AEROSOLIZED SARS-C0V-2
HEALTH CARE PERSONNEL DURING COVID-19 PANDEMIC

The airborne lifetime of small speech droplets and their potential importance in SARS-CoV-2 transmission. Valentyn Stadnytskyi V, Bax CE, Bax A, and Anfinrud P. Proceedings of the National Academy of Sciences of the United States of America, May 13, 2020.
https://www.pnas.org/content/early/2020/05/12/2006874117
https://doi.org/10.1073/pnas.2006874117

> Abstract: Speech droplets generated by asymptomatic carriers of severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) are increasingly considered to be a likely mode of disease transmission. Highly sensitive laser light scattering observations have revealed that loud speech can emit thousands of oral fluid droplets per second. In a closed, stagnant air environment, they disappear from the window of view with time constants in the range of 8 to 14 min, which corresponds to droplet nuclei of ca. 4 μm diameter, or 12- to 21-μm droplets prior to dehydration. These observations confirm that there is a substantial probability that normal speaking causes airborne virus transmission in confined environments.

Visualizing Speech-Generated Oral Fluid Droplets with Laser Light Scattering. Anfinrud P, Bax CE, and Bax A. New England Journal of Medicine (NEJM), April 15, 2020
DOI: 10.1056/NEJMc2007800

> The act of speaking generates oral fluid droplets that vary widely in size,1 and these droplets can harbor infectious virus particles. Whereas large droplets fall quickly to the ground, small droplets can dehydrate and linger as “droplet nuclei” in the air, where they behave like an aerosol and thereby expand the spatial extent of emitted infectious particles.

Aerosol and Surface Stability of SARS-CoV-2 as Compared with SARS-CoV-1. Neeltje van Doremalen et al. The New England Journal of Medicine Downloaded from nejm.org on April 30, 2020. https://www.nejm.org/doi/pdf/10.1056/NEJMc2004973?articleTools=true

> "Our results indicate that aerosol and fomite transmission of SARS-CoV-2 is plausible, since the virus can remain viable and infectious in aerosols for hours and on surfaces up to days (depending on the inoculum shed). These findings echo those with SARS-CoV-1, in which these forms of transmission were associated with nosocomial spread and super-spreading events,5 and they provide information for pandemic mitigation efforts"

Environmental contamination of the SARS-CoV-2 in healthcare premises: An urgent call for protection for healthcare workers. Guangming Ye et al., medRxiv preprint doi: https://doi.org/10.1101/2020.03.11.20034546.this version posted March 16, 2020.

> Many surfaces were contaminated with SARS-CoV-2 across the hospital in various patient care areas, commonly used objects, medical equipment, and PPE. The 13 hospital function zones were classified into four contamination levels. These findings emphasize the urgent need to ensure adequate environmental cleaning, strengthen infection prevention training, and improve infection prevention precautions among HCWs during the outbreak of COVID-19. The findings may have important implications for modifying and developing urgently needed policy to better protect healthcare workers during this ongoing pandemic of SARS-CoV-2.

A Randomized Clinical Trial of Three Options for N95 Respirators and Medical Masks in Health Workers. a MacIntyre et al. AMERICAN JOURNAL OF RESPIRATORY AND CRITICAL CARE MEDICINE VOL 187 2013

> We tested policy recommendations in a randomized controlled trial and found that continuous use of N95s resulted in significantly lower rates of clinical respiratory infection compared with targeted use in high-risk situations, or use of medical masks. These new data inform occupational policy options for healthcare workers and have significance for occupational health and safety

Asymptomatic Transmission, the Achilles' Heel of Current Strategies to Control Covid-19. Monica Gandhi, M.D., M.P.H., Deborah S. Yokoe, M.D., M.P.H., and Diane V. Havlir, M.D. New England Journal of Medicine. Editorial. Downloaded from nejm.org on April 27, 2020.

> What explains these differences in transmission and spread? A key factor in the transmissibility of Covid-19 is the high level of SARS-CoV-2 shedding in the upper respiratory tract…

Presymptomatic SARS-CoV-2 Infections and Transmission in a Skilled Nursing Facility. M.M. Arons et al. New England Journal of Medicine. Downloaded from nejm.org on April 27, 2020.

> Rapid and widespread transmission of SARS-CoV-2 was demonstrated in this skilled nursing facility. More than half of residents with positive test results were asymptomatic at the time of testing and most likely contributed to transmission. Infection-control strategies focused solely on symptomatic residents were not sufficient to prevent transmission after SARS-CoV-2 introduction into this facility.

Aerodynamic analysis of SARS-CoV-2 in two Wuhan hospitals. Yuan Liu, et al. Nature. https://www.nature.com/articles/s41586-020-2271-3

> "Although we have not established the infectivity of the virus detected in these hospital areas, we propose that SARS-CoV-2 may have the potential to be transmitted via aerosols. Our results indicate that room ventilation, open space, sanitization of protective apparel, and proper use and disinfection of toilet areas can effectively limit the concentration of SARS-CoV-2 RNA in aerosols. Future work should explore the infectivity of aerosolized virus. "

Comparative dynamic aerosol efficiencies of three emergent coronaviruses and the unusual persistence of SARS-CoV-2 in aerosol suspensions. Fears AC, Klimstra WB, Duprex P, et al. *Note: This article is a preprint and has not been certified by peer review, posted April 18, 2020.* https://www.medrxiv.org/content/10.1101/2020.04.13.20063784v1

In several laboratory settings, the virus that causes COVID-19 infection was found to remain in the air for up to 16 hours without losing its capacity to infect and it did not show the expected decay. The article states:

> Infectious SARS-CoV-2 was detected at all timepoints during the aerosol suspension stability experiment. . . a minor but constant fraction of the SARS-CoV-2 virus maintained replication-competence at all timepoints performed, including when sampled at 16 hours of aerosol suspension. This resulted in a remarkably flat decay curve when measured for infectivity, and failed to provide a biological half-life. . . Aerosol transmission of SARS-CoV-2, whether through direct respiratory droplet transfer or fomite generation, may in fact be a more important exposure transmission pathway than previously considered.

Fineberg HV. National Research Council. 2020. *Rapid Expert Consultation on the Possibility of Bioaerosol Spread of SARS-CoV-2 for the COVID-19 Pandemic (April 1, 2020)*. Washington, DC: The National Academies Press. https://doi.org/10.17226/25769.

> Currently available research supports the possibility that SARS-CoV-2 could be spread via bioaerosols generated directly by patients' exhalation. One must be cautious in imputing the findings with one respiratory virus to another respiratory virus, as each virus may have its own effective infectious inoculum and distinct aerosolization characteristics. Studies that rely on PCR to detect the presence of viral RNA may not represent viable virus in sufficient amounts to produce infection. Nevertheless, the presence of viral RNA in air droplets and aerosols indicates the possibility of viral transmission via these routes. . . While the current SARS-CoV-2 specific research is limited, the results of available studies are consistent with aerosolization of virus from normal breathing.

Airborne transmission of SARS-CoV-2: The world should face the reality. Morawskaa L and Caob J. *Environment International,* Volume 139, June 2020, 105730. https://www.sciencedirect.com/science/article/pii/S016041202031254X

> One transmission route that is mentioned only in passing, or not at all, is the transport of virus-laden particles in the air. Immediately after droplets are expired, the liquid content starts to evaporate, and some droplets become so small that transport by air current affects them more than gravitation. Such small droplets are free to travel in the air and carry their viral content meters and tens of meters from where they originated. . . It is therefore extremely important, that the national authorities acknowledge the reality that the virus spreads through air, and recommend that adequate control measures be implemented to prevent further spread of the SARS-CoV-2 virus, in particularly removal of the virus-laden droplets from indoor air by ventilation.

Transmission Potential of SARS-CoV-2 in Viral Shedding Observed at the University of Nebraska Medical Center. Santarpia JL, Rivera DN, Herrera V, et al. *This article is a preprint and has not been certified by peer review, posted March 16, 2020.* https://www.medrxiv.org/content/10.1101/2020.03.23.20039446v2

> Air samples, both in the rooms and in the hallway spaces), provide information 40 about airborne viral shedding in these facilities. In room air samples were 63.2% positive by RTPCR (mean concentration 2.86 copies/L of air). In the NQU, samplers were placed either on the bedside table or a desk, wherever there was space. . .Disease spread through both direct (droplet and person-to-person) as well as indirect contact (contaminated objects and airborne transmission) are indicated, supporting the use of airborne isolation precautions.

COMMENTARY: COVID-19 transmission messages should hinge on science. *Center for Infectious Disease Research and Policy (CIDRAP),* March 16, 2020. Brosseau L. http://www.cidrap.umn.edu/news-perspective/2020/03/commentary-covid-19-transmission-messages-should-hinge-science

> The precautionary principle suggests we should approach this organism as we would any novel highly transmissible respiratory disease—as a contact, droplet and airborne disease, but with one important caveat: Short-range aerosol transmission is also a strong possibility. . . Contrary to popular belief, the larger particles (5 to 15 micrometers [µm]) will not immediately drop to the ground but will remain airborne for several minutes. Smaller particles (less than 5 µm) will remain in the air for many minutes or even hours. All particles will immediately begin to evaporate (mucus contains a lot of water), which means the range of particle sizes will decrease overall. Smaller particles are more affected by diffusion than gravity, thus making them more likely to remain airborne. In the absence of air currents, airborne particles will disperse slowly throughout a space.

Study highlights ease of spread of COVID-19 viruses. *Center for Infectious Disease Research and Policy, March 9 2020.* http://www.cidrap.umn.edu/news-perspective/2020/03/study-highlights-ease-spread-covid-19-viruses

> COVID-19 can be spread before it causes symptoms, when it produces symptoms like those of the common cold, and as many as 12 days after recovery, according to a virologic analysis of nine infected patients published today on the preprint server medRxiv.
>
> Also, in a study published in today's Annals of Internal Medicine, researchers at Johns Hopkins found a median incubation period for COVID-19 of 5.1 days—similar to that of severe acute respiratory syndrome (SARS).
>
> Michael Osterholm, PhD, MPH, director of the Center for Infectious Disease Research and Policy at the University of Minnesota, which publishes CIDRAP News, said that the results challenge the World Health Organization's assertion that COVID-19 can be contained.
>
> The findings confirm that COVID-19 is spread simply through breathing, even without coughing, he said. They also challenge the idea that contact with contaminated surfaces is a primary means of spread, Osterholm said.

Protecting health-care workers from subclinical coronavirus infection. *The Lancet VOLUME 8, ISSUE 3, PE13, MARCH 01, 2020.* https://www.thelancet.com/journals/lanres/article/PIIS2213-2600(20)30066-7/fulltext

> Recent evidence suggests that even someone who is non-symptomatic can spread COVID-19 with high efficiency, and conventional measures of protection, such as face masks, provide insufficient protection. . . These findings warrant aggressive measures (such as N95 masks, goggles, and protective gowns) to ensure the safety of health-care workers during this COVID-19 outbreak, as well as future outbreaks, especially in the initial stages where limited information about the transmission and infective potency of the virus is available.

Cal/OSHA Interim Guidance on Coronavirus for Health Care Facilities: Efficient Use of Respirator Supplies. *California OSHA, March 3, 2020.* https://www.dir.ca.gov/dosh/Use-of-Respirator-Supplies.html

> Under Cal/OSHA's Aerosol Transmissible Diseases (ATD) Standard (title 8 section 5199) a novel virus such as the coronavirus (SARS-CoV-2), the virus that causes COVID-19, is considered an airborne infectious disease and control measures such as the use of airborne infection isolation and respiratory protection are required.

WARNING: Surgical and other non-respirator face masks do not protect persons from airborne infectious disease and cannot be relied upon for novel pathogens. They do not prevent inhalation of virus particles because they do not seal to the person's face and are not tested to the filtration efficiencies of respirators. Surgical and face masks must not be used instead of an approved respirator such as an N95 mask.

Unmasked: Experts explain necessary respiratory protection for COVID-19. *Center for Infectious Disease Research and Policy, Feb 3, 2020.* http://www.cidrap.umn.edu/news-perspective/2020/02/unmasked-experts-explain-necessary-respiratory-protection-covid-19

Droplet or aerosol infection spread? Surgical mask or respirator? Asymptomatic transmission or symptomatic only?

These are the defining questions surrounding the person-to-person transmission of the novel coronavirus disease COVID-19 that have yet to be answered—or answered sufficiently—for US experts monitoring the disease. . .

Bruce Ribner, MD, medical director of the Serious Communicable Diseases Unit at Emory University Hospital, said the two masks serve very different functions. A surgical mask, or procedural mask, is meant to protect the environment from the wearer.

"It's meant to keep the surgeon's respiratory issues away from a patient," Ribner explained. A surgical mask does a good job of trapping large droplets, and some aerosol transmission, he said. Many of the masks being worn in China, though, are not designed for medical use or to any standards and so their effectiveness in trapping droplets is unknown.

A respirator, such as an N95, fits tighter to the face and is meant to help protect the wearer from inhaling infectious droplets in the environment.

"We don't really know how the coronavirus is being transmitted from person to person, because no one has done the NIOSH studies that simulate the cough big droplets that land 3 to 6 feet away from a person or the little droplets that can travel long distances and in air handling system," Ribner said. "So we have to use what we know about other coronaviruses and influenza when it comes to this disease."

Coronavirus Disease 2019 vs. the Flu. *Johns Hopkins - Lisa Lockerd Maragakis, M.D., M.P.H., Mar 12, 2020.* https://www.hopkinsmedicine.org/health/conditions-and-diseases/coronavirus/coronavirus-disease-2019-vs-the-flu

While both the flu and COVID-19 may be transmitted in similar ways (see the Similarities section above), there is also a possible difference: COVID-19 might be spread through the airborne route, meaning that tiny droplets remaining in the air could cause disease in others even after the ill person is no longer near.

Guidance for wearing and removing personal protective equipment in healthcare settings for the care of patients with suspected or confirmed COVID-19. Stockholm: ECDC; 2020
European Centre for Disease Prevention and Control, Feb. 2020.
https://www.ecdc.europa.eu/sites/default/files/documents/COVID-19-guidance-wearing-and-removing-personal-protective-equipment-healthcare-settings-updated.pdf

> ECDC suggests the use of class 2 or 3 filtering face-piece (FFP) respirators (FFP2 or FFP3) when assessing a suspected case or managing a confirmed case. A FFP3 respirator should be always used when performing aerosol-generating procedures.

Air, Surface Environmental, and Personal Protective Equipment Contamination by Severe Acute Respiratory Syndrome Coronavirus 2 (SARS-CoV-2) From a Symptomatic Patient
JAMA: Journal of the American Medical Association, March 4, 2020.
https://jamanetwork.com/journals/jama/fullarticle/2762692

> Air samples were negative despite the extent of environmental contamination. Swabs taken from the air exhaust outlets tested positive, suggesting that small virus-laden droplets may be displaced by airflows and deposited on equipment such as vents.

Checklist for Healthcare Facilities: Strategies for Optimizing the Supply of N95 Respirators during the COVID-19 Response. *Centers for Disease Control and Prevention, Reviewed March 5, 2020.*
https://www.cdc.gov/coronavirus/2019-ncov/hcp/checklist-n95-strategy.html

> Use surgical N95 respirators only for HCP who need protection from both airborne and fluid hazards (e.g., splashes, sprays). If needed but unavailable, use faceshield over standard N95 respirator.
>
> Use alternatives to N95 respirators where feasible (e.g., other disposable filtering facepiece respirators, elastomeric respirators with appropriate filters or cartridges, powered air purifying respirators).

Guidance on Preparing Workplaces for COVID-19.
https://www.osha.gov/Publications/OSHA3990.pdf

> Workers, including those who work within 6 feet of patients known to be, or suspected of being, infected with SARS-CoV-2 and those performing aerosol-generating procedures, need to use respirators:
>
> - National Institute for Occupational Safety and Health (NIOSH)-approved, N95 filtering facepiece respirators or better must be used in the context of a comprehensive, written respiratory protection program that includes fit-testing, training, and medical exams. See

OSHA's Respiratory Protection standard, 29 CFR 1910.134 at www.osha.gov/laws-regs/regulations/ standardnumber/1910/1910.134.

- When disposable N95 filtering facepiece respirators are not available, consider using other respirators that provide greater protection and improve worker comfort.

Guidance: High consequence infectious diseases (HCID). *Guidance and information about high consequence infectious diseases and their management in England*. ***Public Health England, , Updated January 16, 2020.*** https://www.gov.uk/guidance/high-consequence-infectious-diseases-hcid

Includes COVID-19 as airborne and as a high consequence infectious disease (HCID)

Position statement on COVID-19. *Canadian Federation of Nurses Unions (CFNU), March 12, 2020.* https://nursesunions.ca/position-statement-on-covid-19/

It is the position of the Canadian Federation of Nurses Unions that in the event of an outbreak of any new virus, all nurses and frontline health care workers at risk (based on an organizational infectious disease risk assessment) with the potential for exposure, and/or who are caring for a suspected or confirmed 2019 novel coronavirus patient, be protected using a fit-tested NIOSH-approved N-95 respirator at a minimum. The N-95 respirator is designed to protect against 95% of airborne particulates free of oil when tested against a 0.3-micron particle.

Furthermore, the CFNU recommends that any worker who will be exposed to aerosol-generating medical procedures must be protected and trained on use, and donning and doffing, of a powered air-purifying respirator (PAPR) and provided with full body protection.