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## **Trisha Greenhalgh**

3 May, 30 tweets, 8 min read

This is a humanitarian emergency. The Covid-19 pandemic is out of control in many countries. A key priority is PREVENTING TRANSMISSION. To do that, we MUST acknowledge how this virus spreads. Thread.

[linkinghub.elsevier.com/retrieve/pii/S...](https://linkinghub.elsevier.com/retrieve/pii/S...)

1/

It's NOT just that the virus is \*occasionally\* airborne (e.g. when a doctor performs an "aerosol generating procedure" (AGP) such as intubation. The virus is INHALED, by any and all of us, in lots of non-medical situations.

2/

We know that the virus becomes airborne when people sing, cough, speak, shout, and even just breathe in and out. Indeed, activities like singing generate MORE viral-laden aerosols than so-called aerosol-generating procedures.

3/

EVIDENCE #1: SUPER-SPREADER EVENTS. There's SO MANY. Here's a meticulous analysis of an ill-fated choir practice by [@ShellyMBoulder](#) and her team. ONLY airborne transmission can fully explain their findings. [onlinelibrary.wiley.com/doi/10.1111/ina...](https://onlinelibrary.wiley.com/doi/10.1111/ina...)

4/

**Transmission of SARS-CoV-2 by inhalation of respiratory aerosol in the Skagit Valley Chorale superspreading event** During the 2020 COVID-19 pandemic, an outbreak occurred following attendance of a symptomatic index case at a weekly rehearsal on 10 March of the Skagit Valley Chorale (SVC). After that rehearsal, 53....  
<https://onlinelibrary.wiley.com/doi/10.1111/ina.12751>

As [@jljcolorado](#) points out, super-spreader events—concerts, conferences, funerals, parties etc in which one person (often without symptoms) infects many others—DRIVE the pandemic.

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# INDOOR AIR

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7/ Some people argue that superspreading events are interesting but minor overall. That is not correct. Superspreading plays a major part on pandemic spread, and controlling SSE is key to control the pandemic, as @nature summarizes here: <https://t.co/s50dDIWNGY>

— Jose-Luis Jimenez (@jljcolorado) April 17, 2021

5/

EVIDENCE #2: LONG-RANGE TRANSMISSION—e.g. in quarantine hotels—where people get infected from SHARING AIR. They never meet the people whose exhaled air they're breathing in; they never touch a common surface or object.

[wwwnc.cdc.gov/eid/article/27...](http://wwwnc.cdc.gov/eid/article/27...)

6/

# EMERGING INFECTIOUS DISEASES

A Peer-Reviewed Journal Tracking and Analyzing Disease Trends

**Transmission of Severe Acute Respiratory Syndrome Coronavirus 2 during Border Quarantine and Air Travel, New Zealand (Aotearoa)** Transmission of SARS-CoV-2 during Air Travel [https://wwwnc.cdc.gov/eid/article/27/5/21-0514\\_article](https://wwwnc.cdc.gov/eid/article/27/5/21-0514_article)

Another example of long-range transmission here.

[Unroll available on Thread Reader](#)

9/ Another recently-published case in which an infected person transmitted to several people who were 15 meters BEHIND. Genome sequencing shows that it was the same virus. Video shows that there was no close contact. <https://t.co/nTOZoZxGFp>  
[pic.twitter.com/TLDgMgdnk7](https://t.co/nTOZoZxGFp)

— Jose-Luis Jimenez (@jljcolorado) [April 17, 2021](#)

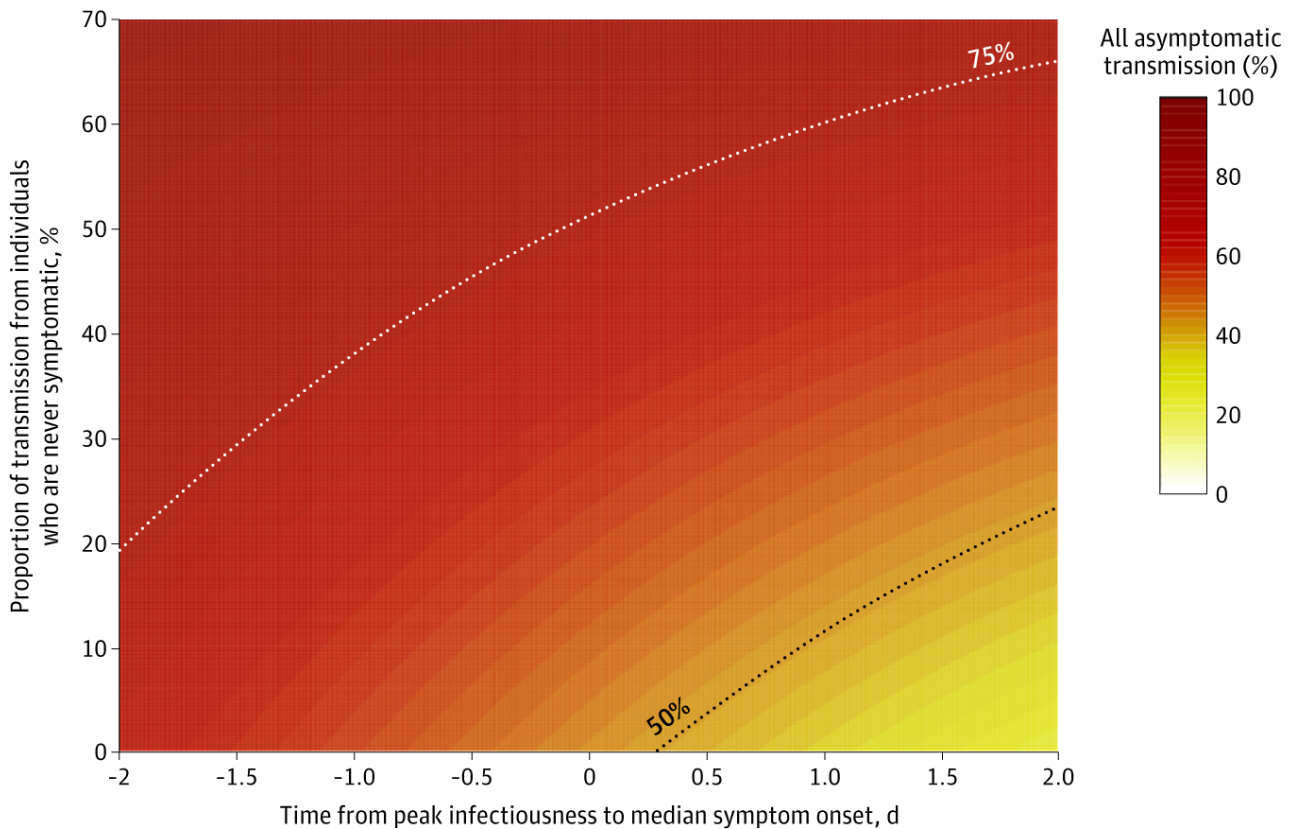
7/

EVIDENCE #3: ASYMPTOMATIC TRANSMISSION. Many people who pass on virus have no symptoms at the time. Asymptomatic people talk, sing & breathe (-> aerosols) but don't usually spit or sneeze (-> droplets) at you.

[jamanetwork.com/journals/jaman...](http://jamanetwork.com/journals/jaman...)

8/

**SARS-CoV-2 Transmission From People Without COVID-19 Symptoms** This decision analytical model assesses the proportion of severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) transmissions in the community that likely occur from



persons without symptoms. <https://jamanetwork.com/journals/jamanetworkopen/fullarticle/2774707>

EVIDENCE #4: TRANSMISSION ALMOST ALWAYS OCCURS INDOORS. If the virus were spread mainly by droplets (a gravity-driven process), indoor and outdoor transmission would be similar at comparable separation. But they're not. [academic.oup.com/jid/article/22...](https://academic.oup.com/jid/article/22...)

9/

EVIDENCE #5: HEALTHCARE WORKERS GET INFECTED DESPITE MEDICAL MASKS. Despite standard-grade PPE (which protects against droplets but not fully against aerosols), HCWs develop \*occupational\* Covid-19. [acpjournals.org/doi/full/10.73...](https://acpjournals.org/doi/full/10.73...)

10/

There has been at least one successful court case where healthcare workers successfully sued their employer for providing inadequate PPE. The judge considered the evidence in support of airborne spread to be overwhelming. [citoyens.soquij.qc.ca/php/decision.p...](https://citoyens.soquij.qc.ca/php/decision.p...)

11/

Indeed, in that case, the judge accused the so-called expert of using "false arguments" and "fallacies", and another expert for being unaware of key scientific developments in his field when testifying.

12/

EVIDENCE #6: VIABLE VIRUS HAS BEEN FOUND IN AIR. It's hard to catch airborne virus so not all studies are positive—but the black swan has been seen, not once but several times. eg this study of virus in a CAR. [sciencedirect.com/science/articl...](https://sciencedirect.com/science/articl...)

13/

**Isolation of SARS-CoV-2 from the air in a car driven by a COVID patient with mild illness** To determine if viable virus could be isolated from the air within a car driven by a patient infected with SARS-CoV-2, and to assess the size range of...

<https://www.sciencedirect.com/science/article/pii/S1201971221003751>

Same team (Lednicky et al—these people are the \*world experts\* on capturing airborne viruses) also isolated SARS-CoV-2 virus from clinic rooms:

[ncbi.nlm.nih.gov/pmc/articles/PMC...](https://ncbi.nlm.nih.gov/pmc/articles/PMC7792982/)

14/

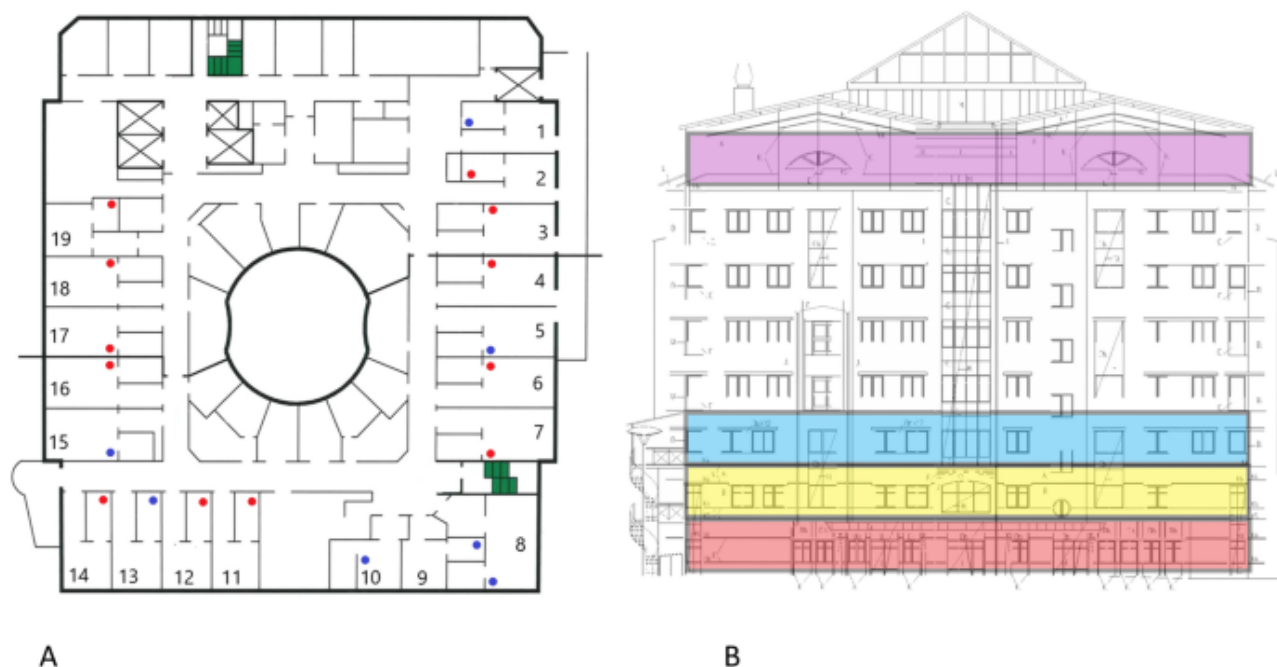
**Collection of SARS-CoV-2 Virus from the Air of a Clinic Within a University Student Health Care Center and Analyses of the Viral Genomic Sequence** The progression of COVID-19 worldwide can be tracked by identifying mutations within the genomic sequence of SARS-CoV-2 that occur as a function of time. Such efforts currently rely on sequencing the ...

<https://www.ncbi.nlm.nih.gov/pmc/articles/PMC7792982/>

EVIDENCE #7: SARS-COV-2 FOUND IN AIR DUCTS. In a hospital, the virus is sucked out in the ventilation system and cultured from the ducts and filters. There's only one way it could have got there: AIRBORNE.

[nature.com/articles/s4159...](https://www.nature.com/articles/s41598-020-76442-2)

15/



**Long-distance airborne dispersal of SARS-CoV-2 in COVID-19 wards**

<https://www.nature.com/articles/s41598-020-76442-2>

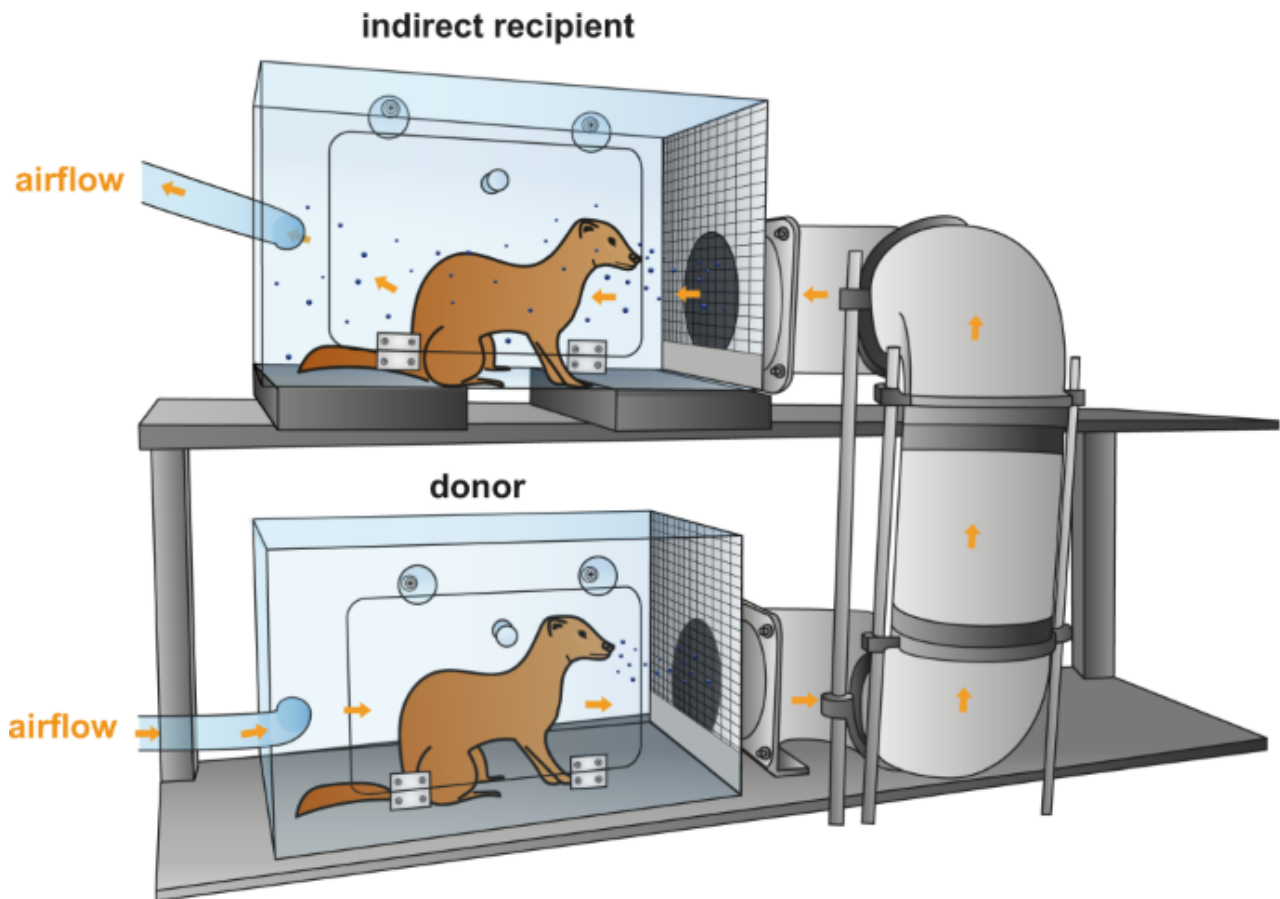
EVIDENCE #8: TRANSMISSION BETWEEN CAGED FERRETS VIA AIR DUCTS. Yes I know, “animal models”. But this isn’t a claim that human physiology is same as ferret physiology. It’s saying \*the only way this could have happened\* is AIRBORNE.

[nature.com/articles/s4146...](https://www.nature.com/articles/s41466-020-0191-2)

16/







**SARS-CoV and SARS-CoV-2 are transmitted through the air between ferrets over more than one meter distance** Some epidemiological data suggests that SARS-CoV-2 can be transmitted through the air over longer distances. Here, Kutter et al. show in the ferret model that SARS-CoV-2 and SARS-CoV can be transmitte...

<https://www.nature.com/articles/s41467-021-21918-6>

EVIDENCE #9: ABSENCE OF DISCONFIRMING STUDIES. We looked hard, and we didn't find a SINGLE study which offered evidence against airborne transmission. If airborne transmission didn't happen, it would surely not be too hard to "disprove" it?  
17/

EVIDENCE #10: ABSENCE OF EVIDENCE THAT OTHER ROUTES OF TRANSMISSION ARE DOMINANT. The evidence for droplet or fomite transmission is weak. These routes likely occur but unlikely to be \*dominant\*.  
[thelancet.com/journals/lanin...](https://www.thelancet.com/journals/lanin...)

18/

**Exaggerated risk of transmission of COVID-19 by fomites** A clinically significant risk of severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) transmission by fomites (inanimate surfaces or objects) has been assumed on the basis of studies that have... [https://www.thelancet.com/journals/laninf/article/PIIS1473-3099\(20\)30561-2/fulltext](https://www.thelancet.com/journals/laninf/article/PIIS1473-3099(20)30561-2/fulltext)

The signs all pointed to the virus being airborne right back in early 2020, but (perhaps because of a dire shortage of PPE), the World Health Organisation and other bodies confidently denied this.

Well they are important, but it's quite likely coronavirus is in aerosols and spread by tidal breathing, so the distance rule is no guarantee.

Washing hands helps a lot

But the only thing that can filter those droplets and aerosols is a N95 or better N99 mask

— Tom Andrews  (@0bj3ctivity)  
February 20, 2020



19/

Here's a previous thread by my co-author [@jljcolorado](#) which goes into more detail on some of the science:

[Unroll available on Thread Reader](#)

25/ Here the Editors of [@nature](#) were practically yelling (on 2-Feb) to [@WHO](#) and [@CDCgov](#) to say clearly that surfaces transmit little, and that surface disinfection is not important, and efforts should focus on the air. <https://t.co/525P7e9aQh>

— Jose-Luis Jimenez (@jljcolorado) [April 18, 2021](#)

20/

A key point: “close-range” is not a route of transmission. We all know the virus is transmitted mostly through close contact. AEROSOLS are transmitted mainly by close contact, but they ALSO travel longer distances in the air.

21/

So talking about “close-range” transmission confuses two different modes of transmission. Yes, we need to keep physical distance. No, that's not only (or even mainly) to reduce droplet transmission, it's to reduce AIRBORNE transmission.

22/

Smell the garlic on someone's breath. You don't want to be close to them do you? But you can still smell it across the room. Washing your hands won't help here. Scrubbing surfaces won't help. But opening the window will.

23/

World Health Organisation got it wrong back in March 2020. They rejected the advice of aerosol scientists offered a year ago. They're now saying that aerosol transmission “can occur in certain situations”, by which they mean (mostly) medical AGPs.

24/

People advising the WHO, and some who claim to speak for WHO, are saying this is all “nuance”, and we should “stop fighting each other” and that aerosol scientists are “trying to further their own careers”. This is gaslighting.

25/

We have a humanitarian emergency. WHO is the leading international organisation for health. It’s still pussyfooting on the question of airborne transmission. Based on current WHO guidance, many HCWs around the world are being denied high-grade PPE.

26/

If the virus is spread mainly by the airborne route, we need to

- Encourage people to go outdoors
- Pay attention to ventilation (don’t use air-con)
- Reduce time spent indoors
- Avoid crowds
- Keep physical distance
- Wear well-fitting, high-quality masks whenever indoors

27/

Finally, if the virus is airborne, health and care workers in infectious settings should be supplied with higher-grade PPE including respirator masks for ALL activities. There are several ongoing court cases. I predict the HCWs will win.

28/

Our paper again here:

[linkinghub.elsevier.com/retrieve/pii/S...](https://linkinghub.elsevier.com/retrieve/pii/S...)

29/

And my response to critics here:

[Unroll available on Thread Reader](#)

Had quite a bit of backlash to our paper, published last week, which set out 10 streams of evidence supporting predominance of AIRBORNE spread of SARS-CoV-2. I respond to some criticisms in this thread.

1/<https://t.co/ZOY0IXx2VJ>

— Trisha Greenhalgh (@trishgreenhalgh) [April 24, 2021](#)

30/end

(PS at NO POINT in this thread have I said we should stop washing our hands).

• • •

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