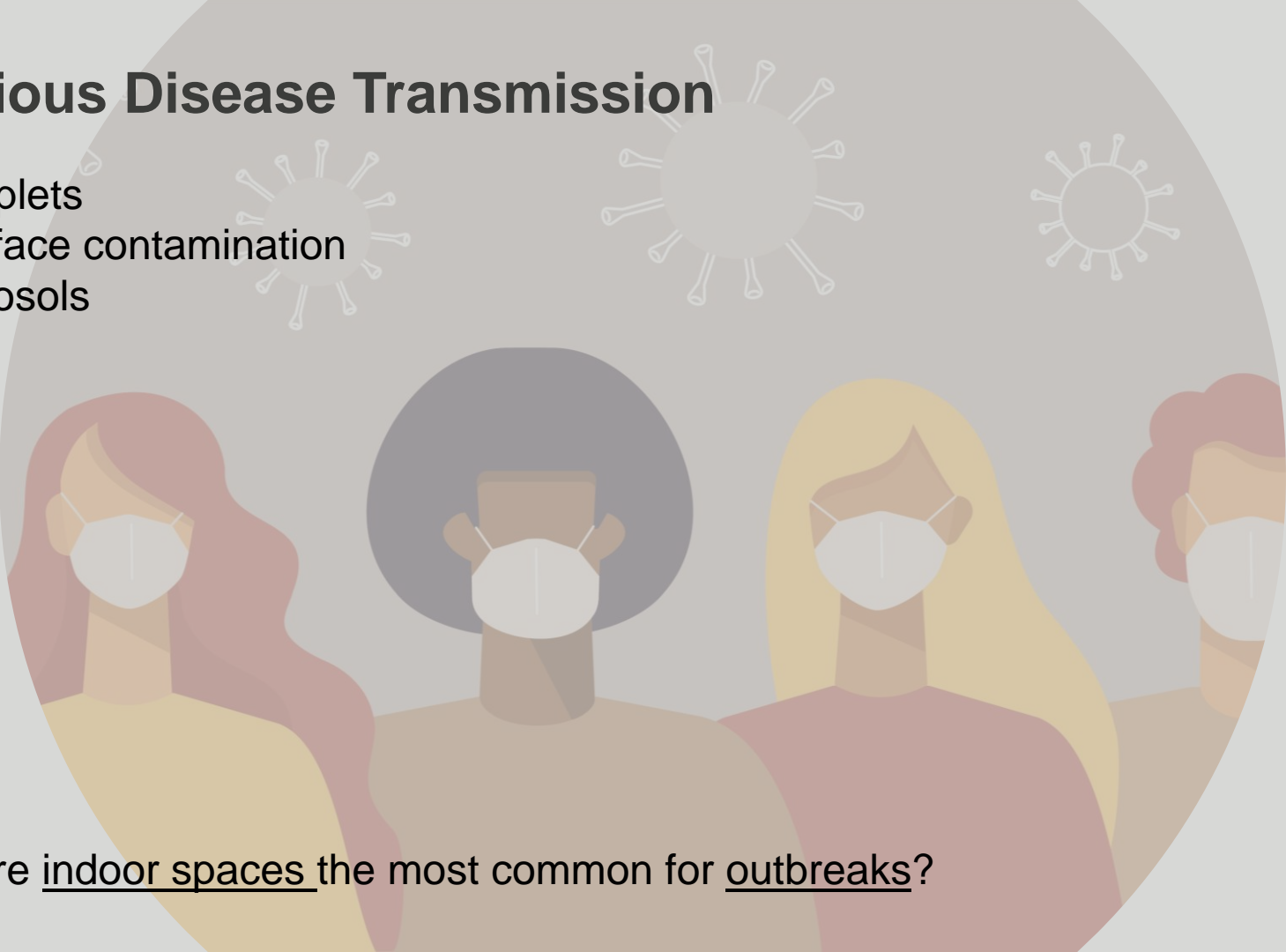


***NOT* Another COVID-19 Webinar**



Infectious Disease Transmission

- Droplets
- Surface contamination
- Aerosols

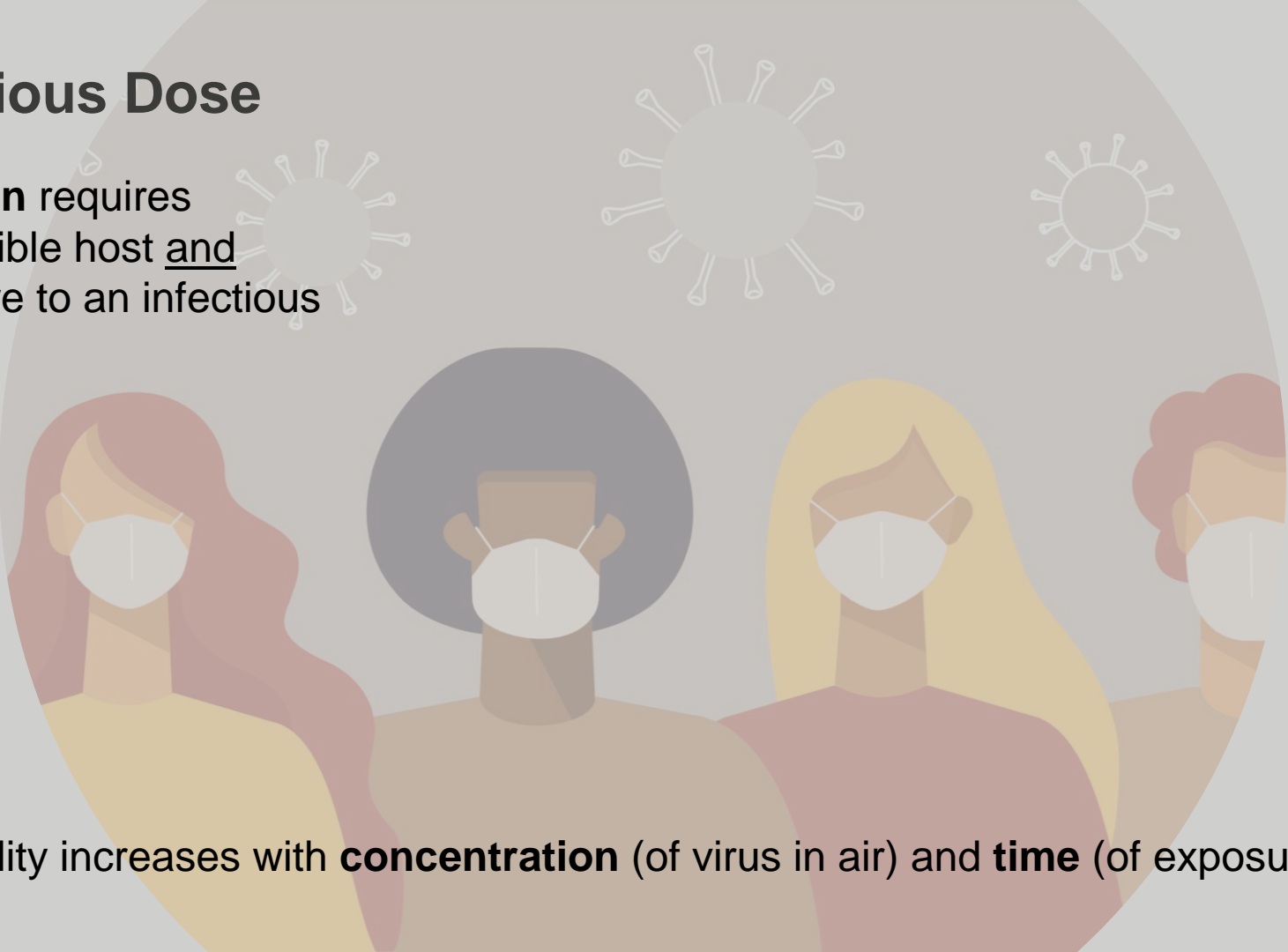


Why are indoor spaces the most common for outbreaks?

Infectious Dose

Infection requires susceptible host and exposure to an infectious dose.

Probability increases with **concentration** (of virus in air) and **time** (of exposure)

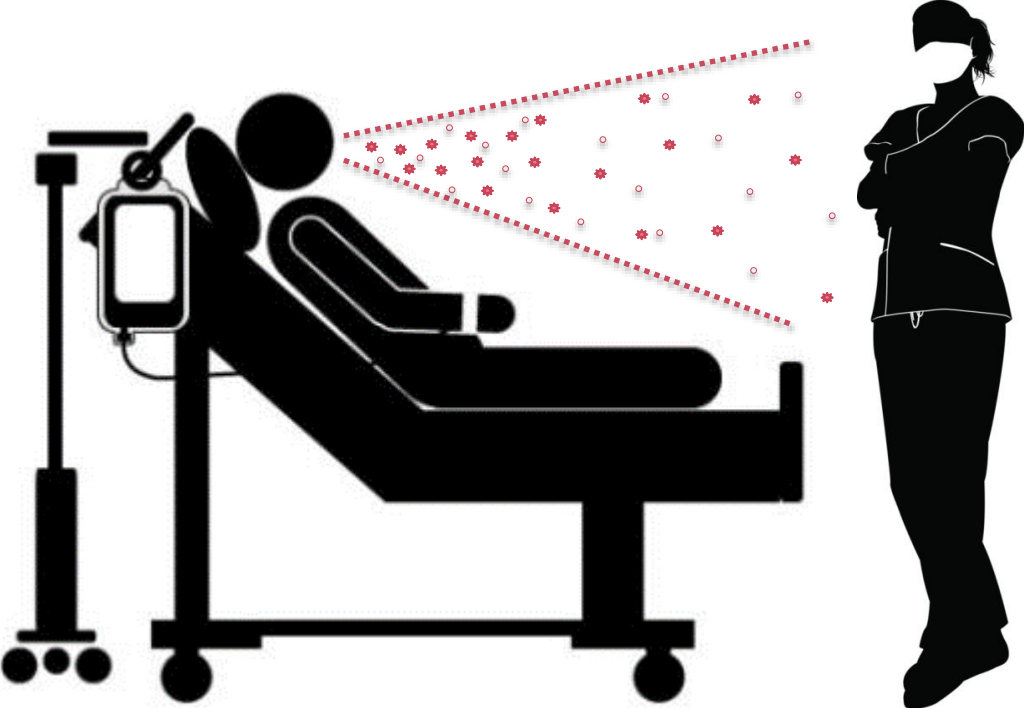


Aerosol Transmission

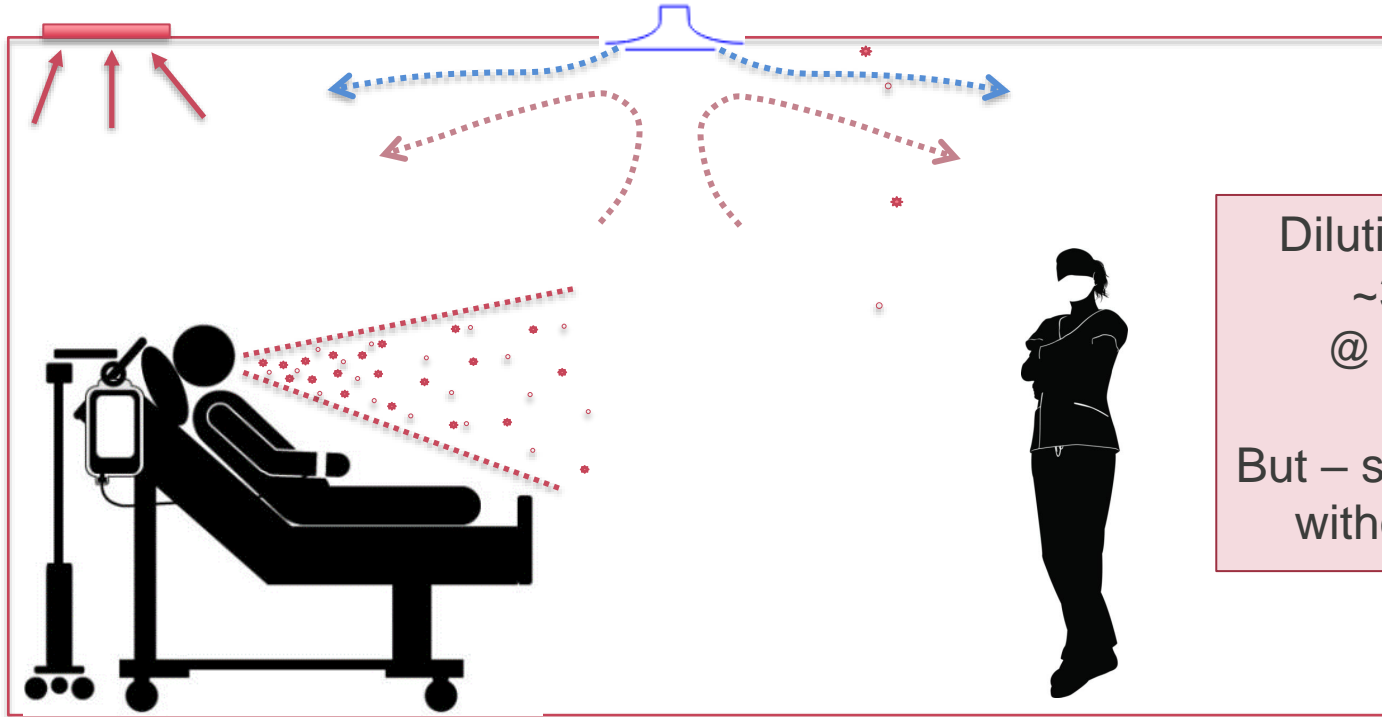
1. Plume
2. Room
3. System or building



Plume



Room



Dilution factor
~300:1
@ 4 ACH

But – still not safe
without PPE

System or Building



Dilution factor
Could be
10,000:1 or
more

Old Tools



Airborne Infectious Isolation Rooms:

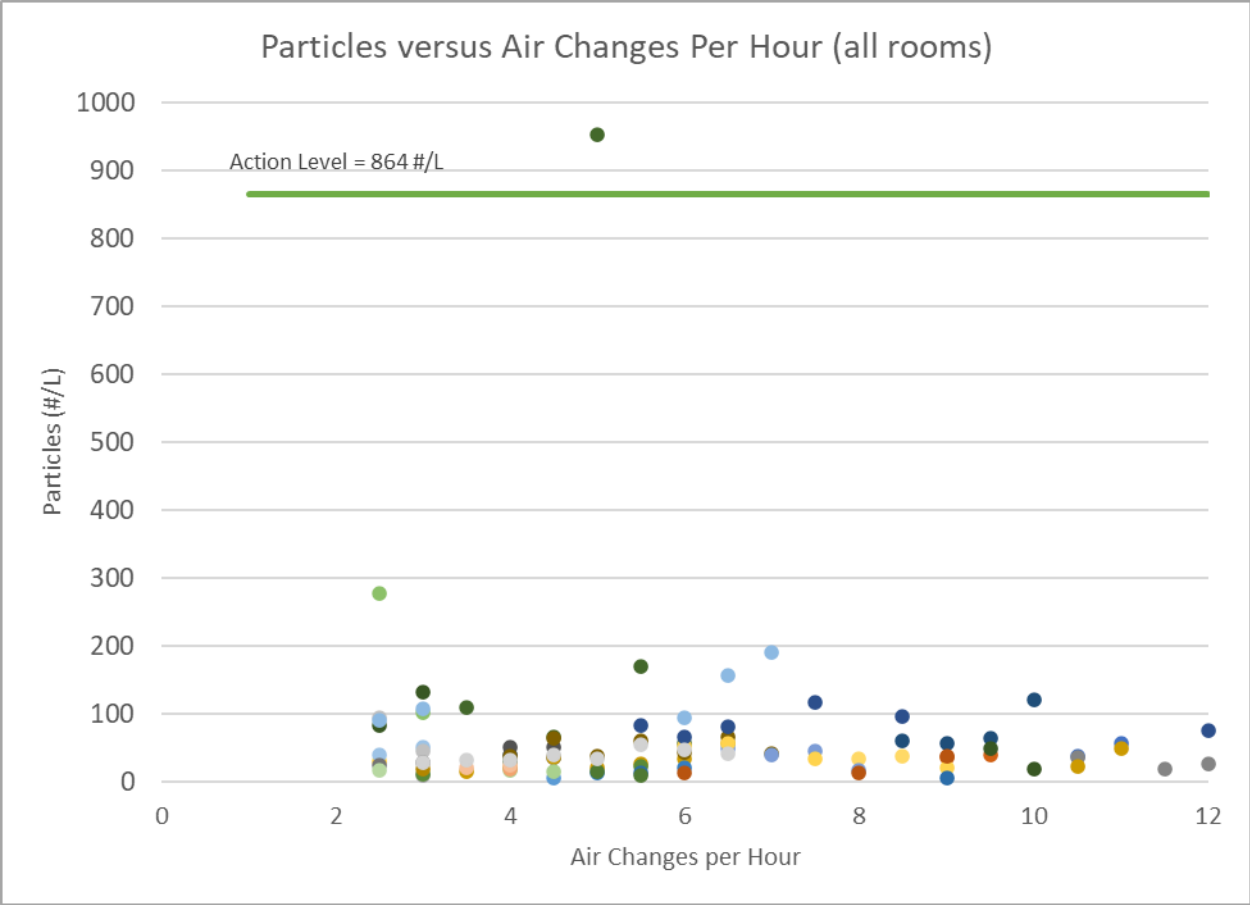
- **12 Air Changes** per Hour (New construction)
- **6 Air Changes** per Hour (existing construction)
- **Negative Pressure** (0.01 in w.c.)
- All **air exhausted**, unless not practical, then HEPA-filtered air can be recirculated
- **Constant-volume** airflow rates

****Not enough AII rooms****

NEW Tools

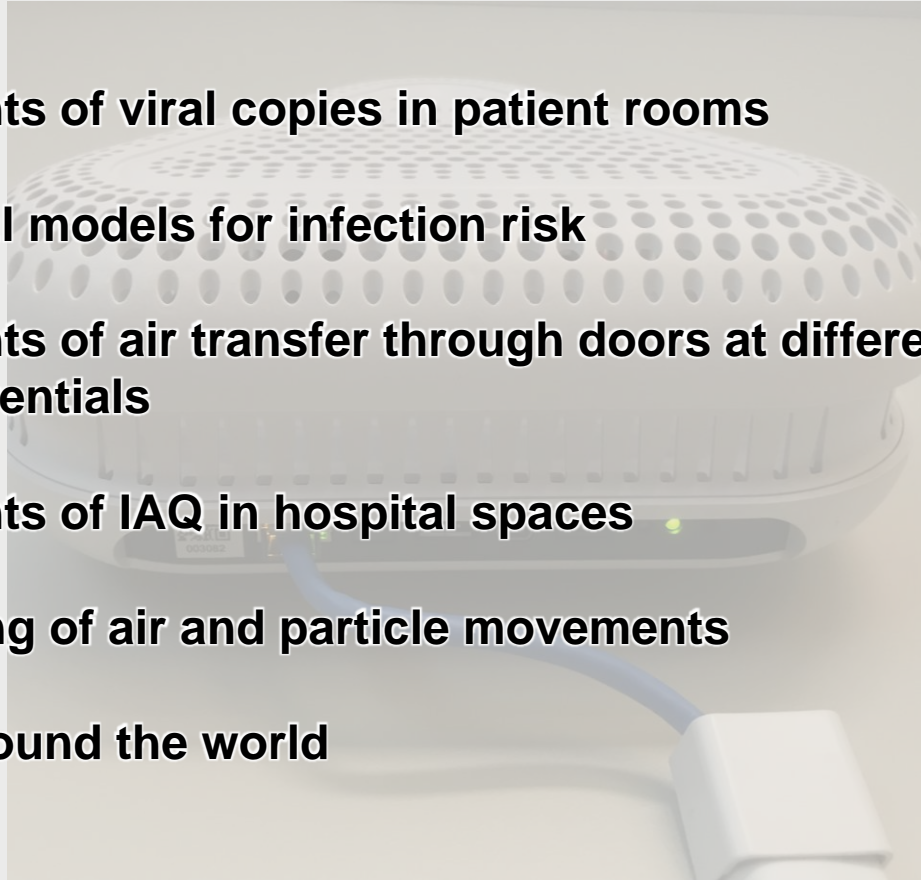
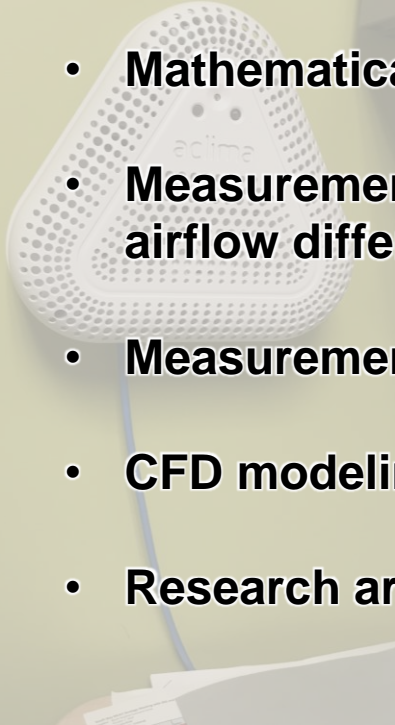


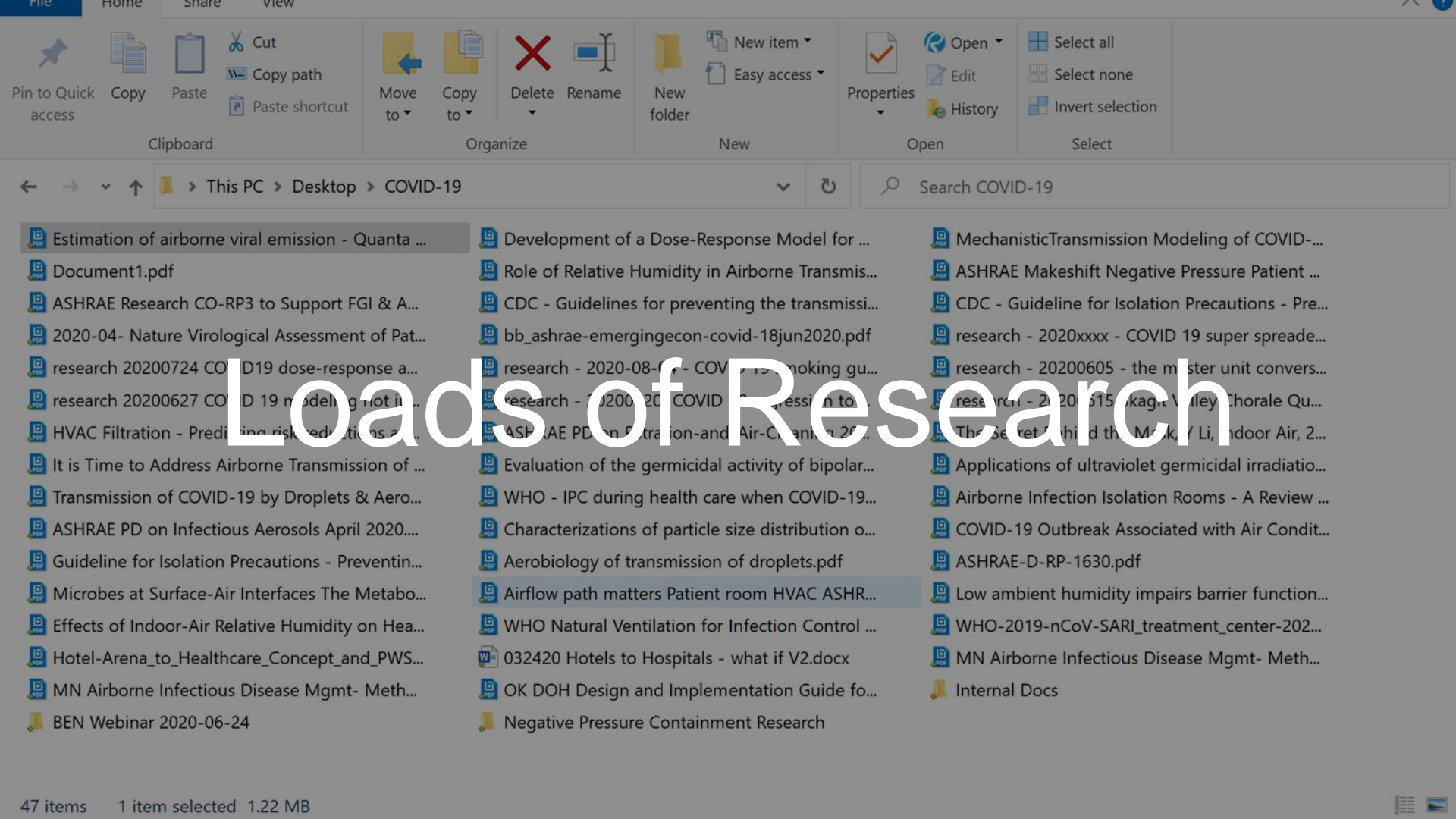
Particulate Measurements in Hospital Spaces



NEW Tools

- **Measurements of viral copies in patient rooms**
- **Mathematical models for infection risk**
- **Measurements of air transfer through doors at different airflow differentials**
- **Measurements of IAQ in hospital spaces**
- **CFD modeling of air and particle movements**
- **Research around the world**





File Home Share View

Clipboard: Pin to Quick access, Copy, Paste, Copy path, Paste shortcut

Organize: Move to, Copy to, Delete, Rename

New: New folder, New item, Easy access

Open: Properties, Open, Edit, History

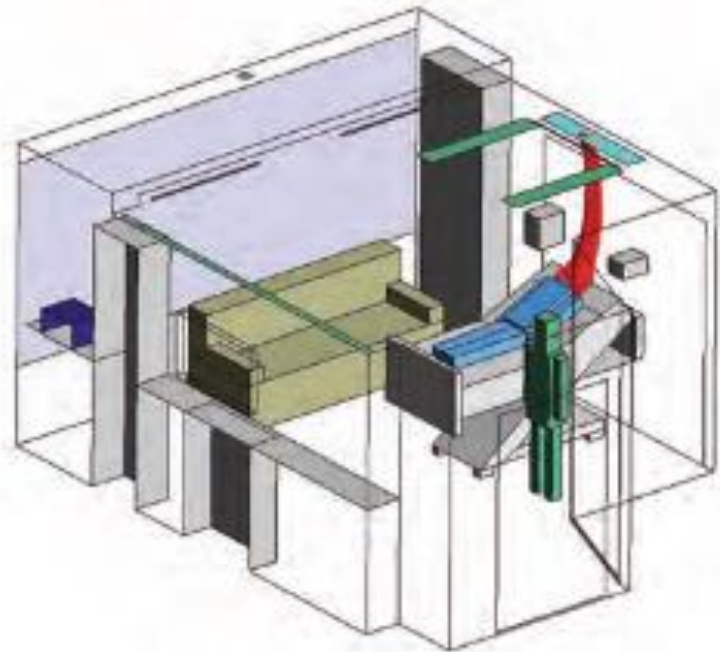
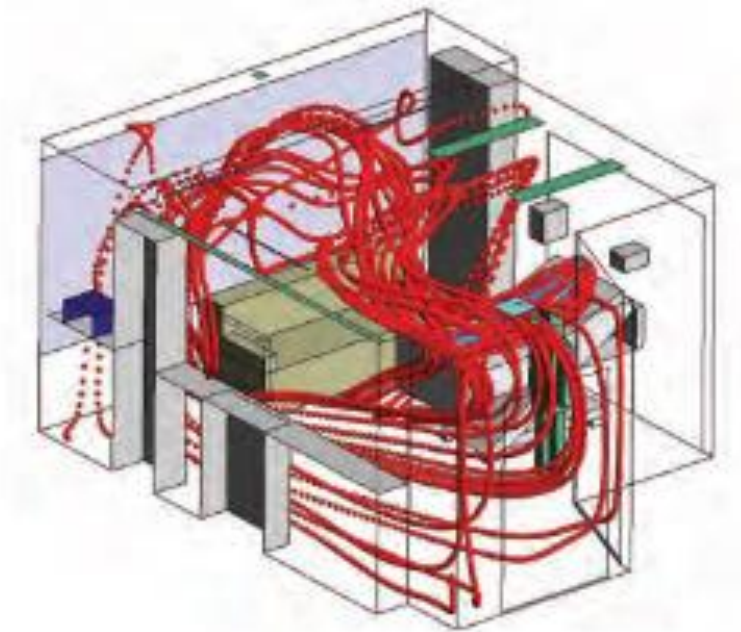
Select: Select all, Select none, Invert selection

← → ▾ ↑ This PC > Desktop > COVID-19 Search COVID-19

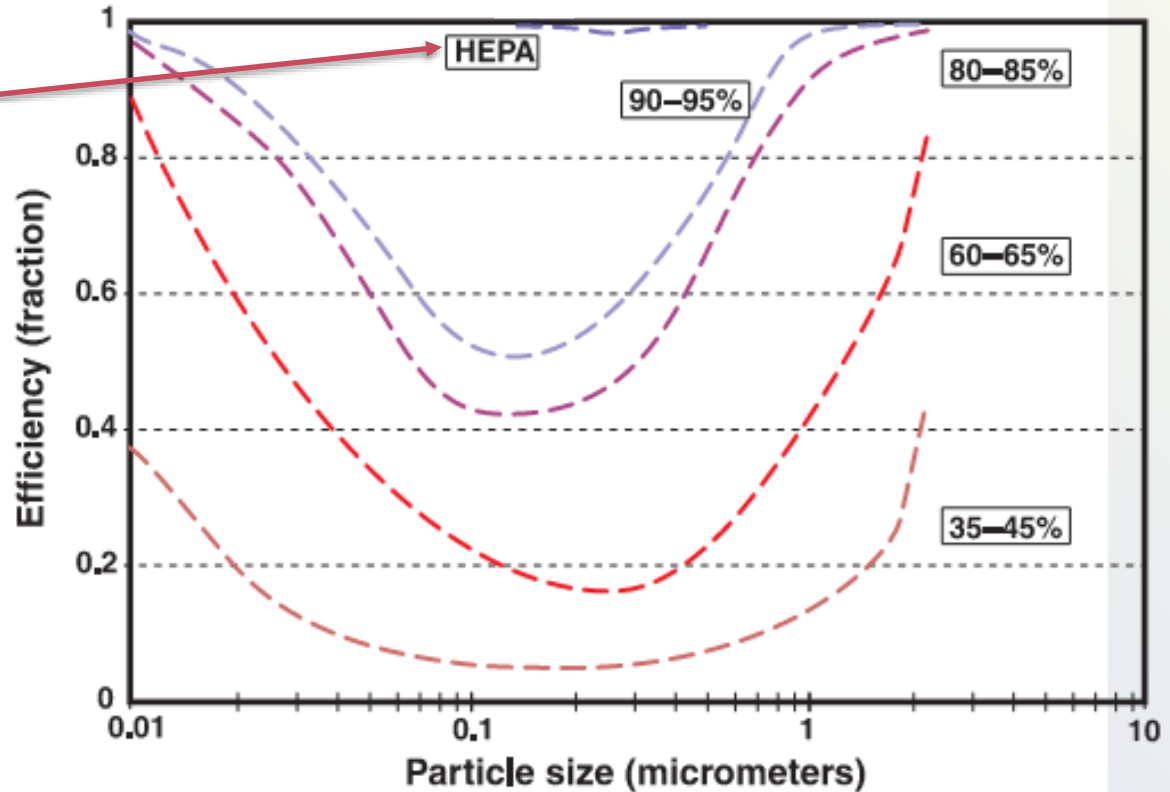
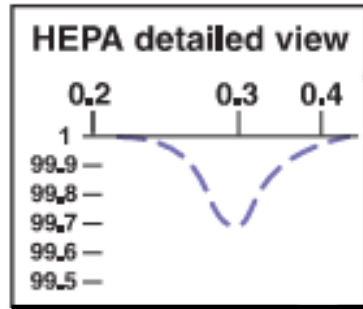
- Estimation of airborne viral emission - Quanta ...
- Document1.pdf
- ASHRAE Research CO-RP3 to Support FGI & A...
- 2020-04- Nature Virological Assessment of Pat...
- research 20200724 COVID19 dose-response a...
- research 20200627 COVID 19 modeling not in...
- HVAC Filtration - Predicting risk reductions a...
- It is Time to Address Airborne Transmission of ...
- Transmission of COVID-19 by Droplets & Aero...
- ASHRAE PD on Infectious Aerosols April 2020...
- Guideline for Isolation Precautions - Preventin...
- Microbes at Surface-Air Interfaces The Metabo...
- Effects of Indoor-Air Relative Humidity on Hea...
- Hotel-Arena_to_Healthcare_Concept_and_PWS...
- MN Airborne Infectious Disease Mgmt- Meth...
- BEN Webinar 2020-06-24
- Development of a Dose-Response Model for ...
- Role of Relative Humidity in Airborne Transmis...
- CDC - Guidelines for preventing the transmissi...
- bb_ashrae-emergingecon-covid-18jun2020.pdf
- research - 2020-08-18 - COVID-19 smoking gu...
- research - 2020-08-20 - COVID-19 transmission to...
- ASHRAE PD on Filtration and Air-Cleaning 20...
- Evaluation of the germicidal activity of bipolar...
- WHO - IPC during health care when COVID-19...
- Characterizations of particle size distribution o...
- Aerobiology of transmission of droplets.pdf
- Airflow path matters Patient room HVAC ASHR...
- WHO Natural Ventilation for Infection Control ...
- 032420 Hotels to Hospitals - what if V2.docx
- OK DOH Design and Implementation Guide fo...
- Negative Pressure Containment Research
- Mechanistic Transmission Modeling of COVID-...
- ASHRAE Makeshift Negative Pressure Patient ...
- CDC - Guideline for Isolation Precautions - Pre...
- research - 2020xxxx - COVID 19 super spreade...
- research - 20200605 - the master unit convers...
- research - 2020-0515 - kagrt Wiley Thorale Qu...
- The Secret Behind the Mask / Li Indoor Air, 2...
- Applications of ultraviolet germicidal irradiatio...
- Airborne Infection Isolation Rooms - A Review ...
- COVID-19 Outbreak Associated with Air Condit...
- ASHRAE-D-RP-1630.pdf
- Low ambient humidity impairs barrier function...
- WHO-2019-nCoV-SARI_treatment_center-202...
- MN Airborne Infectious Disease Mgmt- Meth...
- Internal Docs

Loads of Research

Airflow Path Matters

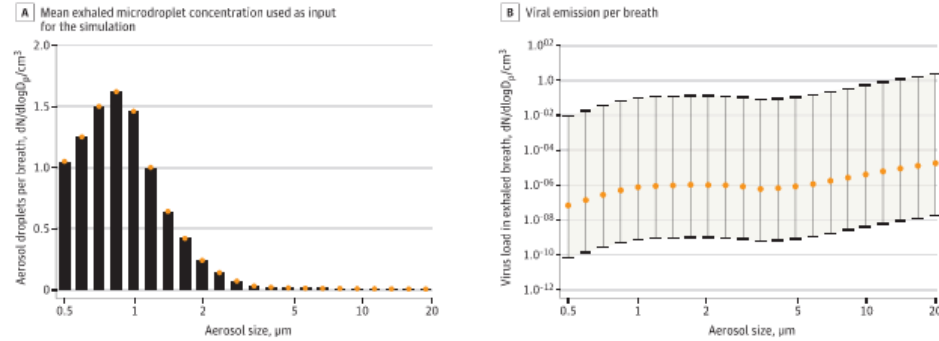


HEPA is VERY Effective



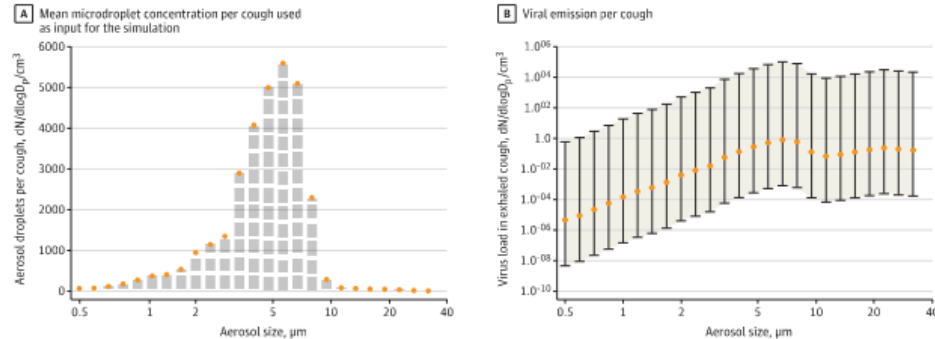
Estimating viral particle emissions and concentrations

Figure 1. Size Distribution of Exhaled Microdroplets and Resulting Viral Emissions During Regular Breathing



A, The typical exhaled microdroplet concentration used as input for the simulation. B, The modeled viral emission per breath for typical (orange), high, and low (whiskers) emitters. $dN/d\log D_p/cm^3$ is the number concentration normalized by the aerosol size-bin width.

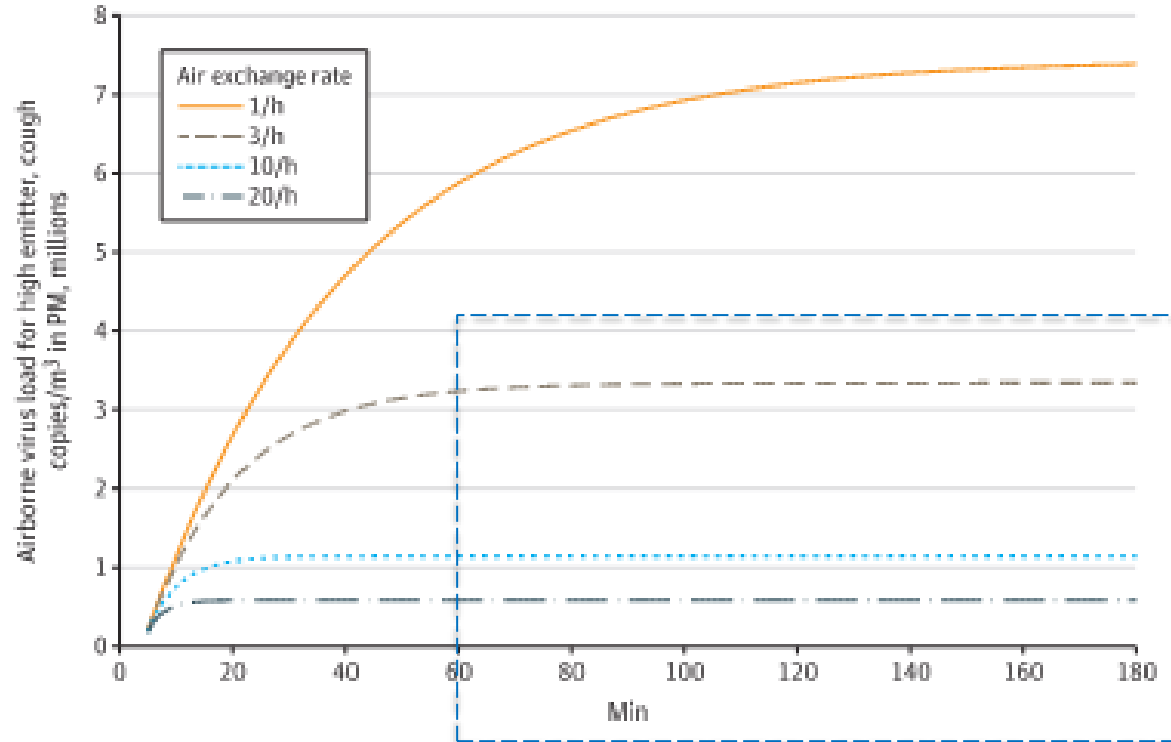
Figure 2. Size Distribution of Exhaled Microdroplets and Resulting Viral Emissions During Coughing



A, The typical exhaled microdroplet concentration used as input for the simulation. B, The modeled viral emission per breath for typical (orange), high, and low (whiskers) emitters. $dN/d\log D_p/cm^3$ is the number concentration normalized by the aerosol size-bin width.

Estimating viral particle emissions and concentrations

Figure 3. Temporal Course of Airborne Virus Load in a Perfectly Mixed Room of 50 m³



Steady-state concentration relates to ventilation rate, not room volume


Ventilation Strategies

Develop a **consensus model** for infectious aerosol emission and behavior, adaptable to specific organisms

Use **CFD modeling** to design airflow in hospitals

Use **math, physics, biology, and actual measurements** to determine ventilation requirements

- Outdoor air for gas-phase contaminants
- Clean air (filtered) for particulates
- Ventilation rate, not ACH



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EDAC, FASHE
Jim Crabb, PE

George Tingwald, MC, AIA
Clayton Mitchell, PE, CEM
Mike Wood, CHC, MSM

