HSE
Occupational Health & Safety
and Environmental Protection unit

Effect of COVID-19 on Indoor Air Quality

Andre Henriques - HSE Unit

EDMS N. 2370372

Introduction

- CERN is gradually restart it’s activities
- This note will address the proposed recommendations related to the impact of COVID-19 (SARS-CoV-2 virus) on indoor air quality
- These recommendations are mainly based on scientific publications on aerodynamic studies on the transmission modes of the virus, together with the particularity of CERN’s infrastructures
- Virology aspects are based exclusively on scientific facts and with a **personal** (non-expert) interpretation
- Thanks to EN/CV and SMB/SE for their input

CERN COVID-19-related health and safety measures

CERN's COVID-19 Health & Safety Instructions

- **CERN's COVID-19 related health and safety measures were issued on May 5th 2020**
  (DG memo, EDMS 2370902 [*])
- Detailed instructions in Annex 1 *(DG memo, EDMS 2370902 [*])*
  - **Individual Responsibility**
    - Hygiene measures
    - Use of PPE
    - In case of symptoms
  - Access to CERN site
  - Transport
  - Work organisation
  - Meetings
  - Duty travel
  - Events

Wearing of Masks required

> 2m distance

Safe re-start of CERN
Respect COVID measures

DG/2020-103 5 May 2020

EDMS: 2370902

MEMORANDUM

From: Fabiola Gianotti, Director-General, Fabiola Gianotti
Doris Forkel-Wirth, Head of the HSE Unit Doris Forkel-Wirth

To: Extended Directorate,
Technical Coordinators of the large LHC experiments,

Cc: SAPOCO Chair, President of SA, HSE-MB members, Chair of ACCU

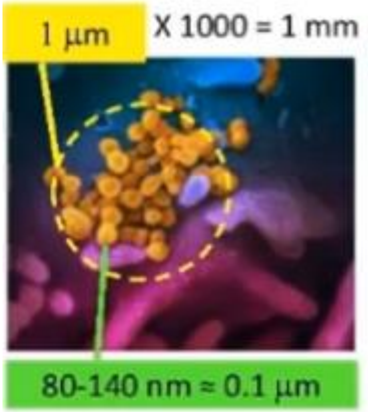
Ref: COVID-19-related health and safety measures for the period covering the restart of CERN's activities

Date: 5th May 2020

Aerodynamics of airborne particles

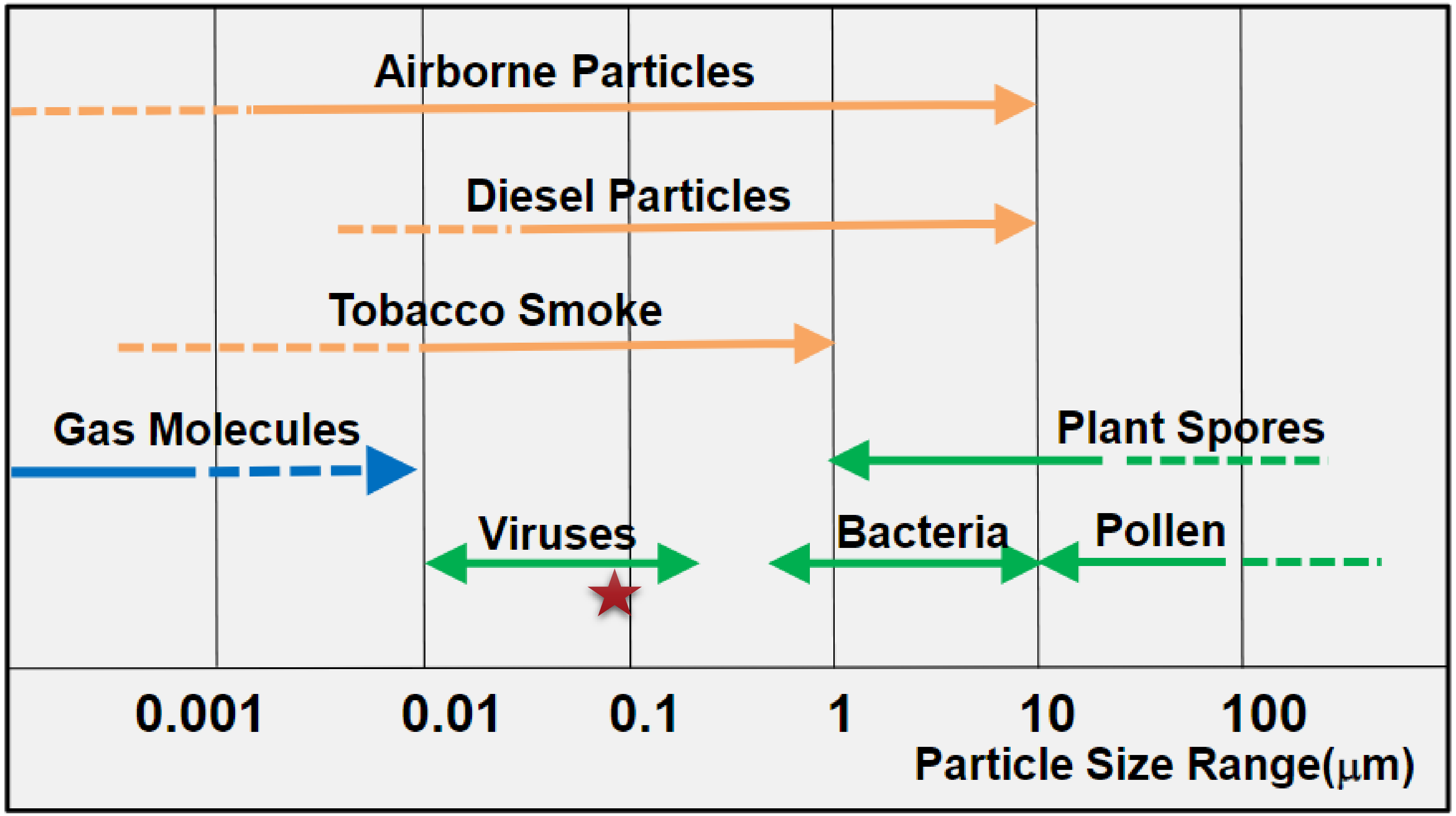
Airborne Particles - Size

★ COVID-19



HEALTH
This Is What The COVID-19 Virus Looks Like Under The Microscope
JACINTA BOWLER
14 FEBRUARY 2020

300 x bigger than nitrogen, oxygen or water vapour molecules



Courtesy of M. Gameiro da Silva

Airborne Particles – Aerodynamics

$$Cd = \frac{F_d}{\frac{1}{2}\rho v^2 A}$$

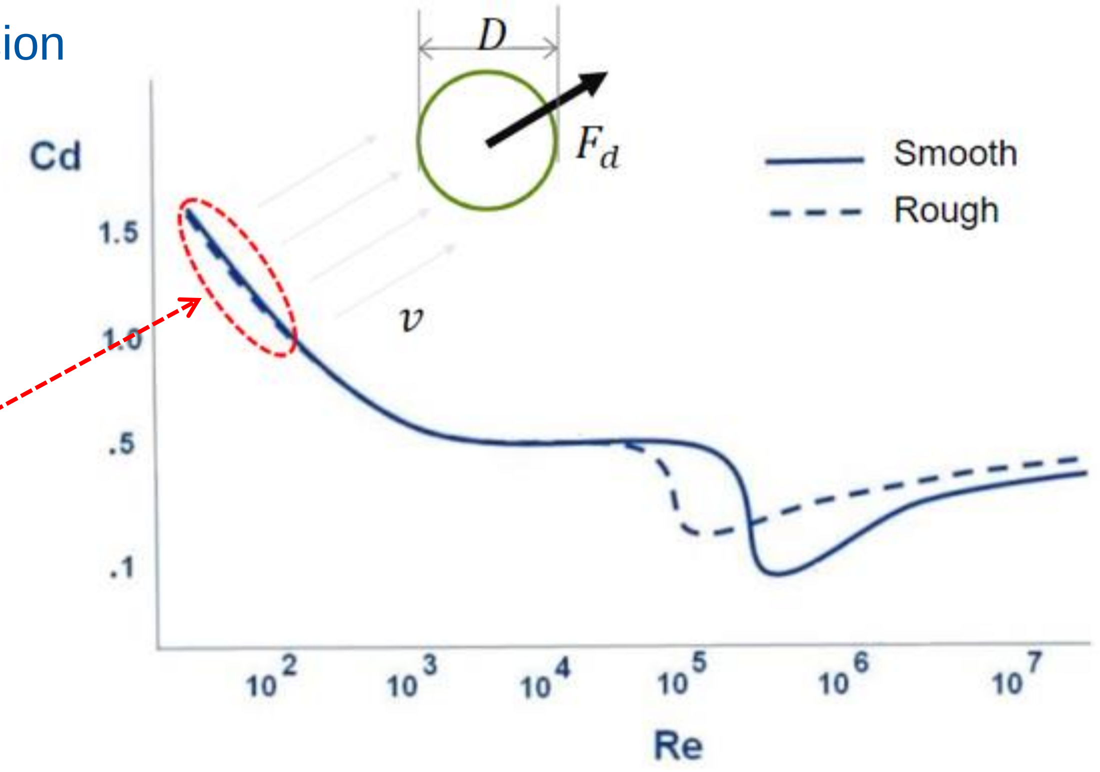
$$Re = \frac{\rho v D}{\mu}$$

Geometric dimension (D)

Normal flow conditions in indoor areas and Geometric dimensions of viruses:

- Laminar flow velocity profile
- Small size particles: > PM10

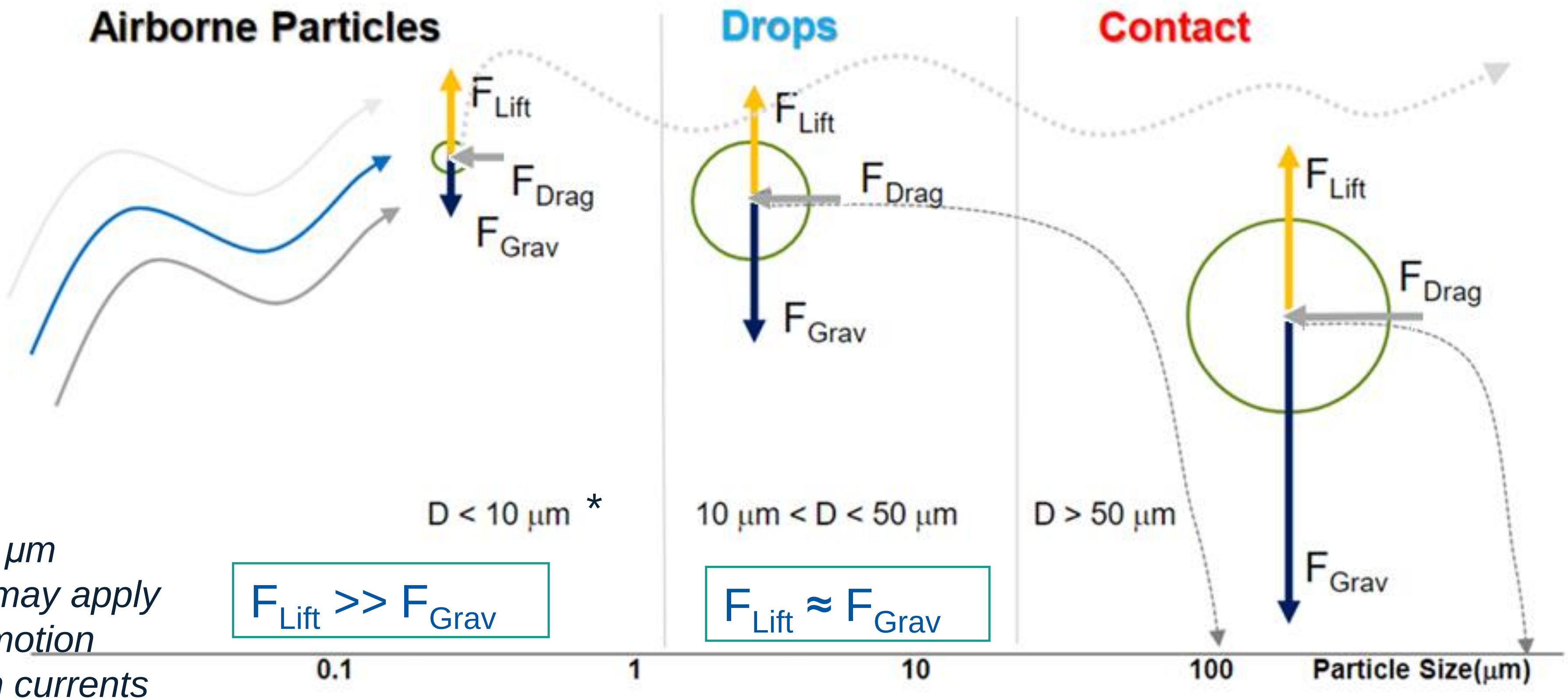
→ Possibility to became airborne



Aerodynamic resistance coefficient (Cd) as a function of the Reynolds Number (Re) [1]

Airborne Particles – Aerodynamics

Typical trajectories of particles in the air, depending on their size [1]



$F_{Lift} >> F_{Grav}$

$F_{Lift} \approx F_{Grav}$

$F_{Lift} << F_{Grav}$

D < 0.3 μm

Other effects may apply

- *Brownian motion*
- *Convection currents*
- *etc*

**Other literature references point to aerosols (< 5 μm) and droplets (> 5 μm)* [4]

Higher ventilation air speed, higher F_{Lift}

Courtesy of M. Gameiro da Silva [1]

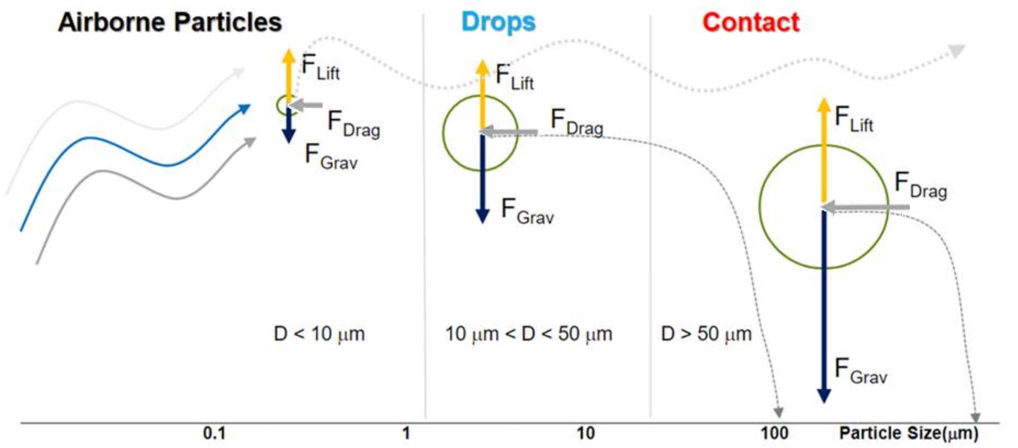
Airborne Particles – Aerodynamics

Principles:

- The larger the aerosol, the larger is its weight, the sooner it will fall (large droplets from sneezes e.g.)

- The larger the aerosol, the larger is the drag force and consequently the lower the velocity of the aerosol will be → The slower it gets, the smaller is the lift force, the sooner it starts to perform a downward motion.

- In case of a forced ventilation, velocity may remain constant after initial projection → The higher the velocity, the longer a particle maintains airborne → higher velocity, higher possibility of a larger droplet to became airborne (due to lift force)



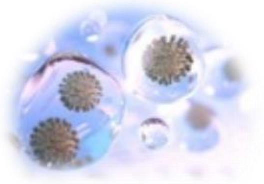
Typical trajectories of particles in the air, depending on their size [1]

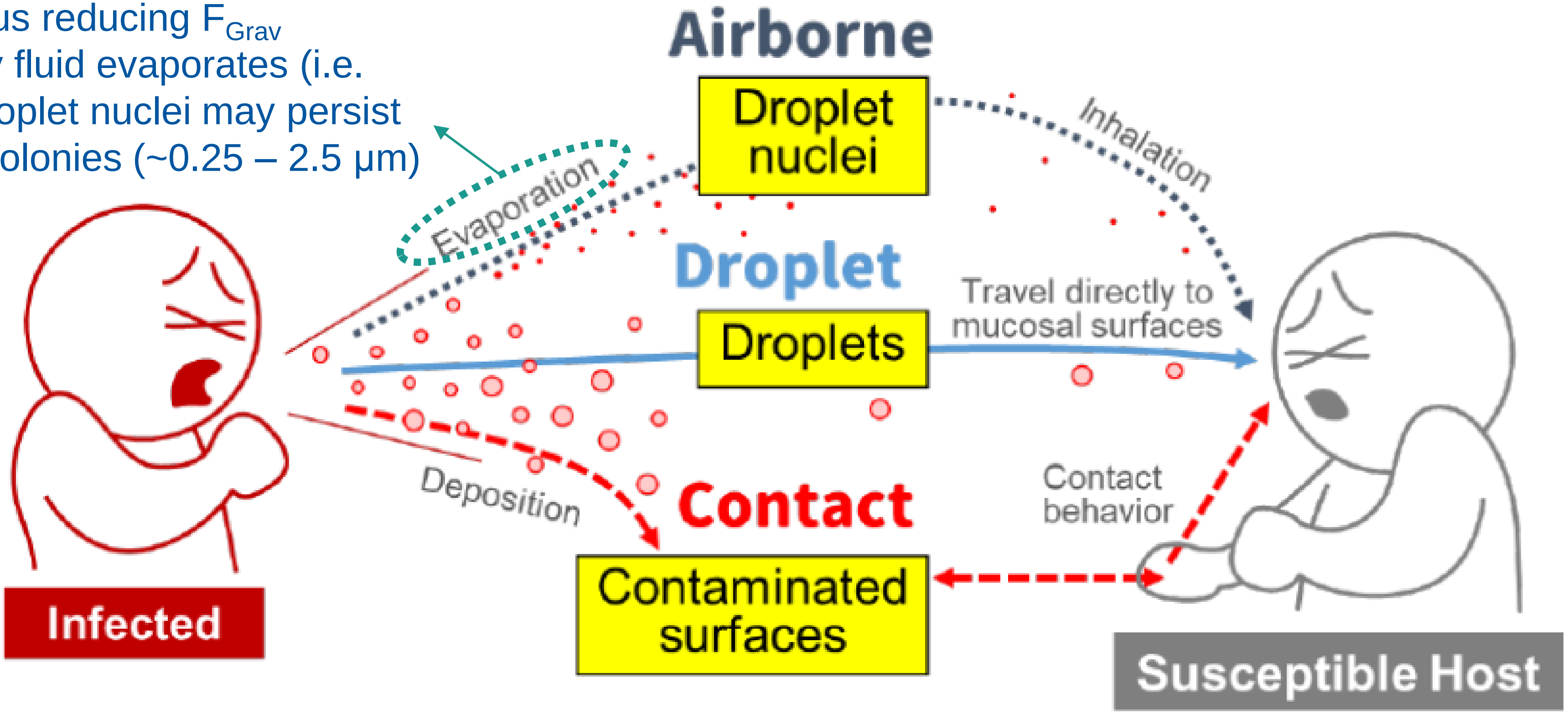
Airborne transmission – SAR-CoV-2

Transmission mechanisms

Small droplets (5-10 μm) may evaporate quickly (<1s)[5], thus reducing F_{Grav}

- When the body fluid evaporates (i.e. desiccates), droplet nuclei may persist with the virus colonies (~0.25 – 2.5 μm)

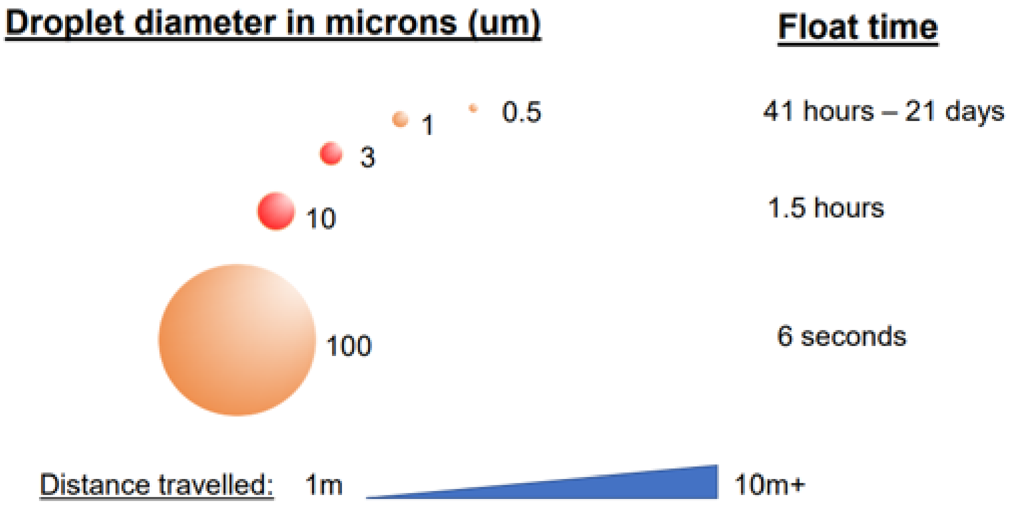




Modes of Transmission from Exhaled Pathogens

(Source: Office of the Prime Minister and the Ministry of Health, Labor and Welfare of Japan, 2020 [2] – adapted by [1])

Airborne transmission



Float time and travel distance of different size aerosols, in normal indoor environments [3]

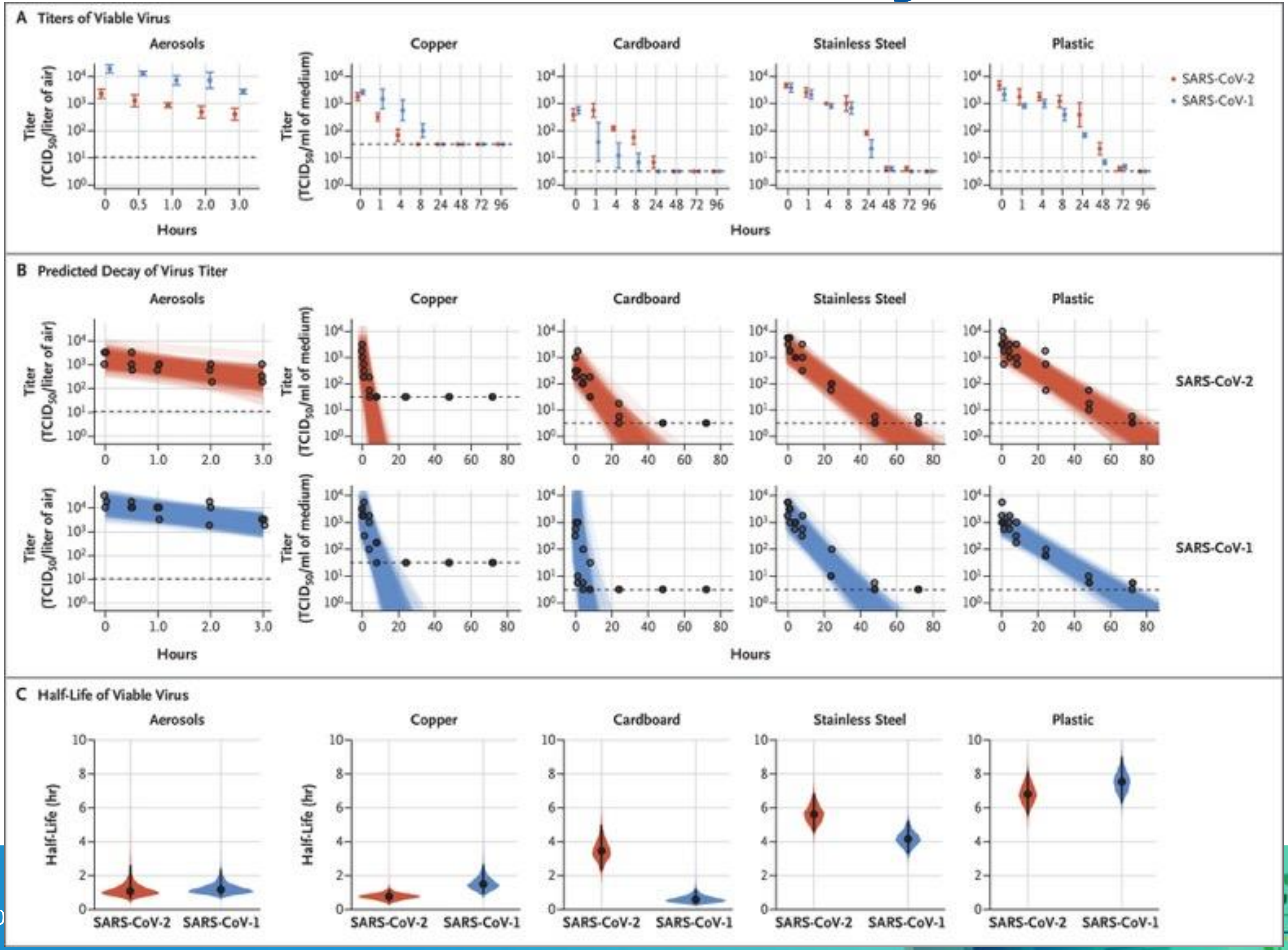
- SARS-CoV-2 remains active up to **3 hours** in indoor air in common indoor conditions [4] and can travel long distances
- SARS-CoV-2 has been **found in exhaust vents** in rooms occupied by infected patients and in **air samples**, meaning it was indeed airborne [5] [12] [19]
- Keeping 1-2 m distance from infected persons might not be enough for aerosol transmission and increasing ventilation is useful to remove these particles and decrease viral density [5]
- Asymptomatic patient (could be shedding the virus 2–3 days before) was found to have a similar viral load as symptomatic patients. Reinforces the hypothesis of airborne transmission [10]
- **Minimum COVID-19 infection does** / virulence of SARS-CoV-2 in air is **still to be determined** [14]
- Evidence is emerging indicating that SARS-CoV-2 is **also transmitted via airborne particles** [5] [6] [8] [10] [12]

SARS-CoV-2 viability

$TCID_{50}$ is an endpoint dilution assay quantifying the amount of virus required to kill 50% of infected hosts (case cells)

Decay from $10^{3.5}$ to $10^{2.7}$ in 3 h

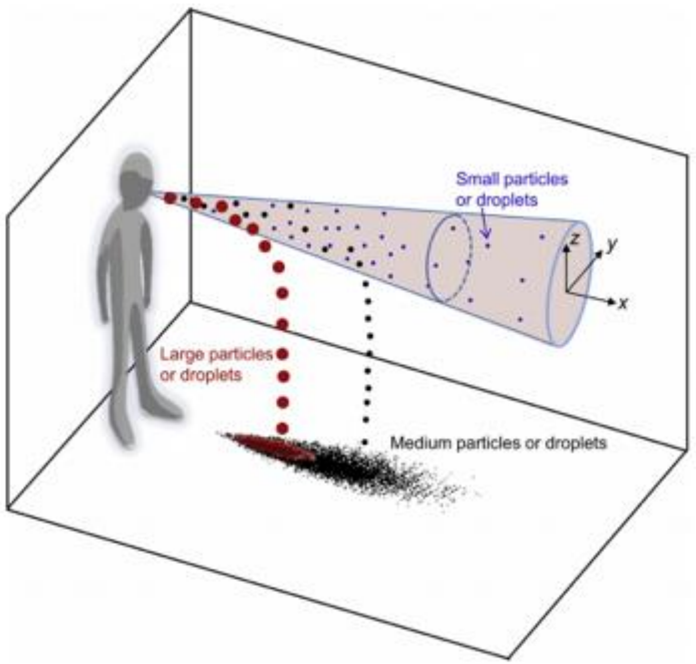
Half-life in air ~ 1.2 h



- Both SARS virus are similar in terms of viability
- Epidemiological differences probably arise from other factors: **high viral loads** in the upper respiratory tract; potential for persons infected with SARS-CoV-2 to **shed and transmit the virus while asymptomatic** [4]

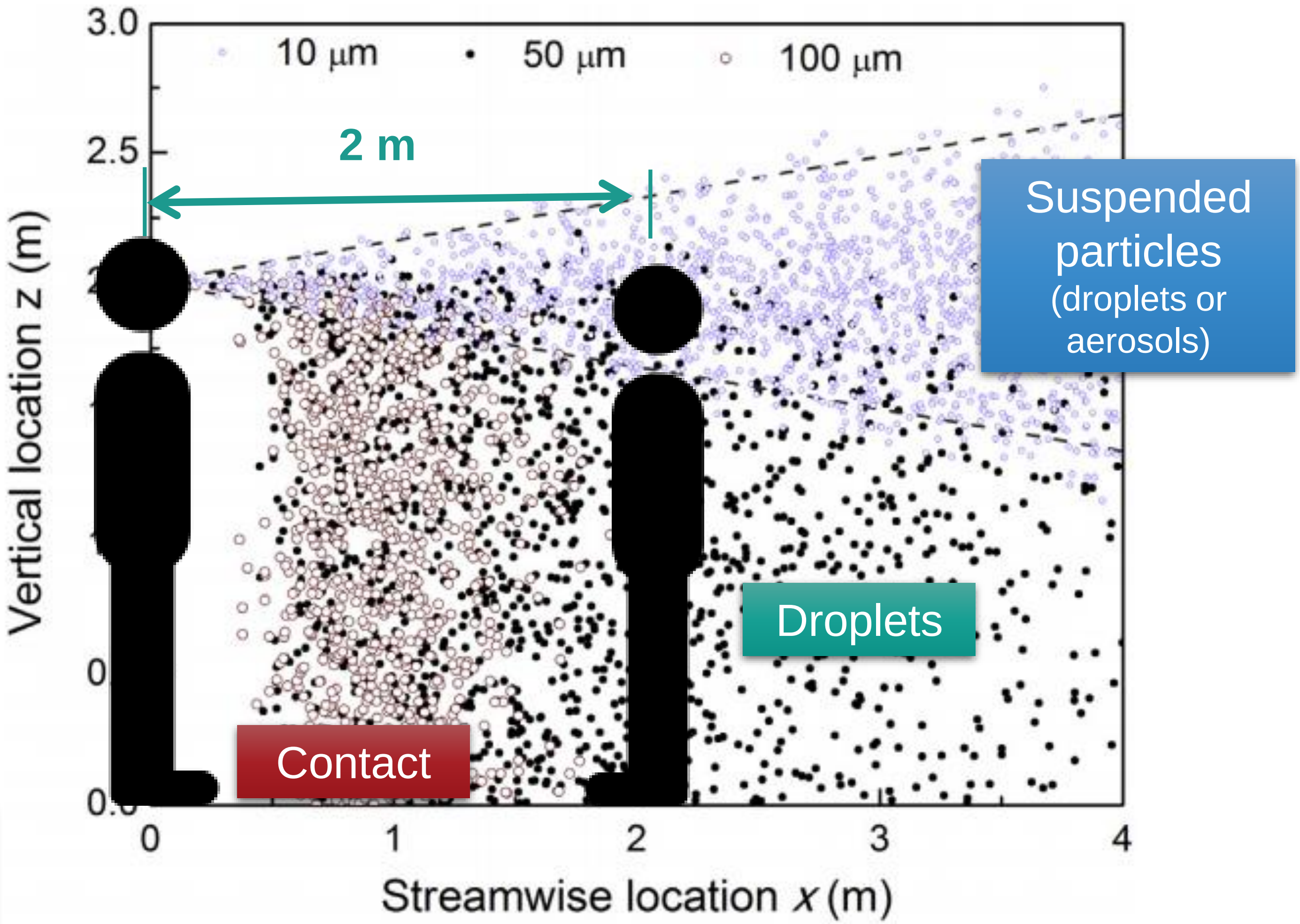
Viability of SARS-CoV-1 and SARS-CoV-2 in Aerosols and on Various Surfaces [4]

Airborne transmission



Simulation of spread of expiratory droplets by turbulence in a cough jet [7]

The 2m rule is still very important to protect against larger droplets



Instantaneous dispersion pattern of particles (t = 100 s) in the buoyancy neutral jet (mouth opening diameter D = 2 cm, initial velocity =10 m/s, Tamb = 25 C). Particles are continuously released from t = 0. The top-hat width of the jet is indicated by the dashed line, which collapses with the visible boundary of the jet.

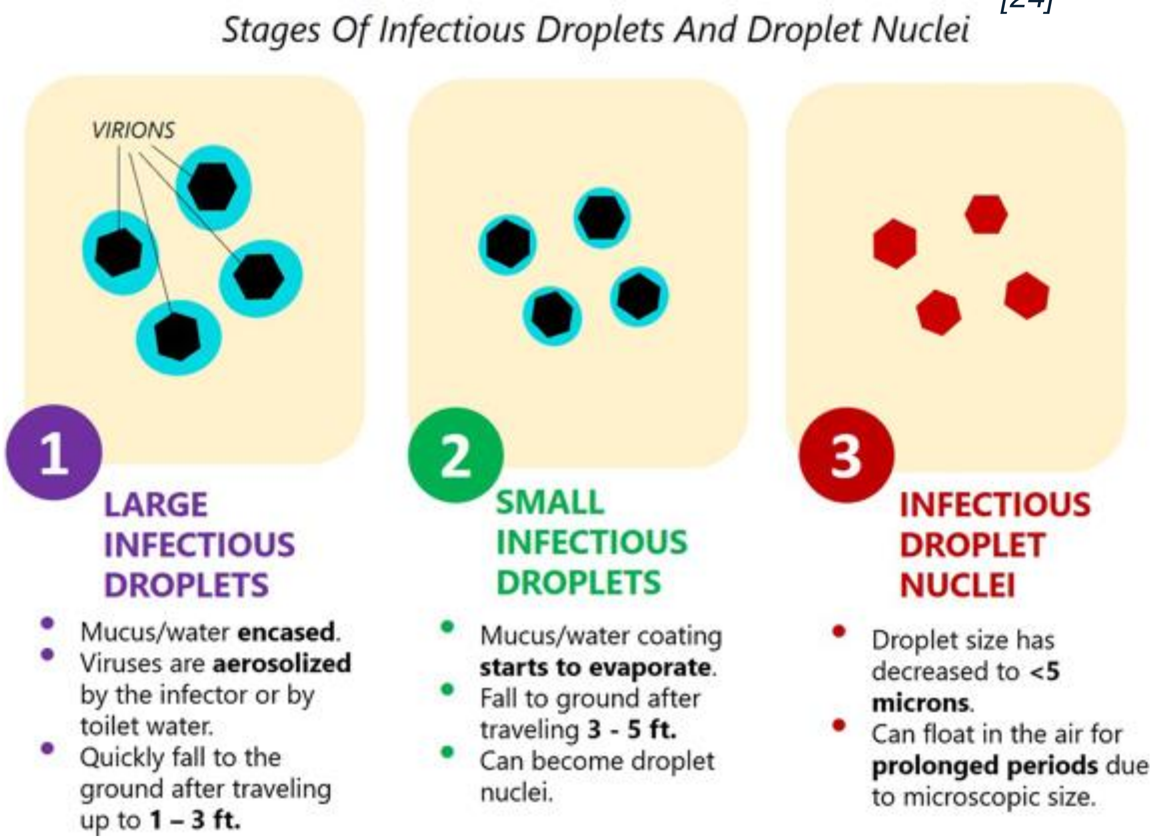
Airborne transmission

1. Large infectious droplets are generally > 60 µm in diameter. Toilet water is noted here as severe acute respiratory syndrome coronavirus was shown to aerosolize in toilet water.
2. Small infectious droplets are generally 10-60 µm
3. Infectious droplet nuclei, are generally < 10 µm in diameter.

Viral load and initial mean and distribution size of droplets are determined by the patient.

[24]

[24]



Airborne Transmission

NHK World Japan Documentary:
Fighting a Pandemic – Micro-droplets
https://www.youtube.com/watch?v=H2azcn7MqOU

Full:
https://www3.nhk.or.jp/nhkworld/en/ondemand/video/5001289/

- 10 people – 1 coughs
- Poor ventilated area
- Micro-droplets spread after a cough

Micro-droplets: ~10 to 0.1 μm

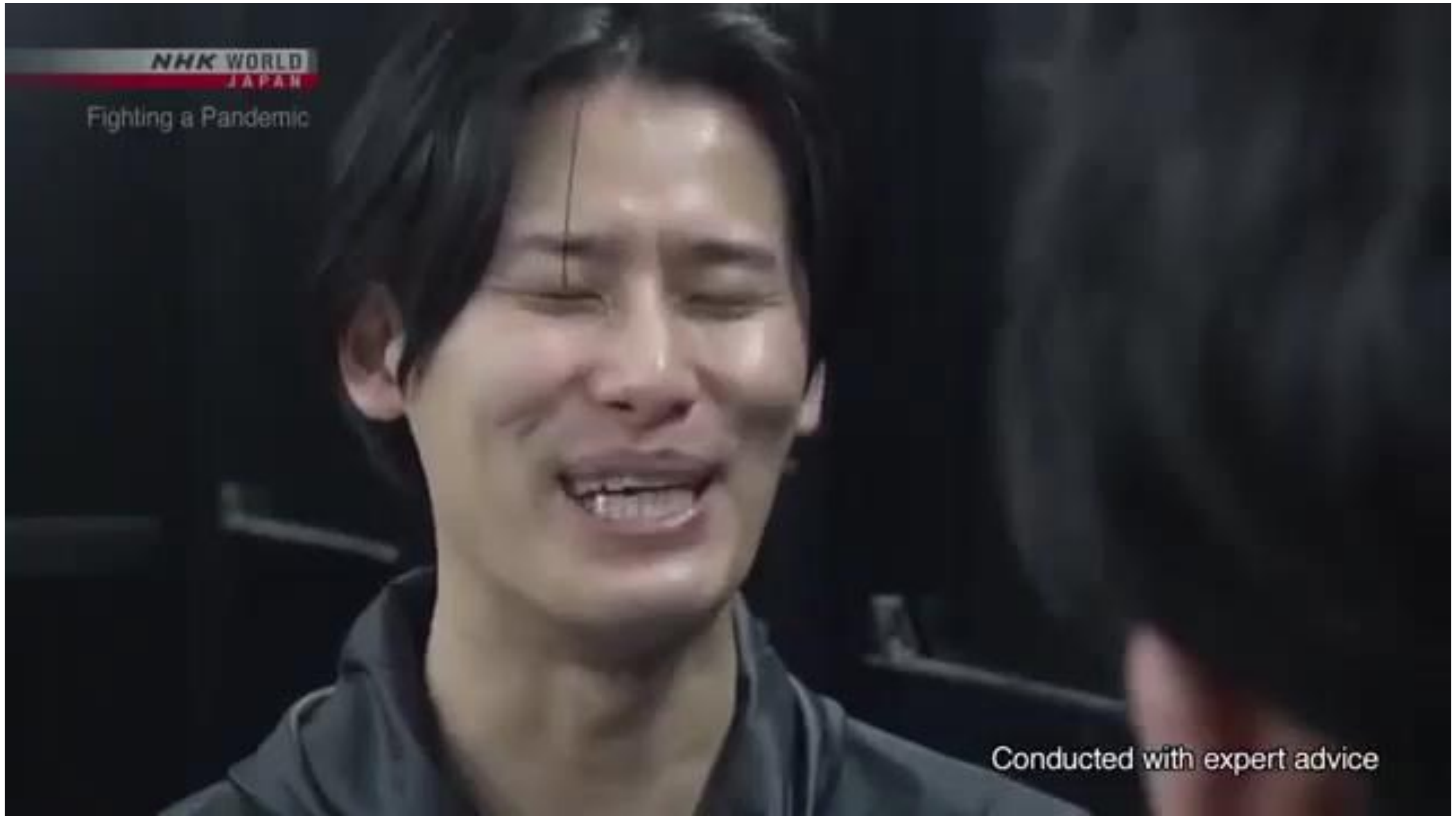
Video

Airborne Transmission

NHK World Japan Documentary:
Fighting a Pandemic – Micro-droplets
https://www.youtube.com/watch?v=H2azcn7MqOU

Full:
https://www3.nhk.or.jp/nhkworld/en/ondemand/video/5001289/

- 2 people talking – micro-droplet projection



Video

Airborne Transmission

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- Natural ventilation effect on the dilution of micro-droplets

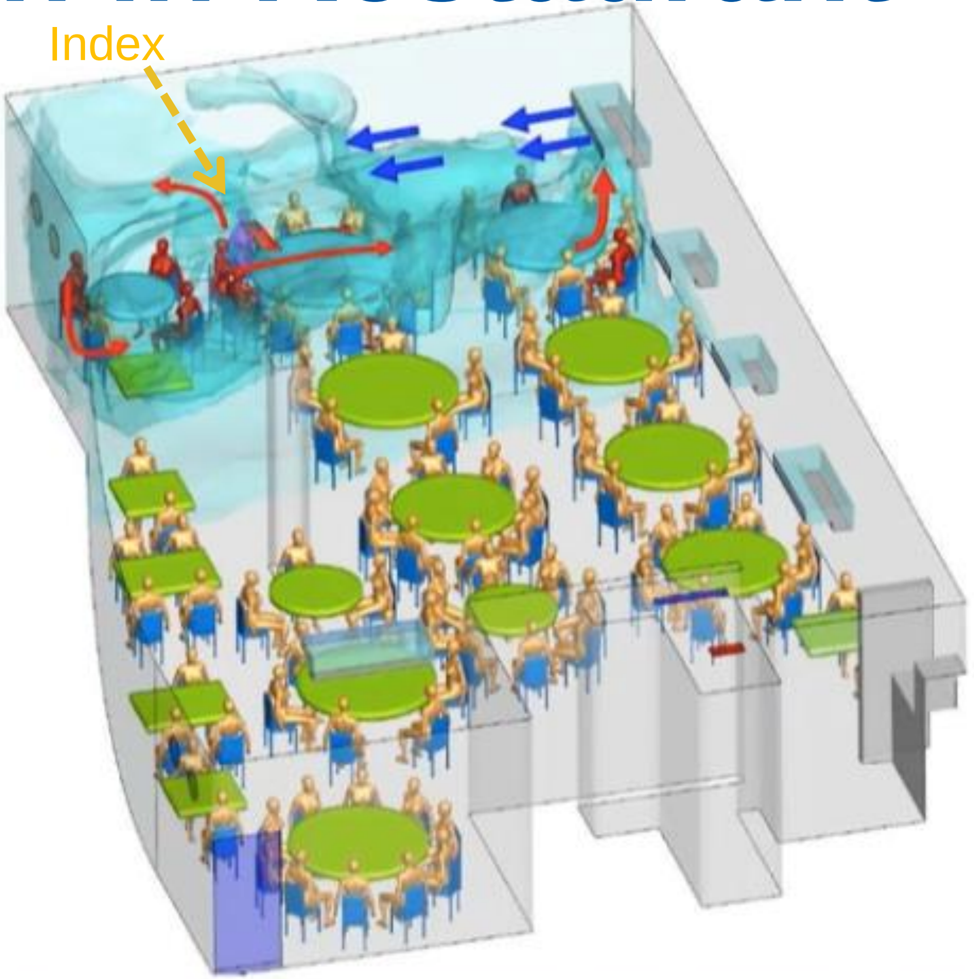
Video

Airborne transmission in Restaurant

SARS-CoV-2 spread in a Chinese restaurant [8] [20]

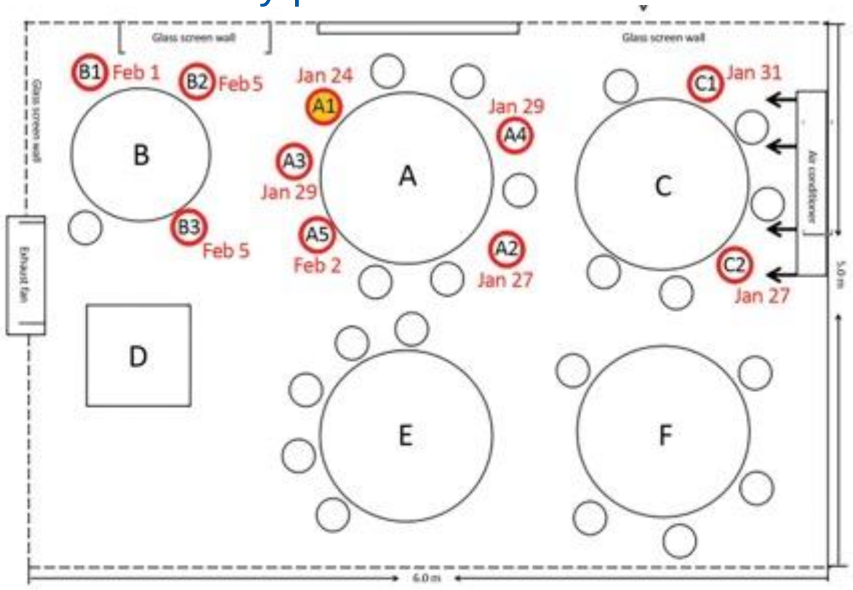
- 1 index patient infected 9 others
- Main reasons:
  - Poorly ventilated (1 L/s/occ.)
  - A/C recirculation units helped spread the virus via airborne transmission

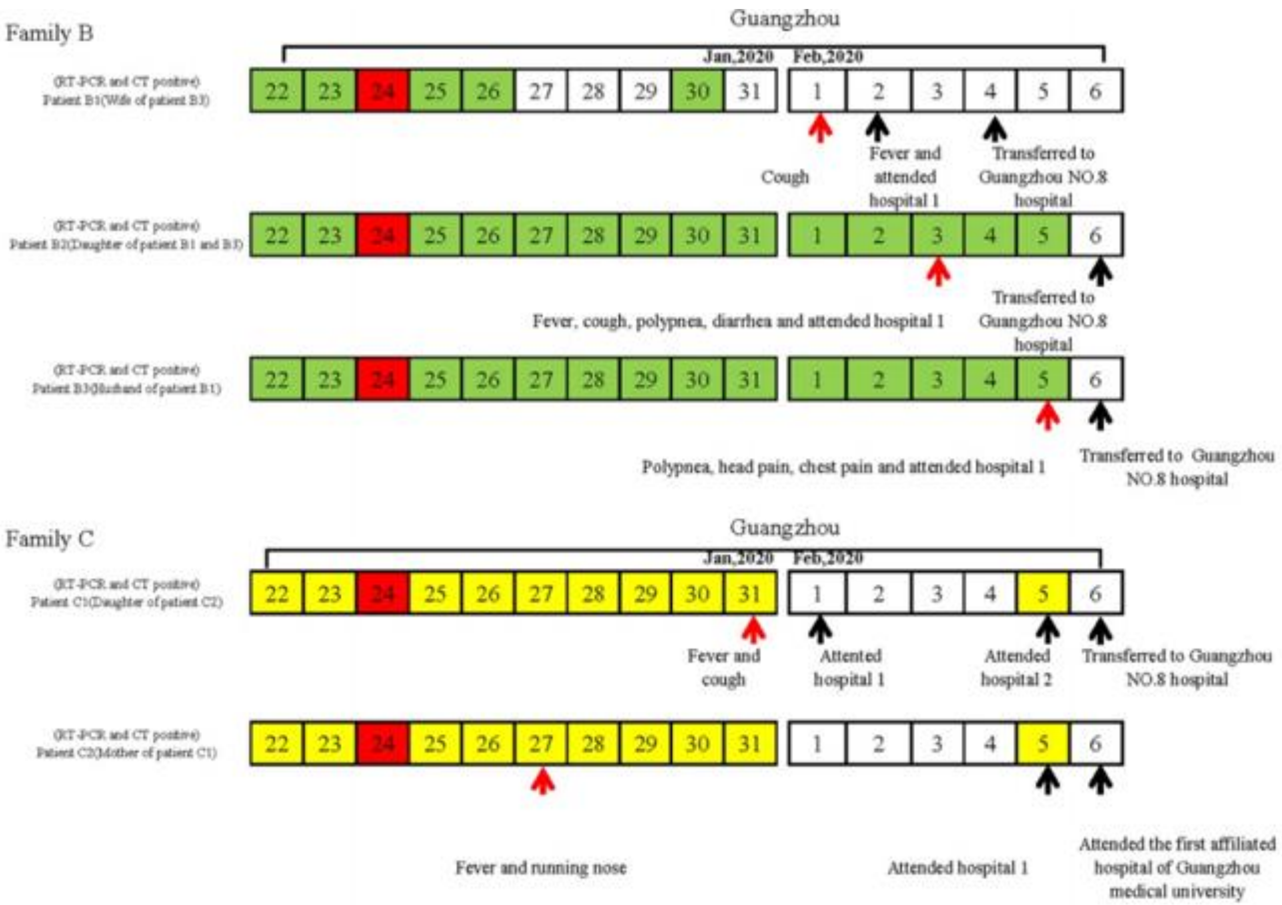
Aerosol transmission of SARS-CoV-2 due to poor ventilation may explain the community spread of COVID-19 [8]



Airborne transmission in Restaurant

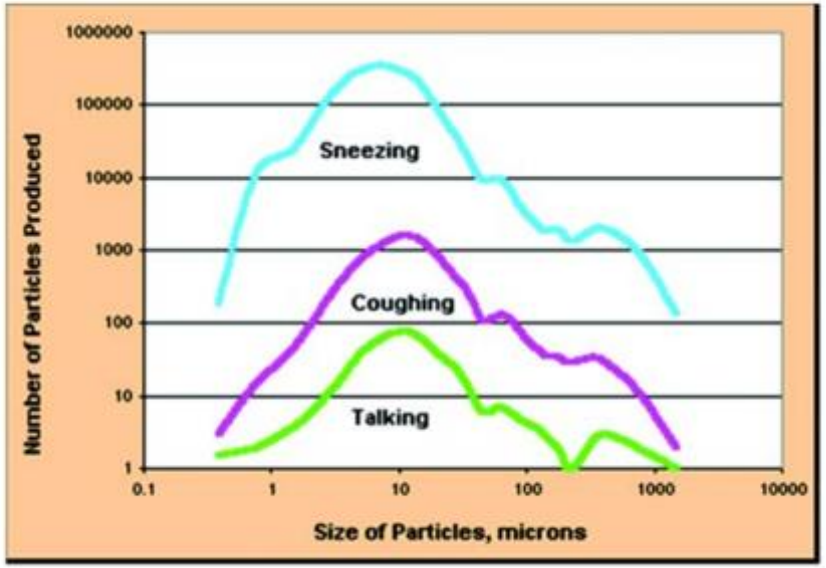
- Lunch at restaurant on 24th – patient A1 went to hospital [20]
- Incubation periods for family B and C; most likely scenario is that all 3 family B members were directly infected by patient A1 [20]
- Cannot exclude the possibility that patients B2 and B3 were infected by patient B1 [20]



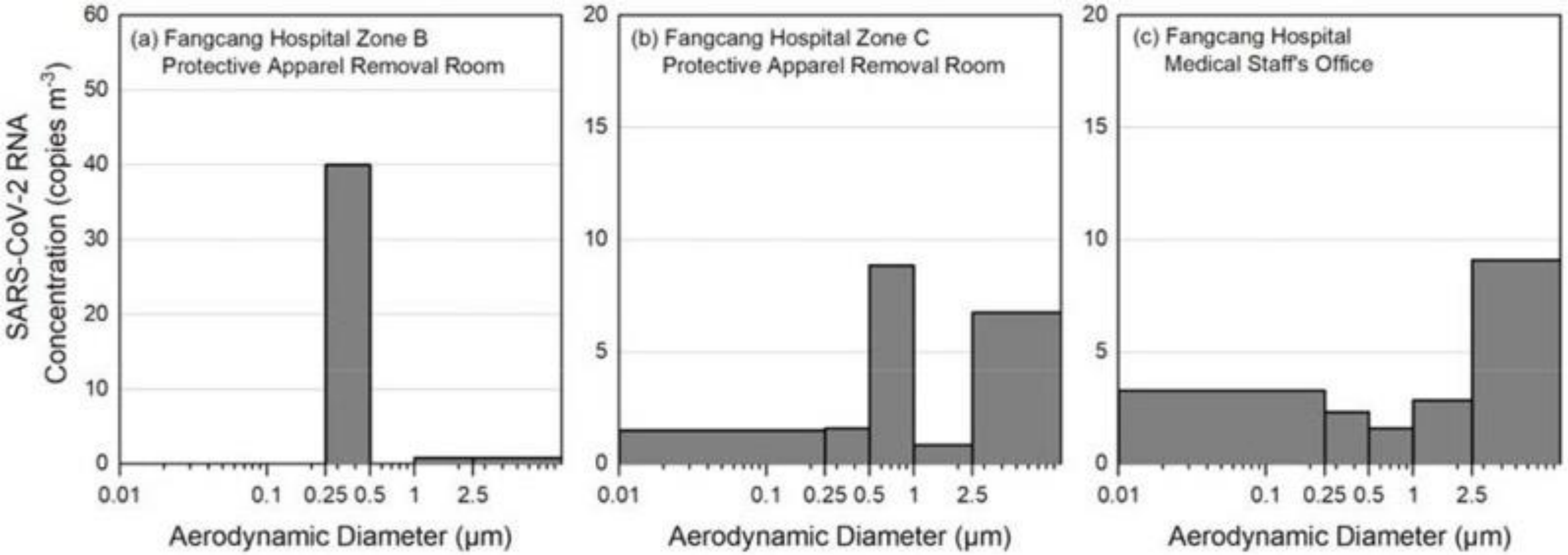


Airborne Transmission

Concentration of SARS-CoV-2 RNA, i.e. viral load, and not infectivity of the virus



Particle generation by sneezing, coughing and during talking [13]



Concentration of airborne SARS-CoV-2 RNA in different aerosol sizes in two hospitals in Wuhan, China [12]

- Half of the particles produced during talking, coughing or sneezing has a large probability of becoming airborne [13]
- The majority of viral RNA in air was associated with aerosols smaller than 2.5 μm [12]
- In patient rooms the largest concentration was in temporary toilet, 1 m^2 and without ventilation (19 copies m^{-3}) [12]
- The levels were high enough in crowded public areas to **result in inhalation exposure to 1 copy of viral RNA in about 15 minutes** [12]

Airborne Transmission

Minimum Infective Dose (MID):

- For many bacterial and viral pathogens there is a general idea of the minimal infective dose but because SARS-CoV-2 is a new pathogen there is a **lack of data**
- For SARS (2003), the infective dose in mouse was **only a few hundred viral particles**
- Even by increase 1 order of magnitude ~ 1000 particles for SARS-CoV-2 (??), this would be a relatively low infective dose and could explain why the virus is spreading relatively efficiently

Source: Professor Willem van Schaik, Professor in Microbiology and Infection at the University of Birmingham

Virus	Type/Strain	Dose	% Infected[a]	Method of delivery
Respiratory				
Influenza virus	Asian influenza A2	0.6–3 $TCID^{b}_{50}$	50	Small particle aerosol (0.3–2.5 μm)
Rhinovirus	RV15	0.032 $TCID_{50}$	50	Nasal drops
Coxsackievirus	A21-48654	6 $TCID_{50}$	50	Nasal drops
Adenovirus	Type 4	0.5 $TCID_{50}$	50	Small particle aerosol
		6.6 virus particles	50	
RSV	ts-1	30–40 $TCID_{50}$	33	Nasal drops/coarse spray
	A2	501 pfu[c]	100	Nasal drops

[a]As determined by virus shedding and/or increase in antibody titer
[b]50% Tissue culture infective dose
[c]Plaque-forming units

Minimum infectious dose of human viruses [25]

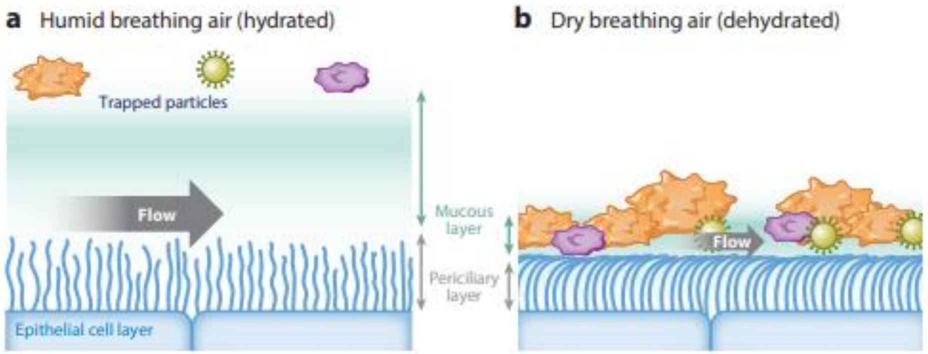
? ? ?

No information on MID yet, but…
think as of any other '*dose*' – e.g. Ionizing Radiation:

1) Reduce exposure time
2) Ensure safe distance
3) Adequate collective / personal protection

Environmental effects

- Low humidity and temperature environment would promote the viability of SARS-CoV-2. Locations with high absolute humidity also had high viral transmission rates [17]
- Respiratory droplets > 5 μm don't reach alveolar cells directly, it appears likely that at least the severe cases of COVID-19 with viral pneumonia are the result of airborne transmission events [17]
- Recommendations from [17]:
  - Maintain indoor humidity between 40 – 60 %, at room temperature
  - Ventilation of indoor air
  - Wear face mask to keep the nose warm and moist



Effect of dry air on mucociliary clearance [17]

Climate/season	Outdoor absolute humidity	Indoor relative humidity (%)	Respiratory virus stability	Proportion of droplet nuclei	Viability of respiratory viruses	Predominant transmission
Tropical	High	60–100	High	Low	High	Fomite, direct and indirect contact
Temperate: spring, fall	Intermediate	40–60	Low	Low	Low	All transmission ways possible
Temperate: winter	Low	10–40	High	High	High	Predominantly airborne

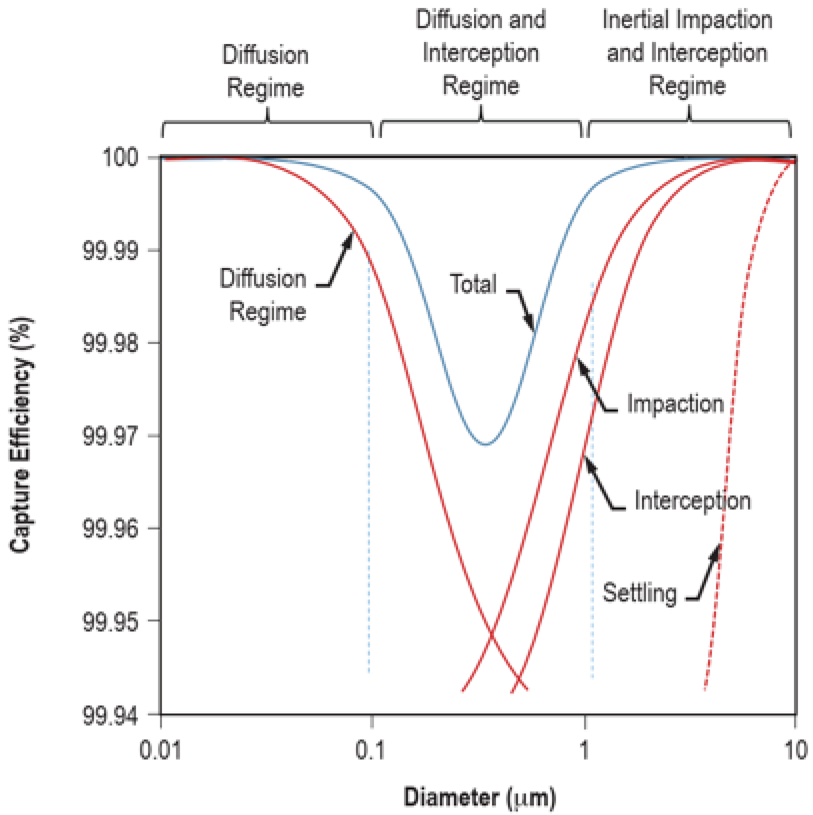
Droplet transmission under different relative humidity conditions [17]

Effect of HEPA Filtration

- Particles of ~ 0.3 µm are the hardest to catch
  - The critical particle diameter is ~ 0.3 µm
  - Reason why 0.3 µm is the Most Penetrating Particle Size (MPPS) in standards for HEPA filters

- Smaller particles are easier to catch due to the effect of the 'Brownian motion' – *Diffusion mechanism*

The filtration % is not the only important aspect

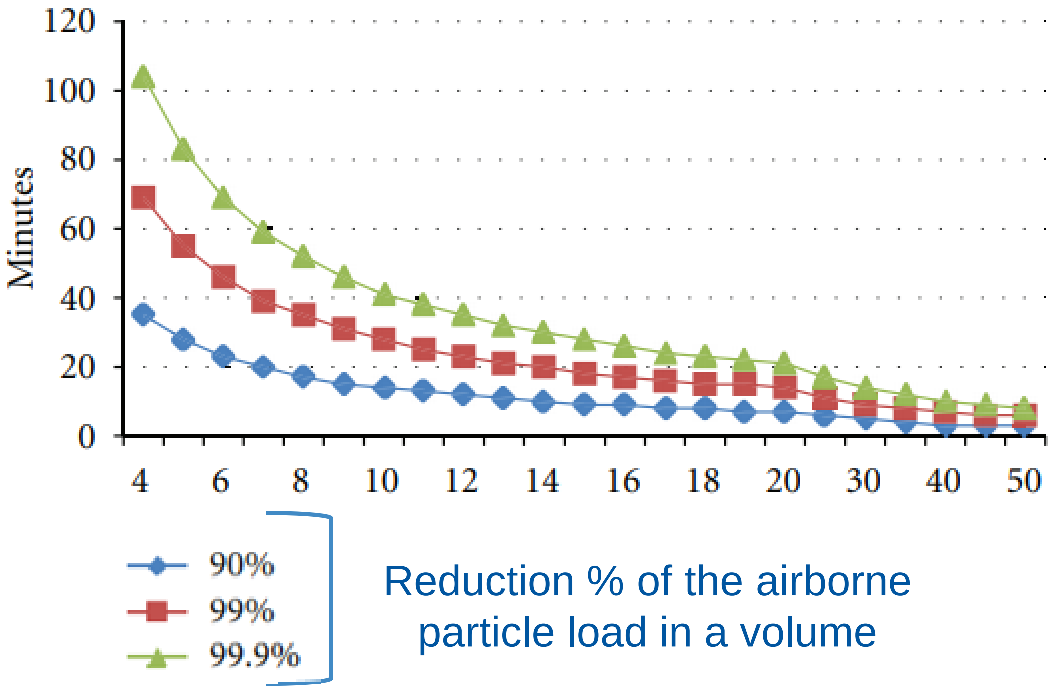


Filter efficiency as a function of particle diameter [21]

Effect of HEPA Filtration

- Filtration efficiency may be helpful, but not sufficient to eliminate airborne transmission of infection, particularly for viruses and bacteria that are extremely virulent and infect at very low exposure doses [16]
- Reduction of viral load also depends of the number of times the air passes through the filter
- Minimal impact for reducing particle load if flow-rates > 12 ACH

ACH ≥ 12 recommended

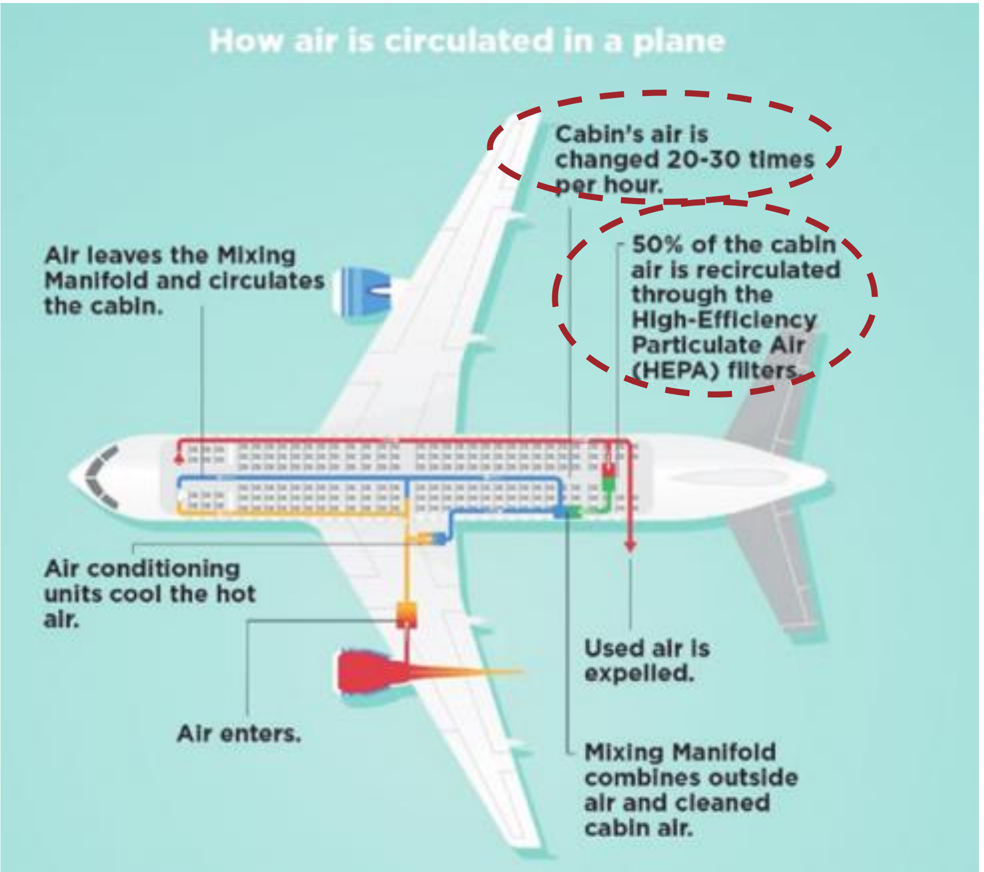


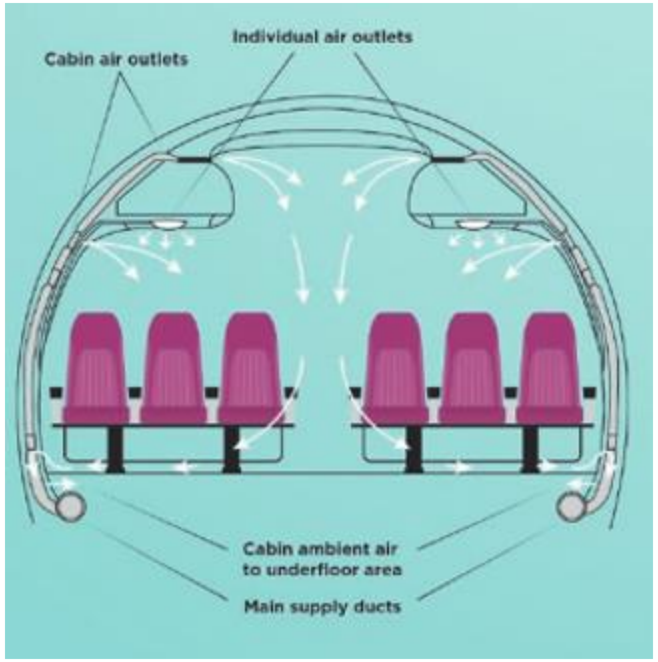
Time required for reduction of airborne particles using HEPA filtration at various air changes per hour, assuming a perfect mixing of air [16]

HEPA Filtration in aircrafts

Aircraft HVAC system:

- 50% of recirculation
- HEPA filtration
- ACH: 20–30 times per hour
- Ventilation by ‘displacement’ (top to bottom)



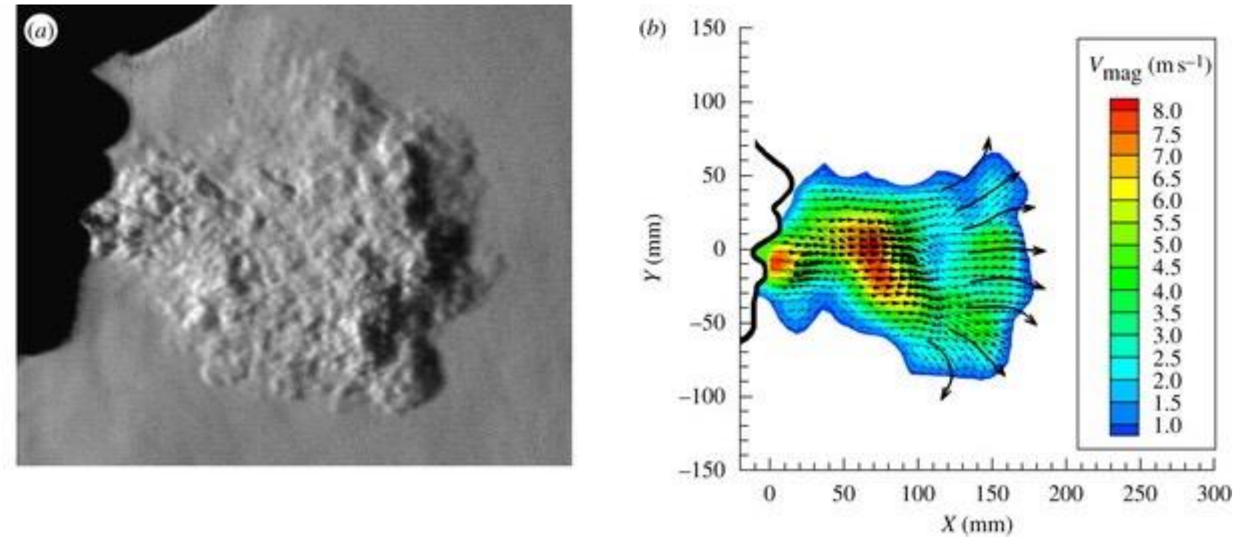


Source: Malaysia Airlines

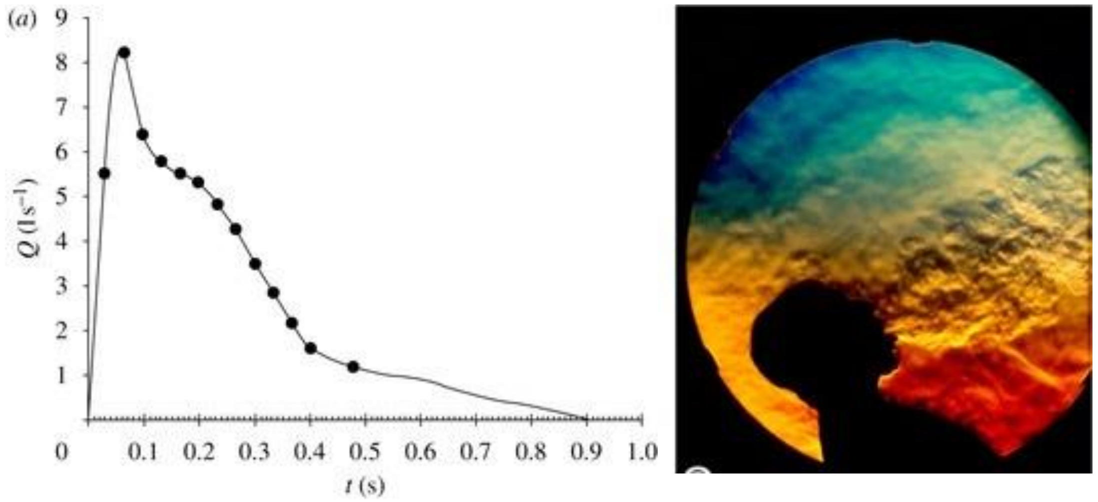
Airborne transmission – Effect of masks

Fluid dynamics of a human cough

- Human cough has an average project velocity of ~ 4 m/s (~8 m/s max)



Quantitative results from a) high-speed video and b) velocity profile of a cough by a 57-year-old male volunteer. [11]



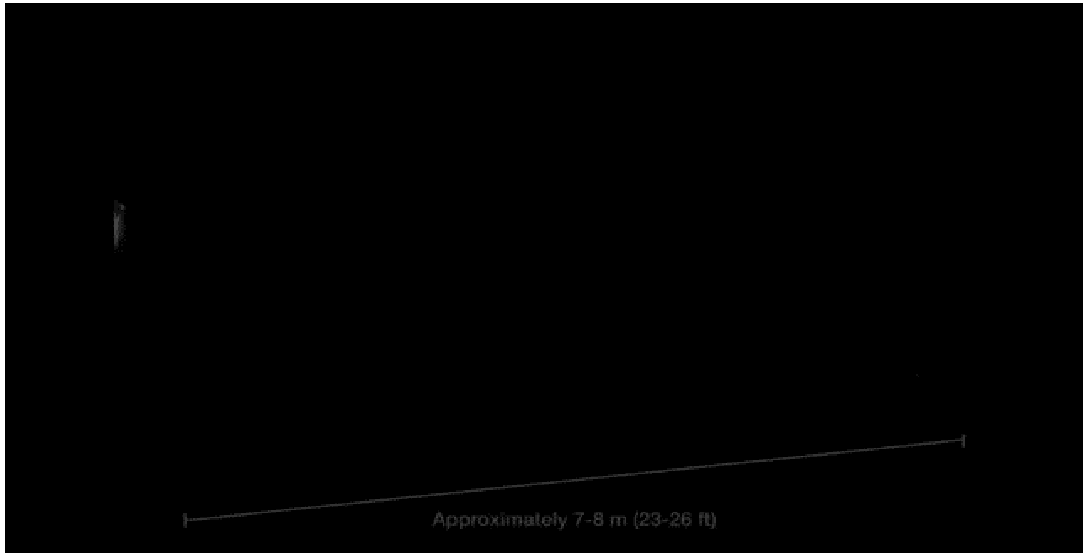
The profile of a typical 'single forced cough' in terms of expelled airflow rate versus time. [11]

Fluid dynamics of a human sneeze

Sneeze can reach up to 8m, using turbulent gas cloud dynamics [11]

- Initial velocity: 10-30 m/s

  Coughing: ~ 5-8 m/s [9]
  Exhale : ~ 2 m/s [11]



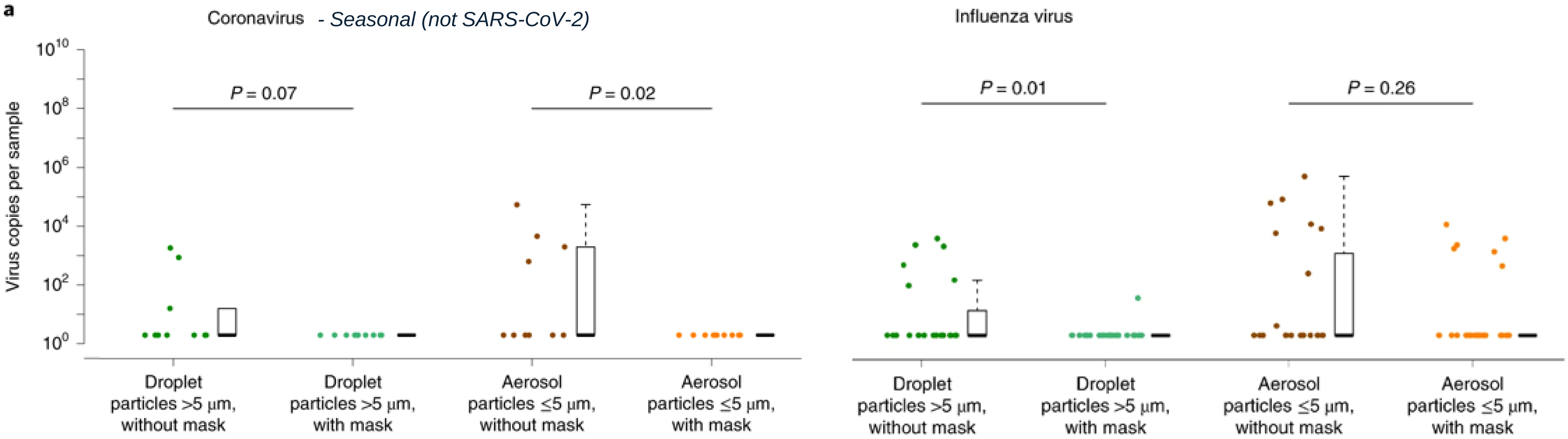
Video: Multiphase Turbulent Gas Cloud from a Human Sneeze [11]

- Infection control strategy: dichotomous classification between large vs small droplets [11]
  - Criteria droplet diameter cutoffs, from 5 to 10 μm [11]
- Such dichotomies may underly current risk management associated with infection control [11]
- Even when maximum containment policies were enforced, the rapid international spread of COVID-19 suggests that using arbitrary droplet size cutoffs may not accurately reflect reality [11]
- Finding virus aerosols in ventilation systems is more consistent with the turbulent gas cloud hypothesis of disease transmission than the dichotomous model [11]

P - values for mask intervention as predictor of $\log_{10}$ virus copies per sample

Use of face masks

- CoVs were more commonly emitted in aerosols than in droplets through normal tidal breathing [18]
- The use of surgical face masks could be used to control the transmission of COVID-19 through exhaled breath [19]



Efficacy of surgical face masks in reducing respiratory virus shedding in respiratory droplets and aerosols during exhaled breath [19]

Fluid flow patterns – with masks

Schlieren imaging to study of the human cough with and without wearing masks for aerosol infection [9]

No
PPE

3l type
mask

N95
(FFP2)

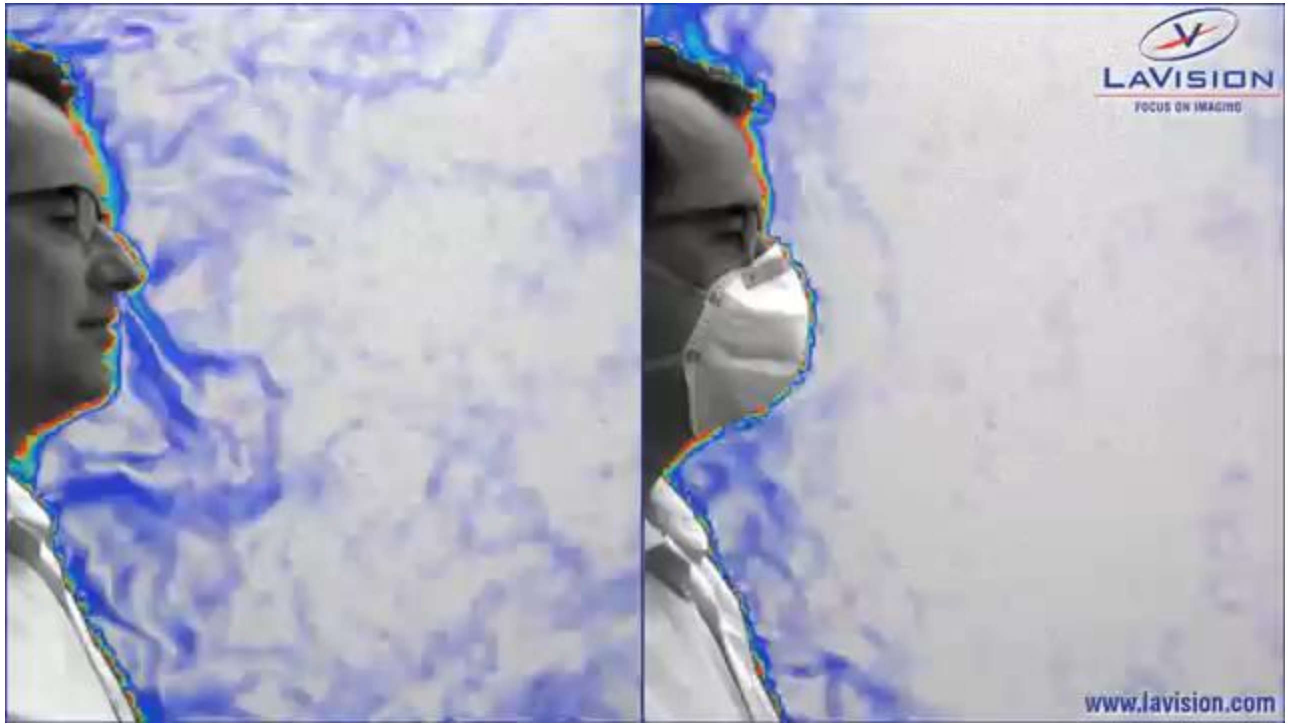
Videos: Schlieren images of two volunteers facing one another [9]

Fluid flow patterns – with masks

- The mask is very important to prevent the projection of large droplets
- Traces of micro-droplets released from the top part of the mask could be suspended in the air

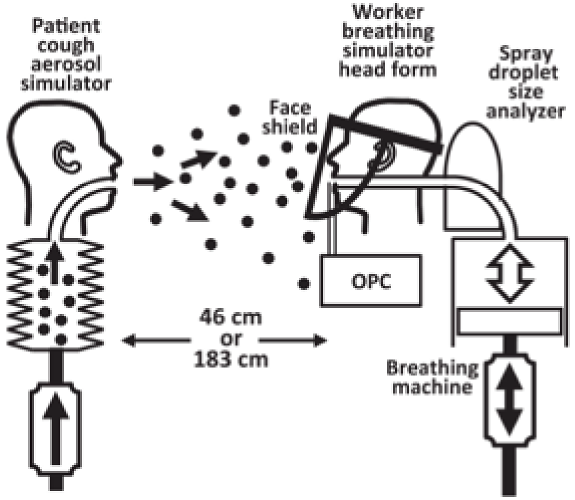
Videos: The importance of wearing a mask (to prevent the transmission of influenza)
Source: MHLWchannel - https://www.youtube.com/watch?v=9Mkb4TMT_Cc

Fluid flow patterns – with masks

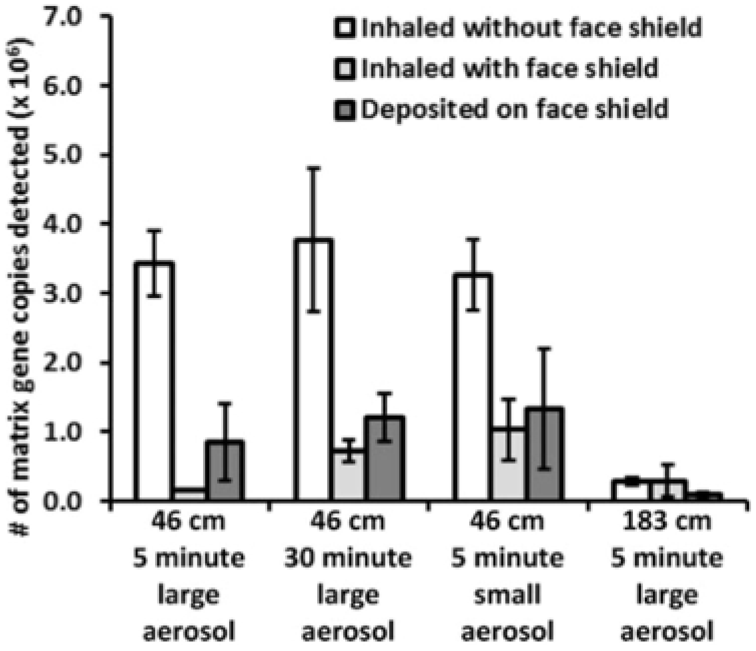


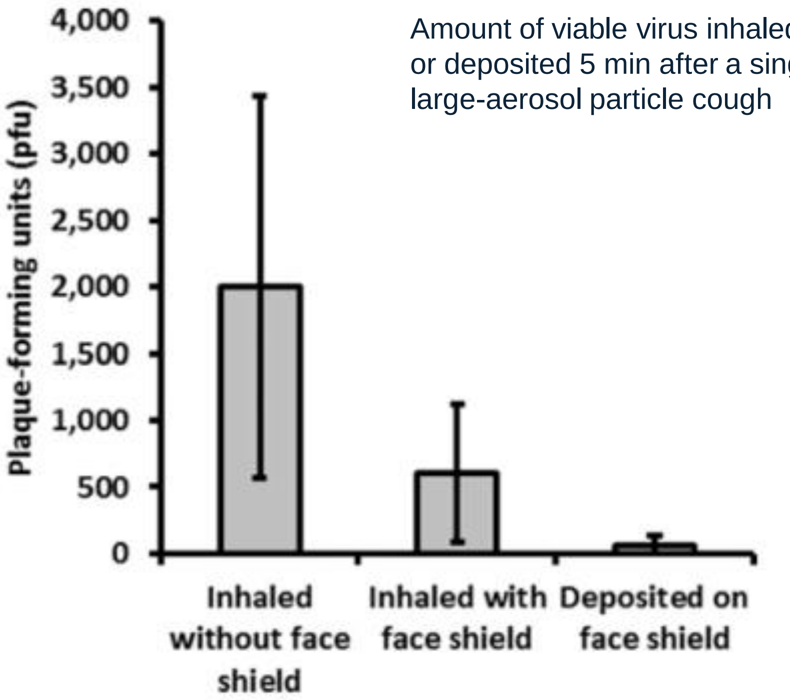
Video: Covid-19 : LaVision imaging technique shows how masks restrict the spread of exhaled air
Source: LaVision - http://www.lavision.de/en/

Fluid flow patterns – with shields



Efficacy of Face Shields Against Cough Aerosol Droplets from a Cough Simulator with Influenza virus. William G. Lindsley, et al. (2014) [22]





Amount of viable virus inhaled or deposited 5 min after a single large-aerosol particle cough

- For large aerosols (8.5 μm): Inhalation reduction ~95% [22]
- For small aerosols (3.4 μm): Inhalation reduction ~70% [22]
- WHO has recommended in the past face shields as an alternative to the use of a medical/surgical or procedural mask with eye protection (eye visor or goggles) [23] - It wasn't for COVID-19

Airborne transmission – Recommendations from WHO, FR, CH

WHO on Airborne transmission

"To date, some scientific publications provide initial evidence on whether the COVID-19 virus can be detected in the air and thus, some news outlets have suggested that there has been airborne transmission. These initial findings need to be interpreted carefully." [14]

"It is important to note that the detection of RNA in environmental samples based on PCR-based assays is not indicative of viable virus that could be transmissible." [14]

"As evidence emerges, it is important to know whether viable virus is found and what role it may play in transmission." [14]

Modes of transmission of virus causing COVID-19: implications for IPC precaution recommendations

Scientific brief
29 March 2020

World Health Organization

This version updates the 27 March publication by providing definitions of droplets by particle size and adding three relevant publications.

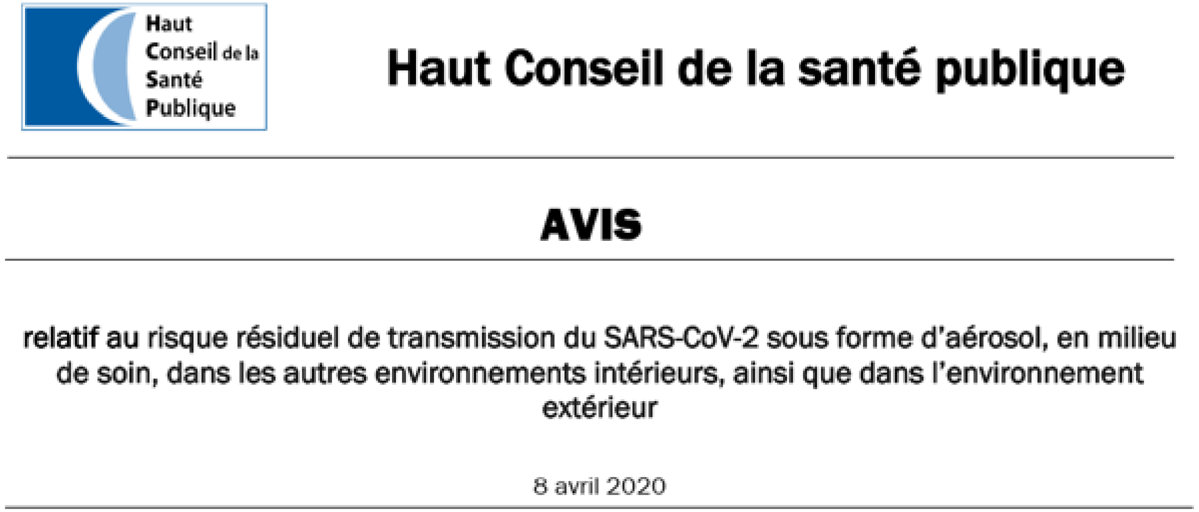
Minimum viral 'dose' to cause COVID-19 ?
Wait until (*equivalent*) '*5σ*' confirmation

Rational use of PPE [15] ⊥ Precautionary Principle

Dichotomous classification [11]: > 5 μm "Droplets" – '*fall*' within 1-2 m [14] (?)
(*cutoff limit*) ≤ 5 μm "Aerosols" – travel longer distances [14]

Recommendations from HCSP - France

- *De nouvelles recherches sont nécessaires pour étudier l'infectiosité des bioaérosols du SARS-CoV-2*
- *Il est également nécessaire de déterminer la proportion des infections à SARS-CoV-2 en relation avec les trois voies de transmission*
- *Toutefois, en l'état actuel des données de la littérature,* ***on ne peut pas exclure une transmission par aerosol dans les environnements intérieurs clos, confinés, mal aérés ou insuffisamment ventilés***


Haut Conseil de la Santé Publique

Haut Conseil de la santé publique

AVIS

relatif au risque résiduel de transmission du SARS-CoV-2 sous forme d'aérosol, en milieu de soin, dans les autres environnements intérieurs, ainsi que dans l'environnement extérieur

8 avril 2020

https://www.hcsp.fr/Explore.cgi/Telecharger?NomFichier=hcspa20200408_corsarcovrisdetraduvirsoufordaro.pdf

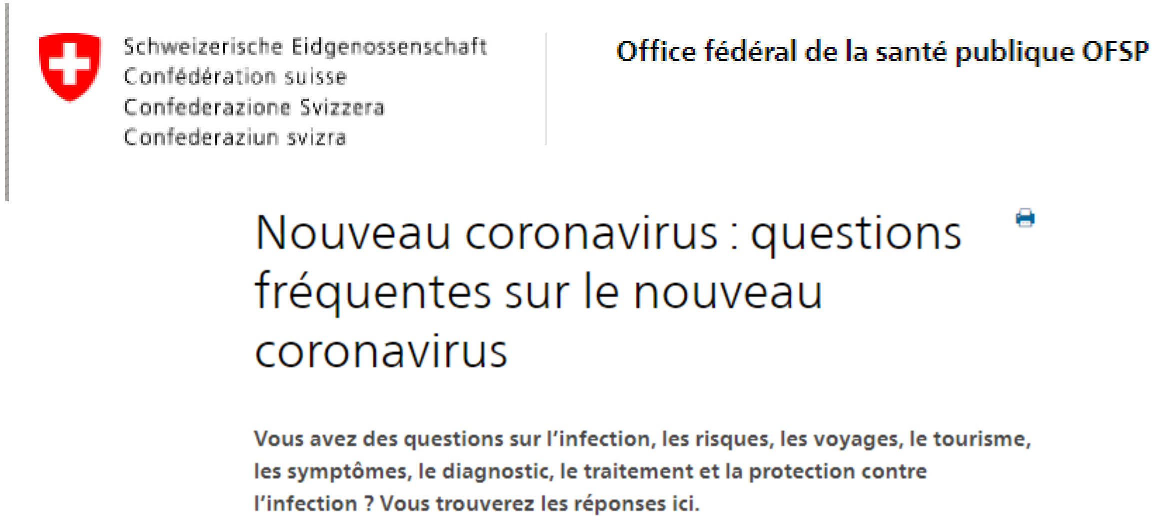
Recommendations form Switzerland

- *Si une personne infectée de votre entourage tousse, éternue ou vous parle, des gouttelettes peuvent pénétrer dans vos voies respiratoires. Dès lors, vous pouvez contracter le nouveau coronavirus.*

- *Il est également nécessaire de déterminer la proportion des infections à SARS-CoV-2 en relation avec les trois voies de transmission*

- *Les salles de classe doivent être aérées entre chaque période au moins (recommandations supplémentaires sur https://simaria.ch/).*

- *Ouvrez les fenêtres toutes les deux heures et faites circuler l'air pendant au moins 5 à 10 minutes.*


Schweizerische Eidgenossenschaft
Confédération suisse
Confederazione Svizzera
Confederaziun svizra

Office fédéral de la santé publique OFSP

Nouveau coronavirus : questions fréquentes sur le nouveau coronavirus

Vous avez des questions sur l'infection, les risques, les voyages, le tourisme, les symptômes, le diagnostic, le traitement et la protection contre l'infection ? Vous trouverez les réponses ici.

https://www.bag.admin.ch/bag/fr/home/krankheiten/ausbrueche-epidemien-pandemien/aktuelle-ausbrueche-epidemien/novel-cov/haeufig-gestellte-fragen.html#-1561207772

Recommended PPE – WHO, CDC, ECDC

- For SARS-CoV (2002), WHO recommended respirators (FFP2/N95) in low and high risk situations [18]
- For COVID-19, WHO recommends respirators only for high risk situations. CDC and ECDC initially recommended respirators in low risk areas, downgraded after PPE shortages [18]

	WHO		CDC		ECDC	
Pathogen	Low Risk	High Risk[a]	Low Risk	High Risk	Low Risk	High Risk
Severe acute respiratory syndrome coronavirus (SARS-CoV)	Respirator[b]	Respirator	Respirator	Respirator	-	-
Middle East respiratory syndrome coronavirus (MERS-CoV)	Mask	Respirator	Respirator	Respirator	Mask/Respirator[c]	Respirator
Severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2)	Mask	Respirator	Mask	Respirator	Mask/Respirator[d]	Respirator

Abbreviations: CDC, Centers for Disease Control and Prevention; ECDC, European Centre for Disease Control and Prevention; WHO, World Health Organization.

[a]High risk are the situations involving an aerosol-generating procedure, ie, endotracheal intubation, bronchoscopy, open suctioning, administration of nebulized treatment, manual ventilation before intubation, turning the patient to the prone position, disconnecting the patient from the ventilator, noninvasive positive-pressure ventilation, tracheostomy, and cardiopulmonary resuscitation.

The Use of Masks/Respirators for Coronaviruses: Recommendations from WHO, CDC, and ECDC [18]

Recommendations for CERN on indoor air quality

Risk Reduction

ELIMINATION
– to physically remove the pathogen

ENGINEERING CONTROLS
– to separate the people and pathogen

ADMINISTRATIVE CONTROLS
- to instruct people what to do

PERSONAL PROTECTIVE EQUIPMENT
- to use masks, gowns, gloves, etc.

Proper Ventilation * & filtration

Open Windows* or procedures

Additional PPE
(a part from mask)

***to dilute the viral density in air**

General recommendations on HVAC systems

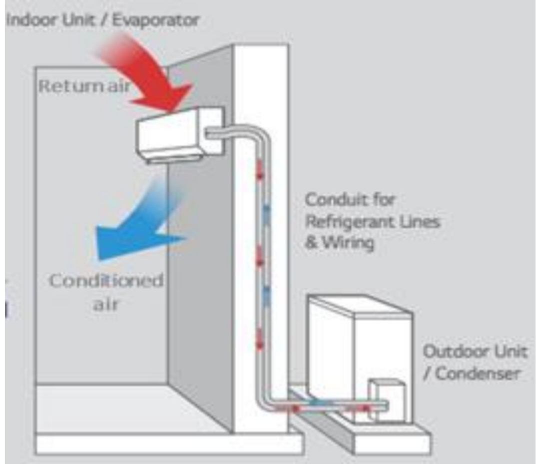
<u>**General requirements**</u>:

- **Ventilate indoor spaces** as much as possible with fresh air
  - Naturally (open windows and doors as much as possible)
  - Mechanical (switch HVAC systems to 100% fresh air wherever possible)
- **Keep the ventilation on 24/7**
- Pure recirculation **A/C units for comfort** (e.g. office-type split A/C) **not allowed**

Additional compensatory measures or case-by-case assessment needed if general req. are not met

Recirculating A/C Unit for comfort

(office-type split systems)

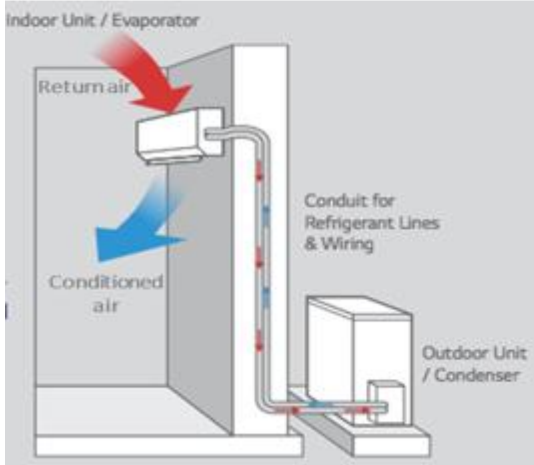


Switch-off

Systems to Cool the Indoor Air

Recirculating A/C Unit for comfort

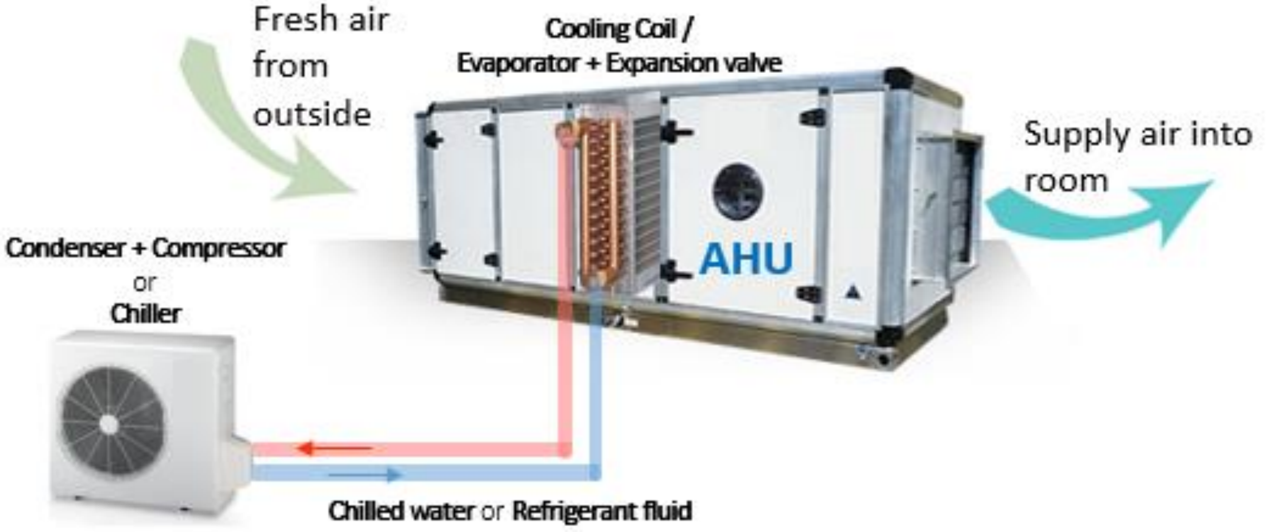
(office-type split systems)



Switch-off

Full (or partial) fresh air cooling

(cooling battery in Air Handling Units - AHU)



Allowed !
Compensatory measures might be necessary

Compensatory measures

- Cannot fully respect the ‘General Recommendations’ ?
- HSE Unit, in collaboration with the technical Departments, are working on an Annex to the COVID memo with further recommendations

  - List the possible ventilation schemes
  - Relate ventilation scheme with max occ./m^3
  - Further PPE recommendations
  - Etc…

For all the other situations: case-by-case assessment needed

Recommendations for Clean Rooms

- Cannot fully respect the ‘General Recommendations’
- Compensatory measures:
  - Keep the ventilation on 24/7
  - **HEPA filtration exits ?**
  - **Air Change per Hour ≥ 12 ?**
  - **>2 m distance respected ?**

Yes:

Besides the use of masks, no further mitigations measures needed

No:

Besides the use of masks, further mitigation measures required (e.g. face shields) based on a case-by-case assessment:

- Agreed with the Supervisor(s) and Organic Unit, in consultation with the HSE Unit

Additional precautions in the maintenance of the HEPA filters

Recommendations for Meeting Rooms

- Cannot fully respect the 'General Recommendations'
- Compensatory measures:
  - Try to increase the % of fresh air as much as possible
  - Adapt the occupancy, if possible

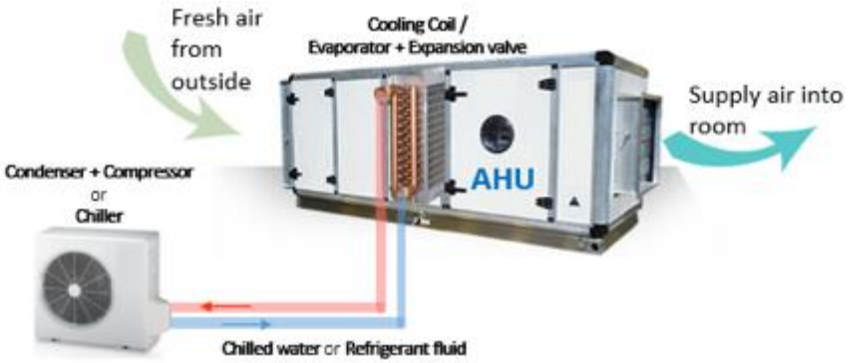
+

  - Besides the use of masks and > 2 m distance, additional further mitigation measures might be required based on a case-by-case assessment:

    - Agreed with the Supervisor(s) and Organic Unit, in consultation with the HSE Unit

Full (or partial) fresh air cooling

(cooling battery in Air Handling Units - AHU)



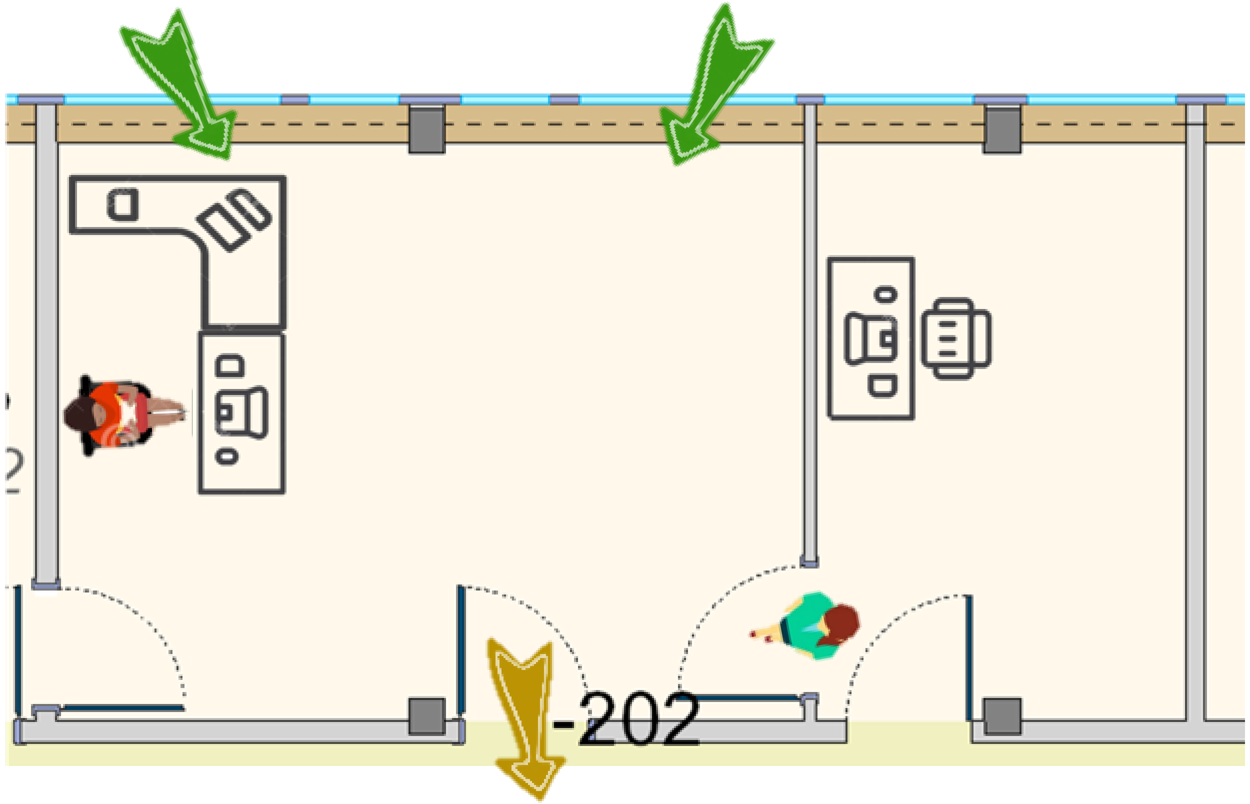
Allowed !
Reduce max capacity in tertiary bldgs. if fresh air < 100%

e.g. by reducing the occupancy capacity to 50% might be an option

Recommendations for single occupancy offices

- 'Optional' use of masks in single occupancy offices (from indoor air point of view)
- **Not allowed to turn on A/C unit**

- **Important:** Ensure proper natural/mechanical ventilation before a colleague enters the office



Recommendations for single occupancy offices

How to ensure proper natural ventilation ?

1) Open windows and doors in opposite locations of the office **as much as possible** (e.g. window in the façade and door towards the corridor), at least every 2 hours for a minimum duration of 10 min.

2) CO_2 measurements: High CO_2 concentration in offices is a good indication of lack of air exchange

MOBISTYLE

Aim to persuade people to change behaviour w.r.t energy efficiency in Bldgs. *one step at the time*. E.g.:
- Open windows more often;
- Take stairs more often.

https://www.mobistyle-project.eu/en/mobistyle

Conclusion

- Emerging scientific evidence showing that traces of SARS-CoV-2 can be found in aerosols and small droplets.
- More statistical evidence on the viability to cause COVID-19 infection of airborne transmission is needed
- Safe distance of 1-2 meters **still important** but may only be valid for (larger) droplets and contact transmission modes
- General **use of surgical-type masks** will significantly reduce the risk of airborne transmission
- The temperature of the air, alone, induced by A/C units does not effect (positively or negatively) the viability of SARS-CoV-2 (can live with -4^{o}C and 56^{o}C [5]). Although, RH might have an effect.
- Most effective measures indoors: 1) **Dilute the air (Ventilation + windows/doors)** ; 2) **Avoid recirculation**; 3) **use of PPE** (masks)
- Other compensatory measures can be prescribed based on a Risk-based approach by the Organic Unit and the possibility to adopt of the precautionary principle in these *'uncharted territories'*
- **Reassure people** with recommendations for protection in an era where there is still not enough scientific data and understanding of how the virus is transmitted

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CERN

www.cern.ch

Spare slides

Mask + shield + helmet

Recommendation from [1]

Transmission	PM size	Measures
Contact	> 50	Hygiene, Disinfection, Behaviour
Droplets	10>PM>50	Social Distancing, confinement
Airborne (droplets or nuclei)	< 10	Ventilation, Mask or Mask + Face Shield

Activity	Measures
Face-to-face meetings	To be avoided
Indoor spaces with human occupancy	Must be properly ventilated
Visit to public spaces	Mask (+ Face Shield as option)
Workers in public places	Mask + Face Shield

WHO on Airborne transmission

Airborne transmission – what is known to date

World Health Organization

- Mainly limited to circumstances and settings in which aerosol generating procedures (AGPs): tracheal intubation, non-invasive ventilation, tracheotomy, cardiopulmonary resuscitation, manual ventilation before intubation, bronchoscopy.
- **Detection of COVID-19 RNA in air samples**
  - Experimental studies not reflecting human cough or clinical settings (e.g. van Doremalen N et al, NEJM 2020)
  - Reports from settings where symptomatic COVID-19 patients have been admitted, in absence of AGPs
    - Negative: Cheng V, et al. *ICHE* 2020; Ong SW, et al. *JAMA* 2020; Faridi S et al. Science of The Total Environment 2020
    - Positive air samples with fragments of the virus detected by RT-PCR in microdroplets: Liu Y et al, 2020, bioRxiv preprint; Santarpia JL et al, 2020, medRxiv preprint; Chia PY, 2020, medRxiv preprint
    - RT-PCR positive respiratory droplet and aerosol samples for coronaviruses: Leung et al. *Nature Med* 2020
  - Detection of COVID-19 RNA in extremely low concentrations (well below what could be the infectious inoculum)
  - The detection of RNA in air samples based on PCR-based assays is not indicative of viable virus that could be transmissible (Wölfel R, Nature 2020)

Recognized for AGP

Viability for 3h in “lab”

Virus found in clinical conditions

Viability still not indicative in ‘*real clinical conditions*’

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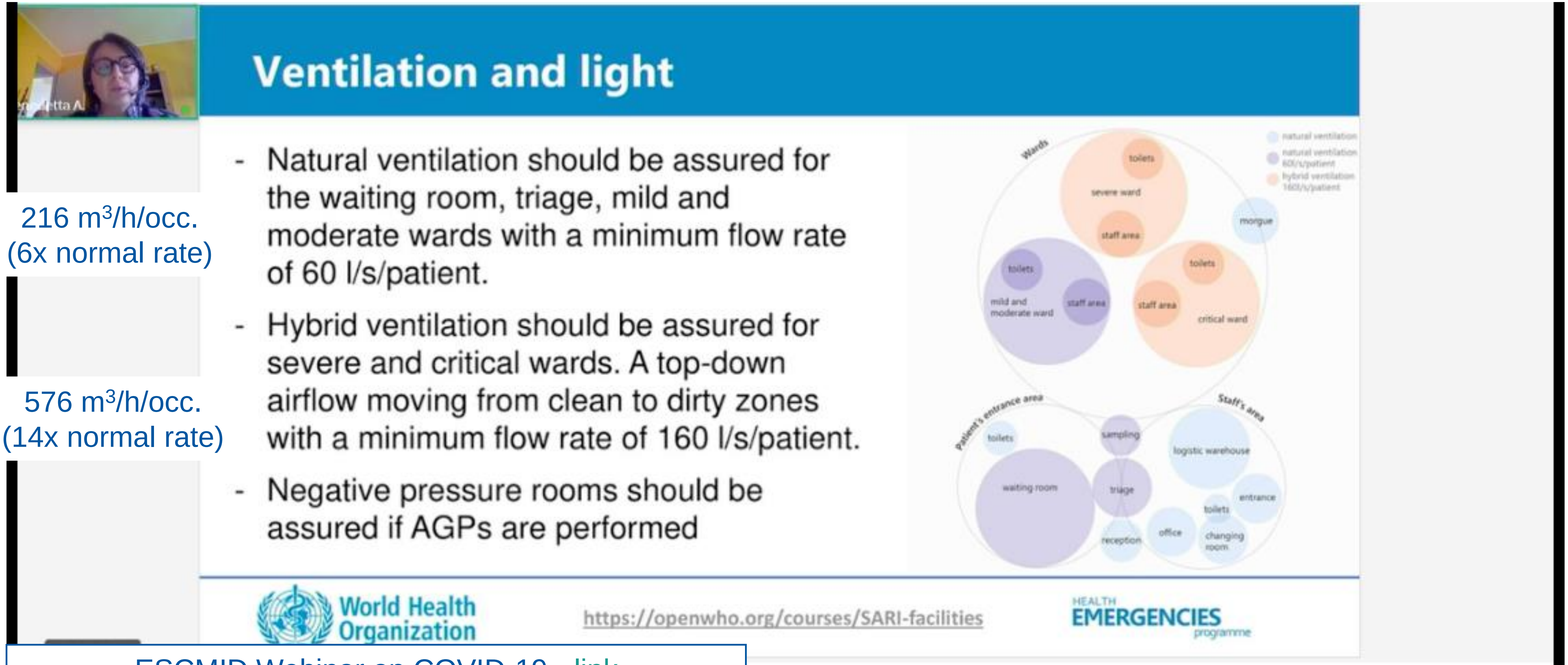
(B. Allegranzi, WHO, Geneva)

WHO on Airborne transmission



216 m^3/h/occ.
(6x normal rate)

576 m^3/h/occ.
(14x normal rate)

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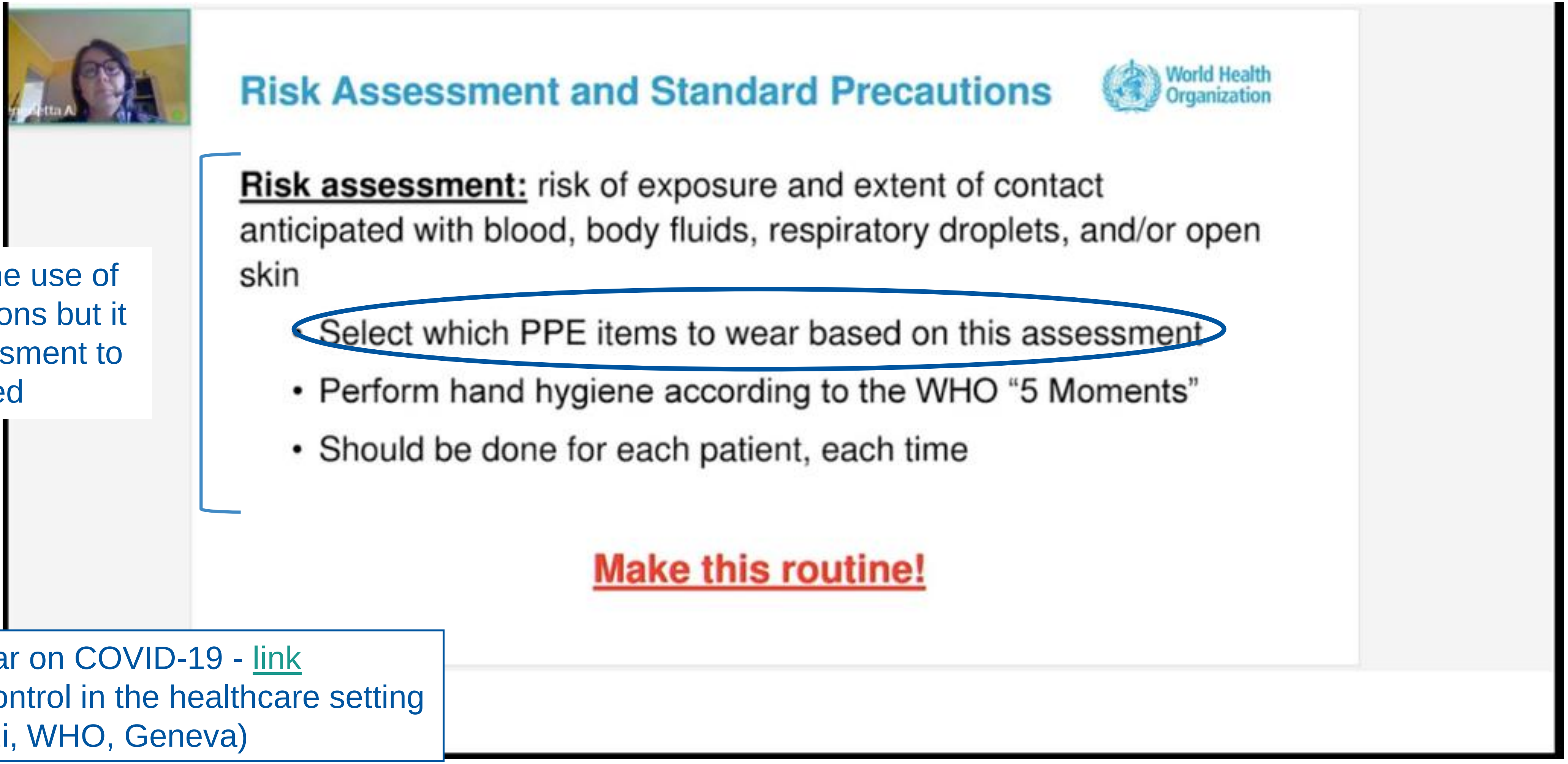
Risk Assessment



WHO recommends the use of PPE for certain situations but it is up to the risk assessment to identify the need

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WHO – Use of PPE

Principles for using PPE (1)

World Health Organization

Always **clean your hands** before and after wearing PPE

PPE should be **available** where and when it is indicated

- in the correct size
- select according to risk or per transmission-based precautions

Always **put on before contact** with the patient

Always **remove immediately** after completing the task and/or leaving the patient care area

NEVER reuse disposable PPE

Clean and disinfect reusable PPE **between each use**

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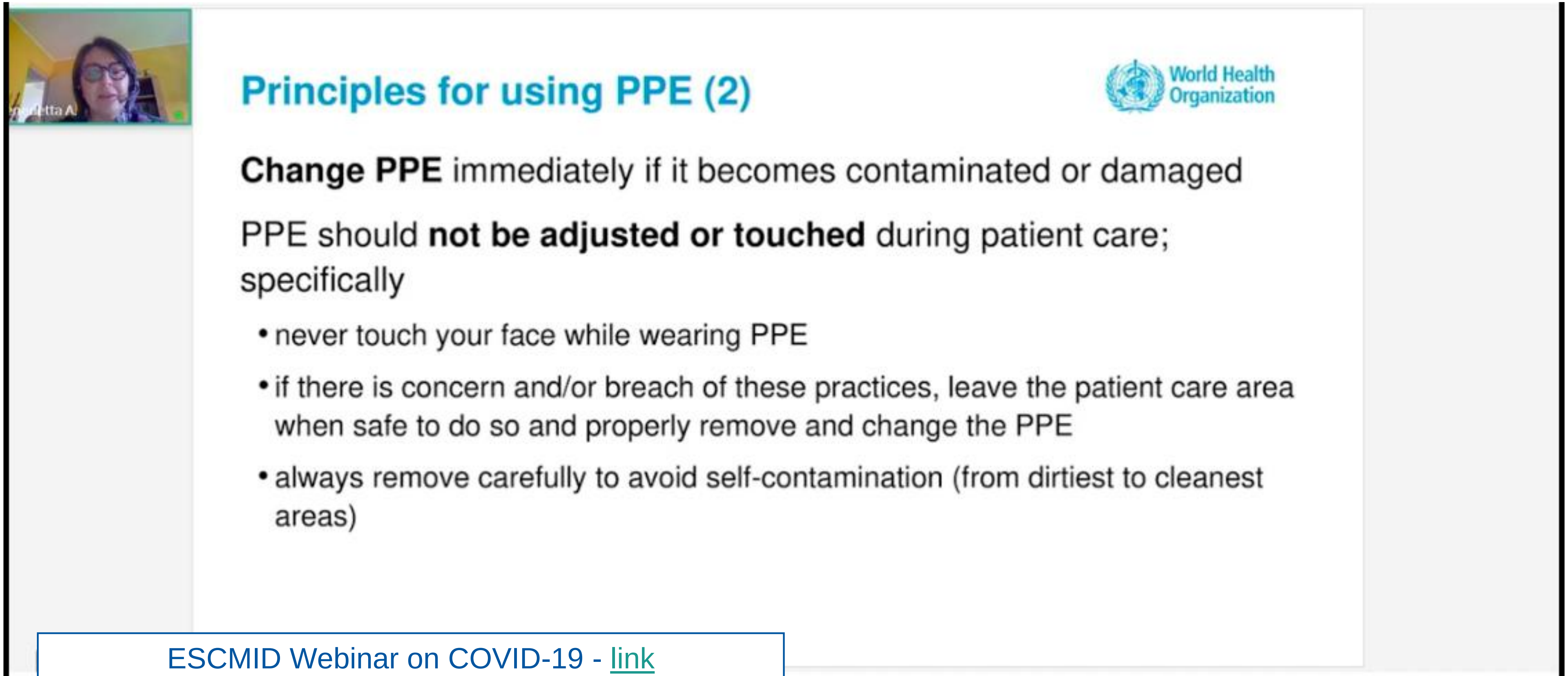
WHO – Use of PPE



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