Bulletin de veille émissions d'aérosols par l'appareil respiratoire humain N° 20 – Mai 2025

Objectifs : veille scientifique sur les émissions d'aérosols (gaz et particules) par l'appareil respiratoire humain (nez/bouche).

La validation des informations fournies (exactitude, fiabilité, pertinence par rapport aux principes de prévention, etc.) est du ressort des auteurs des articles signalés dans la veille. Les informations ne sont pas le reflet de la position de l'INRS. Les éléments issus de cette veille sont fournis sans garantie d'exhaustivité.

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Grandoni L, Méès L, Grosjean N, Leuzzi G, Monti P, Pelliccioni A, et al.

Joint size and velocity statistics of droplets exhaled while speaking, coughing, and breathing.

Phys Rev Fluids. 2025;10(4):28.

https://journals.aps.org/prfluids/abstract/10.1103/PhysRevFluids.10.043102

Human respiratory activities induce the exhalation of a cloud of air laden with droplets. These droplets can harbor pathogens and play a role in the transmission of infectious diseases. Experimentally determining the size and velocity of these droplets, along with the properties of the exhaled air cloud, is crucial for predicting their behavior postemission and developing effective strategies to mitigate infection transmission. Despite the efforts of the scientific community, there is still a lack of comprehensive characterization of exhaled droplet size distribution, with different studies yielding significantly varied results. Additionally, while several studies have measured airflow rate and velocity, droplet velocity is rarely measured and typically only within a limited size range. In this study, we use an enhanced version of the interferometric laser imaging for droplet sizing (ILIDS) technique to simultaneously measure the size and velocity of droplets exhaled by 23 volunteers during speaking, coughing, and breathing. This method allows us to detect droplet diameters as small as 2 mu m, extending the size range reported in the literature for the coupled measure of droplet size and velocity. The ILIDS technique addresses several issues encountered in previous studies by (i) directly measuring droplets larger than 20 mu m, (ii) conducting measurements close to the mouth to reduce droplet evaporation and dilution effects, and (iii) distinguishing between ambient air dust and exhaled droplets, eliminating the need for air filtration. Additionally, this study assesses the impact of protective masks on droplet size and velocity distributions, as well as the variability of the results among different volunteers and the same volunteers repeating the tests multiple times.

Groma V, Vörös M, Osán J, Madas BG, Farkas A, Kugler S, et al.

Characterization of respiratory particles released during continuous speech and its relation to mask performance.

Sci Rep. 2025;15(1):12.

https://www.nature.com/articles/s41598-025-97845-z.pdf

Revealing the physicochemical characteristics of exhaled particles is essential for understanding and efficiently mitigating the airborne spread of contagious human illnesses. Among the most pivotal factors, the number size distribution of emitted particles plays a crucial role when considering atmospheric dispersion. This study focuses on submicron particles emitted during speaking, with particular attention on the changes over time. Moreover, the real-world (source control) efficiency of three types of commonly used facemasks (FFP2, surgical and 2-layer cotton mask) under in vivo conditions was studied. A specially designed cabin ensured a controlled environment, where a set of experiments was conducted on 28 participants. Our findings revealed no substantial variability in the number size distribution among different individuals and pitches. However, the quantity of emitted particles varied significantly among individuals, with differences reaching nearly two orders of magnitude. Additionally, the emitted number of particles strongly depended on the speaking volume, decreasing as speech volume was reduced. Submicron particles originating from the lungs and upper airways exhibited a consistent bimodal pattern, with peaks around 300 nm and below 100 nm. FFP2 and surgery masks worn by the subjects demonstrated robust performance in real-world conditions characterized by 80% source control efficiency even for the smallest particle size ranges tested. At the same time, textile masks yielded less favourable results of 50-60% source control efficiency.

Wang J, John S, Tiina R, Sergey G, Michael Y, and Bunte J.

Aerosol emission, transmission, and mitigation from performing singing and wind instruments.

J Occup Environ Hyg.1-10.

https://doi.org/10.1080/15459624.2025.2491486

https://www.tandfonline.com/doi/pdf/10.1080/15459624.2025.2491486

During the COVID-19 pandemic, concerns about potential airborne virus transmission and exposure during musical performances were raised. Past studies suggest that aerosols are emitted from exhaling and talking with varying magnitudes. Meanwhile, little was known about aerosol emissions from singing and playing wind instruments. The objective of this study was to examine the spatial and temporal build-up of aerosol concentration in a typical studio room where singing, talking, and playing wind instruments are involved, to represent musical practicing and teaching scenarios at the University of Cincinnati College-Conservatory of Music (CCM). Four condensation particle counters were strategically placed throughout a room at various distances from the performer. Besides singing, musical professionals played seven instruments (clarinet, flute, French horn, saxophone, trombone, trumpet, and tuba). Two types of tests were conducted for each instrument: 10 min of playing and 10 min of combined playing and talking to mimic the teaching session. The results show that singing increased aerosol concentration to 3.9 × 103 cm−3 at the performing point, more than double the background (1.2 × 103 cm−3). Most wind instruments had minimal but detectable emission of aerosols over time, suggesting instruments could provide wall deposition for aerosols compared to singing. Particle concentrations decreased further from the performing point; however, they were still *detectable over the background level at 10 feet away. Use of a portable high-efficiency particulate air (HEPA) filtration reduced aerosol concentrations developed during musical performances to below background level. These findings suggest that there are risks associated with aerosolized transmission of infectious agents such as SARS-CoV-2 from musical performance if the performer is infected. Distancing beyond the 6 ft distancing recommendation and proper room and local ventilation combined with disinfecting procedures are needed to minimize the risk of exposure to infectious aerosols.*

Wu XK, Ling R, Wan XY, Ren HH, Jing XR, Feng GZ.

Study on the Impact of Ventilation Methods on Droplet Nuclei Transmission in Subway Carriages.

Appl Sci-Basel. 2025;15(9):28.

https://doi.org/10.3390/app15094919

The environment inside subway carriages is relatively enclosed, putting passengers at risk of respiratory infections during viral pandemics such as COVID-19 and SARS. This paper uses the Euler-Lagrange method to simulate the distribution of droplet nuclei produced by coughing under six different operating conditions in a subway carriage. The study investigates the impact of different air supply characteristics and ventilation methods, including mixed ventilation (MV), floor-supply, and ceiling-return ventilation (SFRC), on the distribution of droplets. These results indicate that under MV mode, the dispersion range of droplets during a patient's cough is the largest, with an average droplet suspension rate (SR) of up to 77% at the initial moment. The SFRC system markedly diminishes droplet dispersion, decreasing the SR by 35%. Upon increasing the air supply velocity to 0.8 m/s, the SR diminishes to 6%, the probability of particles attaining a 2 m social distance (PRP) declines by roughly 70%, and the weighted average contamination range (CR) of coughing particles reaching a safe social distance reduces by 33.5%. These results may act as a guide for the subsequent design and optimization of airflow patterns in carriages to reduce the risk of cross-infection.

Xiao LJ, Li KJ, Wei JJ, Cao ZX, Cheng Y, Gao NP.

Cough airflow dynamics and droplet transmission: Methods, characteristics, and implications.

Build Environ. 2025;278:19.

https://www.sciencedirect.com/science/article/pii/S036013232500455X?via%3Dihub

In recent years, airborne infectious diseases have posed a significant threat to global public health. As coughing serves as a primary pathway for the transmission of airborne pathogens between individuals, a thorough understanding of its airflow dynamics and droplet transport characteristics is essential for effectively preventing and controlling such diseases. This paper provides a comprehensive summary of recent advancements in the study of cough transmission, focusing on the physiological process of coughing, the classification and evaluation of research methods (i.e., theoretical analysis, experimental investigation, and numerical simulations), and the transmission characteristics of cough airflow and droplets. Current studies indicate that the 2-m social distancing rule is insufficient for effectively preventing airborne transmission. Specifically, schlieren imaging experiments and high-fidelity simulations have revealed the presence of separated vortex ring structures in cough-induced airflow, which exhibit faster propagation speeds and more directional movement relative to traditional jets, potentially becoming a major driver of higher infection risk. Additionally, the dispersion of respiratory droplets is highly dependent on ambient environmental conditions, with low humidity and elevated temperatures significantly prolonging their airborne suspension time. In practice, wearing masks has

been demonstrated to effectively block forward cough jets and reduce droplet transmission distances by more than half. However, the potential risk of secondary jets resulting from mask leakage necessitates further quantitative investigation. Finally, this review highlights existing challenges in the field and provides practical implications to mitigate airborne transmission risks, supporting the development of more effective public health policies.