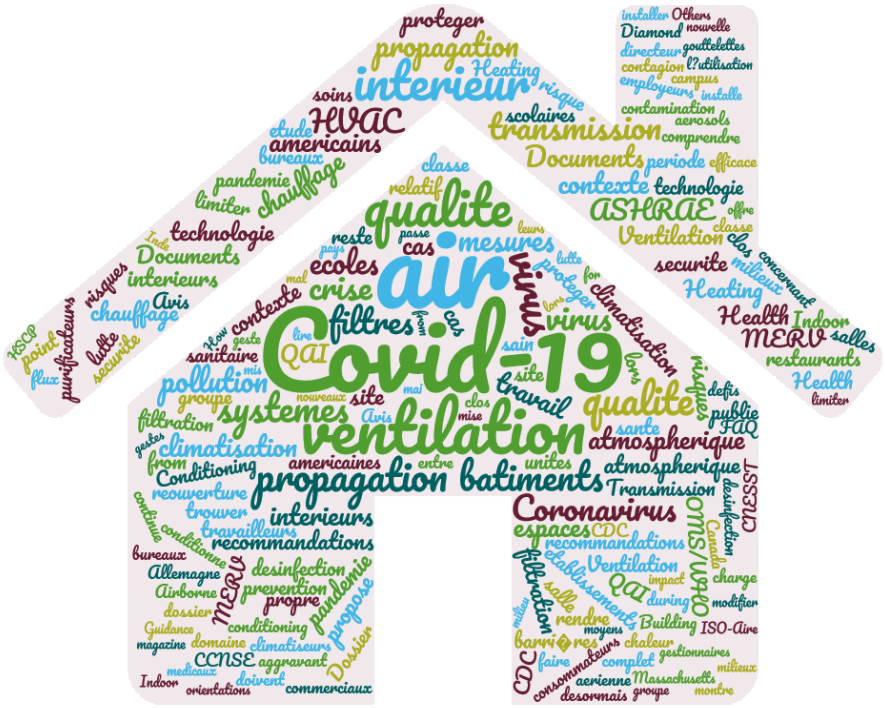

Bulletin de veille AéroCovid
N°137 – 06/05/2026

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

Utami, S. S., Baskara, S. A., Tenggara, A. P.

Air Movement Simulation and a Walkthrough Survey to Simply Evaluate the Air Quality of a Dental Hospital.

Innovation in Green Building and Infrastructure

The use of air conditioning system in dental hospitals creates a higher risk of airborne infection due to the amount of aerosol release form the patient's mouth. Air suction positioned close to the patient seat are necessarily. The effectiveness of the system in reducing the airborne infection risk depends on how the room ventilation for fresh air exchange works. A walkthrough survey was conducted in the RSGM UMY dental hospital. The objective data, which consists of temperature, humidity, airflow, and CO2 levels, were collected using a handheld measuring instrument. Rooms with mechanical ventilation systems are in good indoor air comfort with an average temperature of 26 ℃ and average humidity of 71% based on the standards. However, the effectiveness of the ventilation system in reducing airborne infection risk is not yet measurable. This paper also proposed using computational fluid dynamic simulation as a preliminary technique following the walkthrough survey. The air velocity and the particle movement created by the ventilation system was evaluated.

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Prawitasari, D. A., Isnikarita, R., Lathifa, A. N., Rahmawati, S.

Analysis of the Abundance and Morphological Characteristics of Airborne Microorganisms in an Environmental Engineering Laboratory.

Bioscientist : Jurnal Ilmiah Biologi, Vol. **14** n°(1), (2026), 269-282 p.

This study aimed to analyze the abundance and morphology of airborne microorganisms in the Environmental Engineering Laboratory and to relate their distribution to differences in room conditions and sampling time. Sampling was conducted in two rooms, Room A and Room B, during the morning and afternoon using a microbiological air sampler with Nutrient Agar (NA), Potato Dextrose Agar (PDA), and Plate Count Agar (PCA) media. Statistical analysis showed that room conditions strongly influenced the distribution of airborne microorganisms and were also affected by indoor airflow patterns. The findings revealed higher concentrations in Room B than in Room A (morning averages: 60.75 vs. 23.75 CFU/m^3; afternoon averages: 44.5 vs. 24.25 CFU/m^3), with a statistically significant difference (Mann–Whitney, p-value < 0.05). These results indicate that optimizing airflow direction, scheduling cleaning activities, and conducting routine bioaerosol monitoring are necessary as indicators of control performance. Morphological analysis identified Gram-positive bacteria such as Staphylococcus and Bacillus, as well as fungi such as Aspergillus and Trichoderma, all of which may affect health and indoor air quality. This study underscores the importance of laboratory indoor air quality management in reducing health risks associated with airborne microorganisms.

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Yang, Z.

Badanie zastosowania nowoczesnych nanomateriałów w projektowaniu hoteli turystycznych z wykorzystaniem ich funkcji antybakteryjnych, energooszczędnych oraz oczyszczających.

(Study on the application of new nanomaterials in tourismhotel designtaking antibacterial, energy-saving and purificationfunctions as examples).

Przem Chem, (2026)

Antibacterial, energy-saving, and air purifn. performances of 3 new nanomaterials (nano-TiO2 , nano-Ag-NPs, and nano-aerogel) used in key hotel areas were evaluated. A simulation model of hotel indoor environment and energy consumption was established using DeST-h soft- ware and combined with laboratory tests to quantify the nanomaterials. The nano-Ag-NPs/TiO2 composite coating showed a bacteriostatic rate of 99.2% against common hotel pathogens (E. coli and S. aureus). The nano-aerogel insulated glass reduced the annual total energy consumption of standard guest rooms by 35.7%. The nano-TiO2 photocatalytic coating removed 82.5% of formaldehyde within 8 h and was moreefficient than the activated C.

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Sabine, M.

Cost–benefit analysis of far-UVC lamps for reducing indoor infection transmission in Switzerland and Germany: Insights from the CERN Airborne Model for Indoor Risk Assessment (CAiMIRA).

GHES, Vol. **4** n°(1), (2026), 125-144 p.

Far-UVC light (wavelengths 207–230 nm) can be used directly overhead and has germicidal capabilities to improve indoor air quality. This study evaluates the cost–benefit analysis of implementing far-UVC devices in various settings in Switzerland and Germany. To our knowledge, this is the first study to model the feasibility of direct-acting UVC light in occupied settings, diverging from the consensus on the use of upper-room germicidal UVA and UVB systems. We used the CERN Airborne Model for Indoor Risk Assessment (CAiMIRA) to model infection risk reduction in restaurants, offices, and waiting rooms, considering factors such as room size, occupancy, and ventilation rates. Three scenarios were analysed: a normal winter (22 weeks), a COVID-19-like pandemic (4-week wave), and a severe pandemic (8-week wave). Avoided infections were translated into healthcare, economic, and quality-adjusted life years (QALY) metrics. Costs included purchasing, installing, maintaining, and operating UVC lamps. In Switzerland, cost–benefit ratios ranged 30–290 during a normal winter, 65–430 during a COVID-like pandemic, and 2,300–20,500 during a severe pandemic. In Germany, cost–benefit ratios ranged 10–110 during a normal winter, 30–190 during a COVID-like pandemic, and 1,000–9,000 during a severe pandemic. Far-UVC lamps are a highly cost-effective solution for societies during normal winter and pandemic scenarios. Future studies should focus on implementation in the settings studied; they seem to represent a safe and effective measure for infectious disease control, but need real-world validation.

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Sobirin, I., Pratama, T. O., Faridah, Suroso, D. J., Ridwan, M. K., Siddiq, N. A.*, et al.*

Design and Construction of Measurement Device for Ventilation Rate and Airflow Direction in Living Space.

Innovation in Green Building and Infrastructure

Ventilation control within interior spaces helps in alleviating the spread of airborne diseases. This research presents a new device design that can effectively measure the ventilation rate and detect airflow direction efficiently in household spaces. The device incorporates twin Mass Airflow (MAF) sensors based on hot wire anemometry. These sensors are mounted strategically within a 10 cm long PVC pipe to detect bidirectional airspeed. They are connected to an Arduino Uno controller, and the system integrates the sensor data to calculate the ventilation rate in liters per second (L/s) by multiplying the air speed with the pipe's cross-sectional area. Experimental observation indicates the reliability of the system in having a mean error rate of 0% when capturing velocity, precision as a measure of standard deviation of 0.1 m/s, freedom from hysteresis error, and a sensitivity of 1.4 V per meter per second (V/(m/s)). Second, the two-sensor design facilitates the effective measurement of airflow direction and offers an important dimension of the dynamics of indoor air motion. This research advances the technical frontiers of environmental monitoring. It provides a valuable tool for public health initiatives that aim to control the transmission of infectious aerosols in highly populated indoor settings.

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Pagano, F., De Filippi, F., Simonetti, M.

Design for Temporary Healthcare Facilities in Emergencies: A Simplified Equation for Rapid Natural Ventilation Assessment.

Buildings, Vol. **16** n°(7), (2026)

Health emergencies linked to epidemic outbreaks in vulnerable contexts require rapid and effective architectural responses. Natural ventilation represents a key strategy for infection control and indoor comfort, yet traditional airflow calculation methods require climatic and construction data, which are often unavailable or incomplete. In emergency situations, this results in the inapplicability of such methods and creates a critical information gap. This study proposes a simplified equation to estimate airflow rate (Q) in single-sided and cross-ventilation configurations, based on openable surface area and a reference Effective Window Air Speed (EWAS). Two infectious disease treatment centers were modeled and simulated using EnergyPlus (E+) under five climatic scenarios—two real and three hypothetical—characterized by low, medium, and high wind exposure. Simulation results were compared with existing formulas and with the proposed simplified equation. Although the simplified model introduces a margin of error compared with dynamic simulations, it provides meaningful estimates, with mean deviations typically in the 20–35% range, lower in single-sided conditions and higher for cross-ventilation under medium-to-high wind exposure. The study demonstrates that an ultra-simplified approach can serve as a support tool for the design of temporary healthcare facilities in resource-limited contexts, where rapidity and data accessibility are essential.

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Brockmann, G., Lausch, K. H., Reißner, J., Reichelt, B., Siller, P., Friese, A.*, et al.*

Energetic comparison of the inactivation of airborne corona viruses using UVC radiation or a conventional HEPA filter in an air purification unit.

Energy and Buildings, Vol. **362**, (2026)

During the COVID-19 pandemic, decentralized air purification units have been widely used to reduce airborne infection risks in indoor environments. While both high-efficiency particulate air (HEPA) filtration and ultraviolet C (UVC) irradiation are effective for removing or inactivating airborne viruses, their energetic performance has not yet been systematically compared. Building on previously published experimental measurements of airborne coronavirus (FCoV) inactivation using UVC-LED radiation and filtration in a portable air cleaner, this study evaluates the associated electrical energy demand of both technologies. The experimental results are complemented by computational fluid dynamics (CFD) simulations to determine particle residence times and irradiation dosages within the UVC chamber, as well as analytical modelling of room-scale air purification performance. The results show that, under the investigated conditions, UVC irradiation using low-efficiency LEDs (4.5 %) requires significantly higher electrical power than HEPA filtration to achieve comparable virus reduction. At the reference operating point, the energy demand for UVC-based inactivation exceeds that of filtration by up to a factor of 94. However, the analysis also demonstrates that this relationship strongly depends on key parameters, particularly the efficiency of the UVC source and the geometric design of the irradiation chamber. A parametric evaluation indicates that with improved LED efficiencies and optimized chamber configurations, the energetic gap between UVC irradiation and filtration can be substantially reduced. The results highlight the importance of considering both disinfection performance and energy demand when designing air purification systems and provide a framework for evaluating future UVC-based technologies in building applications.

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Gomiero, A., Skogerbø, G.

From waste to workplace: Airborne microplastics and endotoxins in an indoor industrial environment.

International Journal of Hygiene and Environmental Health, Vol. **274**, (2026)

Airborne microplastics (MPs) and endotoxins are emerging occupational hazards, yet their co-occurrence in real workplaces is poorly documented. The study examined combined exposure in sludge-based fertilizer plant, where digestate handling and drying generate both polymer-rich dust and bioaerosols. Personal and stationary air samples were collected with calibrated pumps at three indoor hotspots: conveyor pipe, dryer, loading dock with an outdoor site. Microplastics were extracted in an ultra-clean laboratory and characterized by μ-FTIR imaging. Endotoxin levels were quantified by the LAL assay. Indoor air contained significantly higher MP counts (24-312 MP m−3) than outdoor (13 MP m−3), dominated by fragment-shaped particles (74%) vs fibres (26%) within the inhalable size fractions. Concentrations peaked near the sludge dryer unit and the conveyor, indicating process-related sources and resuspension of contaminated dust. Endotoxins (<0,7 – 30 EU m−3) were consistently above outdoor levels and highest where sludge-derived material was agitated yet remained below occupational reference values (90 EU m−3). Positive covariation between MP and endotoxin levels suggested that tasks and zones with high dust emissions also drive combined particle–biological exposure. The study provides one of the first integrated datasets on airborne MPs and endotoxin in a circular-economy fertilizer facility and demonstrates a practical, contamination-controlled protocol for joint assessment using coordinated sampling. The results show that workers can be simultaneously exposed to elevated levels of polymer particles and endotoxin, underscoring the need to include microplastics in exposure monitoring, risk assessment, and control strategies across biological-waste and related industrial environments.

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Tang, J. W.

In-flight respiratory virus transmission models need to consider pathogen biology.

Indoor Environments, Vol. **3** n°(2), (2026)

During and after the COVID-19 pandemic, I acted as an external peer reviewer for many transmission modelling papers, some of which involved in-flight transmission scenarios, and noticed that several papers did not take the pathogen biology into account, which reduced the accuracy and predictive value of their models. These models have been modified now, as part of the peer review process, so their final published version will not show such limitations, however, this experience prompted the writing of this article.

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Morel, J., Droillard, C., Lenoir, J.-M., Ménard, C., Le Hir, S., Ensenat, E.*, et al.*

Innovative Test Bench for Comprehensive Evaluation of Portable Air Cleaner Performance Against Infectious Human Respiratory Pathogens.

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

Background The COVID-19 pandemic has underscored the critical role of indoor air quality and ventilation in the transmission of respiratory viruses. Although portable air cleaners (PACs) have proliferated in recent years, most performance evaluations rely on indirect measurement approaches or surrogate microorganisms, leaving uncertainty regarding their true efficacy against infectious human bioaerosols. Objectives We aimed to develop and validate a highly controlled test bench for comprehensive evaluation of PACs in accordance with evolving standards, incorporating infectious respiratory human pathogens, spectrometric analysis under realistic environmental conditions, and computational fluid dynamics (CFD) supporting experimental design and interpretation of airflow patterns. Methods The experimental platform consists of a 20 m3 BSL-3 chamber equipped for precise control of airflow, humidity, and temperature, allowing nebulization of infectious viruses (SARS-CoV-2, influenza A/H1N1pdm09, and adenovirus), bacteria (Staphylococcus aureus), and fungi (Aspergillus fumigatus). Natural decay rates and stabilities were characterized for each microorganism in homogeneous, highly contaminated atmospheres. The

performance of a HEPA H14 PAC (Camfil City M) was evaluated under varying positions (center/corner) and airflow scenarios, with additional interference simulated by open-window ventilation. Air samples were analyzed by TCID50 assays and particle spectrometry. Results Stable contaminated atmospheres were reproducibly generated, with airborne concentrations remaining stable for at least 1 h. S. aureus exhibited the greatest stability, while adenovirus and influenza A decayed more rapidly. PAC efficacy depended on device placement and ventilation conditions, with synergistic effects observed when combining air filtration and ventilation. Experimental decay rates for infectious virus and aerosols consistently exceeded CFD predictions, likely due to modelling limitations. Conclusions This study presents an advanced methodology for evaluating PAC performance against infectious airborne pathogens under realistic, variable environmental conditions. The findings underscore the importance of considering infectious bioaerosol dynamics, device placement, and airflow characteristics when assessing PAC effectiveness and highlight the limitations of solely modelling inert particles in CFD analyses.

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Peng, Z., Ma, B., Henze, D. K., Miller, S. L., De Gouw, J. A., Jimenez, J. L.

Is There an Optimal Wavelength for Germicidal Ultraviolet Air Disinfection?

Environmental Science & Technology, Vol. **60** n°(14), (2026), 10970-10981 p.

Germicidal UV (GUV) disinfection is effective against airborne pathogens, but it has been recently reported to increase indoor air pollution. Conventional GUV at 254 nm is applied in the upper room only due to skin/eye safety limits, while “Far UVC” (e.g., at 222 nm) is applied across the whole room due to less restrictive safety limits, enabling simpler installation and disinfection. GUV light sources at other wavelengths are being actively developed, creating an urgent need for guidance on their relative advantages. We investigate GUV between 185 and 310 nm by modeling in search of an optimal wavelength with both high disinfection and safety. For a specific fluence rate, GUV-induced air pollution health risks are at least ∼20 times larger below 242 nm than above it. This is mainly due to O3 production through O2 photolysis below 242 nm, with a contribution from particulate matter formation from enhanced volatile organic compound oxidation. When normalized to a constant CDC-recommended disinfection rate of 5 equiv air changes per hour (eACH), pollution risk below 242 nm is also at least ∼20 times that above 242 nm. At very high disinfection rates such as 20 eACH, the difference between the ratios below and above 242 nm is smaller, but still a factor of ∼20. Our results show a clear advantage of upper-room GUV vs Far UVC for indoor air pollution. These results appear robust despite substantial uncertainties in absolute disinfection efficiencies, which are a critical limitation for widespread GUV application. Thus, there is no optimal GUV wavelength across all important criteria (exposure limits, disinfection efficiency, indoor air pollution, and logistic requirements), and these trade-offs should be considered in different situations to maximize the overall benefit. The use of Far UVC may require simultaneous deployment of air cleaning for pollution mitigation.

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Battista, G., Barbaro, L., Vollaro, E. D.

Microbial Contamination and Ventilation Strategies in HVAC Systems: A Case-Study Assessment of Infection Risk, Energy Consumption, and Thermal Comfort.

Atmosphere, Vol. **17** n°(4), (2026)

Heating, ventilation, and air conditioning (HVAC) systems are essential for indoor air quality and thermal comfort but can simultaneously act as vectors for microbial contamination, particularly bacteria and fungi. While the COVID-19 pandemic intensified focus on airborne viral transmission, bacterial and fungal contamination in indoor environments remains a persistent and significant health risk. This study presents a detailed case study of a restaurant HVAC system, analysing the impact of different ventilation strategies on bacterial contamination, infection transmission risk, energy consumption, and thermal comfort. By focusing on a real-world application, the research evaluates practical challenges and trade-offs associated with HVAC operation modifications aimed at mitigating microbial risks while maintaining acceptable energy and

comfort levels. The research compares three operational scenarios: normal operation with air recirculation, 24 h operation with 100% outdoor air, and extended operation periods. Results demonstrate that while strategies emphasizing outdoor air intake and extended operation reduce infection probability by up to 60–65%, they simultaneously increase energy consumption by over 1700% and compromise thermal comfort parameters. In the h24 case, the pre-heat coil rises from 2421.7 to 43,923.7 kWh and the post-heat coil from 24,812.8 to 152,970.4 kWh, while the Plus 2 h strategy reduces the energy penalty by roughly 42–51% with respect to the h24 case. The findings are contextualized within current research on bacterial and fungal risks in HVAC systems, highlighting the critical need for balanced ventilation strategies that integrate health protection, energy efficiency, and comfort considerations.

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Suebyat, K., Pochai, N., Sooknum, J., Oyjinda, P.

Three-dimensional numerical modeling for assessing airborne infection risk in hospital waiting rooms with various ventilation approaches.

Modeling Earth Systems and Environment, Vol. **12** n°(3), (2026)

Airborne infectious diseases, such as COVID-19, TB, MERS, and SARS, constitute a profound threat to public health and quality of life. These pathogens are transmitted primarily via atmospheric particles, especially within clinical environments, where they often circulate. Effective ventilation controls to mitigate pathogens and air pollution are thus essential for reducing hospital-based transmission of airborne infections. The purpose of this research is to assess the risk of airborne infectious diseases within a hospital in Thailand using a mathematical model. Specifically, the finite difference technique is employed to estimate carbon dioxide (CO2) concentration as a proxy for indoor air quality to indicate and assess the risk of airborne infectious diseases. The hospital layout is categorized into waiting areas and circulation areas with disparate occupant densities. Three simulation scenarios are conducted, accounting for variations in ventilation rates and architectural structure of hospitals. The results of this research demonstrate that CO2 concentration can be effectively quantified as a proxy for indoor air quality within hospital environments. These calculated CO2 levels are subsequently used to model the risk of airborne infection at a hospital, providing a robust framework for assessing this risk. Crucially, by integrating ventilation dynamics that reflect the physical constraints and structure of the hospital, this research enables precise evaluation of infection risks. The findings indicate that ventilation control can reduce the incidence of airborne infection, with significant practical utility in real-world clinical settings.

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Yurii, B.

Transient thermodynamic modeling of thermal stratification and airborne contaminant transport in cleanroom environments.

XIV International Scientific and Practical Conference «Features and trends of interdisciplinary scientific research», April 7-10, 2026, Sofia, Bulgaria

Aim of the study is to develop a transient thermodynamic model for predicting thermal stratification and airborne contaminant transport in cleanroom environments under variable operating conditions, with consideration of timedependent heat transfer, airflow redistribution, and contaminant concentration dynamics.
Materials and methods. To describe transient thermal behavior and airborne contaminant transport in cleanroom environments, a simplified time-dependent thermodynamic model was developed based on energy balance, contaminant mass conservation, and vertical stratification intensity. The model assumes incompressible airflow, uniform supply conditions, and transient internal heat release from equipment and occupants.

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