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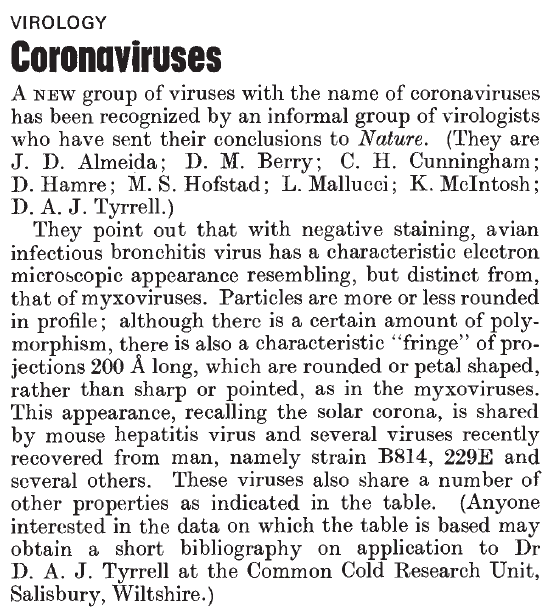
[1.2. References about airborne spread of viruses including SARS-CoV2 2](#_Toc44780081)

# Scientific articles/papers

List will be periodically updated.

## review papers

#### 1968 - Discovery of Corona



#### 1974 Monto - review of corona

<https://www.ncbi.nlm.nih.gov/pmc/articles/PMC2595130/pdf/yjbm00155-0028.pdf>

#### 1975 Coronaviridae. Tyrrell DA, Almeida JD, Cunningham CH, Dowdle WR, Hofstad MS, McIntosh K, Tajima M, Zakstelskaya LY, Easterday BC, Kapikian A, Bingham RW.

<https://www.ncbi.nlm.nih.gov/pubmed/1184350>

#### Intervirology. 1978;10(6):321-8. Coronaviridae: second report. Tyrrell DA, Alexander DJ, Almeida JD, Cunningham CH, Easterday BC, Garwes DJ, Hierholzer JC, Kapikian A, Macnaughton MR, McIntosh K.

<https://www.ncbi.nlm.nih.gov/pubmed/213397>

#### 1979 Characterization of coronaviruses 1-s2.0-0042682279904689-main

#### 1979 Robb and Bond - Pathogenic murine coronaviruses 1-s2.0-0042682279904677-main

<https://www.sciencedirect.com/science/article/pii/0042682279904677>

#### 1980 Siddell - Biochemistry of coronaviruses

<https://www.ncbi.nlm.nih.gov/pubmed/7039259>

#### 1981 Biochemistry and Biology of Coronaviruses V. ter MeulenS. SiddellH. Wege

<https://link.springer.com/content/pdf/10.1007%2F978-1-4757-0456-3.pdf>

#### 1981 Mahy 1981 - Biochemistry Of Coronaviruses

<https://www.ncbi.nlm.nih.gov/pubmed/6300299> <https://www.microbiologyresearch.org/content/journal/jgv/10.1099/0022-1317-64-4-761>

#### 1983 Siddell - Biology of coronaviruses (J Gen Virol) - JV0640040761

#### 1983 Siddell - Coronaviridae (Intervirology)

<https://www.ncbi.nlm.nih.gov/pubmed/6654644>

#### 1983 Sturman

<https://www.ncbi.nlm.nih.gov/pmc/articles/PMC7131312/pdf/main.pdf>

#### 1990 Callow - The time course of the immune response to experimental coronavirus infection of man - about immunity

K. A. CALLOW'\*, H. F. PARRY2, M. SERGEANT1 AND D. A. J. TYRRELL'

<https://www.ncbi.nlm.nih.gov/pmc/articles/PMC2271881/pdf/epidinfect00023-0213.pdf>

#### 2006 Coronaviruses

Adv Virus Res. 2006;66:193-292.

The molecular biology of coronaviruses.

Masters PS1.

#### 2010 Infectious Diseases book - Schaffer et al “Respiratory chapter” <https://www.sciencedirect.com/science/article/pii/B9780323045797001623>

#### 2012 Virus taxonomy book <https://www.sciencedirect.com/science/article/pii/B9780123846846000689>

#### 2012 Virology book - Korsman “Human coronaviruses”

<https://www.sciencedirect.com/science/article/pii/B9780443073670000409>

#### 2015 Anthony R. Fehr and Stanley Perlman, M.D., Ph.D - Coronaviruses: An Overview of Their Replication and Pathogenesis

<https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4369385/>

#### 2018 - Advances in Virus Research - M.Corman et al - Chapter Eight - Hosts and Sources of Endemic Human Coronaviruses

Volume 100, 2018, Pages 163-188

Advances in Virus Research

## References about airborne spread of viruses

#### Willeke, K., and P. A. Baron, eds. 1993. Aerosol Measurement: Principles, Techniques, and Applications. New York: Van Nostrand Reinhold.

To understand the fate and transfer of aerosolized nanodispersions, it is important to look at the different aerosol sizes and their physical behavior (Willeke and Baron 1993): large "sprayed" droplets, larger than about 10 to 20 mm emitted during sneezing and coughing will sediment rapidly, while smaller aerosols can remain airborne much longer.

Once a microdroplet has become airborne, it will disperse in the air. How many of the droplets remain airborne depends not just on their size but also on the turbulence and speed of air. In calm air, the larger droplets - those carrying the biggest load of viruses - will sediment more rapidly than in fast turbulent air. Also, if the aerosol is released into dry air, the droplets will shrink in size and be more likely to remain airborne. Initially, a shrinking size will only result in an increase of the virus concentration in the droplet, though complete drying may passivate the virus (Vejerano and Marr 2018).

#### Yu, I.T., Li, Y., Wong, T.W., Tam, W., Chan, A.T., Lee, J.H., Leung, D.Y. and Ho, T., 2004, Evidence of airborne transmission of the severe acute respiratory syndrome virus. N Engl J Med.,350:1731-1739.

#### Johnson, G. R., and L. Morawska. 2009. “The Mechanism of Breath Aerosol Formation.” Journal of Aerosol Medicine and Pulmonary Drug Delivery 22 (3): 229–237. doi:10.1089/

jamp.2008.0720.

Humans that have respiratory symptoms typically "spray" (a directional high-speed release process) large droplets of "nanodispersions" (the liquid present in the nose and upper airways) also known as sneezing and coughing. In addition, humans always, whether sick or not, release a cloud of much smaller aerosols during breathing, speaking, talking, singing, chanting loudly or coughing (in increasing order) (Johnson and Morawska 2009; Asadi et al. 2019), which corresponds to a fogging process. This "personal cloud" consist of micro-droplets of lung lining liquid that becomes airborne when the terminal bronchioles re-open during inhalation (Johnson and Morawska 2009).

In both processes, the nanoparticles dispersed in the lining fluid are included in the droplets, which is known from studies of nanoparticle exposed individuals (Sauvain et al. 2014). The nanoparticle source strength (how much is released per time unit) corresponds to the cumulative volume of liquid that got airborne.

#### WHO. 2012. Nanotechnology and Human Health: Scientific Evidence and Risk Governance. Report of the WHO Expert Meeting 10-11 December 2012, Bonn, Germany. Copenhagen: WHO Region Office for Europe, 2013. http:// www.euro.who.int/\_\_data/assets/pdf\_file/0018/233154/ e96927.pdf.

When working with hazardous chemicals and biological agents, touching and ingestion must be prevented. This is well covered by COVID-19 recommendations to wash hands. In addition, processes that can – even accidentally – spray and aerosolize the nanodispersion need to be checked in detail. An efficient risk management addresses the risk at the source, during transmission in the air, and at the target (WHO 2012).

#### Schutz, C. A., L. Juillerat-Jeanneret, H. Mueller, I. Lynch, and € M. Riediker, NanoImpactNet Consortium. 2013. “Therapeutic Nanoparticles in Clinics and under Clinical Evaluation.” Nanomedicine (London, England) 8 (3): 449–467. doi:10.2217/nnm.13.8.

To infect a human, these vesicles must reach the target cells to unload the contents of the vesicles, similar to what a nanomedical membrane vesicle does (Schutz et al. € 2013).

#### Sauvain, J.-J., M. S. S. Hohl, P. Wild, J. A. Pralong, and M. Riediker. 2014. “Exhaled Breath Condensate as a Matrix for Combustion-Based Nanoparticle Exposure and Health Effect Evaluation.” Journal of Aerosol Medicine and Pulmonary Drug Delivery 27 (6): 449–458. doi:10.1089/jamp.2013.1101.

Humans that have respiratory symptoms typically "spray" (a directional high-speed release process) large droplets of "nanodispersions" (the liquid present in the nose and upper airways) also known as sneezing and coughing. In addition, humans always, whether sick or not, release a cloud of much smaller aerosols during breathing, speaking, talking, singing, chanting loudly or coughing (in increasing order) (Johnson and Morawska 2009; Asadi et al. 2019), which corresponds to a fogging process. This "personal cloud" consist of micro-droplets of lung lining liquid that becomes airborne when the terminal bronchioles re-open during inhalation (Johnson and Morawska 2009).

In both processes, the nanoparticles dispersed in the lining fluid are included in the droplets, which is known from studies of nanoparticle exposed individuals (Sauvain et al. 2014). The nanoparticle source strength (how much is released per time unit) corresponds to the cumulative volume of liquid that got airborne.

Vejerano, E. P., and L. C. Marr. 2018. “Physico-Chemical Characteristics of Evaporating Respiratory Fluid Droplets.” Journal of the Royal Society Interface 15 (139): 20170939.

#### doi:10.1098/rsif.2017.0939.

#### Asadi, S., A. S. Wexler, C. D. Cappa, S. Barreda, N. M. Bouvier, and W. D. Ristenpart. 2019. “Aerosol Emission and Superemission during Human Speech Increase with Voice

Loudness.” Scientific Reports 9 (1): 2348. doi:10.1038/s41598-019-38808-z.

Humans that have respiratory symptoms typically "spray" (a directional high-speed release process) large droplets of "nanodispersions" (the liquid present in the nose and upper airways) also known as sneezing and coughing. In addition, humans always, whether sick or not, release a cloud of much smaller aerosols during breathing, speaking, talking, singing, chanting loudly or coughing (in increasing order) (Johnson and Morawska 2009; Asadi et al. 2019), which corresponds to a fogging process. This "personal cloud" consist of micro-droplets of lung lining liquid that becomes airborne when the terminal bronchioles re-open during inhalation (Johnson and Morawska 2009).

### 2020

#### Gorbalenya, A. E., S. C. Baker, R. S. Baric, R. J. de Groot, C. Drosten, A. A. Gulyaeva, B. L. Haagmans, et al. 2020. “The Species Severe Acute Respiratory Syndrome-related Coronavirus: Classifying 2019-nCoV and Naming it SARSCoV-2.” Nature Microbiology 5 (4): 536–544. doi:10.1038/ s41564-020-0695-z.

The coronavirus disease 2019 (COVID-19), which emerged in Hubei Province, China is caused by the severe acute respiratory syndrome virus (SARS-CoV2) (Gorbalenya et al. 2020).

#### Chen, C.-M., H.-W. Jyan, S.-C. Chien, H.-H. Jen, C.-Y. Hsu, P.-C.Lee, C.-F. Lee, et al. 2020. “Containing COVID-19 among 627,386 Persons in Contact with the Diamond Princess Cruise Ship Passengers Who Disembarked in Taiwan: Big Data Analytics.” Journal of Medical Internet Research 22 (5): e19540. doi:10.2196/19540.

- no major spreading after disembarkation of 3000 infecteds

#### Chu, D. K., E. A. Akl, S. Duda, K. Solo, S. Yaacoub, H. J. Schunemann, D. K. Chu, et al. 2020. € “Physical Distancing, Face Masks, and Eye Protection to Prevent Person-to-Person Transmission of SARS-CoV-2 and COVID-19: A Systematic Review and Meta-Analysis.” The Lancet. doi:10.1016/S0140-6736(20)31142-9.

#### Hamner, L., P. Dubbel, I. Capron, A. Ross, A. Jordan, J. Lee, J. Lynn, et al. 2020. “High SARS-CoV-2 Attack Rate following Exposure at a Choir Practice – Skagit County, Washington,

March 2020.” Morbidity and Mortality Weekly Report 69 (19): 606–610. doi:10.15585/mmwr.mm6919e6.

- superspreading event at choir practice

Jang, S., S. H. Han, and J.-Y. Rhee. 2020. “Cluster of Coronavirus Disease Associated with Fitness Dance Classes, South Korea.” Emerging Infectious Diseases 26 (8).

doi:10.3201/eid2608.200633.

- superspreading event at fitness centers

Riediker, M., and D.-H. Tsai. 2020. “Estimation of SARS-CoV-2 Aerosol Emissions from Simulated Patients with COVID-19 and no to Moderate Symptoms.” medRxiv. 2020.04.27.20081398.doi:10.1101/2020.04.27.20081398.

- high viral load

Protection against spray exposure by keeping distance or by using face shields seems effective for situations where the time spent in the joint airspace is short and where the room is large and well ventilated. This may explain why there are no reports about excessive infection numbers of supermarket cashiers. The airborne route becomes important when being for a prolonged time in the same room as a virus carrier, especially if that person is singing, shouting or physically active, as seen during superspreading events in choirs (Hamner et al. 2020) and fitness centers (Jang, Han, and Rhee 2020) and having a high viral load in the lining liquid (Riediker and Tsai 2020). In contrast, passing on the street through the "personal cloud" of an individual virus carrier will be a very low risk, as evidenced also by the landfall of the Princess Diamond in Taiwan where 627,386 persons had been in proximity of any of the 3000 embarked passengers, but nobody got sick as a result of the landfall (Chen et al. 2020). As soon as people have to spend prolonged time together, wearing face masks becomes important.

Masks can be used as emission control devices (surgical masks) and to protect the carrier (respirators).

Wide spread use of simple face coverings and surgical masks aimed to control emissions were found to be very effective at reducing community transmissions, while respirators along with splash guards were effective to protect medical staff in high risk situations (Chu et al. 2020).

## references about masks