ENGINEERING TOMORROW

WHO

Guidance **from World Health Organization (WHO):**
Coronavirus disease (COVID-19) outbreak

Scientific papers

Aerodynamic Characteristics and RNA Concentration of SARS-CoV-2 Aerosol in Wuhan Hospitals during COVID-19 Outbreak, Biorxiv, March 10, 2020.

Yuan Liu, Zhi Ning, Yu Chen, Ming Guo, Yingle Liu, Nirmal Kumar Gali, Li Sun, Yusen Duan, Jing Cai, Dane Westerdahl, Xinjin Liu, Kin-fai Ho, Haidong Kan, Qingyan Fu, Ke Lan

https://www.biorxiv.org/content/10.1101/2020.03.08.982637v1

Aerodynamic analysis of SARS-CoV-2 in two Wuhan hospitals, Nature, Published: 27 April 2020

Yuan Liu, Zhi Ning, Yu Chen, Ming Guo, Yingle Liu, Nirmal Kumar Gali, Li Sun, Yusen Duan, Jing Cai, Dane Westerdahl, Xinjin Liu, Ke Xu, Kin-fai Ho, Haidong Kan, Qingyan Fu & Ke Lan

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Aerosol transmission of SARS-CoV-2 Evidence for probable aerosol transmission of SARS-CoV-2 in a poorly ventilated restaurant, medRixv, April 22, 2020

Yuguo Li1*† , Ph.D.; Hua Qian2† , Ph.D.; Jian Hang3† , Ph.D.; Xuguang Chen4 , M.Sc.; Ling Hong3 , Ph.D.; Peng Liang5 , M.Sc.; Jiansen Li4 , M.Sc.; Shenglan Xiao1 , Ph.D.; Jianjian Wei6 , Ph.D.; Li Liu7 , Ph.D.; and Min Kang4† , M.Sc.

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COVID-19 Outbreak Associated with Air Conditioning in Restaurant, Guangzhou, China, center for disease control and prevention (CDC) 2020

Jianyun Lu1, Jieni Gu1, Kuibiao Li1, Conghui Xu1, Wenzhe Su, Zhisheng Lai, Deqian Zhou, Chao Yu, Bin XuComments to Author , and Zhicong YangComments to Author

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Leslie Dietz,a Patrick F. Horve,a David A. Coil,b Mark Fretz,a,c Jonathan A. Eisen,d,e,f Kevin Van Den Wymelenberga,

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Air, Surface Environmental, and Personal Protective Equipment Contamination by Severe Acute Respiratory Syndrome Coronavirus 2 (SARS-CoV-2) From a Symptomatic Patient, JAMA 2020

Sean Wei Xiang Ong, MBBS1; Yian Kim Tan, PhD2; Po Ying Chia, MBBS1; et al

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Practical recommendations for critical care and anesthesiology teams caring for novel coronavirus (2019-nCoV) patients, Canadian Journal of Anesthesia, 2020

Randy S. Wax MD, MEd, FRCPC, FCCM & Michael D. Christian

https://link.springer.com/article/10.1007%2Fs12630-020-01591-x

Re-Thinking the Potential for Airborne Transmission of SARS-CoV-2, Preprints (www.preprints.org) | NOT PEER-REVIEWED | Posted: 7 May 2020

Joseph G. Allen and Linsey C. Marr

https://www.preprints.org/manuscript/202005.0126/v1

Stability of SARS-CoV-2 in different environmental conditions, medRxiv preprint doi, 15/03/2020

Alex W.H. Chin, Julie T.S. Chu, Mahen R.A. Perera, Kenrie P.Y. Hui, Hui-Ling Yen, Michael C.W. Chan, Malik Peiris, Leo L.M. Poon

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Aerosol and surface stability of HCoV-19 (SARS-CoV-2) compared to SARS-CoV-1, The New England Journal of Medicine, 2020

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Persistence of coronaviruses on inanimate surfaces and their inactivation with biocidal agents, healthcare infection society , March 2020

G. Kampf, D. Todt, S. Pfaender,E. Steinmann

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Visualizing Speech-Generated Oral Fluid Droplets with Laser Light Scattering Professional Organization

Philip Anfinrud, Ph.D., Christina E. Bax, B.A., Adriaan Bax, Ph.D.

https://www.nejm.org/doi/full/10.1056/NEJMc2007800?url_ver=Z39.88-2003&rfr_id=ori:rid:crossref.org&rfr_dat=cr_pub%20%200pubmed

The Airborne Lifetime of Small Speech Droplets and Their Potential Importance in SARS-CoV-2 Transmission

Valentyn Stadnytskyi 1, Christina E Bax 2, Adriaan Bax 3, Philip Anfinrud

https://pubmed.ncbi.nlm.nih.gov/32404416/

Estimation of Airborne Viral Emission: Quanta Emission Rate of SARS-CoV-2 for Infection Risk Assessment

G Buonanno 1, L Stabile 2, L Morawska 3

https://pubmed.ncbi.nlm.nih.gov/32416374/
The Airborne Lifetime of Small Speech Droplets and Their Potential Importance in SARS-CoV-2 Transmission

Valentyn Stadnytskyi 1, Christina E Bax 2, Adriaan Bax 3, Philip Anfinrud 3

https://pubmed.ncbi.nlm.nih.gov/32404416/

Airborne Transmission Route of COVID-19: Why 2 Meters/6 Feet of Inter-Personal Distance Could Not Be Enough

Leonardo Setti 1,*, Fabrizio Passarini 2, Gianluigi De Gennaro 3, Pierluigi Barbieri 4, Maria Grazia Perrone 5, , Massimo Borelli 6, Jolanda Palmisani 3, Alessia Di Gilio3, Prisco Piscitelli7,8 and Alessandro Miani 8,9

https://www.researchgate.net/publication/340876488_Airborne_Transmission_Route_of_COVID-19_Why_2_Meters6_Feet_of_Inter-Personal_Distance_Could_Not_Be_Enough

Identifying airborne transmission as the dominant route for the spread of COVID-19

Renyi Zhang, View ORCID ProfileYixin Li, Annie L. Zhang, View ORCID ProfileYuan Wang, and Mario J. Molina

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Professional Organization

ASHRAE Position Document on Infectious Aerosols, Approved by ASHRAE Board of Directors, April 14, 2020

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REHVA, Federation of European Heating, Ventilation and air conditioning Association of designers and building services engineers , April 3, 2020

https://www.rehva.eu/fileadmin/user_upload/REHVA_COVID-19_guidance_document_ver2_20200403_1.pdf

Eurovent : European industry association for indoor climate, process cooling and food cold chain technologies , April 2, 2020

https://eurovent.eu/?q=articles/covid-19-regular-and-correct-maintenance-ventilation-systems-gen-110500

ASHRAE Offers COVID-19 Building Readiness/Reopening Guidance

https://www.ashrae.org/about/news/2020/ashrae-offers-covid-19-building-readiness-reopening-guidance

EPEE COVID-19 Transmission and Air Conditioning, June 2020

News paper

how air conditioners should be used to avoid getting coronavirus

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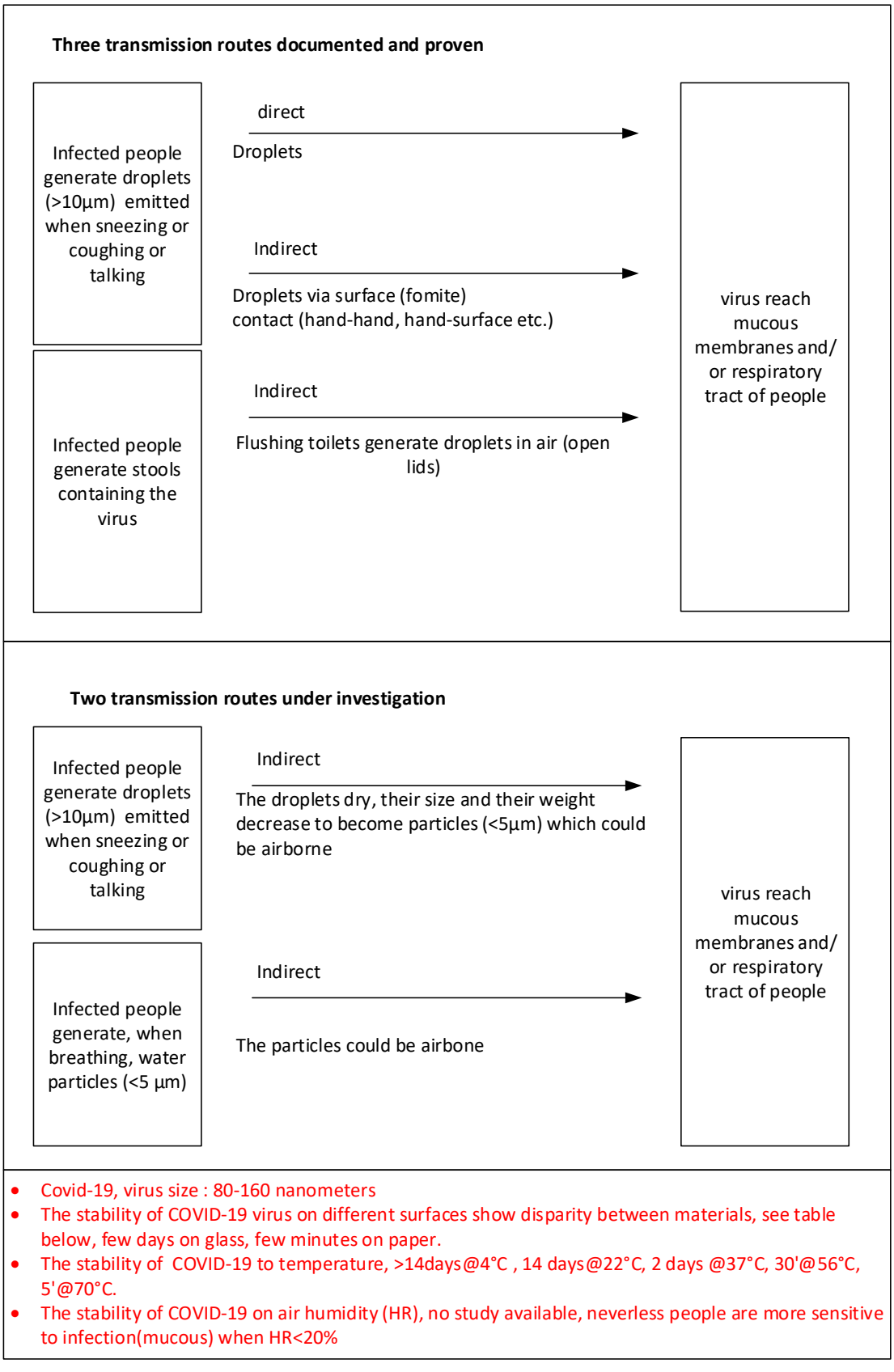

- Covid-19, virus size : 80-160 nanometers
- The stability of COVID-19 virus on different surfaces show disparity between materials, see table below, few days on glass, few minutes on paper.
- The stability of COVID-19 to temperature, >14days@4°C , 14 days@22°C, 2 days @37°C, 30'@56°C, 5'@70°C.
- The stability of COVID-19 on air humidity (HR), no study available, neverless people are more sensitive to infection(mucous) when HR<20%

Time vs material

Time	Virus titre (Log $TCID_{50}$/ml)									
	Paper		Tissue paper		Wood		Cloth		Glass	
	Mean	±SD	Mean	±SD	Mean	±SD	Mean	±SD	Mean	±SD
0 min	4.76	0.10	5.48	0.10	5.66	0.39	4.84	0.17	5.83	0.04
30 mins	2.18	0.05	2.19	0.17	3.84	0.39	2.84	0.24	5.81	0.27
3 hrs	U	-	U	-	3.41	0.26	2.21*	-	5.14	0.05
6 hrs	U	-	U	-	2.47	0.23	2.25	0.08	5.06	0.31
1 day	U	-	U	-	2.07*	-	2.07*	-	3.48	0.37
2 days	U	-	U	-	U	-	U	-	2.44	0.19
4 days	U	-	U	-	U	-	U	-	U	-
7 days	U	-	U	-	U	-	U	-	U	-

Time	Banknote		Stainless steel		Plastic		Mask, inner layer		Mask, outer layer	
	Mean	±SD	Mean	±SD	Mean	±SD	Mean	±SD	Mean	±SD
0 min	6.05	0.34	5.80	0.02	5.81	0.03	5.88	0.69	5.78	0.10
30 mins	5.83	0.29	5.23	0.05	5.83	0.04	5.84	0.18	5.75	0.08
3 hrs	4.77	0.07	5.09	0.04	5.33	0.22	5.24	0.08	5.11	0.29
6 hrs	4.04	0.29	5.24	0.08	4.68	0.10	5.01	0.50	4.97	0.51
1 day	3.29	0.60	4.85	0.20	3.89	0.33	4.21	0.08	4.73	0.05
2 days	2.47	0.23	4.44	0.20	2.76	0.10	3.16	0.07	4.20	0.07
4 days	U	-	3.26	0.10	2.27	0.09	2.47	0.28	3.71	0.50
7 days	U	-	U	-	U	-	U	-	2.79	0.46

Reference: Stability of SARS-CoV-2 in different environmental conditions,
https://www.medrxiv.org/content/10.1101/2020.03.15.20036673v2.full.pdf
Practical recommendation to maintain building Indoor air quality through two mains HVAC systems
https://www.rehva.eu/fileadmin/user_upload/REHVA_COVID-19_guidance_document_ver2_20200403_1.pdf

- AHU/RTU (air handling unit/ roof top unit)
  - Increase air supply and exhaust ventilation, stop air recirculation & switch recirculation to 100% outdoor air as much as possible
  - Use more window airing as possible
  - Safe use of heat recovery sections, Inspect heat recovery equipment to be sure that leakages are under control
  - 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
  - At nights and weekends, do not switch ventilation off, but keep systems running at lower speed
  - Do not change heating, cooling and possible humidification setpoints
  - Replace central outdoor air and extract air filters as usually, according to maintenance schedule
  - Regular filter replacement and maintenance works shall be performed with common protective measures including respiratory protection
  - Do not plan duct cleaning for this period

- VRF/FC (variable refrigerant flow / fan coils)
  - Switch fan coils either off or operate so that fans are continuously on
  - Use more window airing as possible
  - Keep system running 7/24, even if it is low speed.
  - Do not change heating, cooling and possible humidification setpoints
  - Replace air filters as usually, according to maintenance schedule
  - Regular filter replacement and maintenance works shall be performed with common protective measures including respiratory protection

In addition:

- Keep toilet ventilation 24/7 in operation
- Avoid open windows in toilets to assure the right direction of ventilation