



Bulletin de veille Maladies aéroportées

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Objectif : *Air intérieur, ventilation, climatisation et propagation des maladies aéroportées*

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Google Scholar, Lens et WoS

Gaufrès, O., Leclerc, Q. J., Derdevet, J., Shirreff, G., Kernéis, S., Opatowski, L., *et al.*

[Accounting for the long-distance transmission route: An epidemiological model of airborne disease transmission in hospitals.](#)

PLOS Computational Biology, Vol. **22** n°(8), (2026)

We introduce a novel epidemiological model of nosocomial outbreaks of respiratory infections that integrates short- and long-range transmission routes with close-proximity interactions and individual movements between ward rooms. Using simulations, we illustrate how the relative importance of the two transmission routes affects the dynamics of nosocomial transmission and what the implications are for the design of infection prevention interventions that should remain effective, regardless of the dominant transmission route or the ward organization. We showed that HCWs are more affected than patients, constituting a major source of infection. Breaking transmission between HCWs can effectively reduce the infection risk in patients, for example by combining mask wearing during interactions with patients with ventilation in break rooms. Such strategies can offer an effective alternative to universal masking.

Pisaniello, D., Bird, C., Nguyen, L., Chambers, P.

[Airborne fungal and particle mitigation in HVAC systems – An evaluation trial in a coastal healthcare facility.](#)

Journal of Hospital Infection, (2026)

Summary Exposure to airborne fungi can lead to serious health outcomes for vulnerable hospital patients, especially where the facility is situated in a humid environment. Moist conditions can lead to fungal colonisation within air conditioning systems (HVAC), particularly centralised ducted systems such as those typical within healthcare applications. Advanced air cleaning systems can potentially provide both filtration of airborne fungi and decontamination. The primary aim of this study was to compare the performance of a traditional mechanical filter with an advanced air cleaner with multiple modes of bioaerosol mitigation (AMAC). An intervention trial was conducted in a healthcare facility in a semi-tropical location where there is also the potential for seawater aerosol impaction adding to moisture load. Airborne fungi and size-resolved airborne particles were monitored at various points in the air handling unit (AHU) and supply ducts, before and after the installation of the new air cleaner (first intervention). Filter cartridge air sampling coupled with light microscopy were used to determine airborne fungal concentrations and broad taxonomic profiles. Common fungal types found were *Cladosporium*, *Aureobasidium*, *Aspergillus*- and *Penicillium*-like structures, often associated with fungal growth in HVAC systems. Post AMAC installation, filtration efficiency rose from 86.7 to 99.9%. However, total airborne fungal structure concentrations (TAFSC) increased as air left the AHU (rising from 1 to 22 fs/m³) and further at the Nurse Unit Manager's office supply air register (NUMSAR, 387 fs/m³). This was consistent with inspection and surface testing of duct contamination downstream of the AHU filter. Following subsequent duct replacement and cleaning of contaminated surfaces (second intervention), TAFSC at the NUMSAR were lowered further to 171 fs/m³. Concentrations of *Aspergillus*/*Penicillium* spp. reduced significantly from 151 to <1 fs/m³ and *Cladosporium* spp. levels fell from 84 to <1 fs/m³. The findings suggested an original potential source and/or temporary reservoir of key dampness-related genera in the HVAC system. Real time monitoring of undifferentiated airborne particle concentrations followed a similar trend to fungal concentrations. Unlike the mechanical filter, the AMAC performance appeared to be independent of relative humidity within the observed range.

Healthcare facilities, especially in locations subject to elevated humidity or high rainfall events, may consider high performance air cleaning as a key strategy for reducing health risks in healthcare settings.

Wlazło, M., Malec, A., Majerek, D., Trnik, A., Zubrzycki, J., Suchorab, Z.

[Estimation of ethylbenzene, cumene and limonene concentrations using gas sensor arrays and machine learning techniques.](#)

Advances in Science and Technology Research Journal, Vol. **20** n°(10), (2026), 424–434 p.

The objective of this study is to estimate the concentration of selected microbial volatile organic compounds (mVOCs), namely ethylbenzene, cumene, and limonene, using multi-sensor gas arrays combined with statistical regression and machine learning methods. Two sensor array configurations were employed: metal oxide semiconductor (MOS) sensors and electrochemical (EC) sensors. Measurements were conducted under both field conditions, in buildings with varying degrees of microbial contamination, and laboratory conditions using fungal cultures. The results demonstrate that sensor arrays, combined with models such as Support Vector Machines (SVM) and Multi-Layer Perceptron (MLP), can effectively estimate concentrations of mVOCs with different physicochemical properties and concentration ranges. The findings confirm the potential of low-cost sensor systems as an alternative to conventional chromatographic techniques for indoor air quality monitoring.

Morel, J., Lenoir, J.-M., Ménard, C., Le Hir, S., Bourgeay, C., Zambujo, T., *et al.*

[Evaluation of Two Cyclonic Bioaerosol Samplers for Hospital Air Monitoring in a Calibrated Test Chamber Integrating Aerodynamics and Biological Endpoints.](#)

Indoor Air, Vol. **2026** n°(1), (2026), 17 p.

Indoor air quality (IAQ) monitoring in hospital settings is critical to limit airborne transmission of pathogens to vulnerable patients and healthcare workers. However, bioaerosol sampling remains challenging because of the diversity of devices and methodologies and the very low airborne concentration of pathogens in real-world settings, especially when infectivity-based measurements, are required for assessing transmission risk. In the absence of harmonized evaluation procedures, it remains difficult to select sampling strategies that are both reliable and fit for purpose. In this study, we developed a controlled and reproducible experimental framework for the evaluation of bioaerosol samplers under conditions relevant to hospital air monitoring. Two widely used cyclonic bioaerosol samplers, Coriolis+ and Coriolis Compact, were assessed in a calibrated 20 m³ test chamber generating stable atmospheres containing infectious SARS-CoV-2, *Staphylococcus aureus*, or *Aspergillus fumigatus* at different concentration levels. Samplers' performance was evaluated using complementary molecular and viability-based endpoints and was combined with computational fluid dynamics (CFD) and experimental airflow measurements to characterize airflow dynamics. Our results demonstrated that samplers' performance strongly depended on the biological endpoint and microorganism considered. For SARS-CoV-2, the two devices showed comparable recovery of infectious virus, at intermediate and high concentrations, but neither detected infectious particles at the lowest level. In contrast, Coriolis+ achieved near-complete recovery of viral genomes, whereas Coriolis Compact recovered only a fraction of the expected signal. Regarding *S. aureus* and *A. fumigatus*, Coriolis+ achieved superior recovery of viable microorganisms, whereas Coriolis Compact generally yielded higher genomic recovery at moderate and high concentrations. CFD analyses further showed that local airflow conditions and sampler-specific flow patterns, particularly for the higher flow Coriolis+, are critical for interpreting biological recovery and for defining appropriate placement and operating modes. Overall, this study demonstrates that bioaerosol sampler evaluation must jointly consider molecular, microbiological, and aerodynamic dimensions. The proposed framework offers a basis for more standardized and reproducible performance assessment of bioaerosol samplers and supports evidence-based selection of air monitoring strategies in healthcare environments.

Elsarraj, M., Dunne, M., Rannard, D., Mahmoudi, Y., Keshmiri, A.

Experimental validation of a CFD model for an ultra-clean ventilation system in a UK operating theatre under HTM-03-01.

Building and Environment, Vol. **305**, (2026)

Ultra-clean ventilation (UCV) systems are used in operating theatres to reduce airborne contamination associated with surgical site infection risk by supplying downward unidirectional airflow over the surgical zone. In the UK, UCV commissioning is assessed against Health Technical Memorandum (HTM) 03–01 Part A (2021), with acceptance criteria defined for airflow velocity and particle entrainment. However, these tests rely on discrete probe locations and limited sampling heights, providing limited insight into the three-dimensional flow structures that govern velocity distribution and particle transport beneath UCV canopies. This study combines full-scale HTM-compliant measurements with computational fluid dynamics (CFD) to examine the relationship between HTM acceptance criteria and underlying airflow behaviour. Experimental testing was conducted beneath a Howorth UCV canopy in a UK operating theatre, including velocity mapping at 1 m and 2 m above floor level and particle entrainment testing using 0.3 µm aerosols released at prescribed HTM challenge positions. A CFD model was developed to reproduce the same commissioning conditions and simulate three-dimensional airflow and Lagrangian particle transport. The model showed close agreement with measured velocity data and reproduced particle penetration trends across the HTM challenge positions within experimental uncertainty. The UCV system satisfied all HTM acceptance criteria. This study demonstrates how validated CFD can reveal flow mechanisms underpinning commissioning metrics and provides a reproducible HTM-aligned benchmark dataset for future UCV model development and performance assessment.

Lizotte, T.

Exploitation des filtres à air comme stratégie pour la surveillance des bioaérosols.

Université de Laval, Québec. Thèse 2026

Les bioaérosols circulant dans les bâtiments influencent la qualité de l'air intérieur (QAI) et représentent un enjeu croissant de santé publique. Afin de limiter leurs impacts et de comprendre leur nature, il apparaît essentiel de sonder ce qui circule dans l'air intérieur à des fins de surveillance. Cependant, les méthodes conventionnelles d'échantillonnage de l'air reposent sur des prélèvements ponctuels réalisés sur de courtes périodes, ce qui constitue une limite compte tenu de la forte variabilité spatiale et temporelle des bioaérosols. Ainsi, cette étude visait à utiliser les filtres usagés de systèmes de ventilation intérieur, dont les systèmes de chauffage, ventilation et climatisation (CVC) et les unités portatives de filtration (UPFs), comme matrices intégratrices des bioaérosols. L'hypothèse principale reposait sur le fait que l'accumulation progressive des particules trappées dans ces filtres pourrait offrir une caractérisation plus fidèle des bioaérosols intérieurs. Pour y répondre, le projet s'articulait autour de deux objectifs principaux. Premièrement, l'optimisation et la validation de la récupération de la biomasse microbienne (ADN bactérien et fongique) collectée par les filtres. Deuxièmement, évaluer l'applicabilité de cet ADN avec des analyses en aval, notamment la caractérisation de la biodiversité et le criblage des gènes de résistance aux antibiotiques (GRAs). La comparaison de quatre méthodes de récupération de la biomasse microbienne à partir des médias filtrants n'a révélé aucune différence majeure en ce qui concerne le rendement et la reproductibilité. Toutefois, l'utilisation de la plaque agitatrice s'est distinguée par sa simplicité d'emploi et son potentiel pour des applications à haut débit. L'absence de différence majeure entre les méthodes suggère une certaine flexibilité, limitant le risque de biais associés au choix du protocole d'extraction. Par ailleurs, l'analyse de la diversité et la quantification des GRAs à partir de l'ADN extrait des filtres ont permis de discriminer les environnements étudiés (hôpitaux versus avion) à partir de profils distincts. Dans l'ensemble, les résultats montrent que les filtres de ventilation constituent un outil pertinent et prometteur

pour sonder les bioaérosols et compléter les méthodes traditionnelles d'échantillonnage. Malgré leur caractère semi-quantitatif et certaines limites liées aux conditions réelles d'utilisation, ils semblent offrir une vision cumulative et intégrée de la charge microbienne dans les environnements bâtis.

Mirzazade Akbarpoor, A., Salimi, M., Shabani, A., Shahbakhti, M., Nouri, A.

[Natural-Convection-Based thermal disinfection of air Filters: Performance and energy evaluation in HVAC systems.](#)

Thermal Science and Engineering Progress, Vol. **78**, (2026)

Bioaerosols can be effectively entrapped within the porous structure of HVAC filters. Nonetheless, conventional filters do not inactivate accumulated/multiplied microorganisms on the filter media, increasing the risk of pathogen release downstream. To address this challenge, this study presents a fanless, energy-efficient technology for the thermal disinfection of filters. During disinfection, buoyancy-driven flow transfers heat to the filter, eliminating the need for recirculating fans and the reliability and maintenance concerns associated with elevated-temperature operation. The system consists of two identical parallel units, each containing a MERV 11 filter and tubular heating elements. To reduce the temperature non-uniformity inherent to natural convection, three system configurations were experimentally investigated over a range of heater set-point temperatures. The configurations differed in filter housing design and the arrangement of heating elements. A literature-based thermal criterion of 65 °C for 10 min was used to determine the required disinfection time and energy. Moreover, the filtration performance and flow resistance of the system were evaluated using an ASHRAE 52.2-compliant wind tunnel at three air velocities (0.5, 0.75, and 1 m/s). The results revealed that the optimal configuration substantially reduces thermal non-uniformity across the filter, enabling the entire filter to reach the disinfection condition within approximately 35 min, with an energy demand of 0.10 kWh. Furthermore, flow characterization tests indicated that the presence of heating elements and duct modifications does not significantly affect filtration efficiency and results in a minor increase in pressure drop during normal filtration operation.

Shao, X., Yang, Y., Zhu, H., Liu, Y., Liu, Y., Fan, H.

[Non-uniform indoor contamination characteristics of duct-released contaminants through return air recirculation.](#)

Journal of Building Engineering, Vol. **132**, (2026)

Return air recirculation greatly worsens indoor recontamination once hazardous substance is released from ventilation ducts, threatening occupant health. Existing studies oversimplify contaminant mixing and fail to adequately quantify how recirculation interacts with non-uniform contaminant distributions in ducts and rooms to alter supply air quality, within-room contamination and cross-room spread. This study aims to fill this gap by revealing such coupled contamination mechanisms. An accessibility-index-based linear superposition model is used to examine how air handling unit (AHU)-room layouts, duct contaminant source positions, air distribution modes and ventilation capacity shape contaminant spread, with 100% fresh air as the reference case. Results show air recirculation triggers secondary contamination in supply air and occupied spaces. Non-uniform indoor contaminant levels create large supply air concentration disparities among different AHUs. Low-pollution indoor subareas record a maximum concentration ratio (Cr) of 11.5, and clean rooms can accumulate contaminants up to 54.8% of concentrations in heavily polluted rooms. Contaminants released from main supply ducts produce highly uneven supply air concentrations across rooms. Recirculation also creates measurable supply/return air concentration differences between two typical mixed ventilation layouts. Boosting ventilation capacity cuts indoor contamination levels by as much as 61.5%. This work illuminates contaminant transport driven by return air recirculation and offers practical references for indoor pollution control.

Gaillard, A., Ding, E., De Korne, C. M., Bluysen, P. M., Bonn, D.

[The potential of mobile air cleaners for particle removal in school classrooms: A field study.](#)

Indoor and Built Environment, (2026)

In this field study, we assess the potential of using mobile air cleaners (MACs) to reduce the concentration of respiratory particles, responsible for the cross-infection of respiratory diseases, in school classrooms. We used three types of MAC which were found to yield comparably good performances in lab-controlled particle decay tests aimed at measuring their clean air delivery rates (CADR). The purpose of this field study is to evaluate the efficiency of these carefully pre-selected MACs in actual classrooms during typical teaching activities, hence determining whether such high-CADR devices are actually suitable in such real-life situations. The particle and CO₂ concentrations were measured continuously over 6 weeks in 15 classrooms of five primary schools in the Netherlands, three classrooms per school, each equipped with one of the three types of MACs which were turned ON either during the first or the last 3 weeks of the study and turned OFF otherwise. We found that the use of these MACs, with optimum number of devices, location and fan level settings, leads to a systematic reduction in the overall particle concentrations, typically by a factor 2.

Pérez, A. J., Peñaloza-Gutiérrez, J., Rahman, T., Tejada-Martínez, A. E.

[Residence Time Distribution Analysis of Patient-Emitted Air in a Mock Hospital Isolation Room: A CFD Study.](#)

Research Square, (2026)

Air changes per hour (ACH) is the primary metric specifying ventilation in hospital isolation rooms, yet presumes the room behaves as a perfectly mixed reactor. However, short-circuiting pathways and recirculation (dead) zones make the removal of patient-discharged air strongly dependent on airflow topology. This study applies residence time distribution (RTD) analysis to quantify that dependence. Computational fluid dynamics (CFD) simulations of a mock hospital isolation room were performed at 6 and 12 ACH in two exhaust configurations: a normal design (NMD), with the exhaust displaced from the patient, and a short-circuiting design (SCD), preserving a direct patient-to-exhaust pathway that acts as source capture. A passive tracer pulse released at the patient mouth was tracked to the exhaust, giving the breakthrough time, the 10–90% removal spread, and the mean residence time, each normalized by the theoretical mean residence time. At 6 ACH both configurations stayed close to the perfectly mixed prediction. At 12 ACH they diverged sharply: SCD reduced normalized breakthrough time from 0.311 to 0.0283, narrowed normalized spread from 2.29 to 1.64, shortened mean residence time from 6.23 to 2.64 min, and cut long-term healthcare worker exposure from 1.27 to 0.42 times the perfectly mixed value. Doubling ACH reduced that exposure by 75% under SCD but only 39% under NMD, and shortened early exposure only where the direct pathway was preserved. ACH specifies how much air is supplied, not where it goes; RTD metrics capture that difference and are obtainable from CFD or physical tracer testing.

Kanagalingam, S., An, H., Fong, Y. M., Soh, C. B., Chien, S.-C., Wang, P. C., *et al.*

[Thermal-optical coupling and germicidal assessment of in-duct UV-C systems.](#)

J Build Des Environ, Vol. 4 n°(3), (2026)

Ultraviolet germicidal irradiation (UVGI) is widely applied in heating, ventilation, and air-conditioning systems to reduce airborne pathogen transmission, yet its effectiveness depends on airflow-driven changes in lamp thermal condition and particle residence time. This study experimentally characterises the coupled thermal and optical performance of 95 W and 60 W low-pressure mercury ultraviolet-C (UV-C) lamps and uses the measured irradiance fields for comparative germicidal assessment. Air velocities of 1.1–2.5 m/s and ambient temperatures of 14–22 °C were varied to quantify their effects on lamp-surface temperature and 254 nm output. The 95 W lamp maintained near-maximum output over a broader operating range, whereas the 60 W lamp was more sensitive to convective cooling. Reynolds and Rayleigh numbers ranged

from approximately 1.24×10^3 to 2.88×10^3 and 7.2×10^3 to 1.3×10^4 , respectively, while the convection-to-radiation heat-loss ratio increased with airflow velocity. Mean modelled ultraviolet (UV) dose increased with lamp count and decreased with airflow velocity. At 1.1 m/s, six-lamp arrays delivered mean modelled doses of approximately 191 J/m² for the 95 W lamps and 146 J/m² for the 60 W lamps. Published UV susceptibility constants produced calculated reductions exceeding 6 log for susceptible viral and bacterial species, whereas the calculated reductions for *Aspergillus* spores ranged from below 0.05 to approximately 0.4 log. These microbial reductions were calculated from the measured irradiance fields and published susceptibility constants and were not experimentally validated using bioaerosols. The results provide a measurement-informed basis for comparing lamp power, airflow condition, and lamp arrangement in in-duct UVGI systems.
