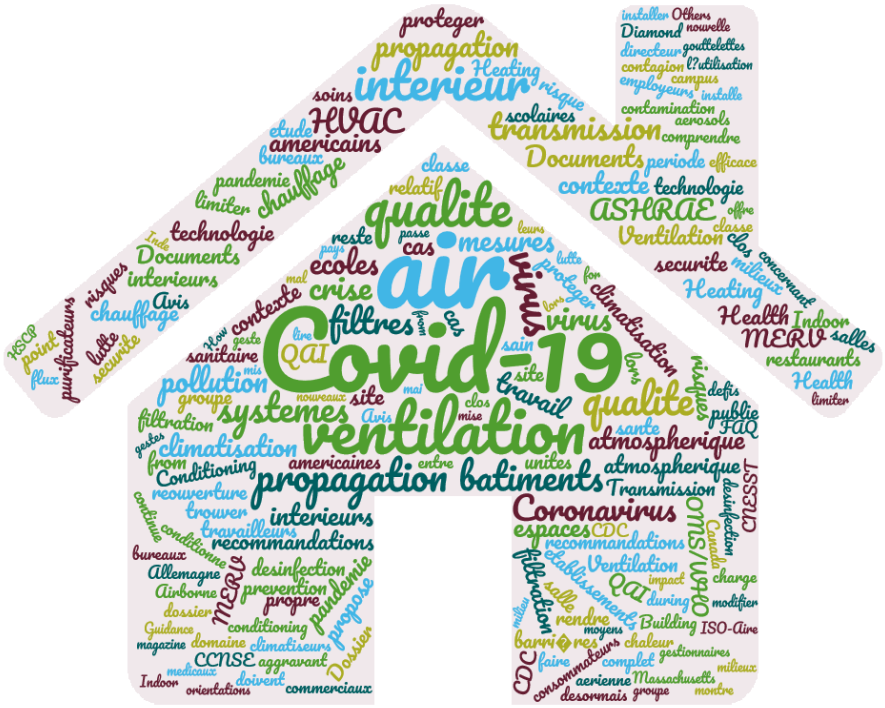

Bulletin de veille AéroCovid
N° 117 – 04/06/2025

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

Sonkar, S., Suchiita, A., Koner, B. C., Chandra, L.

Airborne and Surface Transmission of SARS-CoV-2 in Hospital Settings: Evidence from a COVID-19 Dedicated Hospital in India.

In: Current Topics in Viral Outbreaks. IntechOpen; 2025.

In an era marked by the frequent emergence and re-emergence of viral threats, understanding the dynamics of outbreaks has never been more urgent. From SARS and MERS to Ebola, Zika, mpox, influenza, and COVID-19, viral outbreaks continue to challenge health systems, disrupt societies, and expose global vulnerabilities, particularly in low- and middle-income countries. Current Topics in Viral Outbreaks provides a critical and up-to-date exploration of the most pressing issues in outbreak science and response. This volume brings multidisciplinary perspectives on viral pathogenesis, transmission dynamics, diagnostics, clinical care, public health interventions, and pandemic preparedness. It also examines the roles of environmental change, urbanization, global travel, and One Health interactions in shaping outbreak patterns. Emphasizing equity, scientific rigor, and cross-sectoral collaboration, this book offers actionable insights for mitigating the impact of viral epidemics and enhancing resilience at local, national, and global levels. A valuable resource for infectious disease specialists, epidemiologists, public health practitioners, and policymakers, this work contributes to the knowledge foundation needed to anticipate, detect, and respond effectively to current and future viral threats.

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Radalj, A., Nikšić, A., Trajković, J., Knežević, T., Janković, M., De Luka, S.*, et al.*

Carbon–fiber and other ionizer types in combating airborne pathogens–a Review.

Advances in Solid State Physics and New Materials-30 years of the Center for Solid State Physics and New Materials at the Institute of Physics Belgrade, Belgrade, 19–23 May, 2025

Airborne pathogens can cause infections, intoxications, or allergic reactions through respiration, dermal contact, or ingestion. Air ionization by dielectric barrier discharge or metal tip corona discharge produces ozone, a reactive ionization byproduct harmful to humans. This review focuses on the antimicrobial efficacy of newer carbon-fiber ionizers (CFIs) which can generate high ion concentrations, enhancing pathogen deposition, with almost negligible ozone production. Unipolar ions produced by the CFIs can disrupt microbial membranes, leading to cell death.

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Satryani, D., Santoso, I., Junaidi, J.

Effectiveness of 60-Minute Ultraviolet Sterilization for Eliminating Airborne Bacteria in Hospital Operating Rooms.

Global Health & Environmental Perspectives, Vol. **2** n°(1), (2025), 131-143 p.

Healthcare-associated infections continue to pose a substantial threat in hospital environments, with airborne transmission serving as a primary mechanism for pathogen dissemination, especially in operating theaters. This study assessed the effectiveness of ultraviolet (UV) light sterilization in diminishing airborne bacterial contamination in the operation room of RSUD Datu Kandang Haji, Balangan. Employing a repeated measures experimental design, air samples were obtained before to UV sterilization and after 30, 60, 90, and 120 minutes of exposure utilizing a Midget Impinger Microbiological Air Sampler. Environmental

variables such as temperature, humidity, and illumination were also observed. The results indicated a gradual decline in airborne microbial load from an initial 0.125 CFU/m³ to 0.065 CFU/m³ after 30 minutes of UV exposure, ultimately reaching 0 CFU/m³ after 60 minutes, with no additional drop noted at 90 and 120 minutes. Environmental conditions mostly adhered to the Indonesian Ministry of Health guidelines, however humidity (62-65%) marginally beyond the permissible range (40-60%). Statistical analysis demonstrated a considerable disparity between measured microbe counts and reference values (p<0.001), while all measures were far below the regulation limit of 10 CFU/m³. This study concludes that 60 minutes of UV sterilization effectively eliminates detectable airborne bacteria in operating rooms, indicating that the hospital's existing 120-minute protocol could be halved without jeopardizing air quality, thus enhancing operational efficiency while upholding patient safety standards.

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Okokon, E., Chibuzor, M., Ezema, C., Bernard, M., Barde, V., Oyo-Ita, A.*, et al.*

The effectiveness of air-cleaning technologies against COVID-19 transmission in healthcare settings.

Frontiers in Environmental Health, Vol. **Volume 4 - 2025**, (2025)

This review aims to assess the effectiveness of physical and chemical air purification methods (intervention) in preventing SARS-Cov-2 transmission in the health facility and compare them with equivalent ventilation provided by natural or mechanical modes (control). A secondary objective is to assess the effectiveness of air cleaning in health facilities.

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Bang, J. I., Jo, Y. L., Choi, A., Jeong, J. W., Sung, M.

Effectiveness of Upper-Room Ultraviolet Germicidal Irradiation on Airborne Bacteria Concentration in Full-Scale Airborne Infection Isolation Rooms.

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

The SARS-CoV-2 pandemic has highlighted the importance of maintaining a healthy indoor environment, particularly in healthcare facilities where strict infection control is essential. Airborne infection isolation rooms (AIIRs) are designed to isolate infectious patients and prevent the spread of airborne pathogens. However, additional microbial contamination control measures are necessary to ensure safe indoor air quality for both healthcare workers and patients. In this study, the disinfection performance of upper-room ultraviolet germicidal irradiation (UR-UVGI) was experimentally evaluated in a full-scale AIIR environment. Experiments were conducted under the AIIR minimum operational conditions (i.e., >= 6 air changes per hour (ACH)), using Bacillus subtilis (ATCC 6633) as the microbial contaminant. To simulate practical conditions, two microbial source scenarios were considered: (1) outdoor sources, wherein the microbes infiltrated from the anteroom into the ward, and (2) indoor sources, wherein the microbes were generated directly at the patient's respiratory position. The results indicate that for outdoor sources, UR-UVGI reduced airborne contaminants by approximately 20% at the ward center and 28% at the patient's respiratory position, but these reductions were not statistically significant ($p > 0.05$). By contrast, for indoor sources, UR-UVGI achieved a statistically significant reduction of approximately 23% at the ward center and 25% at the ward exhaust ($p < 0.05$). These findings suggest that UR-UVGI serves as a supplementary disinfection method in AIIRs. In addition, the relatively low disinfection efficacy observed at high ventilation rates (>= 6 ACH) indicates the need for optimized UR-UVGI placement strategies to enhance disinfection performance. Future research will focus on microbial dispersion and deposition patterns, incorporating computational fluid dynamics modeling to assess UR-UVGI effectiveness under various environmental conditions.

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Liang, Q., Bao, X., Qin, C., Zhang, Q., Zou, X., Xu, W.*, et al.*

Emissions of volatile organic compounds from COVID-19 response hospitals using mobile proton transfer reaction mass spectrometry observations in Wuhan in 2020.

Int J Mass spectrom, Vol. **514**, (2025)

To curb the rapid spread of the COVID-19, Wuhan was the first in the world to implement strict lockdown measures on January 23, 2020, and rapidly established several large hospitals. The extensive disinfection operations and daily activities within these hospitals led to the release of significant amounts of volatile organic compounds (VOCs). However, the composition and concentration characteristics of VOCs around these hospitals remain unclear. This study employed a self-developed mobile proton transfer reaction mass spectrometry (M-PTR-MS) system to conduct high spatiotemporal resolution mobile monitoring of VOCs in these hospitals in Wuhan from February 29 to March 15, 2020. The study compared the temporal and spatial variations in VOC across Wuhan, focusing on the frequency and concentration of VOC increases downwind of temporary hospital (Leishenshan Hospital), designated hospitals (Wuhan Xiehe Hospital, Wuhan Jinyintan Hospital), and shelter hospitals (Wuhan Keting Shelter Hospital, Hongshan Stadium Shelter Hospital). The results indicated that during the 14 days of effective mobile monitoring, the average concentration of total VOC (TVOC) in the first seven days was 13.39 % higher than in the latter seven days. Spatially, the average concentration of TVOC in the industrial areas north of the Yangtze River was 8.89 % higher than those in the non-industrial areas south of the river. Leishenshan Hospital exhibited the most diverse VOC composition and sources, with VOCs primarily originating from the fermentation and direct incineration of medical, waste within the hospital grounds and disinfectants. Downwind of the designated hospitals, VOCs related to industrial-source, disinfectants and waste were detected. Ethanol was detected downwind of all these hospitals. Waste generated by hospitals was a significant source of VOCs downwind of both temporary and designated hospitals. This study provides valuable technology for the research on VOC characteristics, disinfection efficacy evaluation, and environmental impact analysis during public health emergencies.

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Bobrovska, S., Newcomer, E., Gottlieb, M., Mcsorley, V. E., Kittner, A., Hayden, M. K.*, et al.*

Hospital air sampling enables surveillance of respiratory virus infections and genomes.

Science of The Total Environment, Vol. **977**, (2025)

There is an urgent need for early detection and comprehensive surveillance of respiratory pathogens. Environmental surveillance may be key to timely responses for newly emerging pathogens and infections that are unreported or underreported. Here, we employed air sampling in a large urban hospital. Air samples (n = 358) were collected weekly at five locations, including two in the emergency department, two in hospital common areas and one in a storage room, for two respiratory virus seasons (November 2022 to June 2024). Air samples were tested for eight respiratory pathogens by qPCR, including RNA and DNA viruses and a bacterium. Air samples had an average of four detected pathogens per sample and 97 % samples contained SARS-CoV-2. Air sample pathogen positivity and quantity were strongly correlated with clinical surveillance for four seasonal respiratory pathogens: influenza A and B, respiratory syncytial virus, and human metapneumovirus. Targeted amplicon sequencing of SARS-CoV-2 showed that lineages detected in air samples reflected those in contemporaneous regional clinical specimens. Metagenomic sequencing with viral capture enrichment detected myriad human pathogens, including respiratory-associated viruses with recovery of full viral genomes. Detection of viral pathogens correlated well between virus capture sequencing and qPCR. Overall, this suggests air sampling can be an agile and effective tool for pathogen early warning, surveillance and genome characterization.

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Romero-López, Y., Martínez-Cruz, A., González, R. Á., Gálvez, A. M. S.

Implementation of an IoT system with a security scheme to predict indoor CO2 levels and mitigate COVID-19 using time series algorithms.

Integration, Vol. **103**, (2025)

The COVID-19 pandemic has significantly impacted face-to-face activities in daily life. With a considerable portion of the population now vaccinated, proposals for the resumption of activities have been

strengthened. Extended time in enclosed spaces can increase carbon dioxide (CO2) levels. Consequently, monitoring CO2 concentrations has become a crucial strategy for evaluating the risk of COVID-19 transmission in indoor settings where people congregate. This work presents a method for measuring indoor CO2 levels and predicting values to mitigate contagion risks by using a time series algorithm and, designing and implementing a custom embedded system. The system provides precise PPM measurements and enhances data security in the embedded system. It accomplishes this through encryption and authentication mechanisms utilizing a TPM, employing AES and HMAC-SHA256 to ensure data confidentiality and integrity. Furthermore, using the MQTT protocol and integrating predictive analytics for indoor air quality supports preventive health management, highlighting the importance of combining security and predictive technologies. Additionally, the scalability of the proposed algorithm and its use in IoT applications, such as real-time alerts and enhancing air quality through smart sensor and actuator networks, are emphasized. According to the results, the ARIMA model accurately predicts CO2 levels, effectively capturing seasonal trends and patterns.

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Elsarraj, M., Mahmoudi, Y., Keshmiri, A.

Linking Airflow Dynamics to Infection Risk Reduction and Predictive Strategies.

Journal of Building Engineering, (2025)

ABSTRACT Indoor airborne infection risk (IR) is a significant challenge, with existing research yet to fully translate complex findings into actionable solutions for ventilation design. This paper addresses these gaps, promoting awareness of critical ventilation parameters that reduce IR and advancing automated IR mitigation research. It applies a ‘probability of infection’ (POI) metric to an office model with occupants and heat sources to analyse how airflow patterns, ventilation rates, and ventilation effectiveness (VE) influence IR and CO2 concentrations. A method is proposed to predict the number of infectious individuals based on local epidemiological data and determines an acceptable POI threshold of 7.5%. The influence of infector positioning (IP) is examined, highlighting that the worst-case IP causes infectious airborne particles to travel through the most occupants and exhibit delayed exit due to airflow patterns. The study has highlighted that VE, which is determined by the age of air, depends on the design, layout, and flow rates of the ventilation system. Recirculations or dead zones increase the age of air, reducing VE by slowing the removal of stale air. The VE significantly affects the increase in flow rates necessary to reduce IR, as systems with higher VE need smaller increase in flowrates. These findings inform a framework for automated indoor IR mitigation, offering guidance on setting up representative computational simulation cases and extracting data to train and optimise Random Forest (RF) models. The latter builds on the authors’ prior work, where RF training is detailed, and enabling practical use of CO2 sensors for predicting indoor IR.

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Liu, F., Zhang, L., Chen, Z., Ma, J., Dong, Q., Qian, H.

Patient movement and ventilation effects on respiratory aerosol dynamics in hospital corridors: A combined CFD and field study.

Building and Environment, Vol. **281**, (2025)

During the COVID-19 outbreak, SARS-CoV-2 RNA has frequently been detected in aerosols sampled from hospital corridors. The high mobility of patients, combined with inadequate ventilation, contributes to high release rates and exposure concentrations of exhaled pathogenic aerosols in these areas, posing health risks to medical personnel. This study focuses on the corridor area, particularly the nurse station in respiratory infection department's inpatient ward, to investigate the dispersion and deposition of aerosols exhaled by walking patients. Various factors, including different respiratory symptoms, walking speeds, walking paths in the corridor, and ventilation conditions, were considered in the numerical simulations. A field measurement was conducted in the hospital corridor to obtain the boundary conditions and validate the numerical models. Results show that aerosol particles exhaled by a moving infectious source remain

suspended along the walking path behind the human body due to the combined effects of oncoming airflow and wake flow compared to the stationary case. These aerosol particles can remain airborne up to 9 m away from the walking path. This phenomenon becomes more significant when the walking path is adjacent to the nurse station or when the air supply vents are closed, with the proportion of suspended aerosols increasing by 3 % and 8 %, respectively, after the patient's departure for 60 s. The findings provide valuable guidance for effective disinfection and highlight the necessity of adequate ventilation in hospital corridors to enhance the removal of suspended particles.

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Kabanshi, A., Andersson, H., Sundberg, M., Senkic, D., Itokazu, R., Ito, K.*, et al.*

Performance of the new spatiotemporal airborne infection risk model across varied indoor air flowrates: An experimental study.

Building and Environment, Vol. **281**, (2025)

Understanding the complex dynamics of indoor airflows is crucial for mitigating airborne infection risks in ventilated spaces. These airflows can be simplified into two populations: Recirculating air that spreads contaminants and outgoing air that evacuates them. Quantifying these populations involves analyzing mass transfer between zones in the room/building. This study builds on the newly proposed model that enhances the Wells-Riley model by incorporating indoor airflow interaction mechanisms. The study explores the transfer probability between zones and the recirculation and purging flowrate at the target location and its impact on the risk of infection in a ventilated room. Our contributions include: (i) Performance evaluation of the revised model that accounts for transfer probabilities between zones and purging flowrates; (ii) a novel tracer-gas measurement method to determine local purging flowrates; and (iii) an analysis of how different ventilation systems interact with internal room flow. We validated the proposed model through experimental measurements in a climate chamber, examining contaminant source locations under varying ventilation rates using mixing ventilation (MV) and displacement ventilation (DV). Results reveal significant spatial and temporal heterogeneities in contaminant distribution, with MV showing pronounced temporal variability and DV exhibiting significant spatial variations. Under MV, purging flowrates increase with higher ventilation rates, whereas DV shows no such change. Our findings underscore the importance of considering airflow dynamics in ventilation design to effectively reduce contaminant transfer and/or airborne infection transmission.

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Sethu, N., Patil, N., Vyas, R.

A Portable Air Purification Device for Occupational Safety of Health Care Professionals.

Aerosol Science and Engineering, (2025)

Healthcare personnel in infectious wards are exposed to bioaerosols, necessitating the use of respirators and personal protective equipment (PPE) to prevent pathogen contact. It is critical to evaluate and enhance the efficiency of portable, commercially available Powered Air Purifying Respirator (PAPR) devices to mitigate the risk of airborne microbial infiltering into the human respiratory system. In this study, a portable, cost-effective, and lightweight ultraviolet (UV) disinfection system was designed and developed. The system actively draws in air, effectively inactivates microorganisms, and releases purified air. The modular HEPA-UVC conjugated PAPR device developed by us can be attached to any existing respirator unit. The device was tested for filtering airborne microbes, mainly bacteria and fungi. Further, the efficiency of the device was assessed by calculating the percentage of airborne bacteria cells and fungal spores. The microbial sampling results indicated that UVC treatment along with HEPA filter operated for 15 min could achieve a 92.63% reduction of bacteria and an 80.43% reduction of fungi as compared to the HEPA filter alone. The time of exposure and flow rate were the dominant parameters affecting the number of bioaerosols in the disinfection performance of a UVC lamp. Thus, HEPA air filtration combined with UVC provided an efficient reduction of airborne pathogens from indoor air. The deployment of such integrated systems is extremely useful to provide cleaner air in infectious wards. These portable devices are a viable

method to improve safeguarding healthcare personnel against pathogen infection and prevent the spread of airborne diseases.

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Li, P.-E., Ho, Y.-H.

Predicting the Occurrence of Respiratory Diseases Based on Campus Indoor Air Quality.

ACM Trans. Intell. Syst. Technol., Vol. **16** n°(2), (2025)

Air quality is known to be strongly correlated with respiratory diseases. Indoor air quality considerably affects human health, especially in spaces such as classrooms, where students gather and interact for long periods. Most schools are located in relatively old buildings, where suitable ventilation systems are difficult to implement. The consequent lack of a standard ventilation rate increases the risk of cluster infections in classrooms. Accordingly, this article proposes a classroom respiratory disease occurrence prediction method based on indoor air-quality data (CROP–IAQ). Early warnings provided by CROP–IAQ will enable authorities to implement measures such as ventilation and isolation that reduce the risk of cluster infections in school campuses. Data on indoor temperature, relative humidity, particulate matter (PM) concentrations (PM1.0, PM2.5, and PM10, referring to the concentrations of particles with diameters of ≤1, ≤2.5, and ≤10 micrometer, respectively), carbon dioxide concentration, total volatile organic compound concentration, and luminosity in classrooms were collected using a MAPS V6.0 airbox. The air-quality data corresponding to potential cluster infections were identified from the aforementioned data and records of student epidemic prevention leaves in each class. Because most of the collected air-quality data did not correspond to potential cluster infections (that is, the dataset was imbalanced), synthetic data samples were generated using a synthetic minority oversampling technique. Four neural network models were constructed for predicting the possibility of disease occurrence and alerting authorities to classrooms at the risk of cluster infections: a convolutional neural network model, the inception model, a residual network model, and a residual network with external transformations model. The predictive capabilities of these models were only slightly improved after implementing a squeeze-and-excitation (SE) module. Experimental results indicated that the inception model with the SE module achieved the best results among the four models, with an F1 score and sensitivity of 0.72 and 0.76, respectively.

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Mijatović, S., Aranđelović, I., Janković, M., Radalj, A., Đoković, S., Trajković, J.*, et al.*

Removal and inactivation of bacteria and fungi by Ionization.

Advances in Solid State Physics and New Materials-30 years of the Center for Solid State Physics and New Materials at the Institute of Physics Belgrade, Belgrade, 19–23 May, 2025, (2025), 61-61 p.

Generally, small air ions have been shown to electrostatically enhance the deposition of airborne particles in indoor air, an effect closely linked to the particle size. Additionally, air ions have been reported to produce a biocidal action on airborne microorganisms. We report on the results of exposure of bacteria and fungi to negatively charged ions of varying concentrations for different time durations. Significant effects were observed in either eliminating the microorganisms or impacting colony morphology and, in case of fungi, spore germination dynamics. Hence, air ions offer the possibility to reduce the amounts of airborne pathogens.

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