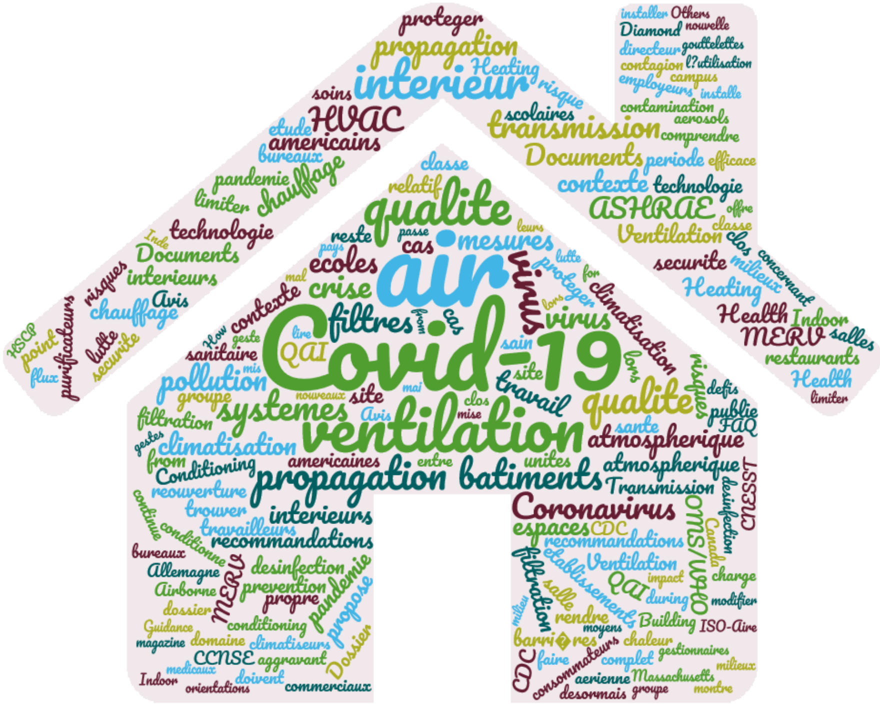

Bulletin de veille AéroCovid
N°126 – 26/11/2025

Objectif : *Air intérieur, ventilation, climatisation et propagation du Covid-19*

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 founis sans garantie d'exhaustivité.

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Google Scholar, Lens et WoS

Firoozi, A. A., Firoozi, A. A.

[Architectural Innovations for Infection Control in Healthcare Environments: Spatial Strategies, Material Selection, and Ventilation Systems.]

In: Transformative Design in Healthcare: Infection Control and Patient Well-being through Architectural Innovation.

Springer Nature Switzerland; 2026. 47-79 p.

This chapter examines the critical role of architectural design strategies in enhancing infection control within healthcare facilities, with a focus on spatial configurations, material innovations, and advanced ventilation systems. Recognizing the heightened significance of these factors in the context of global health crises, such as the COVID-19 pandemic, we explore how the deliberate design of space, the use of antimicrobial materials, and the implementation of sophisticated air quality management systems contribute to mitigating the spread of infectious diseases.

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Ko, S., Park, K. H., Lee, J.-Y., Kim, Y. B.

[Effect of Antimicrobial Filters on Microbial Reduction in an Underground Subway Station.]

Aerosol and Air Quality Research, Vol. **25** n°(11), (2025), 63 p.

Particulate matter (PM) contains ambient bioaerosols and pathogenic microorganisms, which may exacerbate the risk of infectious respiratory health issues upon inhalation. Subway stations, where passengers are crowded in enclosed spaces with limited ventilation, are contaminated with microorganism-containing PM that can potentially contribute to the spread of infectious diseases.

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Foat, T., Higgins, B., Abbs, S., Maishman, T., Gray, L., Kelsey, A., *et al.*

[The effect of the ventilation rate on exposure to SARS-CoV-2 in a room with mixing ventilation.]

Indoor Environments, Vol. **2** n°(4), (2025)

Throughout the COVID-19 pandemic, guidance was to increase ventilation as a way to reduce the risk of transmission. While the benefits of ventilation, when it is used to supply fresh air or to remove virus laden air from a space, is indisputable, we show that in some circumstances it can also enhance the transport of virus from the infected to the uninfected. We used computational fluid dynamics to study exposure to SARS-CoV-2 from a person coughing, in a mechanically ventilated room with mixing ventilation, over short time periods. Models were run with three ventilation rates and two definitions for how the virus is distributed within different size droplets. These showed that up to 3 m from the person (the largest distance assessed in this work), the median exposure had a statistically significant increase as the ventilation rate was increased. For example, as the room air change rate was increased from $0.5h^{-1}$ to $5h^{-1}$, the median exposure after 5 min increased by a factor of 7 or 134 depending on the model settings specified. The models showed that the negative impact of mixing ventilation on exposure (i.e. increased ventilation rate leading to increased exposure) reduced with time, which brings the predictions in line with the general guidance. Ventilation measures are therefore most likely to have the greatest impact on reducing transmission in spaces where people spend longer periods of time.

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Mirzazade Akbarpoor, A., Salimi, M., Rasouli, E., Shahbakhti, M., Nouri, A.

An energy-efficient heat-driven technology for airborne pathogen inactivation: integration of two-stage HVAC filtration with thermal disinfection.

Applied Thermal Engineering, Vol. **284**, (2026)

Air filters are widely used in HVAC systems to control transmission of airborne microorganisms. However, their application is associated with frequent maintenance, accumulation and release of bioaerosols. To address these issues, the present study proposes a novel thermal disinfection approach integrated into a two-stage filtration system comprising a MERV 8 pre-filter and either MERV 11 or MERV 13 main filter. To maintain continuous airflow, the system employs two side-by-side units with the same filters sequentially disinfected via forced convection heating while maintaining continuous filtration. A closed-loop aerosol wind tunnel, based on the ASHRAE 52.2 standard, was implemented to evaluate the filtration efficiency and pressure drop of the system at various configurations and operating modes, including normal operation (both units open) and a disinfection period (one unit closed). Moreover, a heat transfer setup was developed to measure the required time and energy consumption for meeting the literature-based thermal inactivation criteria (10 min exposure to 65 °C) across three inter-filter distances. A comparison of the theoretical correlation for estimating the overall filtration efficiency of multi-stage systems with experimental results confirmed good agreement in normal operation, with some deviations during the disinfection period due to flow redistribution. Furthermore, changing the inter-filter distance has relatively minor impacts on the overall filtration efficiency and pressure drop compared to its effect on the disinfection process. Consequently, the energy performance of the disinfection system should be considered the primary criterion when determining the optimal distance between the pre-filter and the main filter.

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De Oliveira Nunes, É., Barrera, A. I. P., Peralta, L. M. R., Sampaio, P. N. M., Astudillo, F. L. C.

Fuzzy risk assessment system for indoor air quality and respiratory disease prevention.

IAES International Journal of Artificial Intelligence, Vol. **14** n°(5), (2025), 3693-3701 p.

This study addresses the evaluation of indoor air quality, with a focus on mitigating respiratory diseases and sick building syndrome (SBS). Recognizing that different pollutants exhibit variable behavior depending on environmental factors and human activity, the objective was to develop a fuzzy logic-based classification system that integrates environmental variables such as temperature, relative humidity, and pollutant concentrations–particulate matter (PM10, PM2.5), carbon dioxide (CO_2), and total volatile organic compound (TVOC)-into a unified model. The method involved defining risk levels as low, moderate, high, and very high, and implementing 56 fuzzy rules to dynamically and accurately categorize these risks, based on measurements taken between 2022 and 2024 in the states of Morelos and Puebla under various relative humidity and temperature scenarios. The analysis of the results demonstrated robust system performance, with an overall accuracy of 94.08%, but also revealed challenges in distinguishing between adjacent risk classes. This research contributes to a better understanding of the complex impacts of air quality on health and reinforces efforts to mitigate respiratory problems and SBS in densely populated indoor environments.

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Ali, A. R. I., Akil, N. A., Hassan, T.

Modeling the Transmission Dynamics of Airborne Infectious Diseases Using a Hybrid SEIR and Wells–Riley Framework for Risk Assessment and Control Strategy Evaluation.

Indoor Air, Vol. **2025** n°(1), (2025)

Understanding the transmission dynamics of infectious diseases is crucial for developing effective mitigation strategies. This study employs the airborne disease model combined with the SEIR epidemic model to analyze disease spread in enclosed environments while accounting for key epidemiological and environmental factors. The model incorporates parameters such as infection rate (?), incubation rate (α), recovery rate (?), air exchange rates (ACH), quanta generation rate (q), room volume (V), and pulmonary ventilation rate (p), alongside varying population sizes (N). By simulating different scenarios over a 50-day period, we assess the impact of initial infection conditions, recovery rates, and effective contact rates on epidemic progression. Our findings highlight the significant influence of ventilation and contact rates on disease spread, demonstrating that higher air exchange rates can mitigate transmission risks. The results provide critical insights into optimizing infection control strategies, particularly in indoor settings, by emphasizing the importance of air change rate, early interventions, and limiting contact rates.

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Hatif, I. H., Wong, K. Y., Al-Rikabi, I. J., Tan, H., Kek, H. Y., Hawas, M. N., *et al.*

A multi-criteria CFD investigation of mixing, displacement, and stratum ventilation: Trade-offs between energy efficiency, thermal comfort, and airborne infection control.

Building and Environment, Vol. **289**, (2026)

The selection of ventilation systems for indoor spaces involves critical trade-offs between energy efficiency, thermal comfort, and airborne infection control. This study employs a high-fidelity Computational Fluid Dynamics (CFD) model to holistically evaluate mixing (MV), displacement (DV), and stratum ventilation (SV). Using an Eulerian–Lagrangian framework with an RNG k–ε turbulence model, the research simulates airflow and the transport of exhaled droplet nuclei (1–15 µm) in a room with two breathing manikins. Nine test cases explore variations in occupant posture and diffuser alignment. Performance is assessed using the Energy Utilization Coefficient (EUC) for efficiency; Predicted Mean Vote (PMV) and draft rate for thermal comfort; and intake fraction, particle removal efficiency, and surface deposition for infection risk. Results demonstrate that no single system is universally superior. DV achieves the highest energy performance (EUC up to 1.42) and particle removal (>60 %), but its stratification can increase exposure in mixed postures. MV ensures uniform comfort but sustains higher airborne exposure and is the least efficient. SV is highly configuration-dependent, offering targeted protection only with precise diffuser orientation. Each system produces a distinct deposition signature, directly informing surface cleaning protocols. To resolve these trade-offs, a Multi-Criteria Decision Analysis (MCDA) framework is developed to quantitatively select the optimal system based on specific priorities like pandemic preparedness or energy savings. This work concludes that adaptive ventilation design is essential, with the MCDA providing a critical tool for designing resilient, health-conscious, and energy-smart buildings.

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Mody, L., Advani, S. D., Ashraf, M. S., Bartlett, A. H., Bradley, S. F., Burdsall, D. P., *et al.*

Multisociety guidance for infection prevention and control in nursing homes.

Infection Control & Hospital Epidemiology, Vol. **46** n°(11), (2025), 1069-1096 p.

This multisociety guidance was endorsed by SHEA, APIC, IDSA, PALTmed, and AGS. It provides recommendations for infection prevention and control (IPC) in the context of the complexity of nursing home care in the United States: increased medical acuity of residents, the spread of multidrug-resistant organisms, and the threat of emerging pathogens. Recommendations and implementation suggestions address IPC leadership, staffing, and resources, healthcare personnel and residents‘ adherence to precautions and effective hand hygiene, outbreak preparedness, training, occupational health, cleaning and disinfection in the care environment, and the involvement of IPC in the facility. The guidance also addresses the challenges of maintaining a home-like care space while sustaining necessary IPC measures. The guidance covers the role of regulatory bodies like the Centers for Medicare and Medicaid Services (CMS) and recommendations from the Centers for Disease Control and Prevention (CDC). It should serve as a resource for IPC program leaders in nursing homes who are aiming to enhance infection prevention efforts.

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Nikoopayan Tak, M. S., Mousavi, E.

Ventilation and Infection Control in Healthcare Facilities: A Post-COVID-19 Literature Synthesis.

Air, Vol. **3** n°(4), (2025), 30 p.

The COVID-19 pandemic has reshaped the global understanding of airborne disease transmission, particularly in healthcare environments. This literature review examines how building ventilation and indoor air quality strategies have evolved in response to SARS-CoV-2, with a specific focus on healthcare settings. A systematic review of 163 post-pandemic studies, alongside a selective review of pre-COVID-19 literature, was conducted to assess how scientific knowledge, practical recommendations, and HVAC-related interventions have changed. The review categorizes studies across detection methods, simulation models, observational analyses, and policy recommendations, drawing attention to novel findings and evidence-supported practices. While the body of research reaffirms the critical role of ventilation, many recommendations remain unevaluated through empirical methods. This study identifies the gaps in evidence and highlights the most impactful advances that can inform future design, maintenance, and operational protocols in healthcare facilities to mitigate airborne infection risks.

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