
FOR HEALTH
HEALTHY BUILDINGS
Our goal is to improve the lives of all people, in all buildings, everywhere, every day.
A Program at the
HARVARD T.H. CHAN
SCHOOL OF PUBLIC HEALTH
9 FOUNDATIONS OF HEALTHY BUILDINGS
COGFX STUDY
CLIMATE CO-BENEFITS
APPLAB RESEARCH PLATFORM
HEALTHY HOMES
NEXT

Journal of Exposure Science & Environmental Epidemiology

Editorial | Published: 02 December 2019

Harnessing the power of healthy buildings research to advance health for all

Joseph G. Allen & Michael S. Waring

The two forces of rapid population growth and urbanization are colliding and creating one of the greatest public health challenges, and opportunities, ever—our buildings. As consumers of 40% of energy globally, buildings contribute greatly to emissions of air pollutants and greenhouse gases, but also have the potential to mitigate emissions by way of efficient improvements. Buildings also influence our health directly from the time we spend in them, due to our exposure to air pollution of both outdoor and indoor origin, as well as their microbiomes.

> "The need for this research remains in light of the potential for **new and old pandemics**, and for continued exploration of how building systems may play a role in mitigating transmission."

– Joseph Allen & Michael Waring
December 2, 2019

Buildings that fight disease…

…and Promote Health

The New York Times

Your Building Can Make You Sick or Keep You Well

Proper ventilation, filtration and humidity reduce the spread of pathogens like the new coronavirus.

By Joseph G. Allen

Dr. Allen is director of the Healthy Buildings program at Harvard T.H. Chan School of Public Health.

The Washington Post

Opinions

We cannot keep ignoring the possibility of airborne transmission. Here's how to address it.

White House coronavirus response coordinator Deborah Birx listens as President Trump speaks in the Rose Garden at the White House on May 15. (Jabin Botsford/The Washington Post)

Opinion by **Joseph Allen**

May 26, 2020 at 1:55 p.m. EDT

+ Add to list

The New York Times

Your Building Can Make You Sick or Keep You Well

Proper ventilation, filtration and humidity reduce the spread of pathogens like the new coronavirus.

By Joseph G. Allen

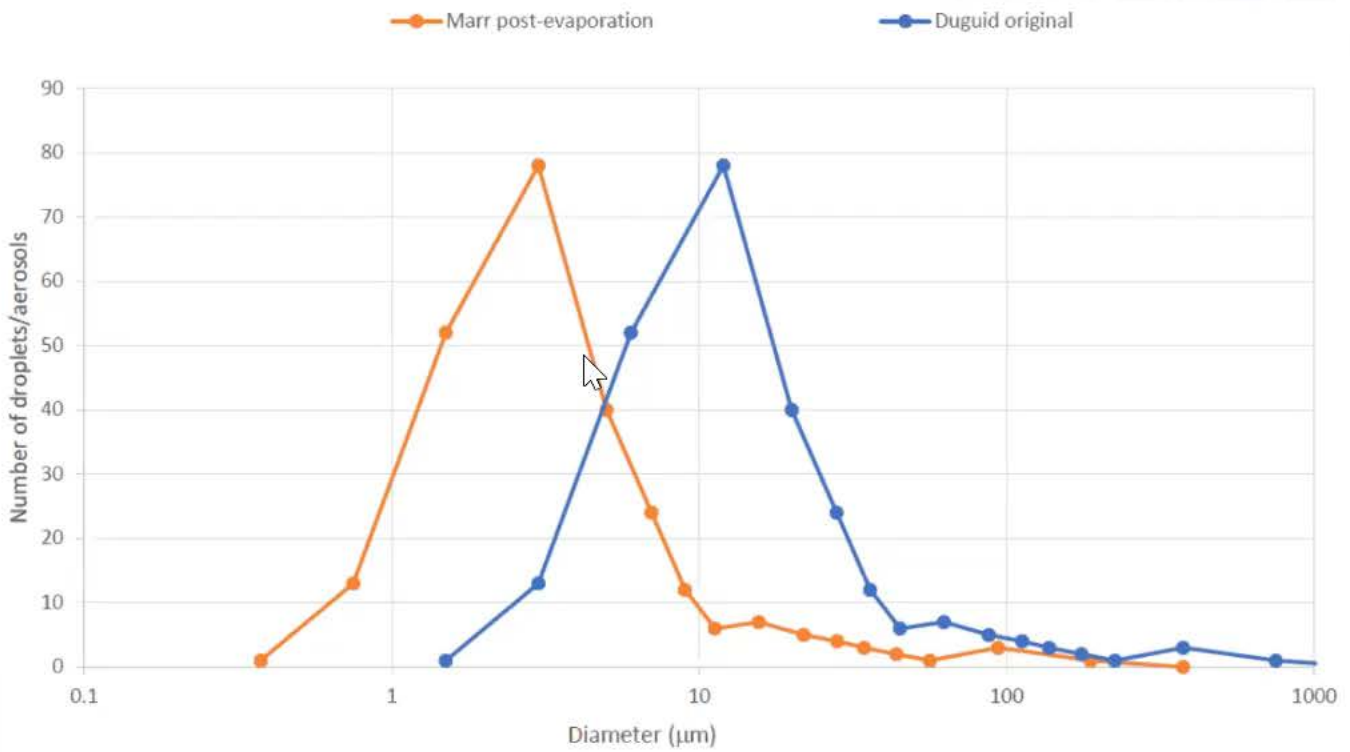
Dr. Allen is director of the Healthy Buildings program at Harvard T.H. Chan School of Public Health.

The Evidence for

Airborne Transmission

Aerosol Physics

Rapid evaporation

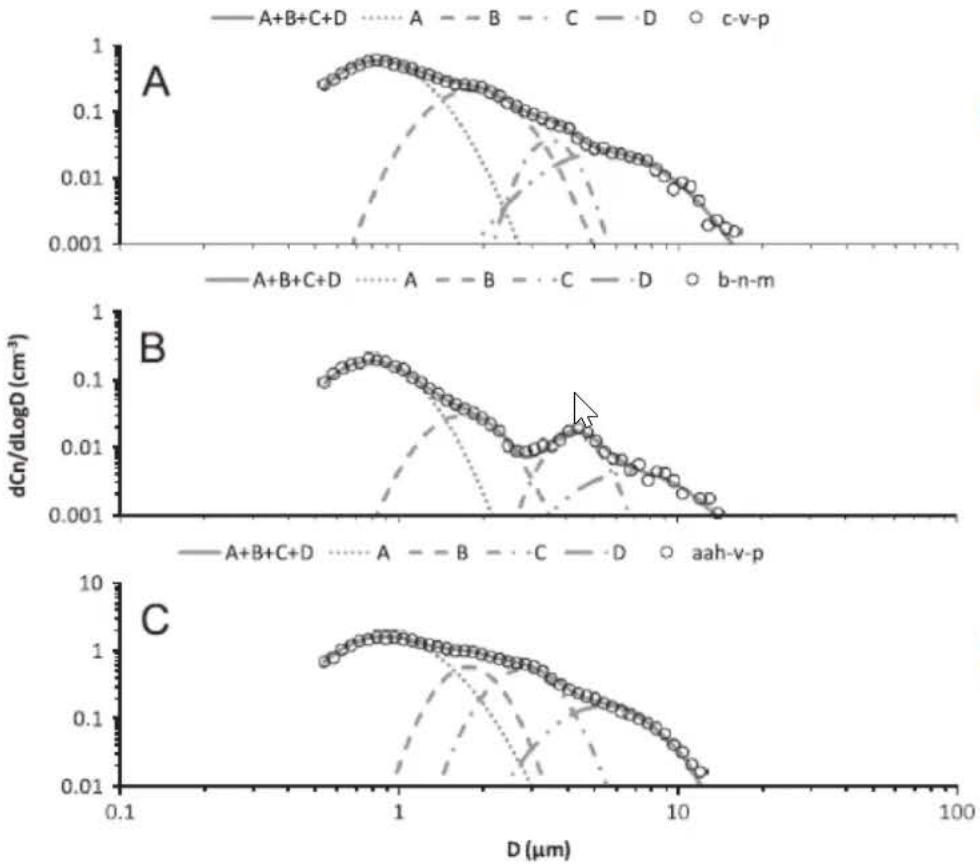


SOURCE: Evaporation transformation based on Duguid (1946) and Marr, L. C., et al. (2019).

Aerosol Physics

Rapid evaporation

Most particles <10 um



Counting

Breathing

Say 'ah'

SOURCE: *Morawska, L., et al. (2009). Size distribution and sites of origin of droplets expelled from the human respiratory tract during expiratory activities, Journal of Aerosol Science, 40, 257-269.*

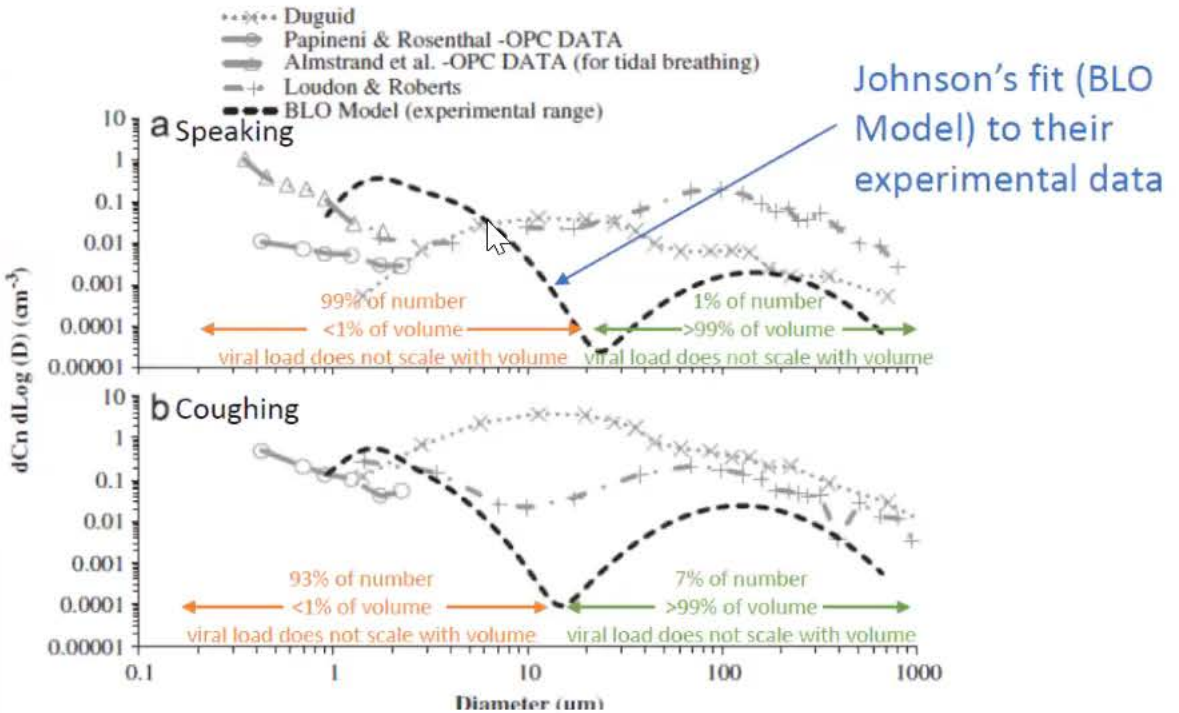
Aerosol Physics

Rapid evaporation

Most particles <10 um

Higher viral load

"Viral load does not scale with volume, but rather is enhanced in smaller aerosols for influenza"



SOURCE: Linsey Marr, citing Yan, J. et al. (2018); Yang, W., Elankumaran, S., & Marr, L. C. (2011).

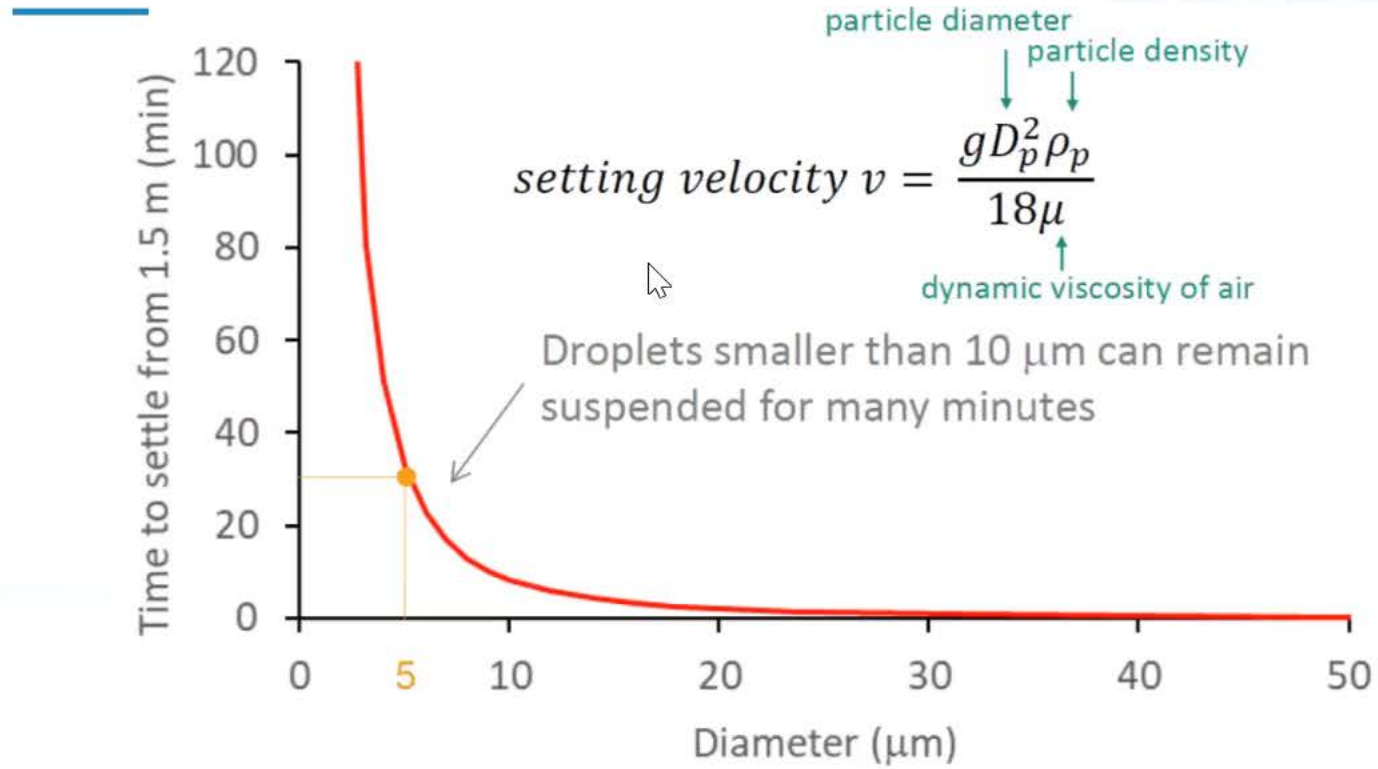
Aerosol Physics

Rapid evaporation

Most particles <10 um

Higher viral load

Small particles stay aloft



Aerosol Physics

Rapid evaporation

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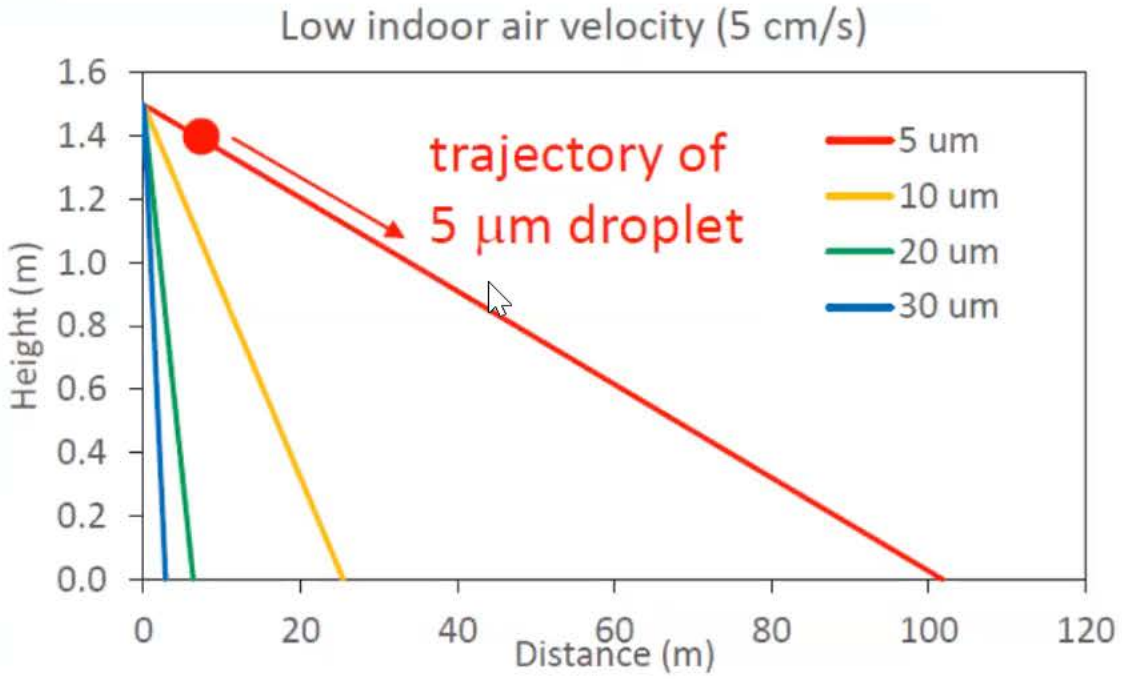
Higher viral load

Small particles stay aloft

Settling distance



Aerosol Physics

Rapid evaporation

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Small particles stay aloft

Settling distance

Air Sampling

RNA in hospitals

INDOOR AIR
International Journal of Indoor Environment and Health

EDITORIAL | Free Access

Recognizing and controlling airborne transmission of SARS-CoV-2 in indoor environments

Joseph G. Allen, Linsey C. Marr

First published: 19 June 2020 | https://doi.org/10.1111/ina.12697

SARS-COV-2 viral RNA in air

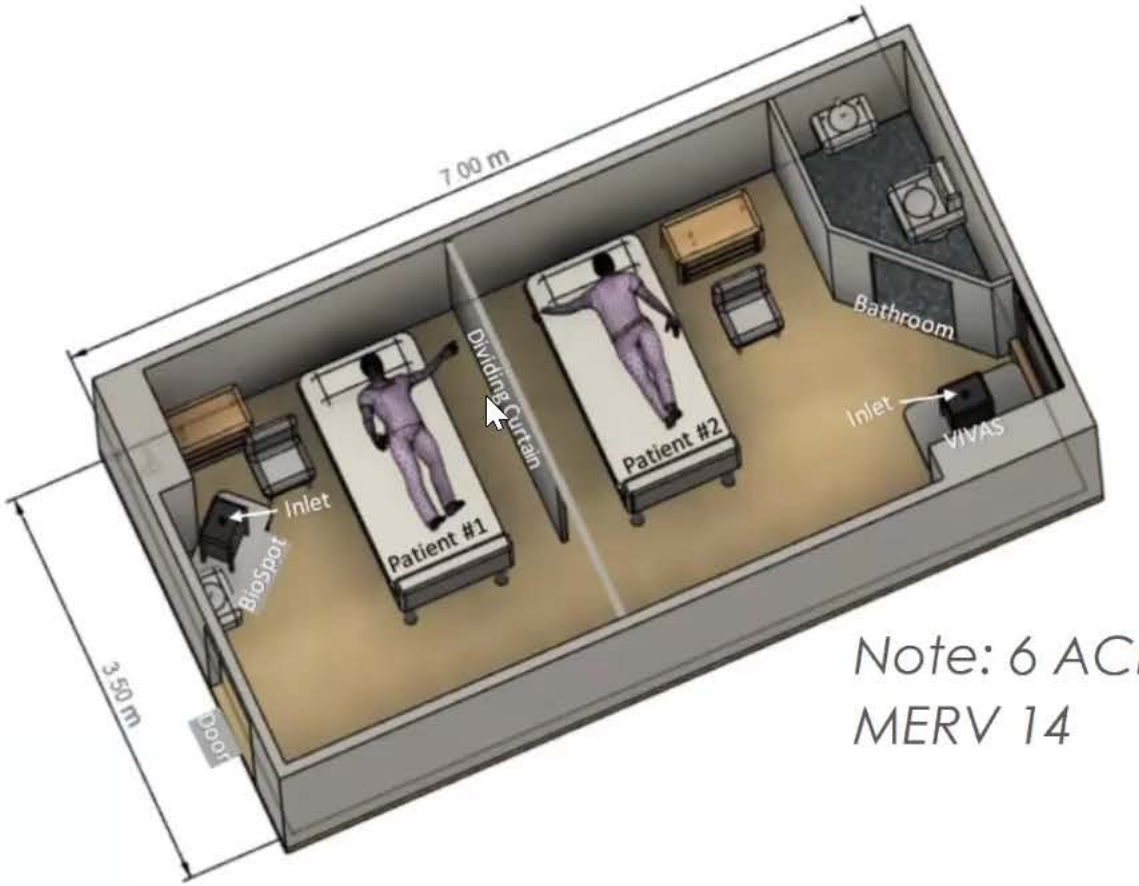
- >2M distance in hospital
- Also found in air exhaust and fan
- Majority of viruses in particles <2.5 um
- Another found majority in 1-4 um

Aerosol Physics

- *Rapid evaporation*
- *Most particles <10 um*
- *Higher viral load*
- *Small particles stay aloft*
- *Settling distance*

Air Sampling

- *RNA in hospitals*
- ***Viable virus at 16 feet***



Note: 6 ACH + MERV 14

SOURCE: Lednicky et al. (preprint)

Aerosol Physics

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Air Sampling

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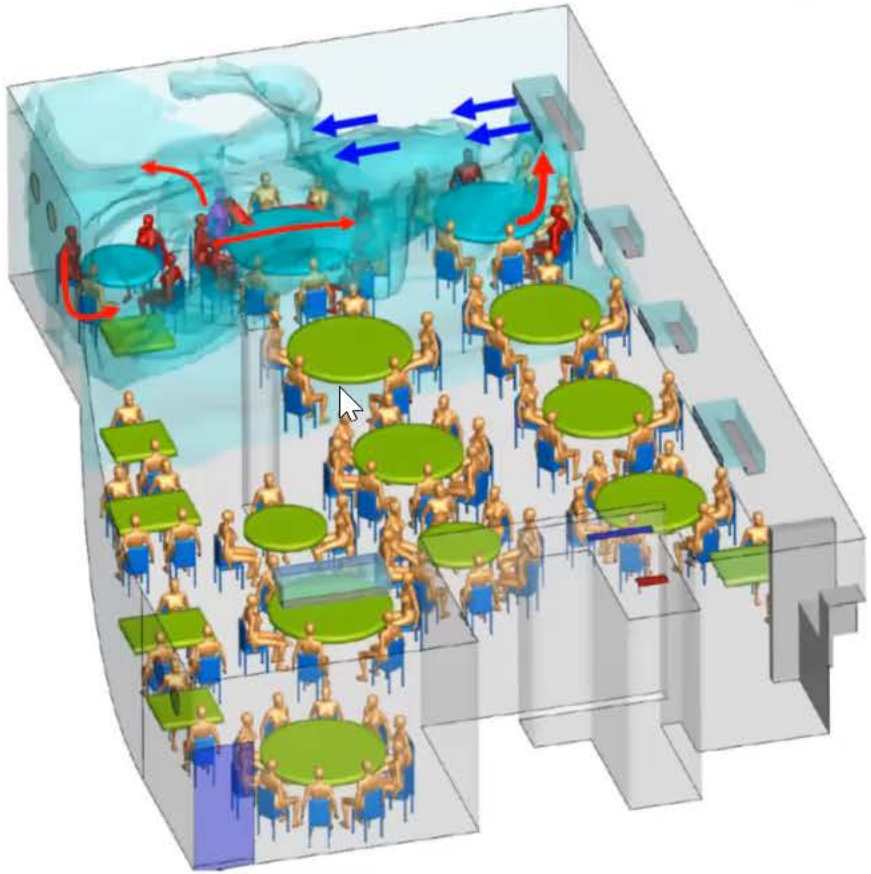
Case Studies

- ***Restaurant***



SOURCE: Li et al. (preprint)

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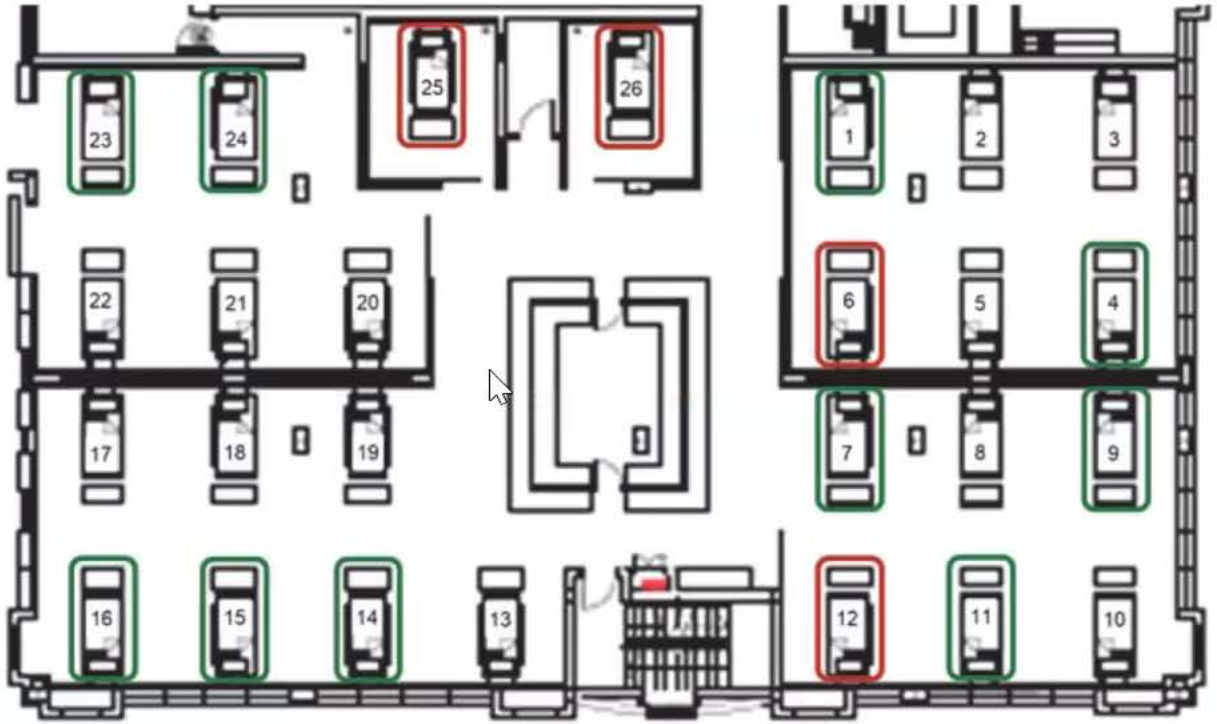

SOURCE: Report into a nosocomial outbreak of coronavirus disease 2019 (COVID-19) at Netcare St. Augustine's Hospital). May 15, 2020

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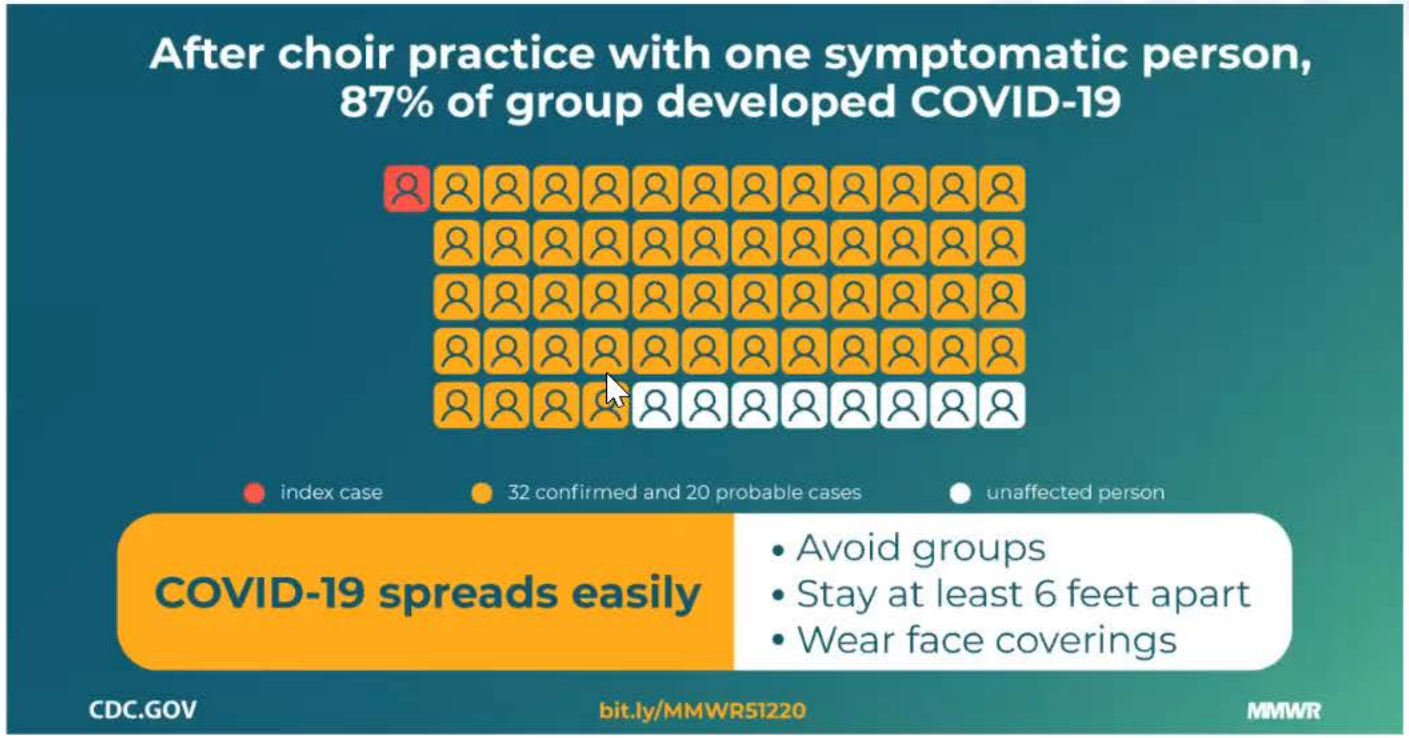
- *Hospital*
- ***Choir practice***



SOURCE: Miller et al. Transmission of SARS-CoV-2 by inhalation of respiratory aerosol in the Skagit Valley Chorale superspreading event. Preprint.

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Air Sampling

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- *Viable virus at 16 feet*

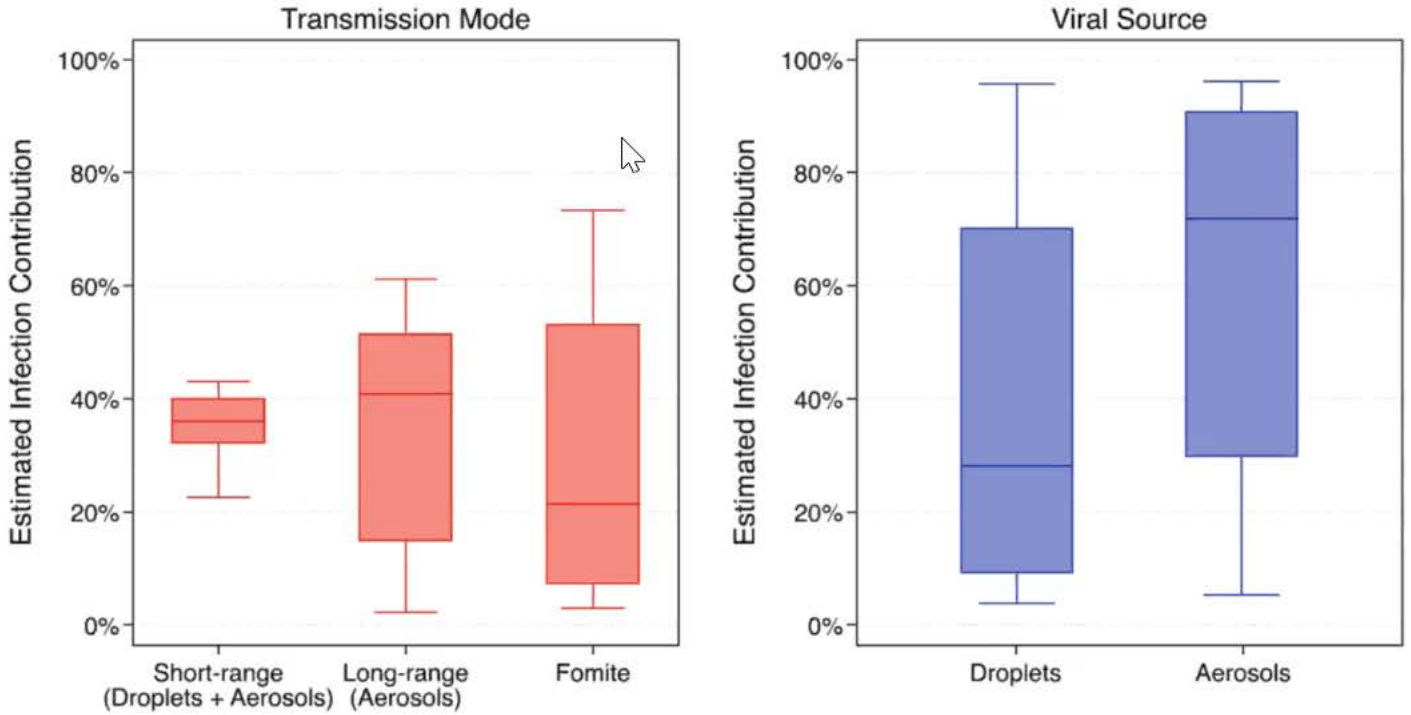
Case Studies

- *Restaurant*
- *Hospital*
- *Choir practice*
- ***Cruise Ship***

Mechanistic Transmission Modeling of COVID-19 on the Diamond Princess Cruise Ship Demonstrates the Importance of Aerosol Transmission

Parham Azimi, Zahra Keshavarz, Jose Guillermo Cedeno Laurent, Brent R. Stephens, Joseph G. Allen

doi: https://doi.org/10.1101/2020.07.13.20153049



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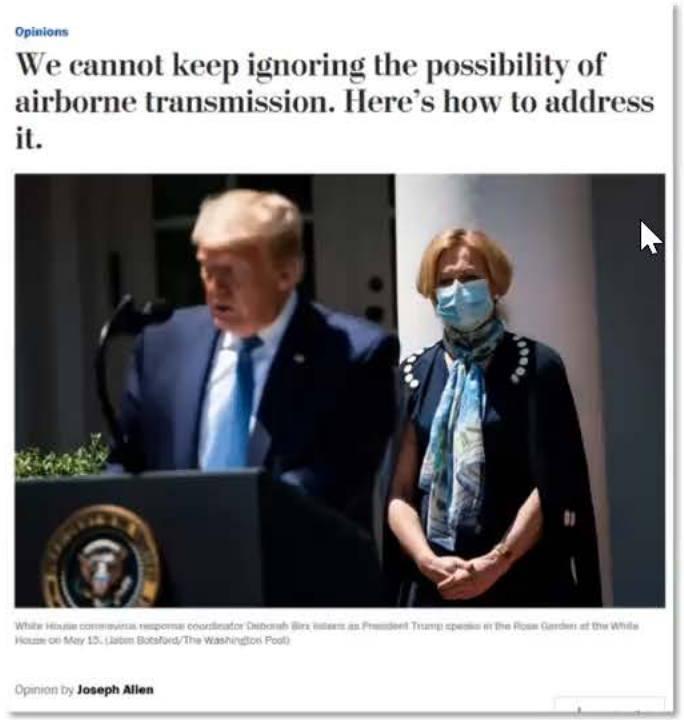
- *Hospital*
- *Choir practice*
- *Cruise Ship*

Epidemiology


The Washington Post

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Opinion by **Joseph Allen**

"Why is airborne transmission so important?

One reason: super-spreader events. "

- Nearly all outbreaks >3 indoors
- 10% of cases cause 80% of spread
- R_0 value of 5.7 (95% CI 3.8–8.9)

Joseph Allen @j_g_allen · Aug 5

ME: Why do you think CDC and WHO have been so reluctant to acknowledge airborne transmission? Do you think it's happening?

FAUCI: This is an area that right now I have brought this to the task force to really take a really good look at this.

Thank you, Dr. **Fauci** 🙌

27 133 383

Joseph Allen @j_g_allen · Aug 5

ME: Why do you
acknowledge air

FAUCI: This is an
really take a real

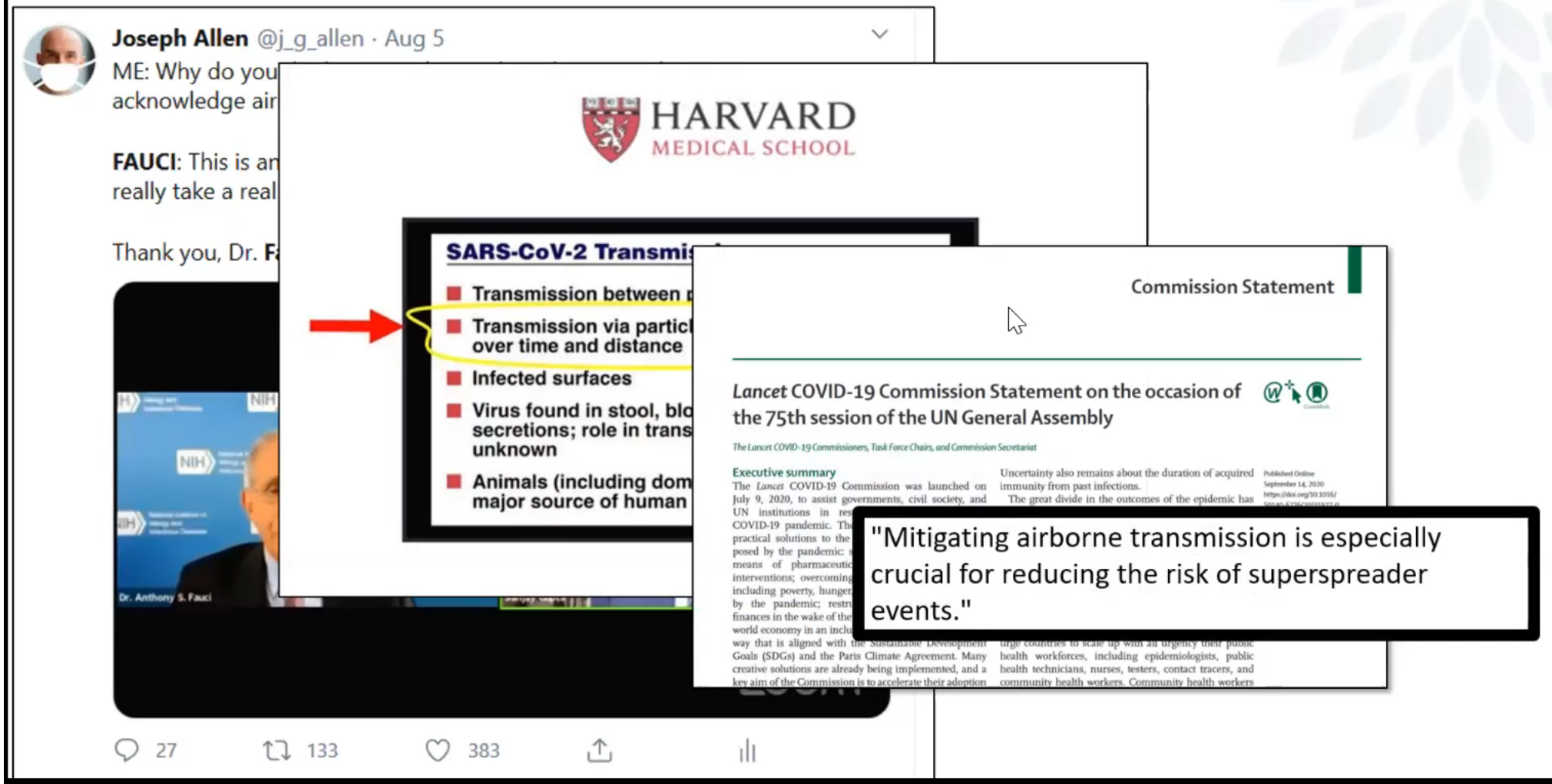
Thank you, Dr. F

HARVARD MEDICAL SCHOOL

SARS-CoV-2 Transmission

- Transmission between people in close contact
- Transmission via particles that remain in the air over time and distance
- Infected surfaces
- Virus found in stool, blood, semen and ocular secretions; role in transmission unknown
- Animals (including domesticated
major source of human infection

27 133 383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27
133
383
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SARS-CoV-2 Transmis
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Transmission via partic
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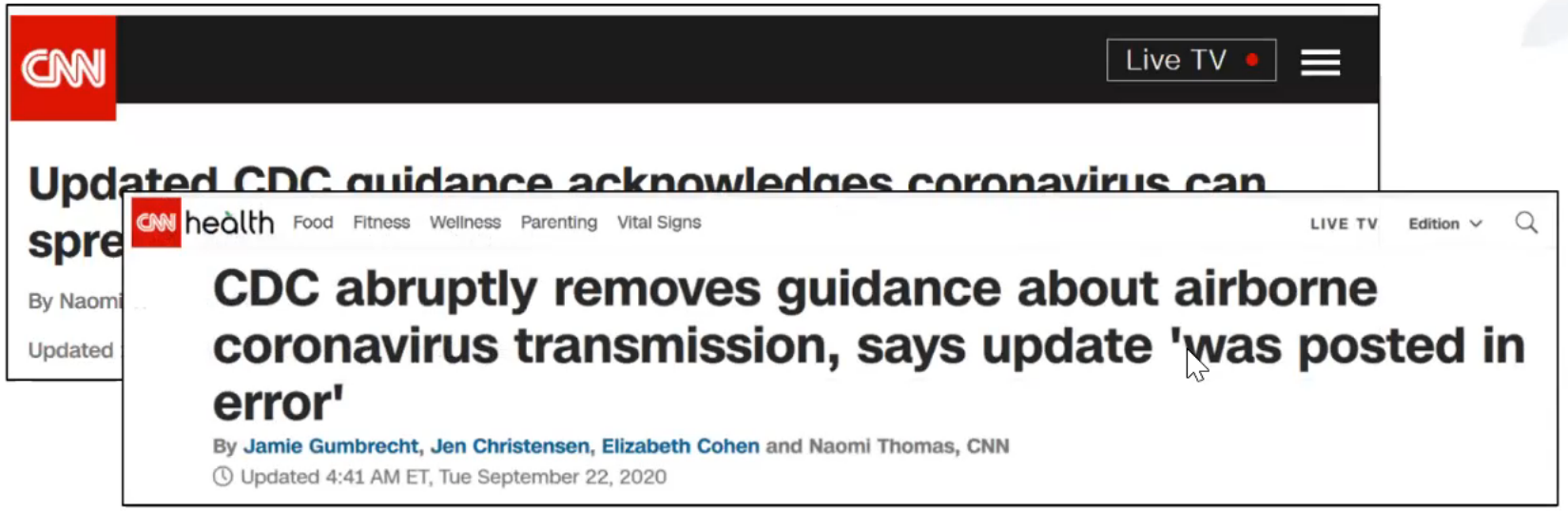
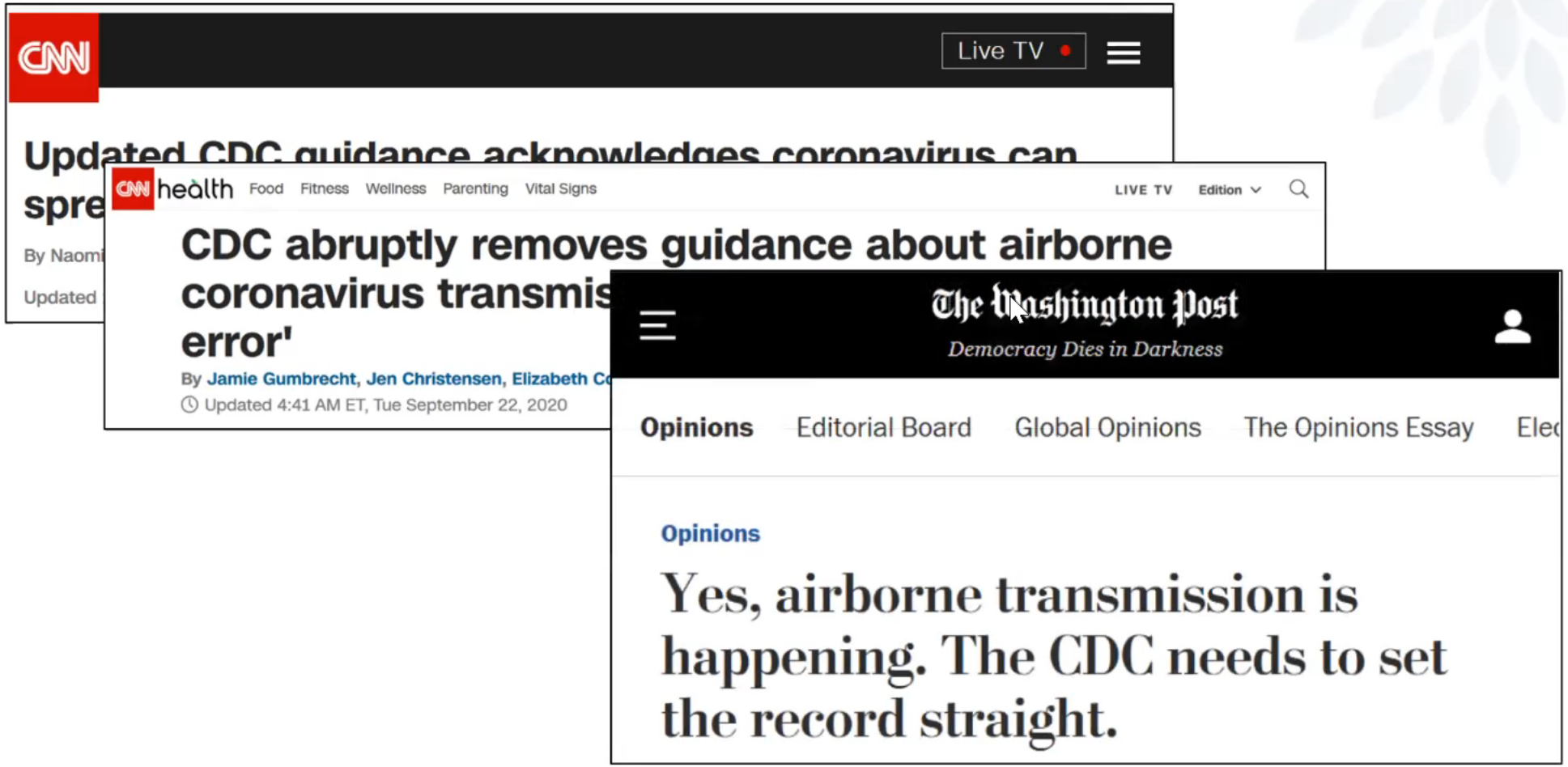
Infected surfaces
Virus found in stool, blo
secretions; role in trans
unknown
Animals (including dom
major source of human
Dr. Anthony S. Fauci
Commission Statement
Lancet COVID-19 Commission Statement on the occasion of the 75th session of the UN General Assembly
The Lancet COVID-19 Commissioners, Task Force Chairs, and Commission Secretariat
Executive summary
"Mitigating airborne transmission is especially crucial for reducing the risk of superspreader events."


CNN
Live TV
Updated CDC guidance acknowledges coronavirus can spread through the air
By Naomi Thomas, CNN
Updated 10:15 PM EDT, Sun September 20, 2020


CNN
Live TV
Updated CDC guidance acknowledges coronavirus can spre
By Naomi
Updated
CNN health
Food
Fitness
Wellness
Parenting
Vital Signs
LIVE TV
Edition
CDC abruptly removes guidance about airborne coronavirus transmission, says update 'was posted in error'
By Jamie Gumbrecht, Jen Christensen, Elizabeth Cohen and Naomi Thomas, CNN
Updated 4:41 AM ET, Tue September 22, 2020


CNN
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Updated CDC guidance acknowledges coronavirus can spre
By Naomi
Updated
CNN health Food Fitness Wellness Parenting Vital Signs
LIVE TV Edition
CDC abruptly removes guidance about airborne coronavirus transmis
error'
By Jamie Gumbrecht, Jen Christensen, Elizabeth Co
Updated 4:41 AM ET, Tue September 22, 2020
The Washington Post
Democracy Dies in Darkness
Opinions Editorial Board Global Opinions The Opinions Essay Elec
Opinions
Yes, airborne transmission is happening. The CDC needs to set the record straight.

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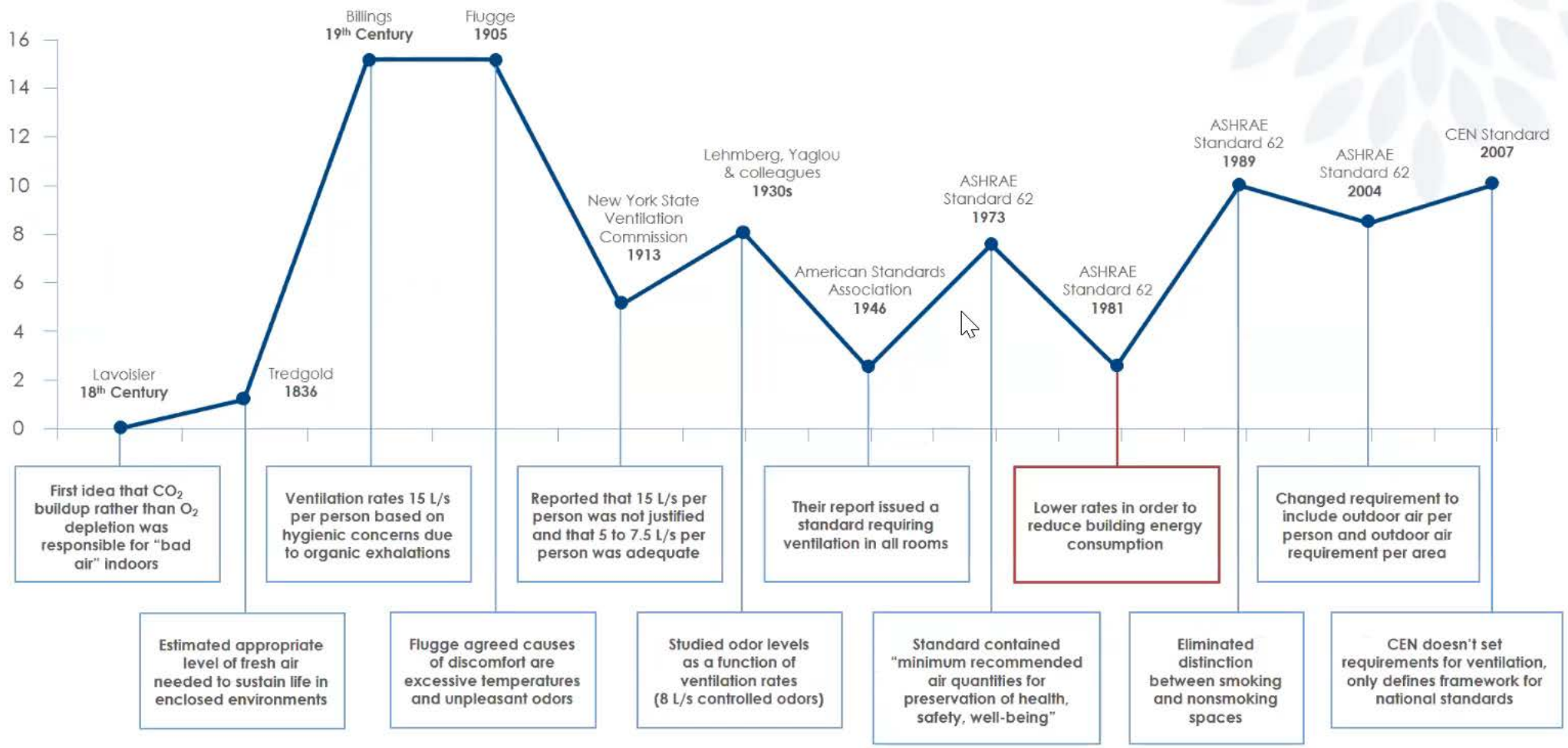

*Cleanliness, **fresh air from open windows**, are the only defence a true nurse either asks or needs."*

*I have seen to be most effectual: **open air** during the greater part of the day… [and] **bedroom ventilation** at night."*

– Florence Nightingale (1860)

Control Strategies for

Airborne Transmission

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SPECIAL COVID-19 REPORT:

RISK REDUCTION STRATEGIES FOR REOPENING SCHOOLS

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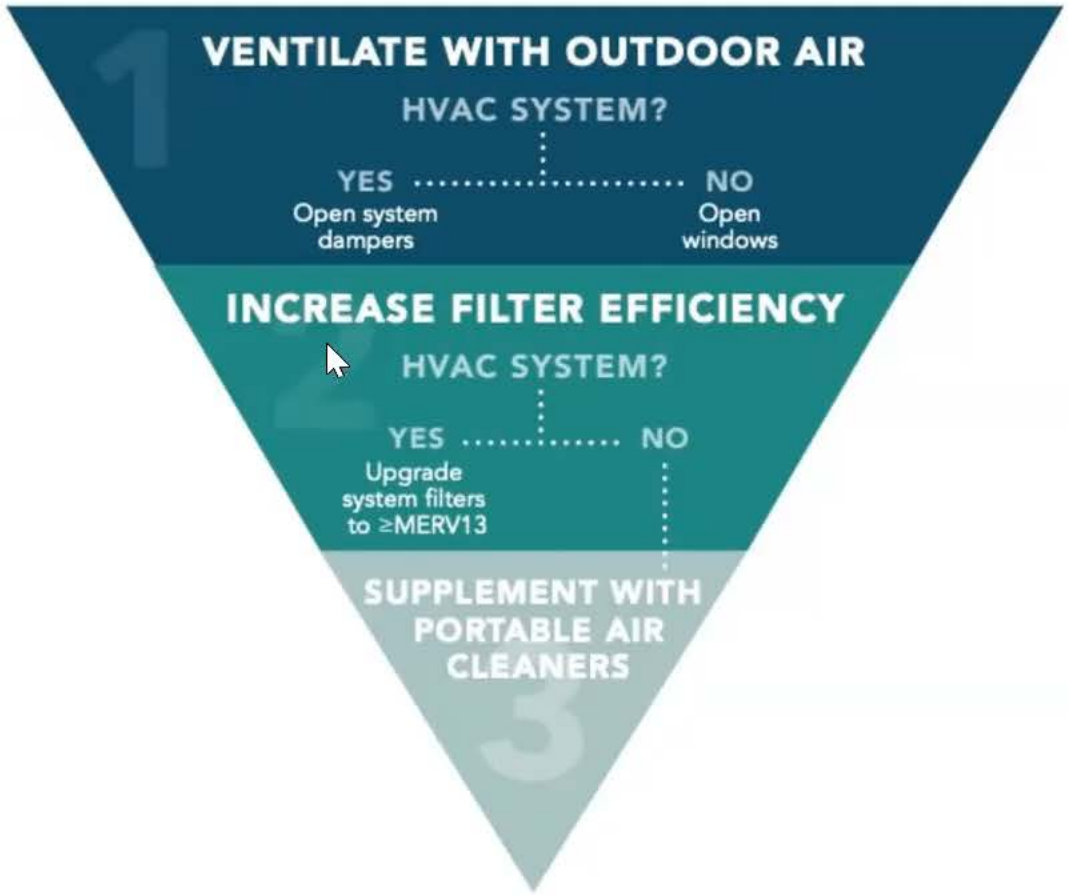

Minimizing Risk in the Workplace

Using a hierarchy of controls as a response framework, companies can take a range of actions – weighing the effectiveness and financial impact of each – to combat Covid-19 in their buildings.

SOURCE: Allen, J.G. and Macomber, J. What makes an office building "healthy"? Harvard Business Review. April 29, 2020.

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WORKING KNOWLEDGE

Business Research for Business Leaders

20 YEARS

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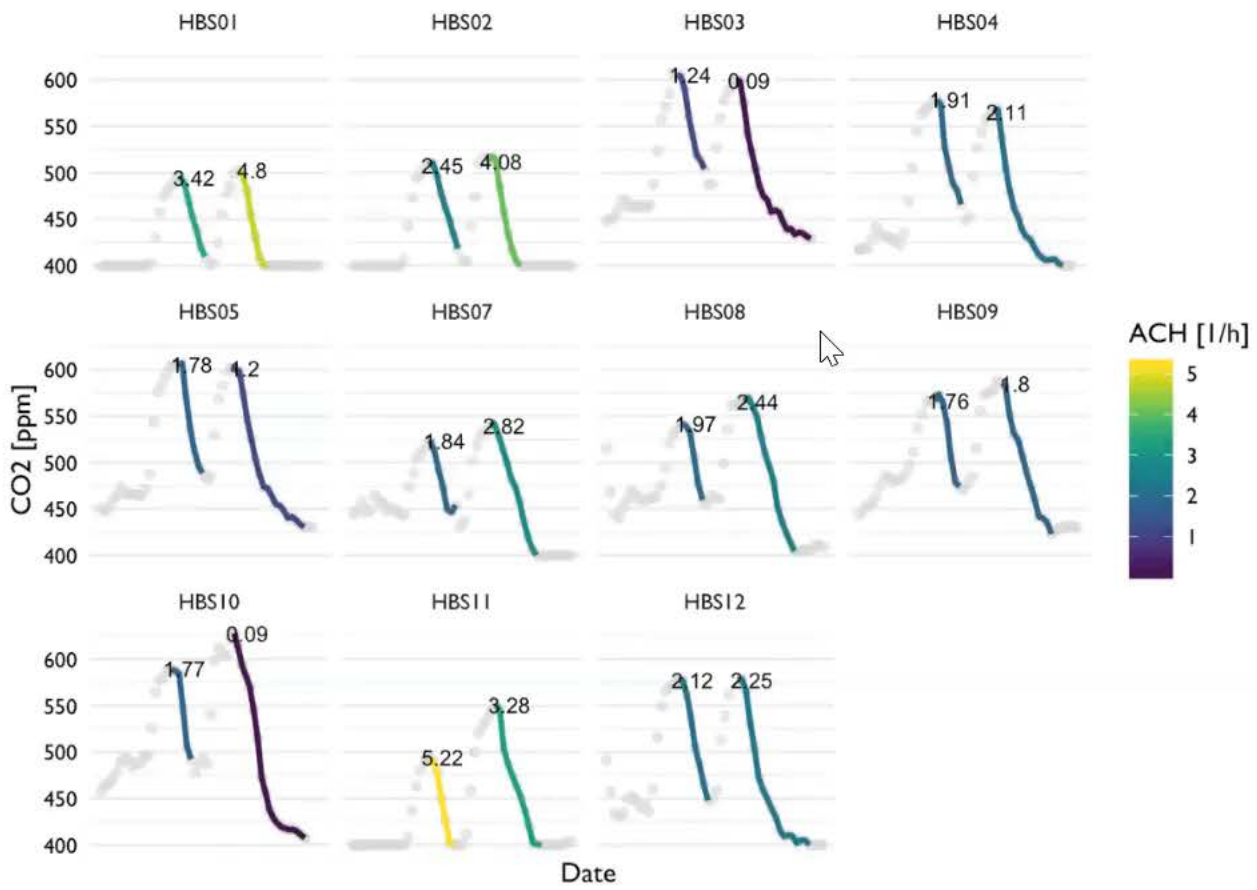
Who Guarantees Your Workplace is Safe for Return?

03 JUN 2020 | by John Macomber and Joseph Allen


HBS01
HBS02
HBS03
HBS04
HBS05
HBS07
HBS08
HBS09
HBS10
HBS11
HBS12
CO2 [ppm]
600
550
500
450
400
3.42
4.8
2.45
4.08
1.24
0.09
1.91
2.11
1.78
1.2
1.84
2.82
1.97
2.44
1.76
1.8
1.77
0.09
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3.28
2.12
2.25
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Beyond Covid-19

Resiliency

The Global Mega-Changes Shaping our World, our Buildings and Us

From chapter 2 *Healthy Buildings: How Indoor Spaces Drive Performance and Productivity*

1 CHANGING **POPULATIONS**

2 CHANGING **CITIES**

3 CHANGING **RESOURCES**

4 CHANGING **CLIMATE**

5 CHANGING **ROLE OF PRIVATE SECTOR**

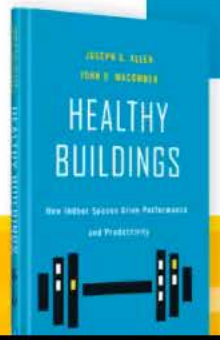
6 CHANGING **DEFINITION OF HEALTH**

7 CHANGING **BUILDINGS**

8 CHANGING **WORK**

9 CHANGING **TECHNOLOGY**

10 CHANGING **VALUES**



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