

SARS CoV-2/Covid is in the air!
Airborne spread =
inhalation of aerosol particles

Hands. Face. Space
Won't cut it!
Ventilation. Ventilation. Ventilation!

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We didn't vote to die at work- Hazards Campaign

HAZARDS
CAMPAIGN

Ventilation requirements

- People breathing in indoor space take Oxygen out of air reducing it's level from 20% in inhaled to 16% in exhaled breath+ increase Carbon dioxide from 0.04% in inhaled air to 4% in their exhaled breath; and exhaled air contains viruses, bacteria, fungi, droplets from the lungs and airways, and is saturated with water and warm.
- Ventilation – natural by windows/doors, trickle vents or HACV system – is air flow in and out, it removes stale air (environmental contaminants, dust, plastic fibres/particles, VOCs , traffic pollution etc) and brings fresher, cooler, drier air containing more oxygen, less CO2 and less water vapour + microbes including Covid.
- Can use CO2 level as proxy for ventilation: 0.04% = 300-400 ppm CO2 outside near ground level. 600 to 800ppm, parts per million of air = a well ventilated room, over 1,000 concern, over 1,500 ppm
- Fresh/outdoor air: Optimum = 10 litres per second per person - Fewer people=more fresh air p/person – half number = 2x as much ventilation per person
- Recommended Air Changes per Hour (ACH) per room: 6 per hour or higher 9x 10x ?
- Air Cleaners/Filtration- HEPA filters, UVc disinfection at source HACV; upper room
- HSE advice is poor <https://www.hse.gov.uk/coronavirus/equipment-and-machinery/air-conditioning-and-ventilation.htm>– European REHVA, CIBSE and US ASHRAE recommendations are better <https://www.ashrae.org/technical-resources/resources> UK Govt [SAGE C/te](https://www.gov.uk/government/organisations/sage)

Ventilating

Hands, face, space. We all know the mantra. But you can't stop breathing and if the workplace air is going nowhere and is chock-full of coronavirus you'll still be at risk. Hilda Palmer of the Hazards Campaign explains the critical importance of ventilation and why it is necessary to clear the air.

PHOTO: WWW.ISTOCKPHOTOS.COM



AND BREATHE Carbon dioxide (CO₂) monitors can give a rough indication of how well your workplace ventilation – whether it's via an open door or a full-on mechanical system – is working.

Coronavirus is in the air. It spreads like smoke in tiny aerosol particles exhaled by infected individuals with every breath.

The prevention three amigos of 'hands, face, space' deals with contact and droplet risks – but does not address transmission of virus-laden airborne aerosols.

A microscopic, invisible virus-carrying cloud – a 'far-field aerosol' – can get you at a distance. It is likely to be the most important mode of transmission.

This isn't just theory – infectious disease experts, aerosols scientists and epidemiologists have established the mode of aerosol transmission in Covid-19 studies, sentinel cases, super-spreader events, cluster outbreaks and laboratory experiments.

Months before the UK government, Public Health England and the UK Scientific Advisory Group for Emergent

panel conceded the airborne transmission risk (*Hazards* 151).

And specific guidance from the workplace safety regulator the Health and Safety Executive (HSE) was late and remains weak and unenforced.

The consequence has been hundreds of workplace clusters each week, some seeing hundreds of workers test positive and some die (page 4).

Every breath you take

SARS Cov-2, the coronavirus responsible for Covid-19, infects a person when it is inhaled (droplet and airborne transmission) or gets into the mouth and nose via touch (fomite transmission).

Droplets in spit or exhaled can evaporate to become smaller aerosols, and spread further.

Aerosols can fill a room and linger in

the air for seconds to hours, often after the infected person has left. They fall out of the air, are deposited on surfaces and can be recirculated by air currents.

Virus concentrations can build up in indoor areas that are poorly ventilated, where workers breathe shared air for hours at a time.

Aerosols persist longer in colder, drier air, an added occupational risk in jobs like food processing (page 8).

Face masks can help, but good ventilation is critical to reducing the viral load in the air. Lower loads reduce the risk of infection and the severity of infection.

Effective ventilation removes stale air and brings in cooler, drier air containing more oxygen, less carbon dioxide (CO₂) and water vapour and fewer microbes.

The concentration of carbon dioxide in indoor air is a useful indication of how well the ventilation is functioning.

Carbon dioxide increases from 0.04 per cent to 4 per cent in exhaled breath. Outside air contains 300-400 parts per million (ppm) carbon dioxide near ground level.

Indoor air at 600 to 800 ppm carbon dioxide indicates a relatively well-ventilated room. Over 1,500 ppm means very poor ventilation and action is needed. A minimum of six air changes per hour is recommended.

There is no one silver bullet that is 100 per cent effective to prevent infection from coronavirus in near- and far-field aerosols. But a combination of good ventilation, 2 metre minimum distancing and PPE all contribute to overall protection.

UK rules on ventilation

An infectious person may exhale 100,000 to 10 million virus particles an hour, so effective ventilation is essential to infection prevention. UK guidance was slow to recognise this.

It was as recently as 26 November 2020 when the UK business department BEIS issued updated workplace guidance, with an 'objective' recommending "ventilation to mitigate the transmission risk of Covid-19."

The BEIS guide notes: "Good ventilation can be different for areas depending on how many people are in there, how the space is being used, and the particular layout of the area. Therefore you will need to consider the particular ventilation requirements in the area you are considering."

"Ventilation and air conditioning during

the coronavirus (Covid-19) pandemic', an HSE guide published in December 2020, notes: "Good ventilation, together with social distancing, keeping your workplace clean and frequent hand-washing, can help reduce the risk of spreading coronavirus."

The Workplace (Health, Safety and Welfare) Regulations lays down the legal ventilation requirements at work. The regulations note: "Effective and suitable provision shall be made to ensure that every enclosed workplace is ventilated by a sufficient quantity of fresh or purified air."

"The fresh-air supply rate should not normally fall below 5 to 8 litres per second, per occupant. When establishing a fresh-air supply rate, consider the following factors: the floor area per person; the processes and equipment involved; whether the work is strenuous."

HSE references technical guidance from the building services professional body, CIBSE.

An October 2020 CIBSE update recommends a minimum of 10 litres per second per person of outside air in offices and avoiding recirculating air.

That's your benchmark.

Assessing the risks

Ventilation systems can be as simple as opening windows and doors to complex centralised Heating Air Conditioning Ventilation systems (HACV).

Find out the type of ventilation system in your workplace, how well it is performing in removing stale shared air and bringing in fresh air.

The employer should provide safety reps with information about the workplace ventilation system – is it providing the recommended air flow, is it maintained properly, are the correct filters in use and replaced and maintained frequently?

Ask for monitoring and maintenance data, including CO₂ levels.

Workplace risk assessment must consider all the factors affecting the risk of inhaling near- and far-field aerosols. Key factors to consider are:

- **Location:** Outdoors less risk, indoor workplaces higher risk, increasing with factors below.
- **Occupancy:** Halving occupancy is equivalent to doubling the ventilation rate. Remember, though, that aerosols can linger for minutes or hours, so previous occupancy levels may create lingering risk.
- **Infection levels:** Research suggests that around half of coronavirus transmission could be from people with no symptoms (asymptomatic).
- **Proximity:** 2 metres physical distancing is a rough minimum distance to avoid inhaling high concentrations of near-field aerosols or being sprayed with droplets.

- **Duration:** The longer the space with poor ven, the higher the risk.
- **Activity:** Aerosols are exhaled during breathing and talking, music, singing or other aerobic activity.
- **Environment:** Cooler, darker, drier conditions assist aerosol spread and persistence; higher temperature and humidity shorten the survival time of the virus.
- **Air flow:** The lower the air flow the higher the risk. Doubling ventilation rate per person can halve the risk.
- **Masks:** Face masks use can reduce the amount of virus in the air.

Hazards Campaign

» www.hazardscampaign.org.uk

HSE

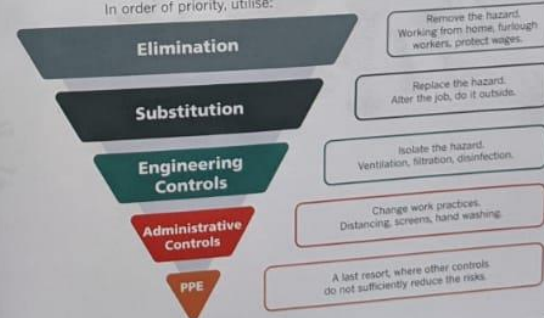
» www.hse.gov.uk/coronavirus

SAFETY REPS' CHECKLIST

1. Do risk assessments consider ventilation requirements?
2. Have safety reps been consulted on the Covid risk assessment?
3. Is the ventilation system effective and maintained?
4. Is the air flow at least 10 litres per second per person with a minimum of six air changes per hour?
5. Is the ventilation system set for 100 per cent outdoor air to prevent recirculation, turned on 2 hours before occupation, and automatic CO₂ sensor switching off or set to 400ppm?
6. If there is no ventilation system, does natural ventilation create an unsatisfactory work environment (temperature, noise, pollution) or pose a risk of spreading infection?
7. Are areas with inadequate ventilation taken out of use or are alternative methods to reduce risk used (eg reducing occupancy, use of upper room UV disinfection, portable HEPA air filtration units)?
8. Are rooms subject to periods of no occupancy to allow contaminants to dissipate?
9. Are rooms cleaned regularly to reduce recirculation of any virus deposited on surfaces, adsorbed on dust?
10. Is the relative humidity too low for the air to dry?

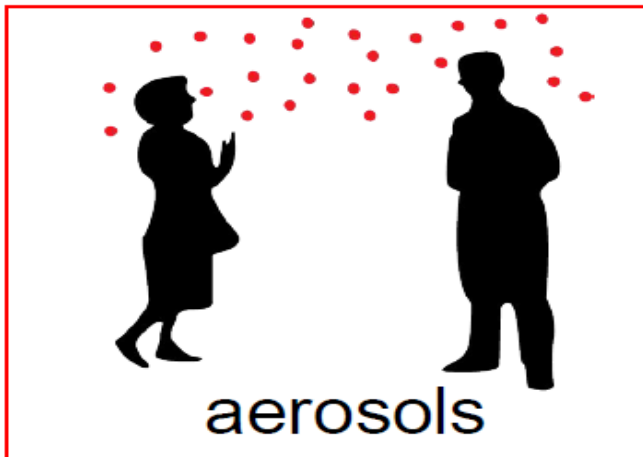
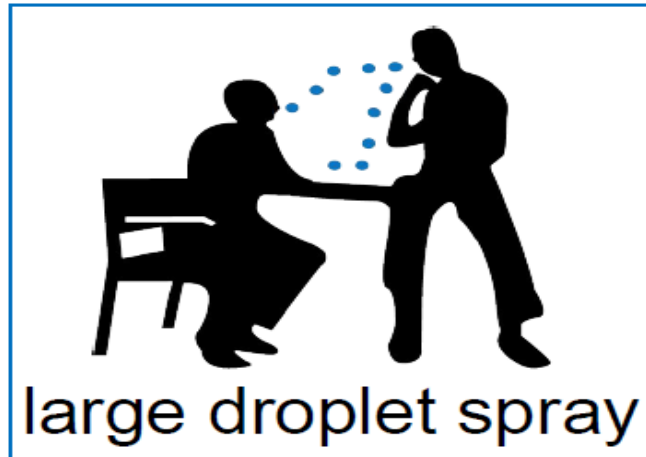
REDUCING THE RISKS

Follow the hierarchy of prevention. In order of priority, utilise:



Transmission Routes

Aerosol transmission is proven via observation, case studies, sentinel cases, cluster outbreaks + experimental studies. WHO reluctantly forced to accept it. UK Govt SAGE accepts, Guidance from HSE late + weak



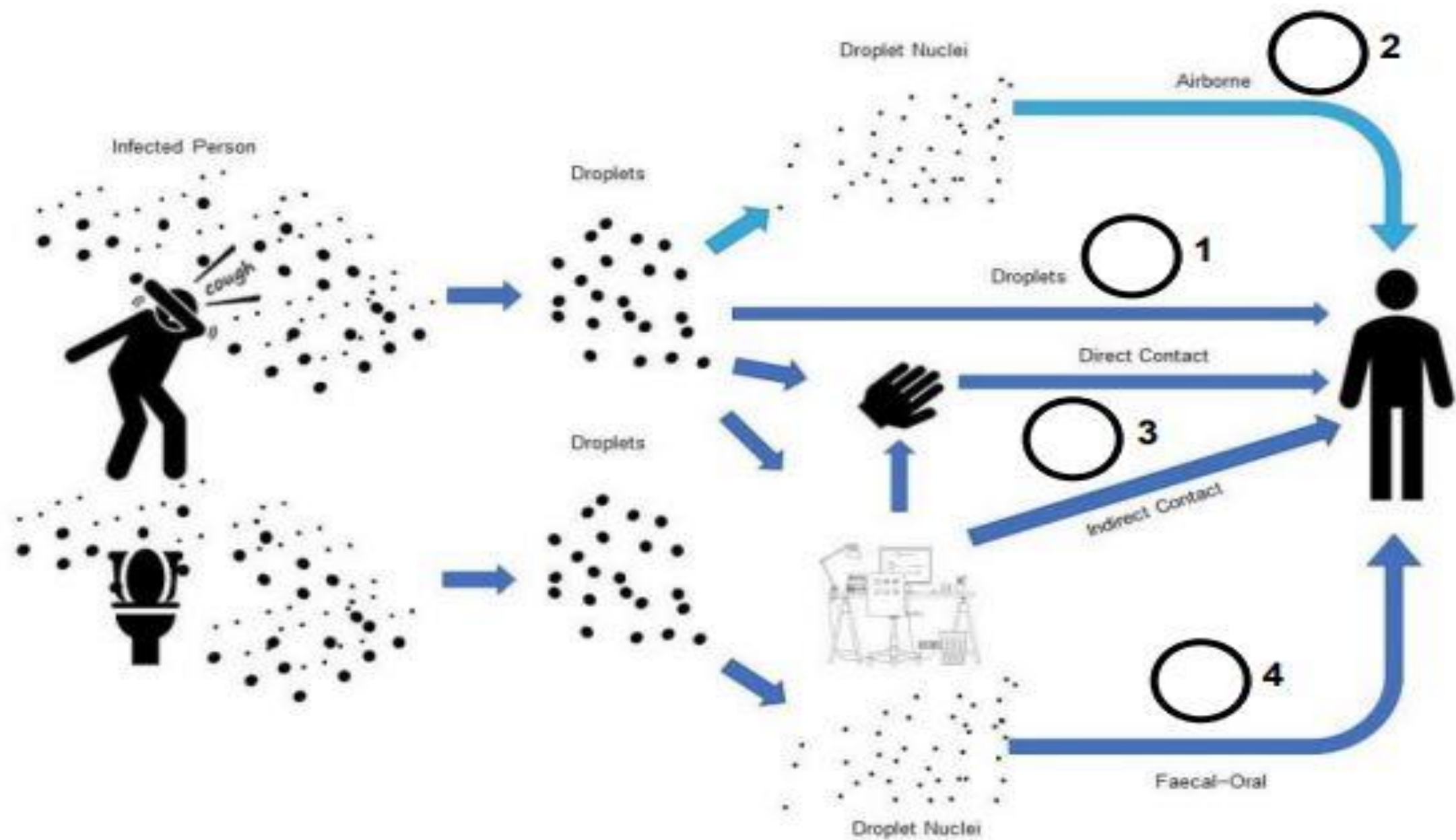
Traditionally defined as $>5 \mu\text{m}$ and happening at close-range only ($<2 \text{ m}$)

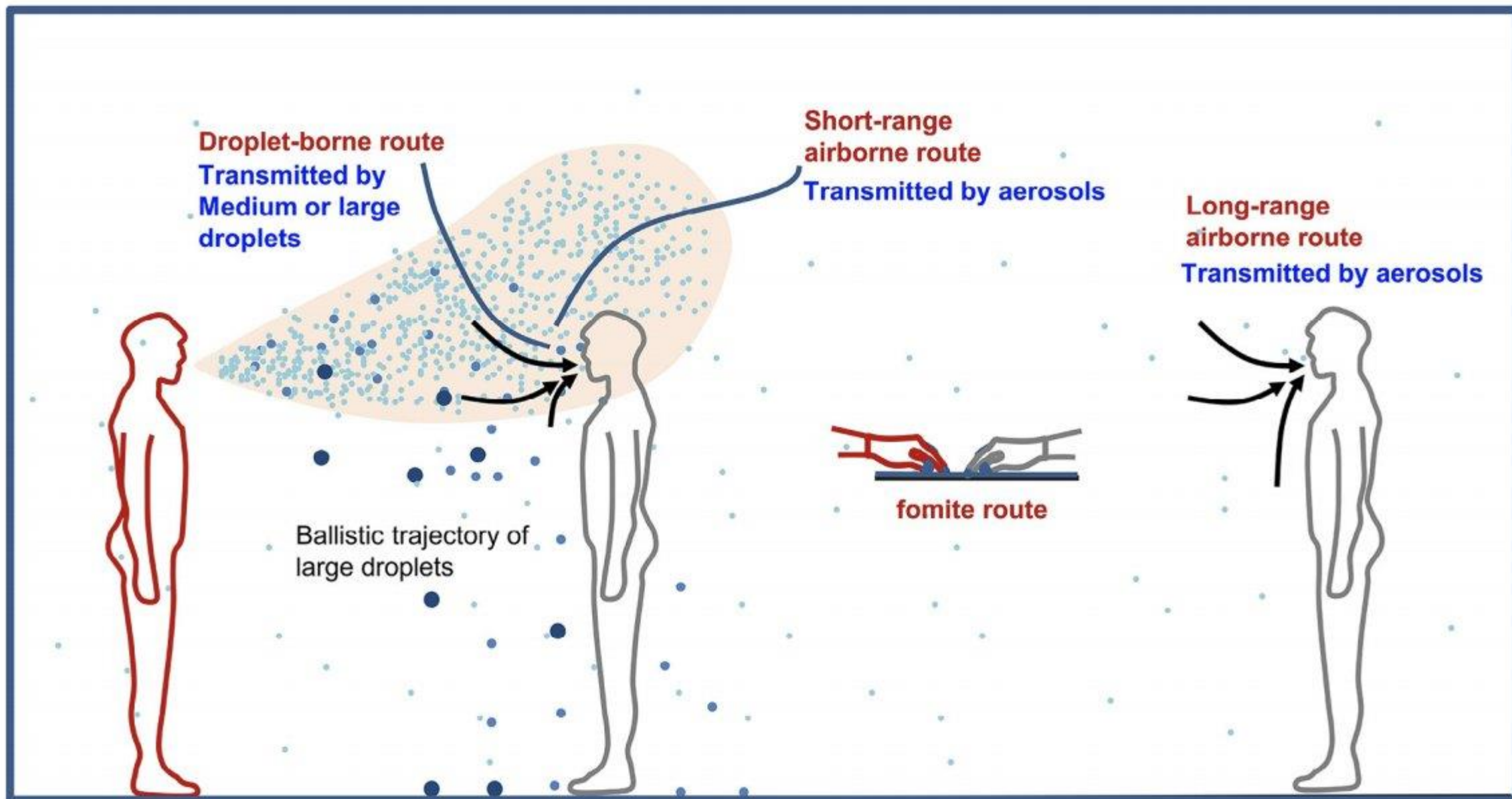
Kate Cole
Occupational Hygienist Australia
<https://twitter.com/YouAreLobbyLud/status/1351455732680466442>

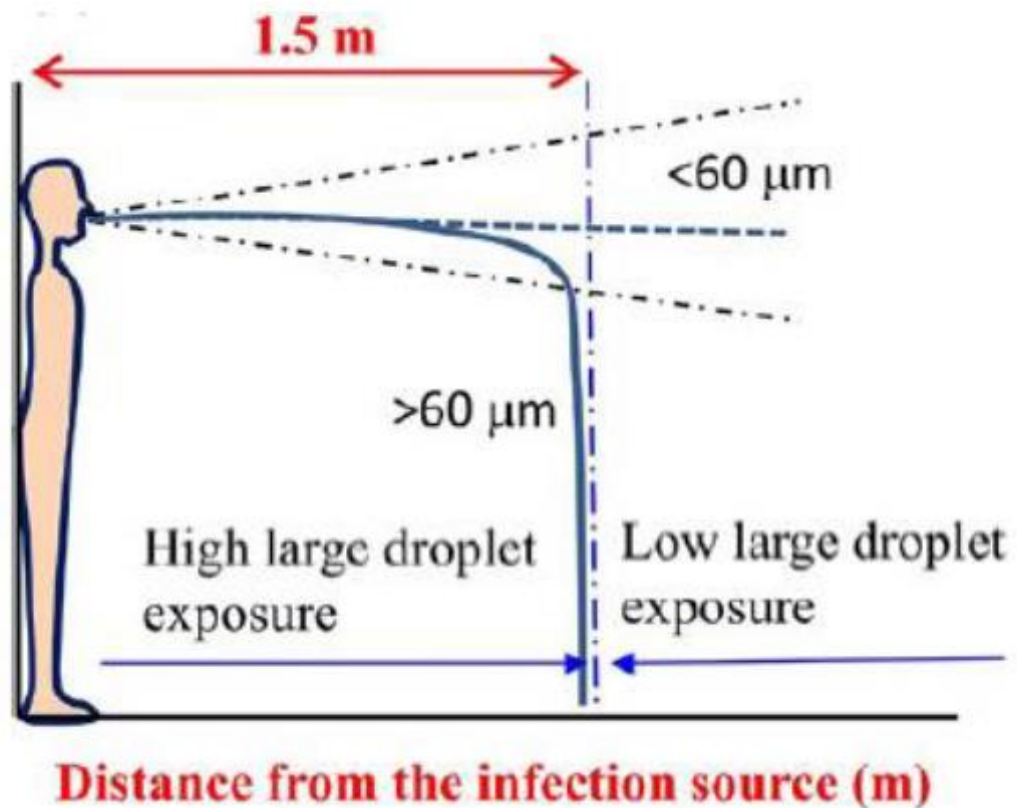
<https://english.elpais.com/society/2020-10-28/a-room-a-bar-and-a-class-how-the-coronavirus-is-spread-through-the-air.html>

Traditionally defined as $<5 \mu\text{m}$ and happening mainly at long-distance ($>2 \text{ m}$)

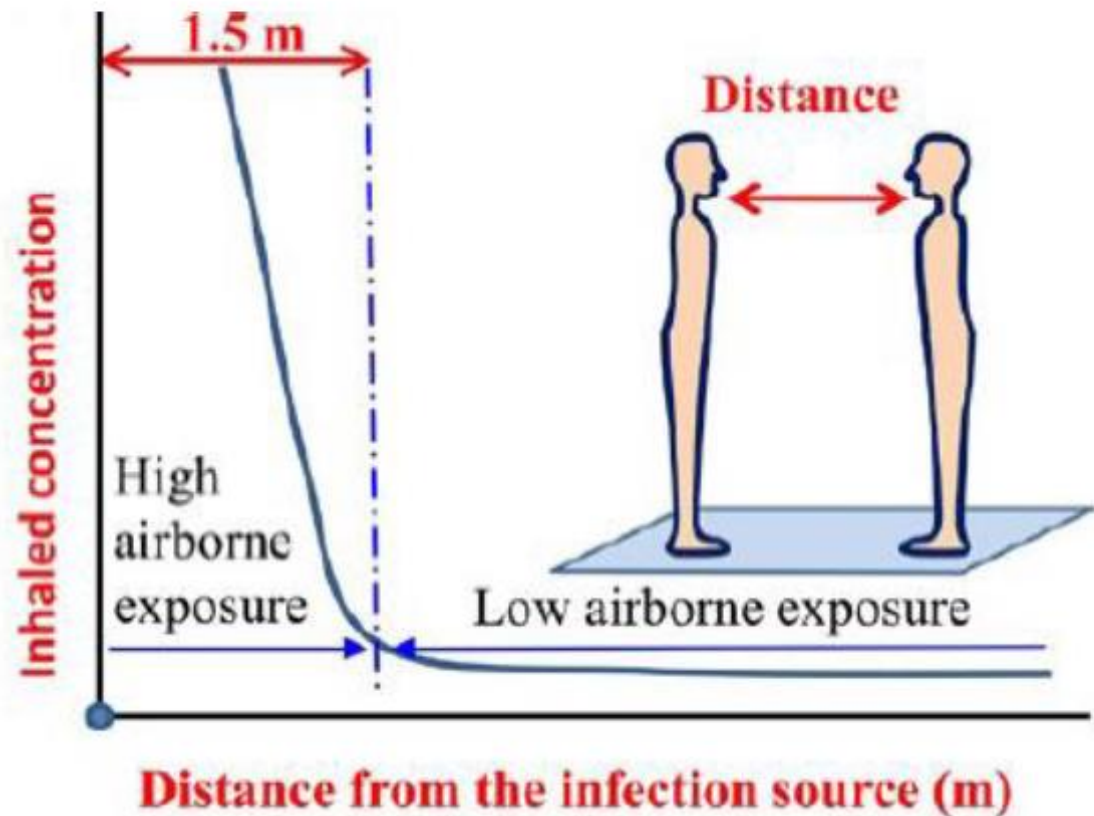
The origin of the $5\text{-}\mu\text{m}$ cutoff is not clear. This cutoff is not supported by modern aerosol science. This distinction has hampered our understanding of transmission.







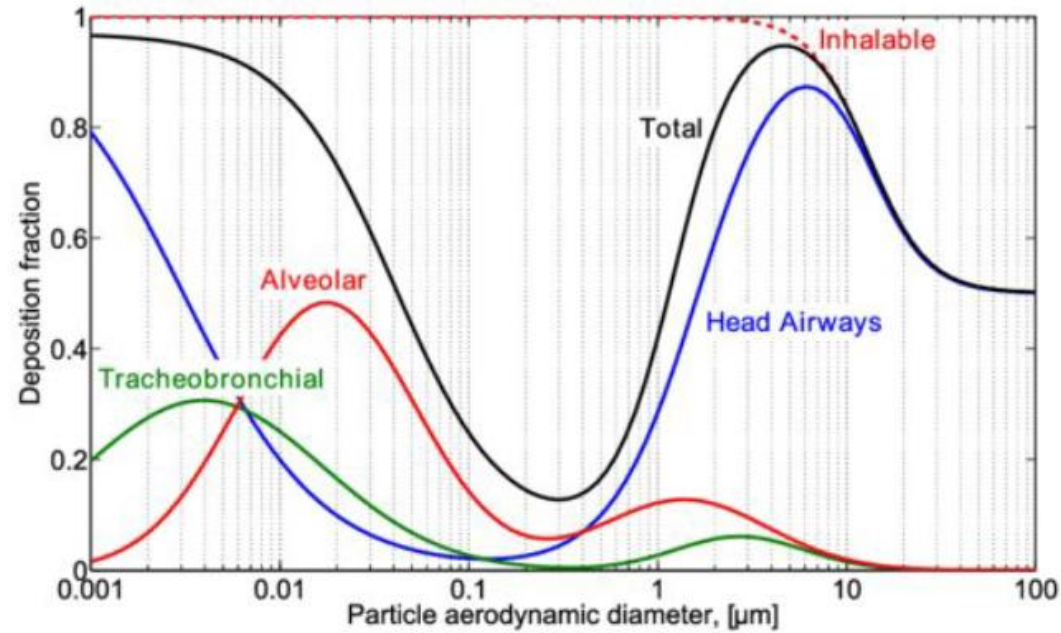
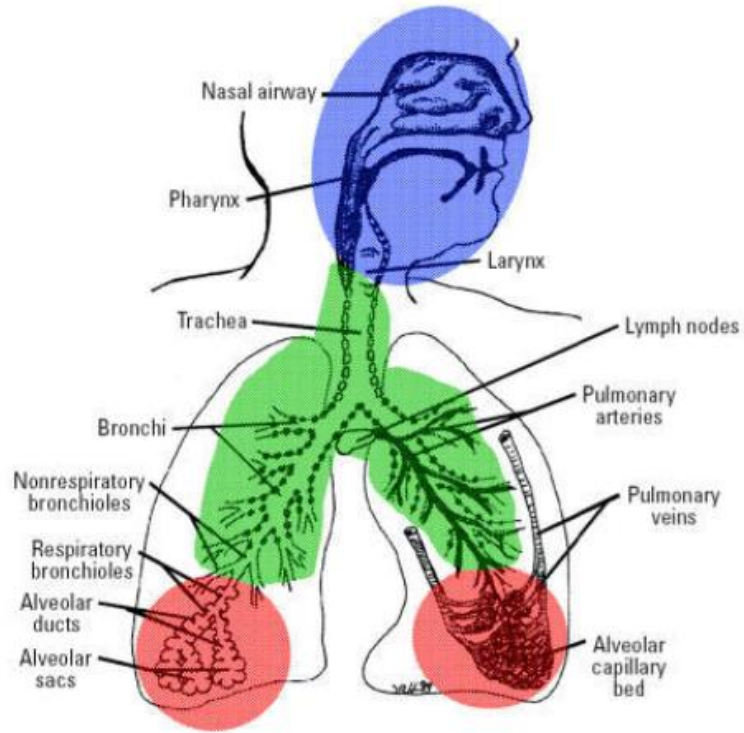
Close contact: combined exposure from droplets and droplet nuclei (aerosols)



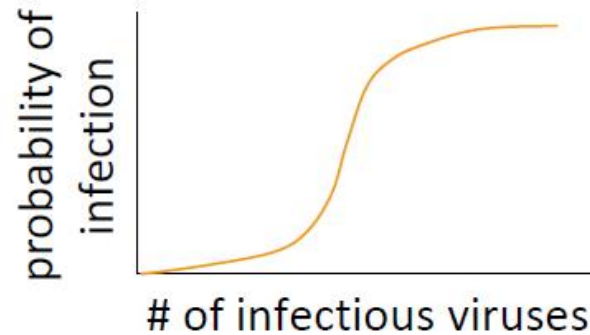
Long range: exposure from droplet nuclei (aerosols) can be controlled with sufficient ventilation

Figure 1. The distinction between close contact combined droplet and aerosol transmission (left) and long-range aerosol transmission (right) which can be controlled with ventilation diluting the virus concentration to a low level. (Figure: courtesy L. Liu, Y. Li, P. V. Nielsen et al.^{xii})

Deposition and Dose



Dose-response curve



Smaller particles/ aerosols can be inhaled more deeply into lungs – red area and graph- and cause most severe infections.

The more particles inhaled the more severe the illness: viral load.

So any reduction in smaller particles can reduce chance of infection and the severity of illness

(1) Oberdörster, G., Oberdörster, E., Oberdörster, J., 2005, Nanotoxicology: An emerging discipline evolving from studies of ultrafine particles, *Environ Health Persp*, 113, 823-839 (2) Kovisto, A.J., 2013, Source specific risk assessment of indoor aerosol particles, Ph.D. dissertation (3) Watanabe, T., Bartrand, T.A., Weir, M.H., et al., 2010, Development of a Dose-Response Model for SARS Coronavirus, *Risk Anal*

Safety Reps Ventilation Checklist

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2. Have safety reps been consulted on the Covid risk assessment?
3. Is the ventilation system effective and maintained?
4. Is the air flow at least 10 litres per person per sec with minimum of 6 Air Changes an Hour ?
5. Is the ventilation system set for 100% outdoor air to prevent recirculation, turned on 2 hours before occupation and automatic CO₂ sensor switched off or set to 400ppm?
6. Is there is no ventilation system, does natural ventilation create an unhealthy or uncomfortable work environment (temperature, noise, pollution) or pose risk of spreading infection?
7. Are areas with inadequate ventilation taken out of use or alternative methods to reduce risk used (e.g. reducing occupancy, use of upper air UVC disinfection, portable HEPA filtration units)?
8. Are rooms subject to no occupancy to allow contaminants to dissipate?
9. Are rooms cleaned regularly to reduce recirculation of any virus deposited on surfaces, adsorbed on dust?
10. Is the relative humidity too low and the air dry – optimum is 40-70%

Summary of practical measures for building services operation

REHVA: Federation of European Heating, Ventilation and Air Conditioning Associations <https://www.rehva.eu/activities/covid-19-guidance>

1. Secure ventilation of spaces with outdoor air
2. Switch ventilation to nominal speed at least 2 hours before the building usage time and switch to lower speed 2 hours after the building usage time
3. At nights and weekends, do not switch ventilation off, but keep systems running at lower speed
4. Ensure regular airing with windows (even in mechanically ventilated buildings)
5. Keep toilet ventilation 24/7 in operation
6. Avoid open windows in toilets to assure the right direction of ventilation
7. Instruct building occupants to flush toilets with closed lid
8. Switch air handling units with recirculation to 100% outdoor air
9. Inspect heat recovery equipment to be sure that leakages are under control
10. Switch fan coils either off or operate so that fans are continuously on
11. Do not change heating, cooling and possible humidification setpoints
12. Do not plan duct cleaning for this period
13. Replace central outdoor air and extract air filters as usually, according to maintenance schedule
14. Regular filter replacement and maintenance works shall be performed with common protective measures including respiratory protection

Role of ventilation – to remove stale exhaled air and replace with fresher/outdoor air
– Beware air pollution - to keep Oxygen O₂ level up, remove Carbon dioxide, microbes and moisture. Ventilation can achieve dilution, dispersal, removal of virus
Can add disinfection of air at ventilation system intake – use of UVC light and other methods; Filtration of air with HEPA -High Energy Particle Air - filters at intake or via portable air cleaning units in room, or attached to intake/extraction fans, at suitable for size + number of people; Air Conditioning cools air and recirculates so should be switched off; Desk, floor fans recirculate air so don't use.

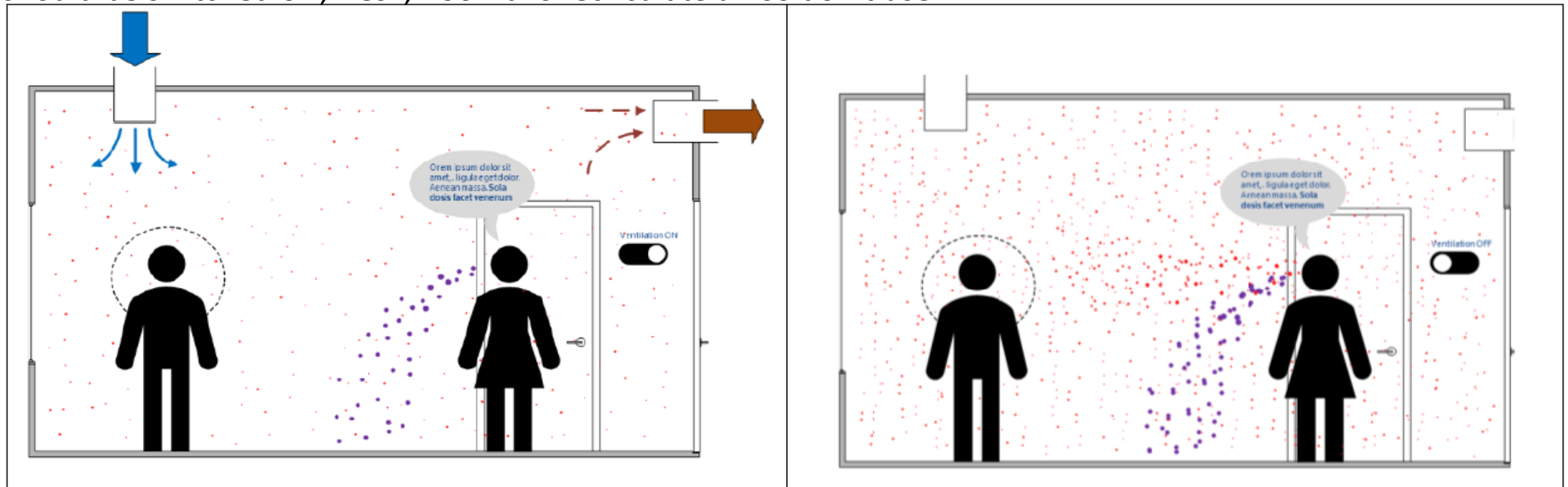


Figure 2. Illustration of how an infected person (speaking woman on the right) leads to aerosol exposure (red spikes) in the breathing zone of another person (man on the left in this case). Large droplet exhalation is marked with purple spikes. When the room is ventilated with mixing ventilation system, the amount of virus-laden particles in the breathing zone is much lower than when the ventilation system is off. Left figure: ventilation system on, right figure: ventilation system off.

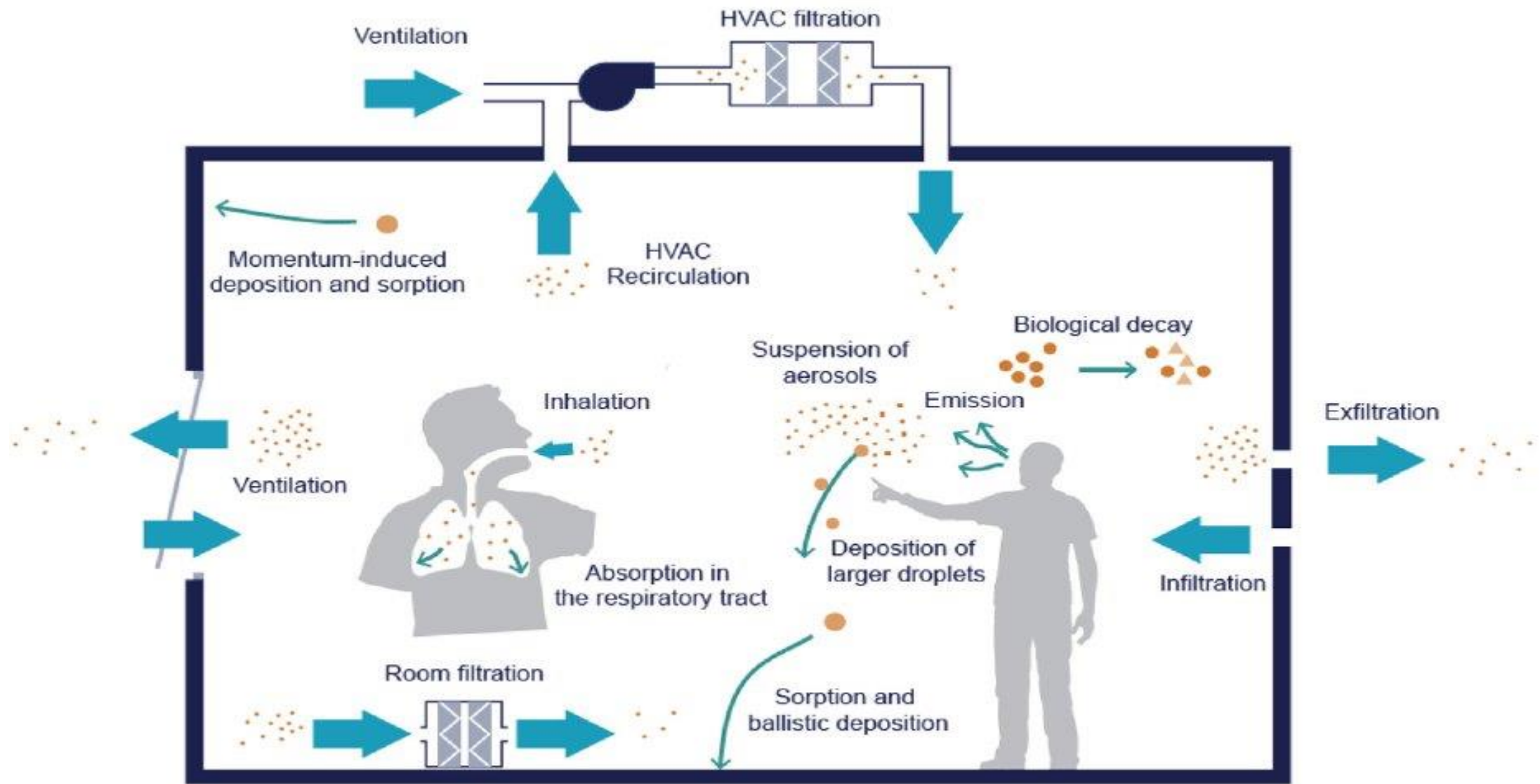


Fig. 1. Single-zone mass-balance model of virus transport via exhaled aerosols. Image used under a creative commons license¹.

Location Outdoors less risk, indoor workplaces higher risk, increasing with factors below.

Occupancy Halving occupancy is equivalent to doubling the ventilation rate. Remember, though, that aerosols can linger for minutes or hours, so previous occupancy levels may create lingering risk.

Infection levels Research suggests that around half of coronavirus transmission could be from people with no symptoms (asymptomatic).

Proximity 2 metres physical distancing is a rough minimum distance to avoid inhaling high concentrations of near-field aerosols or being sprayed with droplets.

Duration The longer spent in a space with poor ventilation, the higher the risk.

Activity Aerosols are exhaled when breathing and talking. Loud talking, singing, aerobic activity result in more potentially virus-loaded aerosols being exhaled.

Environment Cooler, darker and drier conditions assist aerosol spread and persistence; higher temperature and humidity shorten the survival time of the virus.

Air flow The lower the air flow the higher the risk. Doubling the ventilation rate per person can halve the infection risk.

Masks [Face masks](#) use can [reduce the amount of virus in the air](#) and [is particularly effective if they are used 'properly' and by all occupants of the room](#)

Type and level of group activity	Low occupancy			High occupancy		
	Outdoors and well ventilated	Indoors and well ventilated	Poorly ventilated	Outdoors and well ventilated	Indoors and well ventilated	Poorly ventilated
Wearing face coverings, contact for short time						
Silent	Low	Low	Low	Low	Low	Medium
Speaking	Low	Low	Low	Low	Low	Medium
Shouting, singing	Low	Low	Medium	Medium	Medium	High
Wearing face coverings, contact for prolonged time						
Silent	Low	Low	Medium	Low	Medium	High
Speaking	Low	* Low	Medium	* Medium	Medium	High
Shouting, singing	Low	Medium	High	Medium	High	High
No face coverings, contact for short time						
Silent	Low	Low	Medium	Medium	Medium	High
Speaking	Low	Medium	Medium	Medium	High	High
Shouting, singing	Medium	Medium	High	High	High	High
No face coverings, contact for prolonged time						
Silent	Low	Medium	High	Medium	High	High
Speaking	Medium	Medium	High	High	High	High
Shouting, singing	Medium	High	High	High	High	High

Risk of transmission
 Low ■ Medium ■ High ■

* Borderline case that is highly dependent on quantitative definitions of distancing, number of individuals, and time of exposure

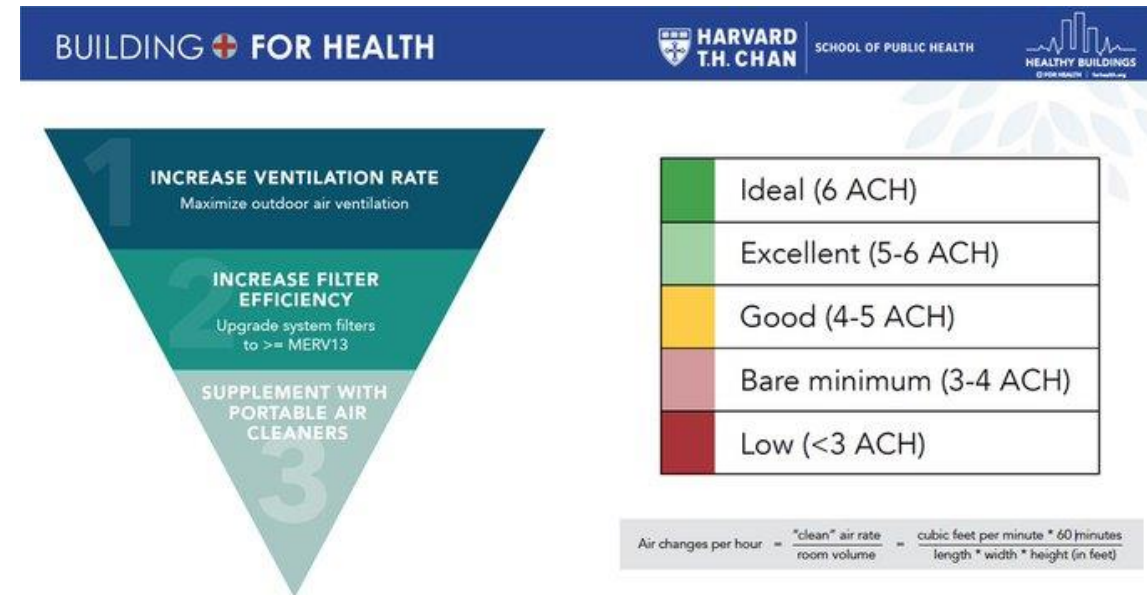
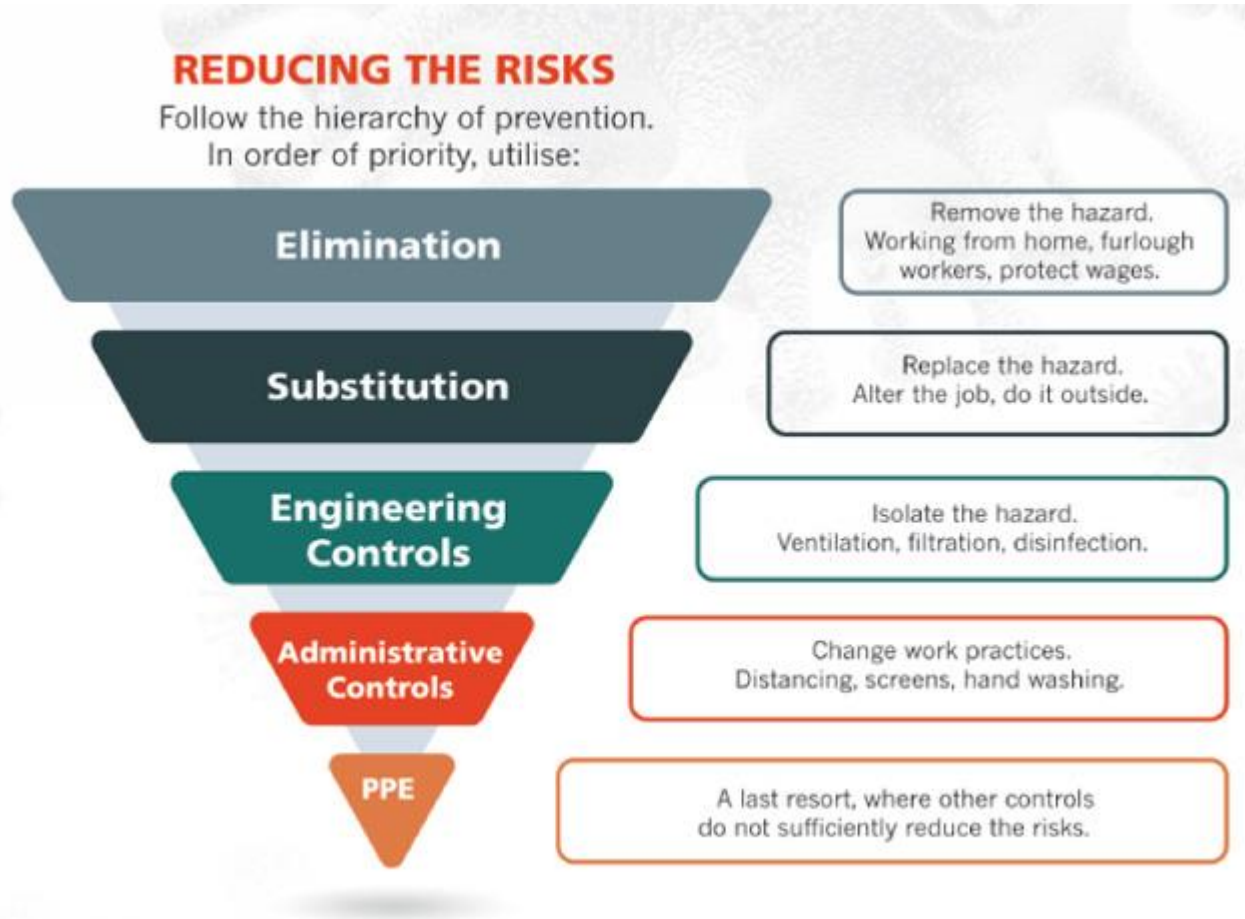
Risk matrix – work in progress From:

<https://www.bmj.com/content/370/bmj.m3223>

[VENTING | Coronavirus risks are mostly up in the air - Hazards magazine](#)

<https://www.hazards.org/infections/venting.htm>

Risk Control Hierarchy



Non PPE Face Masks do work- in addition to other measures + especially for airborne aerosol transmission but they vary in efficiency and do leak

Masks reduce airborne transmission

Infectious aerosol particles can be released during breathing and speaking by asymptomatic infected individuals. No masking maximizes exposure, whereas universal masking results in the least exposure.

Particle size (μm)



Infected, asymptomatic



Healthy

Maximum exposure



Minimum exposure

GRAPHIC: V. ALTOUNIAN/SCIENCE

N95/FFP2 mask with exhale valve



(a) (b) (c) (d)

Medical mask



(a) (b)

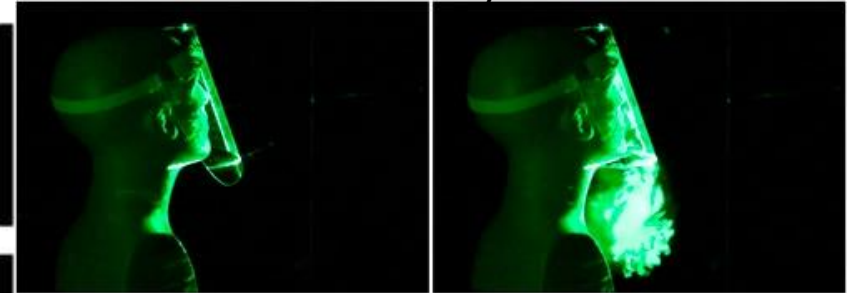


N95/FFP2 mask without valve

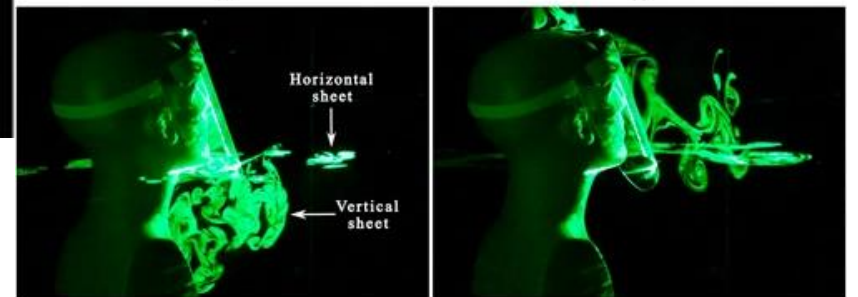


(a) (b) (c) (d)

Face shield/visor



(a) (b)

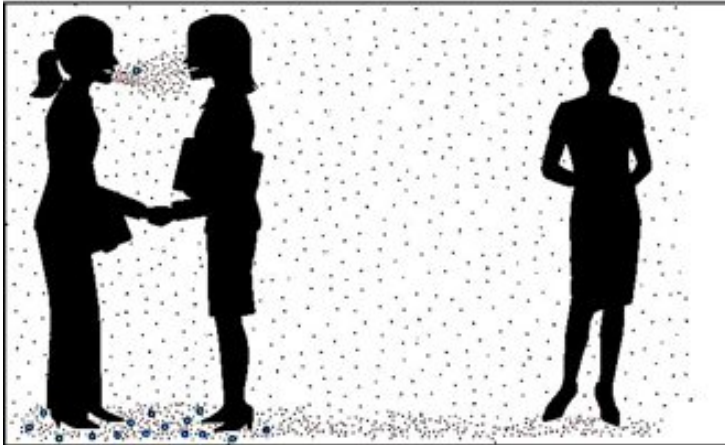


Beautiful visualization by Philo Bluysen's team showing imp. is to control leakage
<https://youtube.com/watch?v=mJ81IBTMvcU&feature=youtu.b>
[e...](https://youtube.com/watch?v=mJ81IBTMvcU&feature=youtu.b) Surgical-type mask terrible. Good-fitting cloth mask at the end has the least leakage.

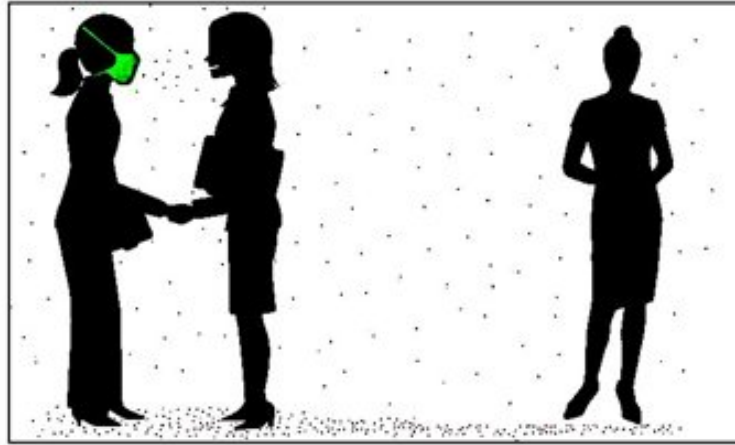
Employers must implement multiple control measures

Layered controls are safer

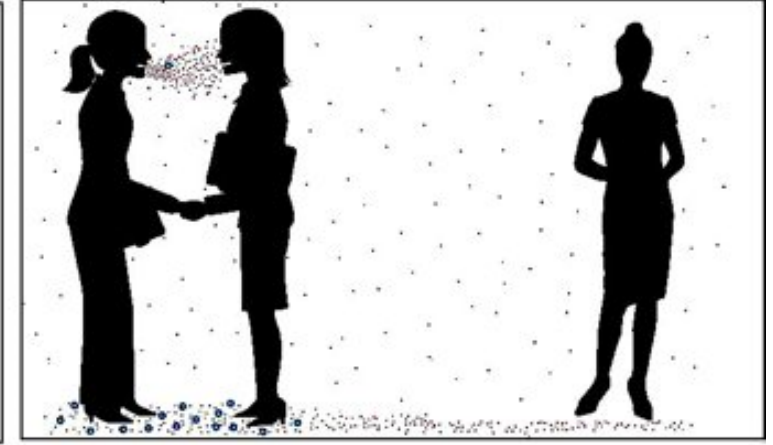
No interventions



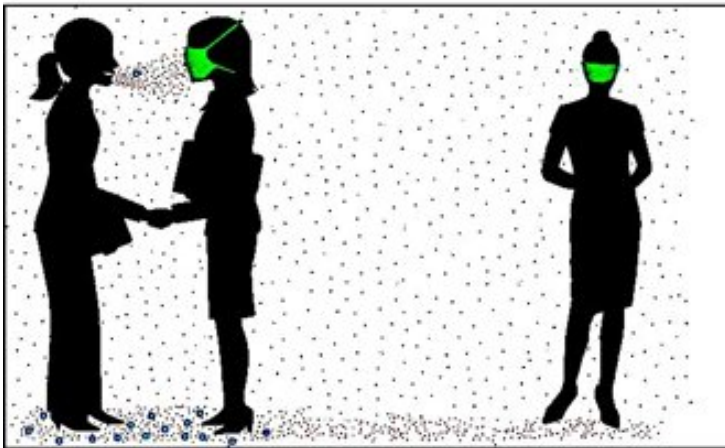
1. Source control



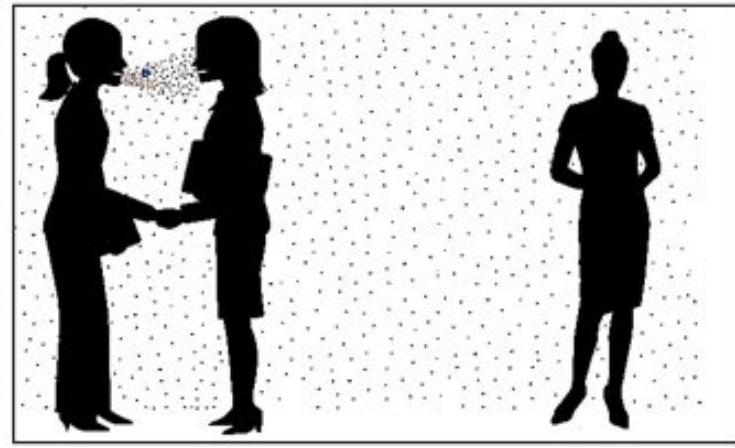
2. Ventilation and filtration



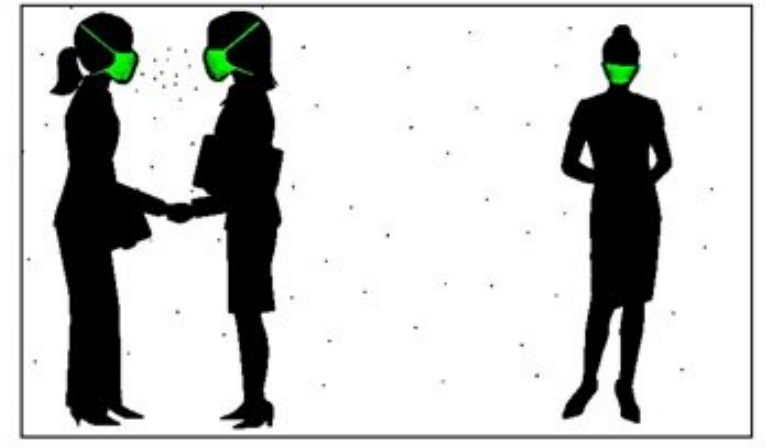
3. Distance and PPE



4. Hygiene

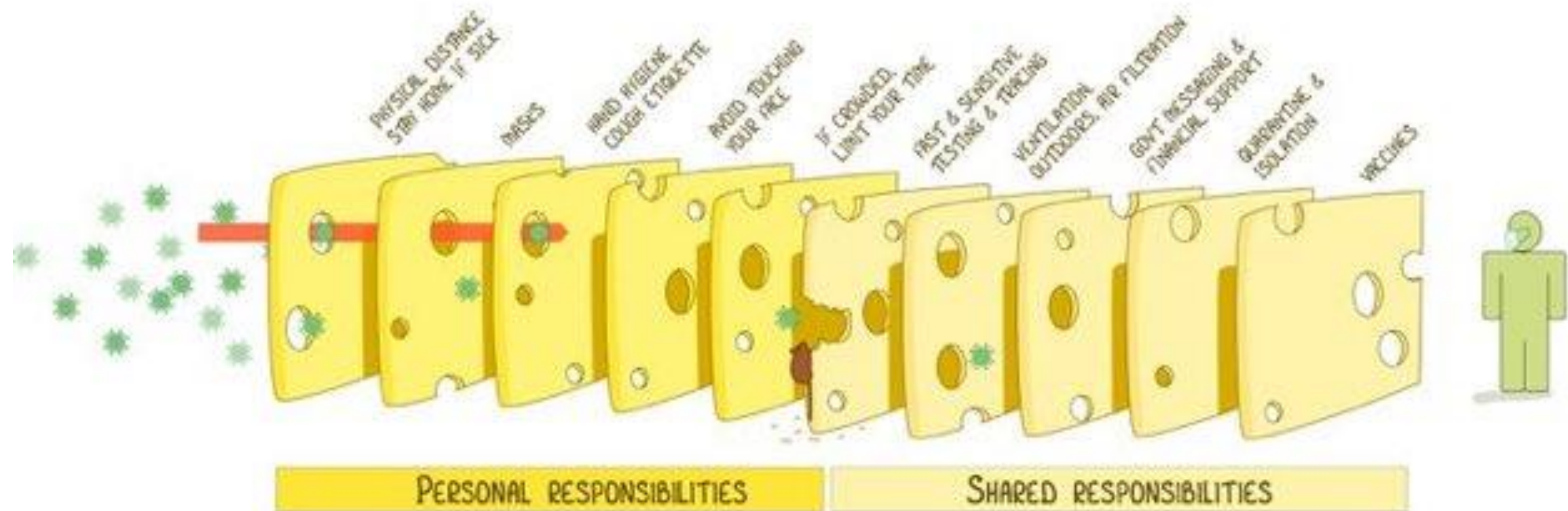


All interventions



THE SWISS CHEESE RESPIRATORY VIRUS PANDEMIC DEFENCE

RECOGNISING THAT NO SINGLE INTERVENTION IS PERFECT AT PREVENTING SPREAD



EACH INTERVENTION (LAYER) HAS IMPERFECTIONS (HOLES).
MULTIPLE LAYERS IMPROVE SUCCESS.

Resources

Hazards Magazine 152 Fact Sheet on Ventilation: <https://www.hazards.org/infections/venting.htm> with questions to ask, and need for layered preventions to reduce viral load in air – good ventilation, 2m + distancing, short duration, masks/PPE indoors, good hygiene though fomites appear to be least important mode of transmission

VIDEO AND RESOURCES: Is two metre physical distancing enough? <http://www.hazardscampaign.org.uk/blog/video-and-resources-is-two-metre-physical-distancing-enough-aerosol-transmission-and-other-emerging-issues>

Hilda Palmer presentation: <https://gmhazards.org.uk/wp-content/uploads/2020/09/Hilda-Palmer-3.9.20-Thursday-Talk-Aerosols-Control-measures2.pdf>

Visualisation of aerosol transmission <https://english.elpais.com/society/2020-10-28/a-room-a-bar-and-a-class-how-the-coronavirus-is-spread-through-the-air.html>;

Reel News: COVID Transmission and Killer Workplaces: New Reel News film with Hazards Campaign released <https://reelnews.co.uk/2020/11/04/coronavirus/covid-transmission-and-killer-workplaces/>;

Useful modelling tools that show how changing different factors affect ventilation allows visual comparison of the risks factors and the effects of control measures and mitigations:

https://www.zeit.de/wissen/gesundheit/2020-11/coronavirus-aerosols-infection-risk-hotspot-interiors?utm_referrer=https%3A%2F%2Ft.co%2F;

Airborne.cam - evaluate COVID-19 risk of infection from airborne transmission <https://airborne.cam/>
<https://indoor-covid-safety.herokuapp.com/apps/advanced>

[Harvard School of Public Health: 'Schools for Health 5 step guide to checking ventilation rates in classrooms](https://schools.forhealth.org/ventilation-guide/)

<https://schools.forhealth.org/ventilation-guide/>;

<https://schools.forhealth.org/wp-content/uploads/sites/19/2020/08/Harvard-Healthy-Buildings-program-How-to-assess-classroom-ventilation-08-28-2020.pdf>

Resources

Hazards Campaign + Independent Sage The COVID-19 Safe Workplace Charter and briefing document on ending work lockdowns in GB

<https://www.independentsage.org/the-covid-19-safe-workplace-charter-and-briefing-document-on-ending-work-lockdowns-in-gb/>

Hazards Magazine generally : <http://www.hazards.org/index.htm> - SUBSCRIBE

Keep up to date by subscribing to Hazards Magazine, and TUC Risks <https://www.tuc.org.uk/news/risks-union-health-and-safety-news-number-962-august-26-2020> and following us all on Twitter and Facebook

TWITTER: @hazardscampaign @hazardsmagazine @hazardseitor @aew1aew1 @Jnewsham @centregreater

FACEBOOK: We didn't vote to die at work - Hazards Campaign Greater Manchester Hazards Centre Hazards Magazine

Experts to follow: @linseymarr @ShellyMBoulder @Globalbiosec **Dr. Richard Corsi** @CorsiAQ @j_g_allen @jljcolorado @kprather88 Don_Milton

[@cathnoakes SAGE EMG](#)

<https://www.gov.uk/government/publications/emg-role-of-ventilation-in-controlling-sars-cov-2-transmission-30-september-2020>

<https://www.gov.uk/government/publications/emgspi-btweg-mitigations-to-reduce-transmission-of-the-new-variant-sars-cov-2-virus-22-december-2020>

<https://www.gov.uk/government/publications/emg-summary-of-disinfection-technologies-for-microbial-control-18-may-2020>

Control Measures and transmission including aerosol transmission

Rory O'Neill Hazards Editor: WHO KNEW : <http://www.hazards.org/coronavirus/WHO/index.htm>

Hazards Magazine Stick to 2metres whatever the PM says: <http://www.hazards.org/coronavirus/outoftouch.htm>

Keep your distance : is 2 metres enough Andrew Watterson <http://www.hazardscampaign.org.uk/wp-content/uploads/2020/06/two-metre-commentary.pdf>

Two metres or one: what is the evidence for physical distancing in covid-19? <https://www.bmj.com/content/370/bmj.m3223>

Doctors in Unite: <https://doctorsinunite.com/2020/09/02/the-role-of-airborne-spread-in-factory-outbreaks-of-covid-19/>

Dr Shelly Miller: <https://www.theatlantic.com/health/archive/2020/07/why-arent-we-talking-more-about-airborne-transmission/614737/> and theconversation.com/how-to-use-ventilation-and-air-filtration-to-prevent-the-spread-of-coronavirus-indoors-143732

We have enough evidence of airborne aerosol transmission : https://time.com/5883081/covid-19-transmitted-aerosols/?amp=true&_twitter_impression=true

FAQS : <https://tinyurl.com/FAQ-aerosols>

https://docs.google.com/document/d/1fB5pysccOHvxphpTmCG_TGdytavMmc1cUumn8m0pwzo/preview?pru=AAABdLDnOIs*v4cCRbkcnRGUcdGnlsefTQ#heading=h.k10zp34x5s0p

USA Environmental Health Matters Initiative: Airborne Transmission of SARS-CoV-2: A Virtual Workshop Many specialists talking about aerosol transmission and ventilation, prevention

<https://www.nationalacademies.org/event/08-26-2020/airborne-transmission-of-sars-cov-2-a-virtual-workshop> _Dr Shelly Miller is presentation on ventilation is

at No 21 Linsey Marr powerpoint : https://doc-00-9k-apps-viewer.googleusercontent.com/viewer/secure/pdf/pnigm9u8t71s6fmvnr8r878oobcaeh6/thg6qs0se4d5likl7aq78j263oh7k7/1599137100000/drive/05711236725275265647/ACFrOgCWY-oPIZy-iHAw4XPivBQhT0ca6z0QGUi3_in2SC9bdg9qlpaipPc92DoaQxztGOCUq9fJSypWfJ6_vG10JebAOGtx1WZcKQEFW_yDIrwt6iquYbWliq7LxzR0UAZ4PaFJBidcg6ZOjME?print=true&nonce=28o3v8g6kltqk&user=05711236725275265647&hash=bc10verp2aeel0q3sicsajp46m080s5q

[viewer.googleusercontent.com/viewer/secure/pdf/pnigm9u8t71s6fmvnr8r878oobcaeh6/thg6qs0se4d5likl7aq78j263oh7k7/1599137100000/drive/05711236725275265647/ACFrOgCWY-oPIZy-iHAw4XPivBQhT0ca6z0QGUi3_in2SC9bdg9qlpaipPc92DoaQxztGOCUq9fJSypWfJ6_vG10JebAOGtx1WZcKQEFW_yDIrwt6iquYbWliq7LxzR0UAZ4PaFJBidcg6ZOjME?print=true&nonce=28o3v8g6kltqk&user=05711236725275265647&hash=bc10verp2aeel0q3sicsajp46m080s5q](https://doc-00-9k-apps-viewer.googleusercontent.com/viewer/secure/pdf/pnigm9u8t71s6fmvnr8r878oobcaeh6/thg6qs0se4d5likl7aq78j263oh7k7/1599137100000/drive/05711236725275265647/ACFrOgCWY-oPIZy-iHAw4XPivBQhT0ca6z0QGUi3_in2SC9bdg9qlpaipPc92DoaQxztGOCUq9fJSypWfJ6_vG10JebAOGtx1WZcKQEFW_yDIrwt6iquYbWliq7LxzR0UAZ4PaFJBidcg6ZOjME?print=true&nonce=28o3v8g6kltqk&user=05711236725275265647&hash=bc10verp2aeel0q3sicsajp46m080s5q)

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[DIrwt6iquYbWliq7LxzR0UAZ4PaFJBidcg6ZOjME?print=true&nonce=28o3v8g6kltqk&user=05711236725275265647&hash=bc10verp2aeel0q3sicsajp46m080s5q](https://doc-00-9k-apps-viewer.googleusercontent.com/viewer/secure/pdf/pnigm9u8t71s6fmvnr8r878oobcaeh6/thg6qs0se4d5likl7aq78j263oh7k7/1599137100000/drive/05711236725275265647/ACFrOgCWY-oPIZy-iHAw4XPivBQhT0ca6z0QGUi3_in2SC9bdg9qlpaipPc92DoaQxztGOCUq9fJSypWfJ6_vG10JebAOGtx1WZcKQEFW_yDIrwt6iquYbWliq7LxzR0UAZ4PaFJBidcg6ZOjME?print=true&nonce=28o3v8g6kltqk&user=05711236725275265647&hash=bc10verp2aeel0q3sicsajp46m080s5q)

Professor Raina MacIntyre Question for Covid19 Control Webinar Recording: <https://youtu.be/VzoDVP2G2C8> Q+A
<https://kirby.unsw.edu.au/event/professor-raina-macintyre-questions-covid-19-control-schools-airborne-transmission-ppe-and>

For ventilation, you might also check the US ASHRAE recommendations, to back up other good ones. <https://www.ashrae.org/technical-resources/resources>

PCS Questions on ventilation <https://www.pcs.org.uk/justice-sector/news/air-handling-and-ventilation>

HSE Guidance <https://www.hse.gov.uk/coronavirus/equipment-and-machinery/air-conditioning-and-ventilation.htm>

REHVA guidance V3 3.8.20 REHVA Federation of European Heating, Ventilation and Air Conditioning Associations
<https://www.rehva.eu/activities/covid-19-guidance>

UK Chartered Institute of Building and Services Engineers, CIBSE v4 : <https://www.rehva.eu/activities/covid-19-guidance>

Overview of evidence for aerosol transmission: https://docs.google.com/spreadsheets/d/1-l78z-rSodmSfsfChv7d_tubb6d1Zxst-d7Yl4HZp4g/edit?usp=sharing

FAQs on aerosols and indoor ventilation

<https://theconversation.com/what-a-smoky-bar-can-teach-us-about-the-6-foot-rule-during-the-covid-19-pandemic-145517>

<https://partners.mediasite.com/mediasite/Play/17db07327ba3458cb647cb511c3aa2f71d>

https://docs.google.com/document/d/1fB5pysccOHvxphpTmCG_TGdytavMmc1cUumn8m0pwzo/edit

Faecal transmission <https://www.acpjournals.org/doi/10.7326/M20-0928>

Mask testing <http://jv.colostate.edu/masktesting/>

Wear a mask and why advice changed

https://edition.cnn.com/2020/06/25/health/face-mask-guidance-covid-19/index.html?utm_medium=social&utm_term=link&utm_content=2020-06-26T04%3A13%3A04&utm_source=twCNN

Visualizing droplet dispersal for face shields and masks with exhalation valves <https://aip.scitation.org/doi/10.1063/5.0022968> - great videos showing aerosols leaking out

Safer cleaning and disinfecting <https://www.womensvoices.org/infographic-safer-cleaning-disinfecting-at-home-in-the-times-of-coronavirus/>

Toxics Use Reduction Institute TURI , recent webinar on cleaning in schools:

https://www.turi.org/Our_Work/Cleaning_Laboratory/COVID-19_Safely_Clean_Disinfect/Safer_Cleaning_and_Disinfection_for_Schools?fbclid=IwAR0RAaXA7KUcycUaFE3v_mpNv11HutAzvTgLL0U8tw_W7dQQ1AmzMgJfTas

Informed Green Solutions specializes in school cleaning and disinfection, emphasizing less toxic products and practices. See their materials at <https://www.informedgreensolutions.org/covid-19-information>

Women's Voices for the Earth info on safer less toxic cleaning for homes and schools <https://www.womensvoices.org/infographic-safer-cleaning-disinfecting-at-home-in-the-times-of-coronavirus/>