Bulletin de veille émissions d'aérosols par l'appareil respiratoire humain N° 12 – Septembre 2024

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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Giri A, García-Sánchez C, Bluyssen PM.

Quantifying airborne transmission in ventilated settings: A review.

Build Environ. 2024;266:12.

https://doi.org/10.1016/j.buildenv.2024.112049

As mandatory masking and social distancing measures decrease post-COVID-19, the risk of airborne pathogen transmission in crowded indoor spaces remains a significant public health concern. The pandemic highlighted the critical role of indoor air quality and ventilation in mitigating the spread of infectious diseases, underscoring the urgent need to improve our understanding and prediction of indoor airflow to minimise airborne transmission. In this review, studies on airborne transmission in indoor settings were systematically reviewed to identify research gaps and recommend changes in approach. The analysis is categorised into indoor airflow, dynamics of infectious respiratory particles (IRPs), and investigation methodologies. Findings reveal that almost 40% of the reviewed literature does not specify the type of indoor setting, with only 3% focusing on restaurant environments. Additionally, indoor air conditions are typically assumed to be constant, and respiratory activities are often limited to coughing and breathing. The review identifies the challenge of replicating the complex behaviour of IRPs in experiments and the computational expense of predicting turbulent indoor flows. Recommendations for future research include: i) focusing on social settings like restaurants, ii) considering varying air temperatures and humidity, iii) examining speech-related respiratory flows, and iv) employing visual and accurate tools to investigate particle-laden airflow. These insights aim to enhance public health guidelines and building designs to reduce the risk of airborne diseases.

Saha S, Manna MK, Chakravarty A, Sarkar S, Mukhopadhyay A, Sen S.

Insights into the fluid dynamics of bioaerosol formation in a model respiratory tract.

Biomicrofluidics. 2024;18(5):14.

https://doi.org/10.1063/5.0219332

Bioaerosols produced within the respiratory system play an important role in respiratory disease transmission. These include infectious diseases such as common cold, influenza, tuberculosis, severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) among several others. It is, therefore, of immense interest to understand how bioaerosols are produced within the respiratory system. This has not been extensively investigated. The present study computationally investigates how bioaerosols are produced in a model respiratory tract due to hydrodynamic interactions between breathed air and a thin mucus layer, which lines the inner surface of the tract. It is observed that Kelvin-Helmholtz instability is established in the thin mucus layer due to associated fluid dynamics. This induces interfacial surface waves which fragment forming bioaerosols under certain conditions. A regime map is created-based on pertinent dimensionless parameters-to enable identification of such conditions. Analysis indicates that bioaerosols may be produced even under normal breathing conditions, contrary to expectations, depending on mucus rheology and thickness of the mucus layer. This is possible during medical conditions as well as during some treatment protocols. However, such bioaerosols are observed to be larger (similar to O (100) mu m) and are produced in less numbers (similar to 100), as compared to those produced under coughing conditions. Treatment protocols and therapeutic strategies may be suitably devised based on these findings.

Wu F, Fan ZQ, Dong H, Ma S, Xu RZ, Li HK.

A numerical investigation on the effects of passenger movement on droplet dispersion in a high-speed train compartment.

Phys Fluids. 2024;36(8):20.

https://doi.org/10.1063/5.0220131

Cough droplets pose significant risks to human respiratory health, potentially leading to severe infections in indoor environments. In the confined and densely populated high-speed train compartment, passenger movement is unavoidable and follows a fixed path. This movement impacts the designed airflow and, consequently, influences the dispersion of cough droplets. In this study, a validated computational fluid dynamics overset mesh method was adopted to implement passenger movement along the aisle, and the impact of passenger movement on droplet dispersion inside a high-speed train compartment was investigated. The results show that the wake flow generated by moving passengers can carry cough droplets along the direction of movement. The timing and speed of passenger movement play a pivotal role in the extent of droplet dispersion. Premature and delayed interactions with the droplet cloud diminish engagement due to inadequate and excessive dispersion, respectively. When a passenger begins walking at the 10th second, droplet transfer in the direction of movement peaks, reaching up to 4.9 times that of the stationary case in the area of seat 13A, with droplet transmissions extending up to 6 m. The walking speed affects the intensity of the wake flow. A walking speed of 1.0 m/s or higher results in the noticeable transmission of droplets in the direction of the walking passenger. These findings underscore the necessity for incorporating human movement dynamic in the development of ventilation strategies and public health guidelines to mitigate airborne transmission risks in enclosed public spaces.