

Webinar #1

Webinar Series: COVID Research Solutions for Campus *Aerosols, HVAC, Buildings & Classrooms*

Panelists

Shelly Miller—Professor, Mechanical Engineering; Environmental Engineering Program

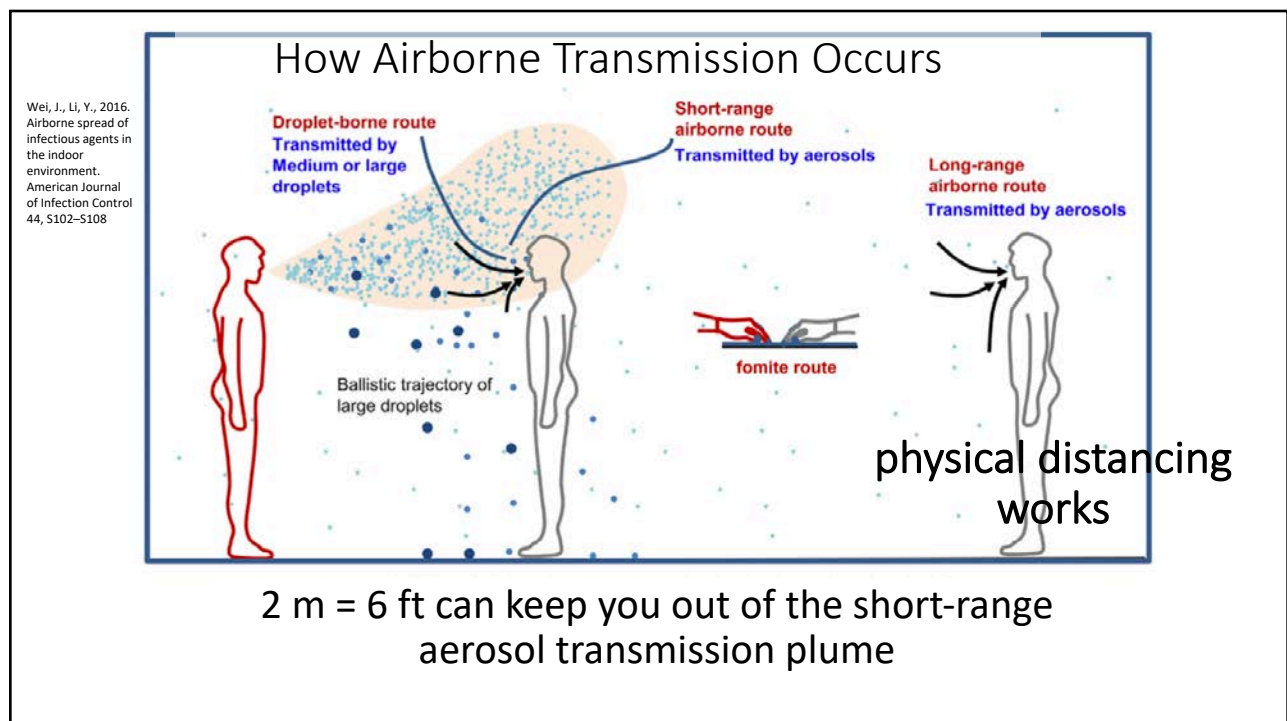
Jose-Luis Jimenez—Professor, Chemistry; Institute Fellow, CIRES

Chris Ewing—Assistant Vice Chancellor, Facilities Management; Campus Planning, Design & Construction

Shannon Horn—Mechanical Engineer, Facilities Management

Moderator- Terri Fiez—Vice Chancellor for Research and Innovation

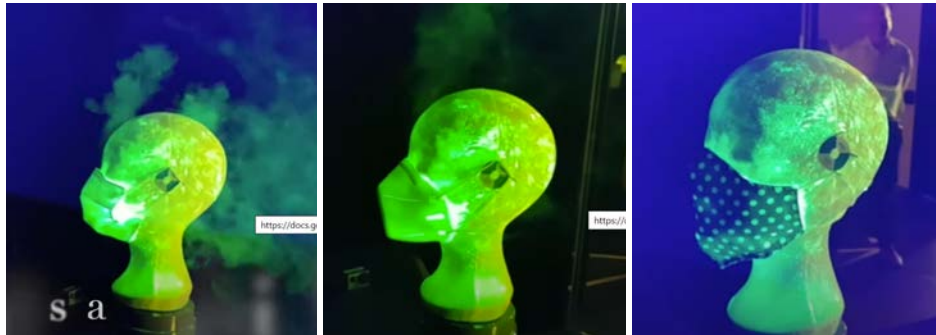
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<https://youtu.be/mJ81IBTMvcU>

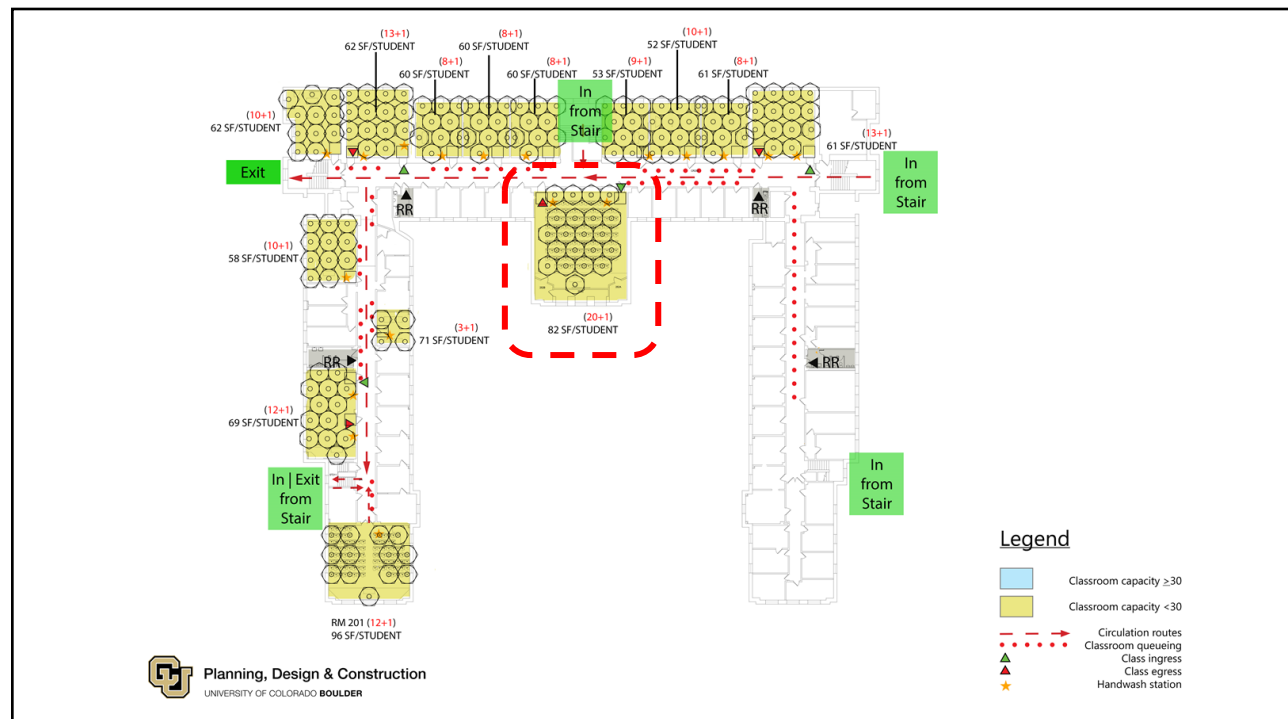
Mask Fit is Critical



- Pay attention to mask fit: avoid gaps, tight around the nose
 - I see lots of people w/ loose masks
 - Don't stand behind someone with a poorly-fitting mask
- **Keep mask on when speaking, x5-30 times more aerosols than just breathing**

Visualization by Prof. Philomena Bluyssen, TU Delft, The Netherlands

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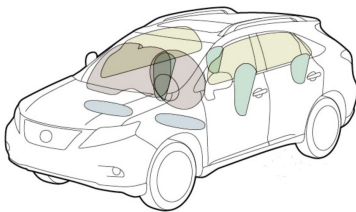


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Automobile Risk Analogy



Mask ~ Brakes on your Car

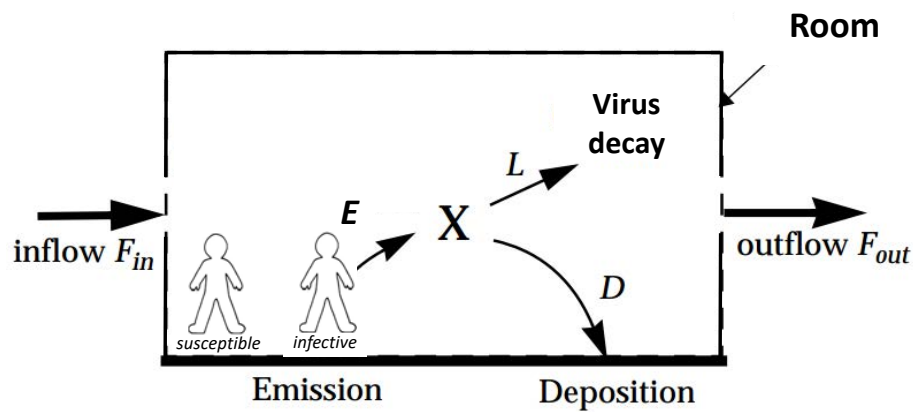
Cleaning and Washing Hands ~ Seat Belt

Social Distancing/Tracing ~ Air Bags

Ventilation and Maintenance ~ LDS
(Lane detection system)

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Simple “box model” of room-level transmission



- Infective emits virus particles, which mix in the room
 - Ignore details of mixing, which can be important at times, but are very specific to each situation (think or test with smoke)
 - Susceptible breathes in some of those particles over time, some probability of infection (Wells-Riley)
- Same as modeling radon. Ordinary differential equations, solved analytically
 - Numerical solution also possible (maybe in future version, allows more complicated events)
- Implemented in spreadsheet
 - Read “readme” and “FAQs” if you want to use it seriously <http://tinyurl.com/covid-estimator>

Adapted from Jacob Fig. 3-1 <http://arma.sas.harvard.edu/pscole/faculty/dli/book/booktrans3.html#fig3-1>

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Webinar #2 & #3

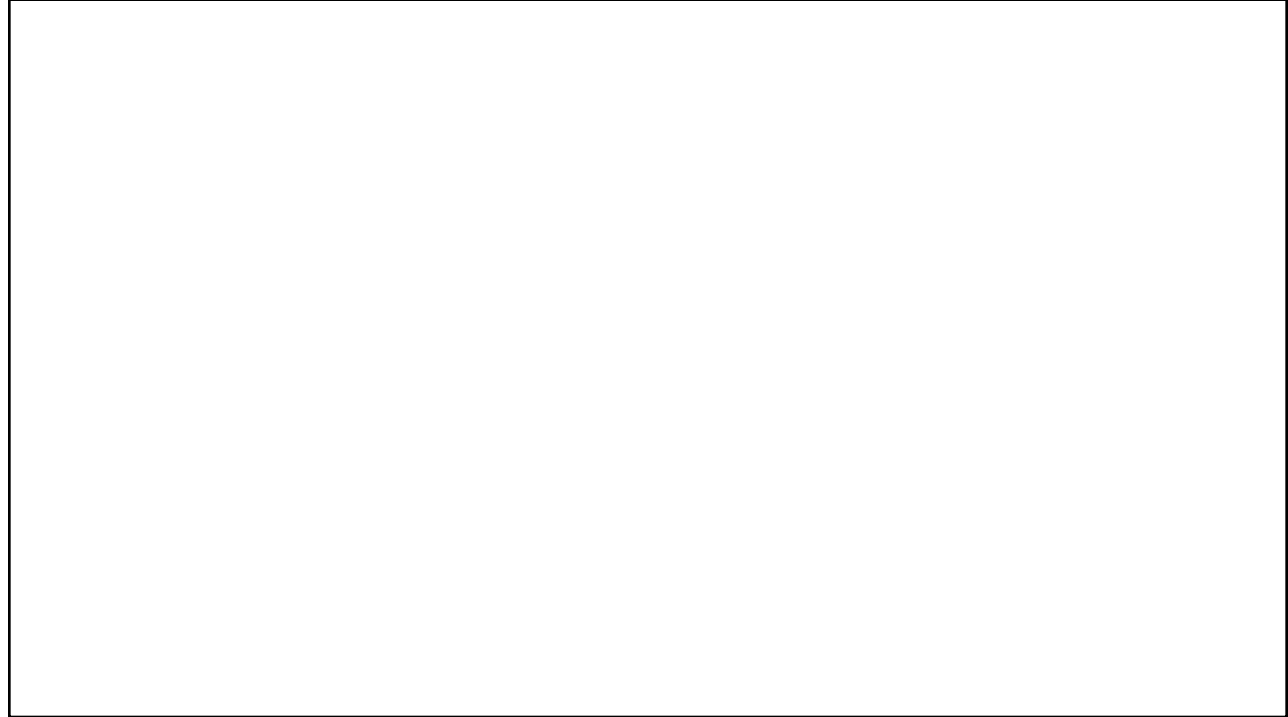
COVID Research Solutions for Campus

Monday, Aug. 10 Epidemiology, Monitoring & Awareness (4-5:15 p.m.)

Wednesday, Aug. 12 Health Assessment, Surveillance and Testing (12-1:15 p.m.)

<https://www.colorado.edu/rio>

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Some Key Ideas about Transmission of COVID-19

Prof. Jose L. Jimenez
University of Colorado, Boulder

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“Close contact” vs. Room-level

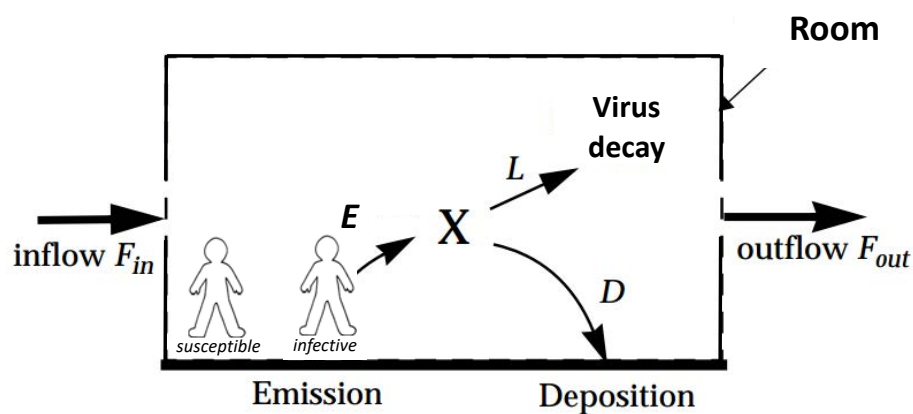
- Expiratory plume visualized by smoke
- Avoid breathing exhaled air, most important reason why keeping > 6 ft works
- Room-level is harder to avoid, main topic of discussion today
 - This is what the calculator estimates, assuming social distancing kept



<https://www.kun.org/post/drieseachers-find-e-cigs-leave-cancer-causing-chemicals-junesfirstroom/0>
<https://www.dailymail.com/stories/2019/11/16/1899711/The-Smoke-Filled-Room-Unsolicited-Advice-as-Who-Should-Be-Vice>

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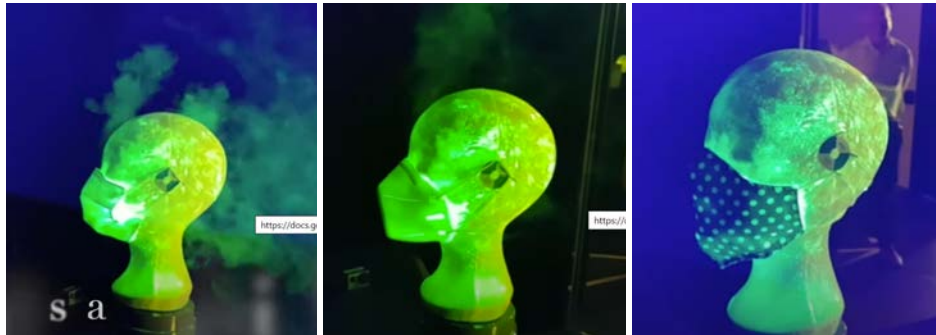
Adapted from Jacob Fig 3-1 <http://acme.seas.harvard.edu/people/faculty/dji/book/book-chap3.html#fig3-12721>

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Mask Fit is Critical



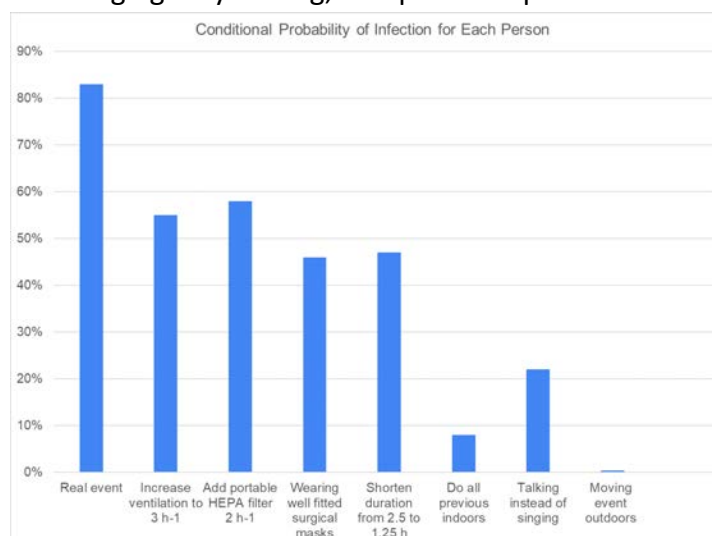
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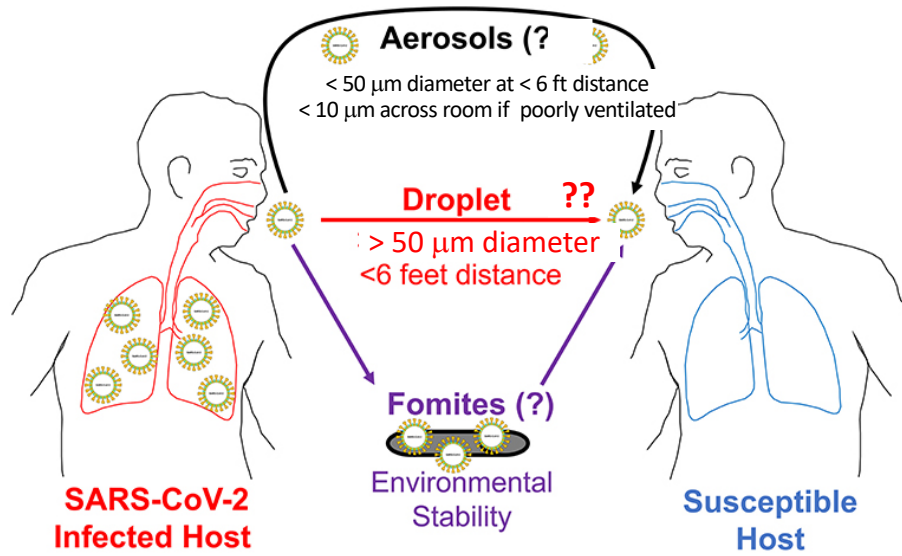
Example of Skagit Choir & Controls

- What happens if we could change conditions
- All are changing only 1 thing, except “do all previous indoors”



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The Modes of Transmission



Adapted from <https://www.frontiersin.org/articles/10.3389/fpubh.2020.00163/full>

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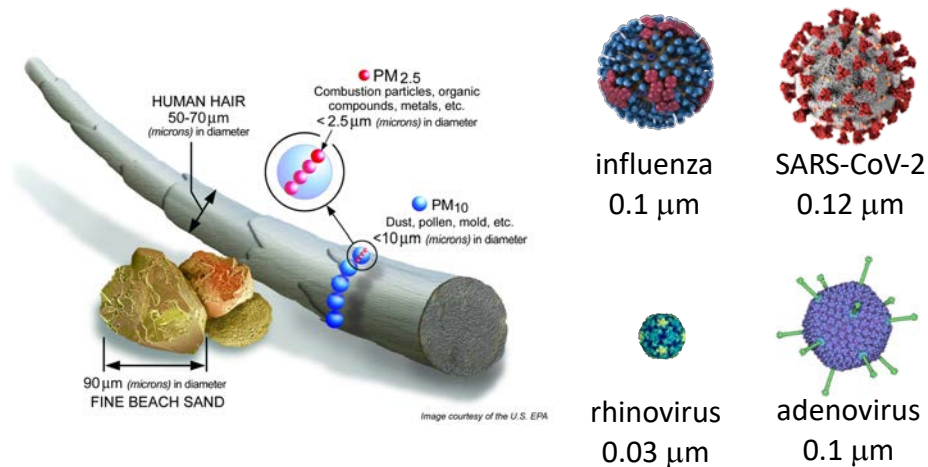
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Quick Aerosol Primer

Shelly Miller

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Virus Size



<https://www.cdc.gov/flu/resource-center/freeresources/graphics/images.htm>, <http://solutionsdesignedforhealthcare.com/rhinovirus>,
<https://phil.cdc.gov/Details.aspx?pid=23312>, <https://pdb101.rcsb.org/motm/132>

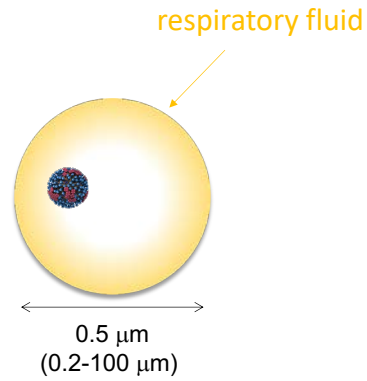
Courtesy of Linsey Marr, Virginia Tech, March 2020

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Size Matters

- Airborne virus is not naked!



- Size determines
 - Lifetime in the atmosphere
 - Where it deposits in the respiratory system

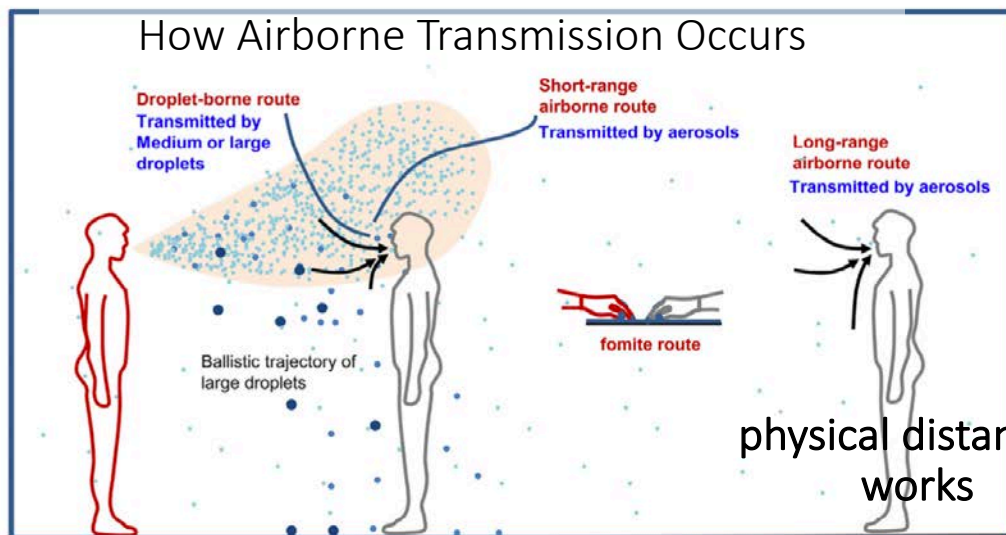
Courtesy of Linsey Marr, Virginia Tech, March 2020

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How Airborne Transmission Occurs

Wei, J., Li, Y., 2016.
Airborne spread of
infectious agents in
the indoor
environment.
American Journal of
Infection Control
44, S102–S108



2 m = 6 ft can keep you out of the short-range aerosol transmission plume

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Compelling evidence to show significant transmission in crowded **poorly ventilated** spaces

- Clusters in Japan resulted from close contact in fitness gyms, restaurant boat on a river, hospitals, snow festival tented restaurants
- Ski-chalet associated transmission in France, ski-gondola transmission in Idaho
- Singapore Clusters from tourist shop, banquet dinner, church
- Church-associated clusters in South Korea and Washington state
- 3 family clusters in air-conditioned restaurant

Ordinary speech aerosolizes significant quantities of respiratory particles. Some people are also super emitters (10-min conversation = cloud of 6000 aerosol articles)

Short-range airborne route dominates during talking and coughing during close contact (< 2 m). Large droplet dominates when > 100 μm and within 0.2 m while talking

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Outdoor Transmission? Our study does not rule out outdoor transmission of the virus. However, among our 7,324 identified cases in China with sufficient descriptions, only one outdoor outbreak involving two cases occurred in a village in Shangqiu, Henan. A 27-year-old man had a conversation outdoors with an individual who had returned from Wuhan on 25 January and had the onset of symptoms on 1 February.



Indoor transmission of SARS-CoV-2

Hua QIAN^{1,2}, Te MIAO^{2,3}, Li LIU¹, Xiaohong ZHENG¹, Danting LUO¹, and Yuguo LI^{1,4*}

1. School of Energy and Environment, Southeast University, Nanjing, China
2. Department of Mechanical Engineering, The University of Hong Kong, Pokfulam, Hong Kong, China
3. School of Architecture, Tsinghua University, Beijing, China
4. School of Public Health, The University of Hong Kong, Pokfulam, Hong Kong, China

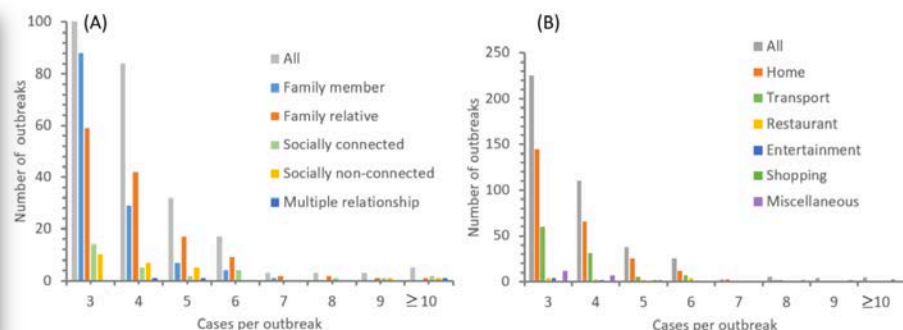
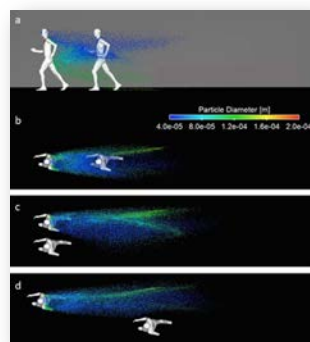
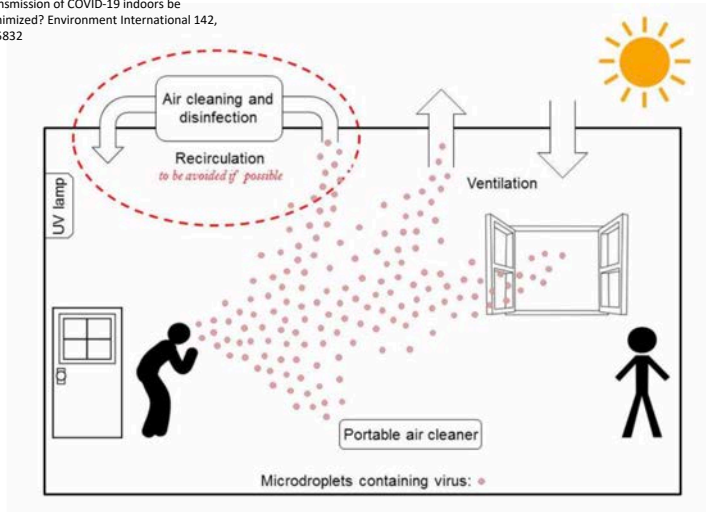


Figure 1. Distribution of all identified 318 outbreaks (A) involving confirmed cases of different relationships and (B) for each category of the 416 venues.

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Morawska et al 2020. How can airborne transmission of COVID-19 indoors be minimized? Environment International 142, 105832



- **Ventilation** provides outdoor air to a space by natural or mechanical means
- Controls how quickly room air is removed/replaced over time
- Ventilation rates recommended for different spaces by ASHRAE

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Air cleaners really work!

Clean Air Delivery Rate
Certified Rating

From air cleaner to air cleaner, compare the CADR numbers. First, look at suggested room size. Then refer to the dust, tobacco smoke and pollen Clean Air Delivery Rate (CADR) numbers. The higher the numbers, the faster the unit filters the air.

This air cleaner is suggested for use in a single closed room up to 120 square feet.

Room size ratings conform to the AHAM Certification Program criteria of 80% smoke reduction. Higher Clean Air Delivery Rates provide improved performance in all room sizes. Portable air cleaners will be much more effective in rooms where all doors and windows are closed.

Dust: 80 Tobacco Smoke: 80 Pollen: 80

These values represent performance that can be expected within the first 72 hours of operation. Subsequent performance may vary with use.

Association of Home Appliance Manufacturers **AHAM**

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Air cleaners really work!



Airmega 300S Smart HEPA Air Purifier by Coway

Model: 300S SKU: co5313 ★★★★★ (9 Reviews) Ask Question



List Price: \$649.00

Sale: \$515.00

Free 3 Day Delivery to 50309

In Stock - Order Now. Your item will ship Thursday, Apr 30th.

Quantity: 1

Add To Cart

Or as low as \$23.77 / Month *

CADR = 260

Max flow = 340 cfm

Area for cleaning? 700 ft²

25

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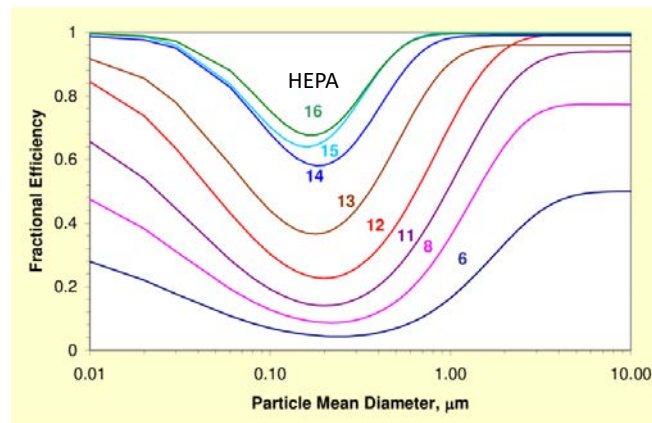
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surgical face masks could prevent transmission of human coronaviruses and influenza viruses from symptomatic and asymptomatic individuals

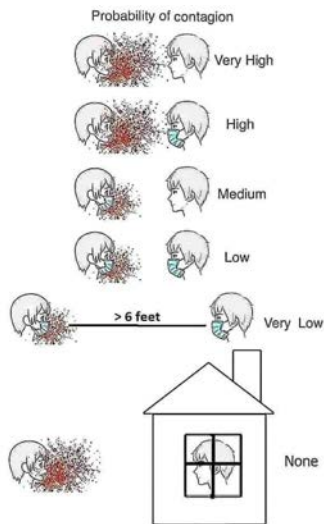
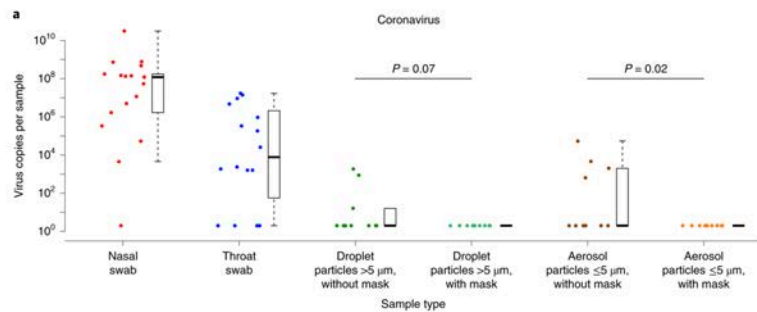


Fig. 1: Efficacy of surgical face masks in reducing respiratory virus shedding in respiratory droplets and aerosols of symptomatic individuals with coronavirus, influenza virus or rhinovirus infection.

From: Respiratory virus shedding in exhaled breath and efficacy of face masks



Leung, et al., 2020. Respiratory virus shedding in exhaled breath and efficacy of face masks. *Nature Medicine*, pp.1-5.

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Increase (clean) outdoor air supply

- building ventilation can be as effective as public health interventions
- existing ventilation rates may be too low to prevent or control airborne infectious diseases indoors
- and might need to be increased by 10x

Gao, X., Li, Y. and Leung, G.M., 2009. Ventilation control of indoor transmission of airborne diseases in an urban community. *Indoor and Built Environment*, 18(3), pp.205-218.

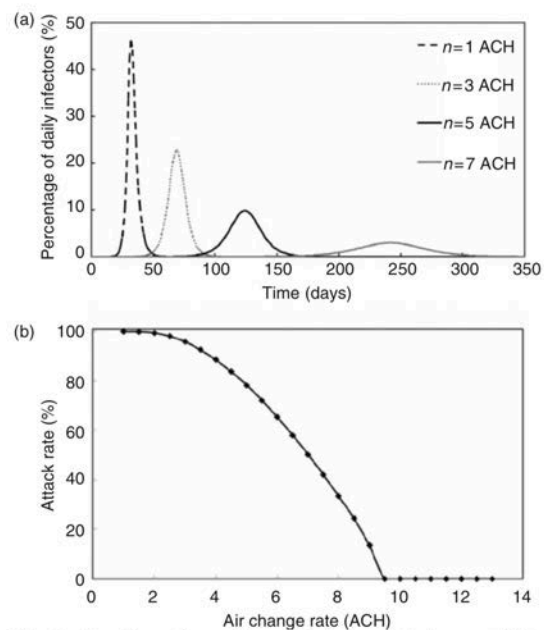


Fig. 2. The effect of increasing ventilation rate: (a) change of daily incidents, (b) change of overall attack rate.

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Evidence-based airborne infectious disease controls – during epidemics

Wear Masks

- precautionary principles

Minimize the number of people sharing the same indoor space allowing for spatial distancing

- Reduce viral loading, unsuspected transmission, social distance to get out of aerosol plume

Wash hands and surfaces with soap

Increase outdoor air ventilation rates and distribute effectively

- Do not recirculate the air

Use air cleaning and disinfection devices

- Germicidal ultraviolet (gUV) light
- Filtration

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Shannon Horn

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Risk Management Principles

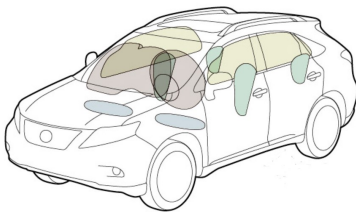
Containment

Dilution

Duration

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Automobile Risk Analogy



Mask ~ Brakes on your Car


Cleaning and Washing Hands ~ Seat Belt

Social Distancing/Tracing ~ Air Bags


Ventilation and Maintenance ~ LDS
(Lane detection system)

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Ventilation Optimized and Enhanced to compliment Primary Containment Measures



Increased Outside Air



Improved Filtration






Extended Building Operation

Background
Risk Management
Implementation
FAQ

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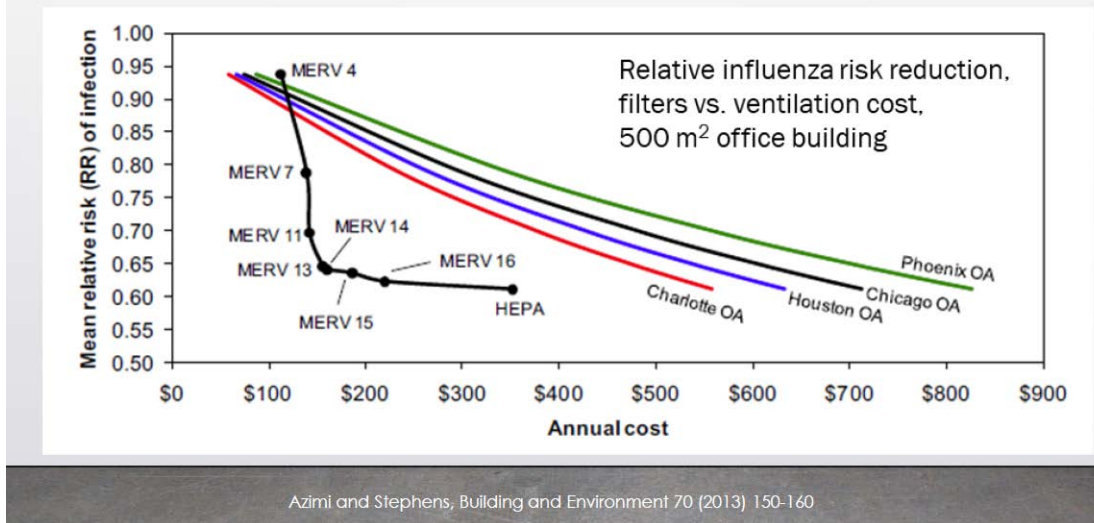
Ventilation Types and Recommendations

Campus Inventory	Increased Filtration	Increased Building Operations	Increased Ventilation	Profile Analogy
Type 1 Mechanical (Recirc/OA)	MERV 13	24/7	Yes	 <p>TOYOTA</p>
Type 2 Mechanical (100% OA)	MERV 13	24/7	Yes	
Type 3 Natural Ventilation (Windows)	Portable HEPA Filters	24/7	Yes	
	Containment	Dilution/Duration	Dilution/Duration	

8/6/20
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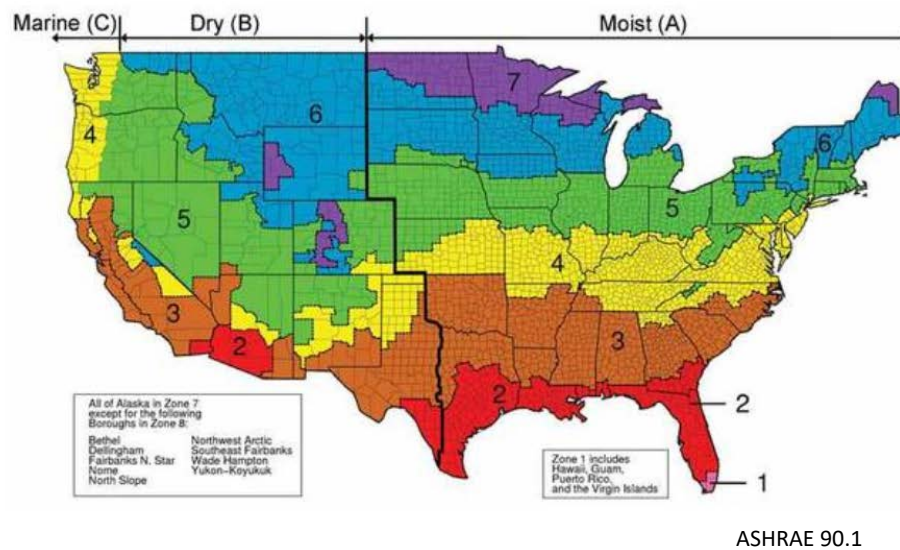
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Filtration can be a lower energy way to reduce aerosol/airborne infection risk



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Favorable Climate for Non-Recirculated Air



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