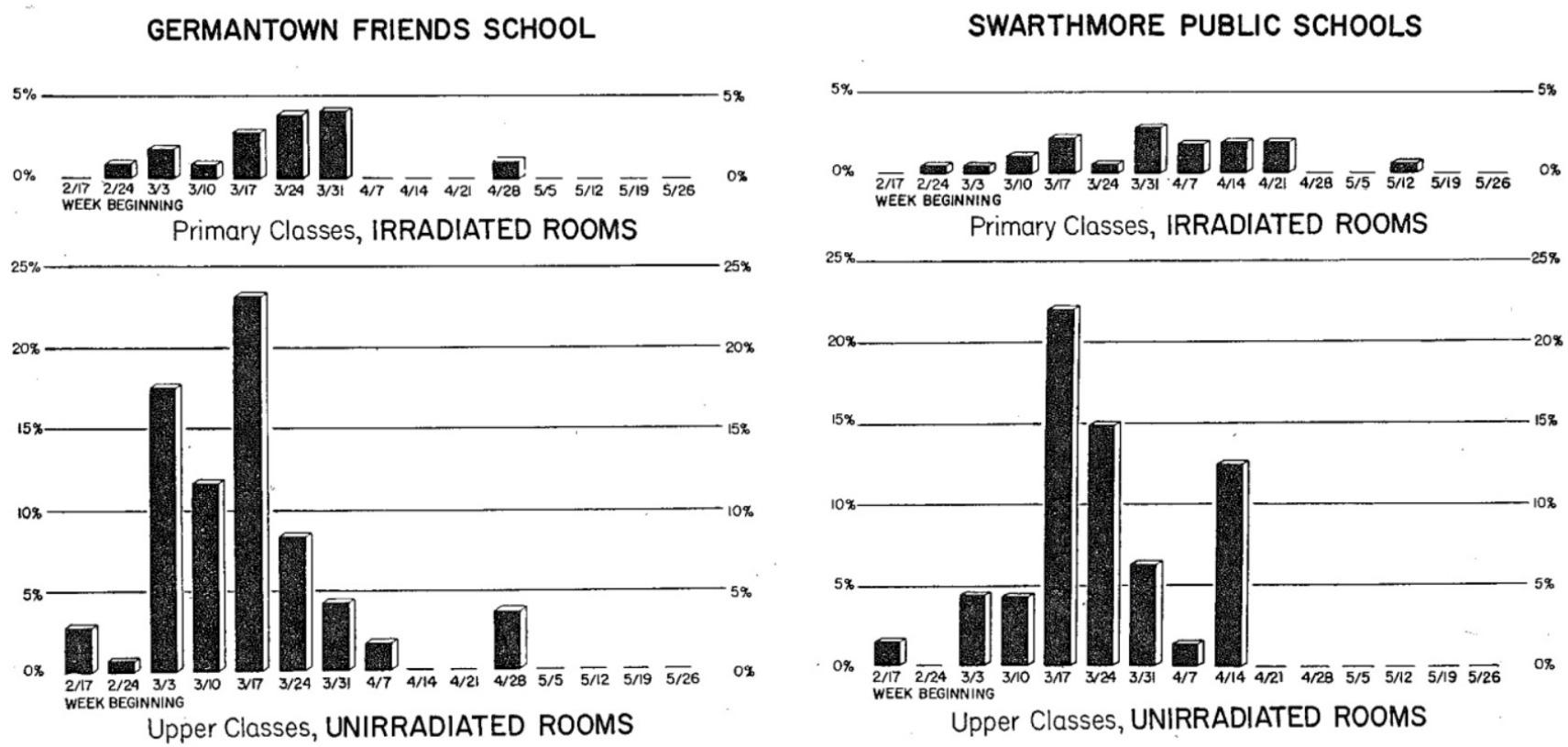


FIGURE 45. MEASLES EPIDEMIC IN PHILADELPHIA, 1941. Weekly attack rate among susceptibles (home secondaries excluded)

ORIGINAL ARTICLE

Institutional Tuberculosis Transmission

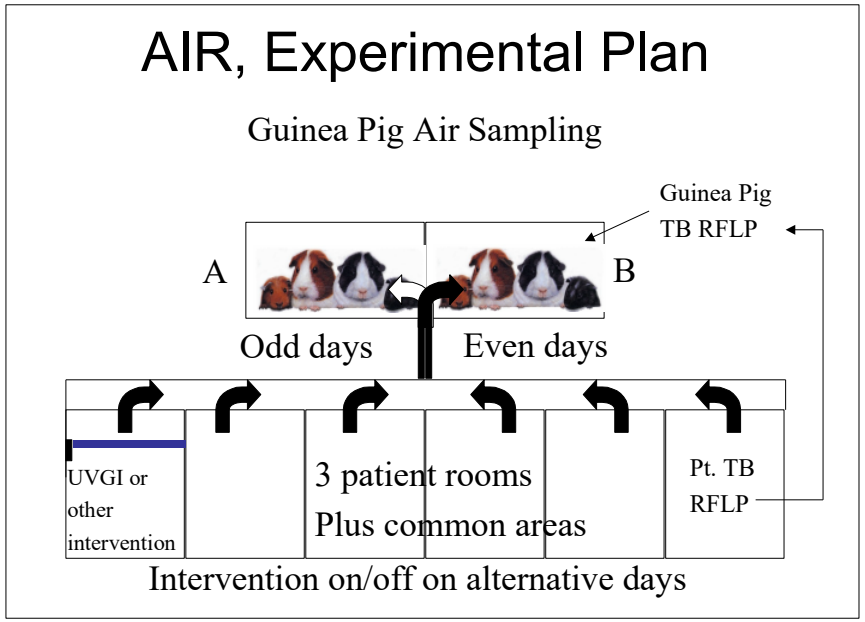
Controlled Trial of Upper Room Ultraviolet Air Disinfection: A Basis for New Dosing Guidelines

Matsie Mphaphlele[1], Ashwin S. Dharmadhikari[2], Paul A. Jensen[3], Stephen N. Rudnick[4], Tobias H. van Reenen[5], Marcello A. Pagano[6], Wilhelm Leuschner[7], Tim A. Sears[8], Sonya P. Milonova[4], Martie van der Walt[9], Anton C. Stoltz[10], Karin Weyer[11], and Edward A. Nardell[2,12]

Upper Room Germicidal Ultraviolet Systems for Air Disinfection Are Ready for Wide Implementation

Shelly Miller editorial

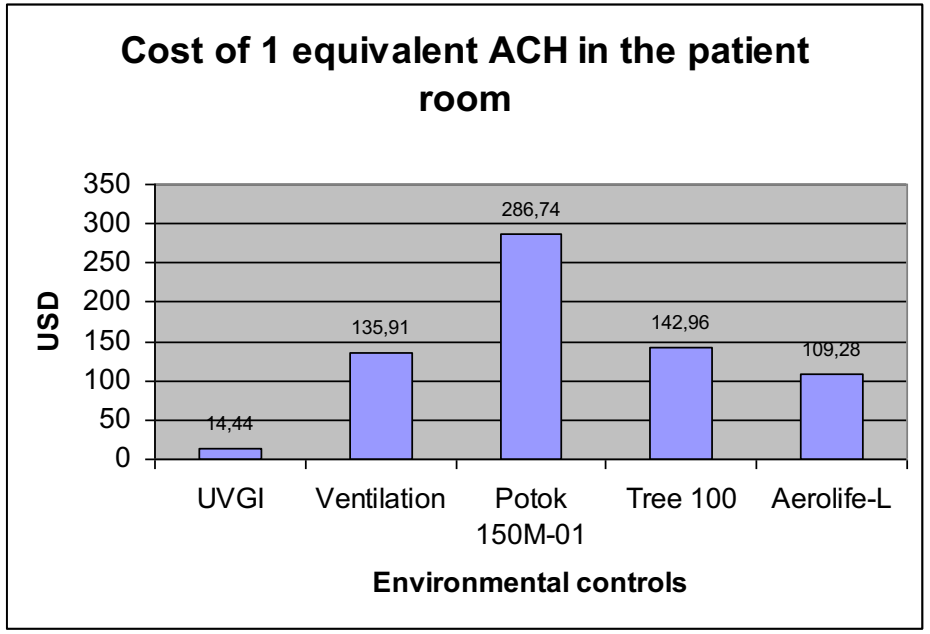
80% effective
Added 24 equivalent ACH

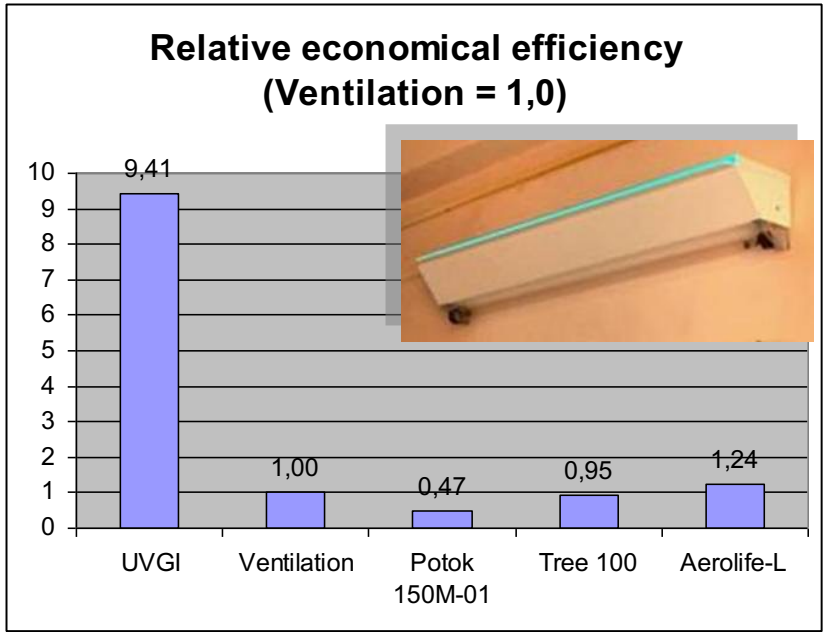


Cost effectiveness: ventilation vs 3 different room air cleaners vs GUV

Grigory V. Volchenkov, MD, Oblast TB Dispensary, Vladimir, Russia
in collaboration with Paul Jensen, PE, IH, PhD (CDC)

Test chamber studies: aerosolized 2 test bacteria, mechanical air sampling

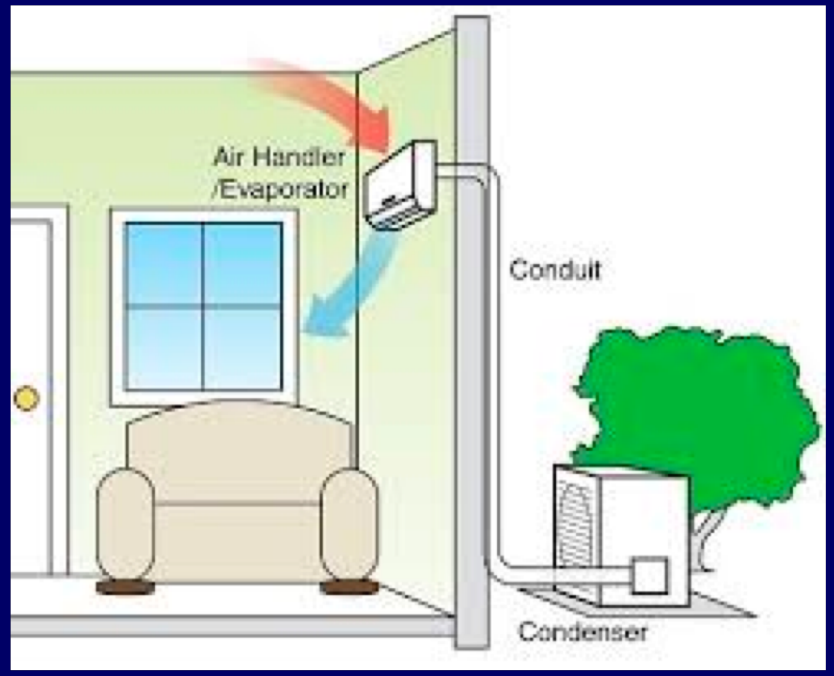




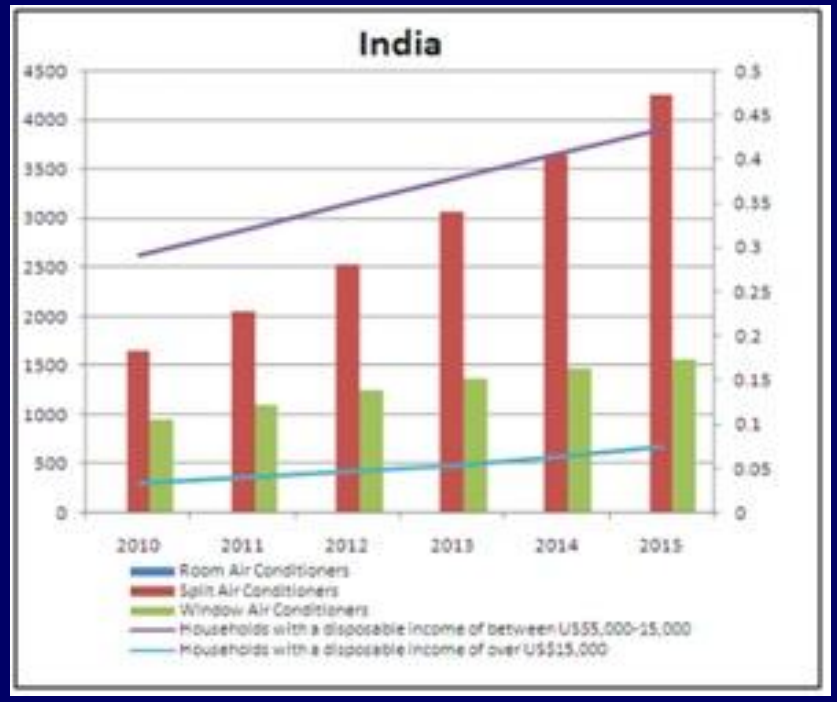
Operating cost per year per Eq ACH

Global Warming: Ductless AC requires closed windows

AC produces little if any air exchanges with outdoor air

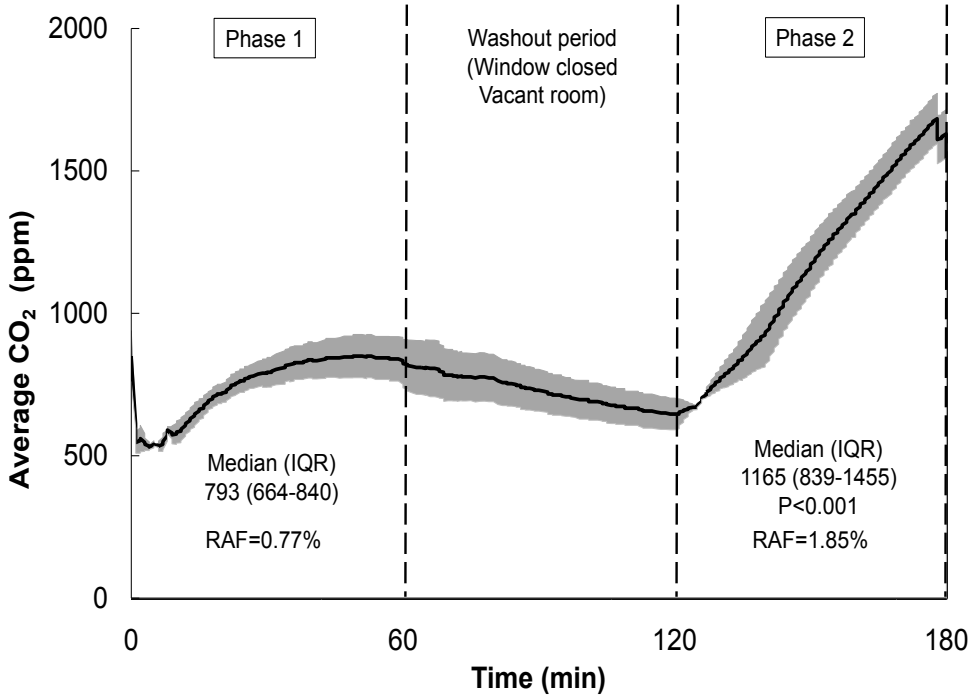


Ventilation reduced by 80% or more



AC sales in India, 2010 – 2015
Red bars are ductless models

Risk of airborne infection increases promptly when windows are closed?



CO_2 measurements over time CO_2 is a good surrogate for Rebreathed Air Fraction and risk of infection.

In one hour after window was closed in an occupied room, the risk of airborne infection doubled!

Received: 10 September 2019 | Accepted: 29 September 2019

DOI: 10.1111/ina.12608

EDITORIAL

WILEY

Cool but dangerous: How climate change is increasing the risk of airborne infections

Indoor Air. 2020;30:195–197.

Summary: *Covid-19 has raised the profile of air disinfection in poorly ventilated buildings*

- Like TB, Covid-19 is predominantly airborne (inhaled aerosol)
  - Large droplet spread and surface spread is relatively less important.
  - RNA found on surfaces and in air is not replication competent
- Unlike TB, Covid-19 is briefly infectious – 48 hrs
- Unlike TB, infectious covid patients are often pre-symptomatic
- TB and Covid-19 spread predominantly indoors
  - TB, measles, etc can spread through ventilation ducts – no reports so far of Covid-19 spreading floor to floor or room to room without close contact.
  - If Covid-19 is not being recirculated, duct filters may not help
  - Room air cleaners are flow-limited
  - Upper room UV is the most cost-effective means of room air disinfection