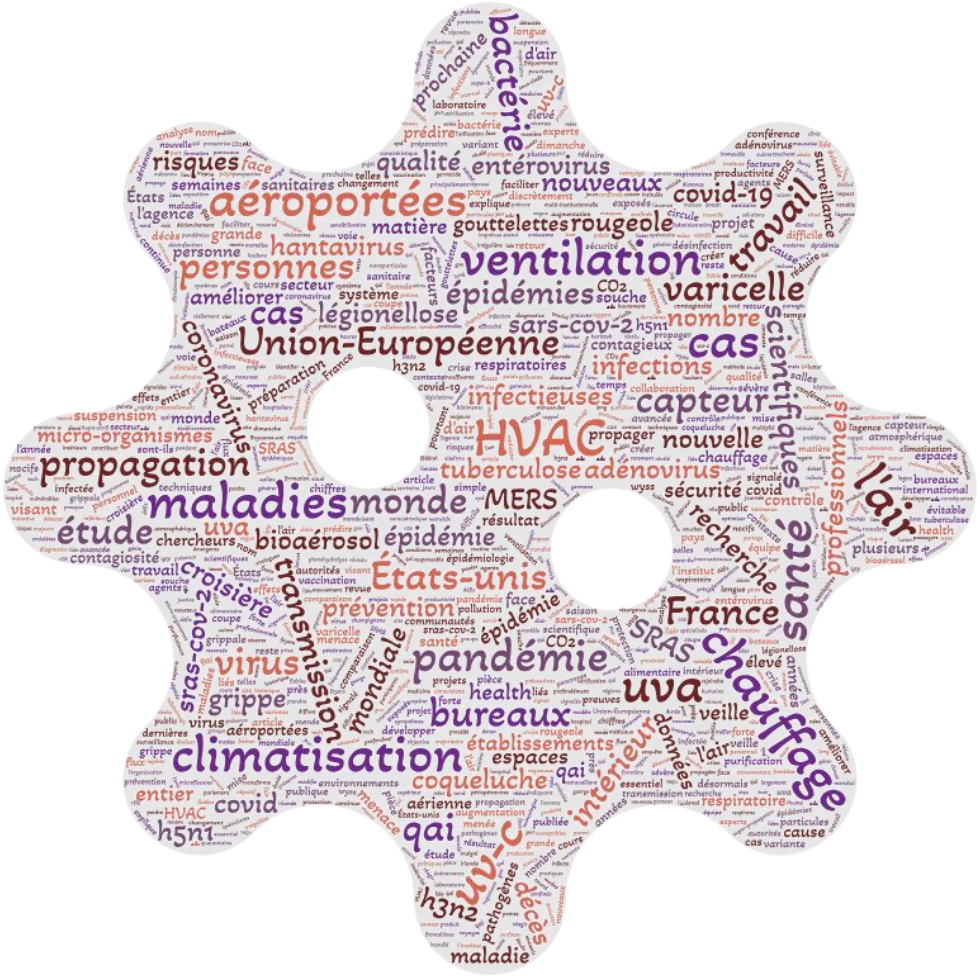

Bulletin de veille Maladies aéroportées
N°1 – 09/09/2026

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

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Google Scholar, Lens et WoS

Mommert, M., Volkmann, A., Werner, F., Schmeling, D.

Aerosol dispersion of state-of-art ventilation concepts in passenger trains—A comparative study.

Atmospheric Environment: X, Vol. **31**, (2026)

We report on an experimental study regarding the performance of state-of-the-art ventilation systems with different inlet positions with respect to the aerosol spread. For that, the spatial distribution of aerosol exposure was determined for six different source locations in a generic passenger compartment. This allowed us to evaluate the different concepts in terms of parameters such as contaminant removal efficiency, the number of seats above a certain threshold or the mean particle concentration in the breathing zone of the passengers. The results revealed strong differences in the local particle concentrations depending on the source position. Further, it was found that two ceiling-based concepts, microjet ceiling and ceiling mounted slot diffusers aimed at the passengers, have significant advantages over the other concepts, especially when it comes to the number of seats with aerosol exposures above certain thresholds. Yet, which concept is optimal still depends on the chosen threshold. The contaminant removal efficiency fluctuates only weakly around 0.5 for the different concepts, revealing mixing-ventilation principles for all concepts.

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Yang, J., Wang, F., Zhang, T.

Aerosol emissions from an evaporative humidifier.

Journal of Hazardous Materials, Vol. **515**, (2026)

The widely used evaporative humidifier can be a source of airborne particulate hazards. Available knowledge about the aerosol emissions from an evaporative humidifier is lacking. We measured the particle/droplet emission rates and particle size spectra from an evaporative humidifier, and examined key factors affecting the particle emissions. We found most of the emitted aerosols from an evaporative humidifier are from its reservoir. The formation of reverse water jets and their fragmentation into secondary droplets after the impaction of the dripping water on the reservoir constitute the primary particle emission. The particle emission rate increases sharply when the Froude number of the dripping water drops exceeds 100. The presence of waterborne Pseudomonas aeruginosa remarkably increases both the total particle emissions and the airborne bacteria numbers. These findings are vital for developing scientific strategies to reduce the probability of airborne contamination by an evaporative humidifier.

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Strom, R.

Air quality in care facilities.

Chalmers University Of Technology. Thèse 2026

This study investigates how air cleaning reduces airborne particle and bacterial concentrations in healthcare environments, aiming to lower infection risk without increasing mechanical ventilation rates. The study combines laboratory experiments, infection risk modelling, and field measurements in a hospital waiting room.

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Rosales, C. M. F., Cayetano, M. G., Saghir, S. A.

Airborne Particles.

In: Patty's Toxicology. 2026. 1–25 p.

While many terms are usually associated with suspended matter in the air, airborne particles or particulate matter (PM) generally refer to solid particles that may be composed of multiple phases (e.g., solids, liquid droplets, etc.). Airborne particles vary extensively in physical and chemical characteristics; their sizes can vary from tens of micrometers, that is, slightly smaller than beach sand or hair, to tens of nanometers. Solid airborne particles have been historically related to a wide range of occupational diseases such as various types of pneumoconioses (e.g., black lung disease), as well as less occupationally targeted respiratory illnesses such as acute respiratory irritation, asthma, or lung cancer. This chapter outlines airborne particles, its adverse health effects to workers in (1) areas with targeted production of particles and (2) in areas where exposure to ambient pollution is inevitable. This chapter presents metrics, techniques, exposure assessments, and biomarkers used for particulate measurements and routine monitoring. Also summarized in this chapter: its toxicity, mechanisms of attack, and carcinogenicity. Lastly, it tabulates existing standards both for the ambient and workplace and outlined some of the existing removal and control technologies. The ubiquity of airborne particles from outdoor jobs, such as construction and firefighting, to indoor occupations, such as healthcare and custodial jobs, make it a central issue that is necessary to be addressed in any workplace area.

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Wong, S. J., Kek, H. Y., Tan, H., Othman, M. H. D., Van Fan, Y., Woon, K. S.*, et al.*

Airborne transmission of cough droplets: evaluating mitigation strategies and ventilation optimization in consultation clinics.

Aerobiologia, Vol. **42** n°(1), (2026)

This study investigates the dispersion of infectious particles generated during a human coughing event in a consultation clinic. The objective is to identify ventilation strategies that minimize particle exposure to healthcare personnel. A simplified computational fluid dynamics model was developed to represent the consultation clinic environment and its occupants. A customizable coding approach was implemented using user-defined functions to replicate realistic, time-dependent coughing behavior. This approach overcomes the limitations of simplified steady injection methods commonly used in previous studies. The RNG k–ε turbulence model was applied to simulate airflow. The discrete phase model was used to track particle transport. The selection of these models was supported by comprehensive validation against published data. Several ventilation configurations were evaluated to examine their impact on particle concentration near the doctor's workspace. Results show that a conventional mixing ventilation system effectively reduces particle concentration across the doctor's working zone. It achieves a minimum value of approximately $1.0 \times 10^{-}5$ kg/m3 within a horizontal distance of 0.728 m from the cough source. Compared to other ventilation schemes reporting a higher concentration of $1.0 \times 10^{-}4$ kg/m3, the mixing ventilation scheme achieves a tenfold reduction. In contrast, displacement ventilation shows localized particle accumulation near the monitor, despite improved removal along the cough jet path. Overall, the findings indicate that mixing ventilation provides a more uniform and comprehensive reduction in airborne particle concentration. The outcomes offer practical guidance for optimizing ventilation design in hospital consultation environments.

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Sze-To, G. N., Yuen, P.

Antimicrobial Air Filter as a Sustainable Alternative to Ultraviolet Germicidal Irradiation for Inactivating Airborne Microorganisms in Building Ventilation System.

E3S Web Conf., Vol. **725**, (2026)

Indoor air quality is critical as people spend most of their time inside. The COVID-19 pandemic intensified concerns over airborne pathogens, leading many buildings to install ultraviolet germicidal irradiation (UVGI) in ventilation systems. However, UVGI is often ineffective due to short pathogen exposure times and energy intensive. This study proposes a sustainable alternative: antimicrobial air filters. These fibrous filters trap microorganisms, prolonging contact with the microbicidal agent to inactivate them. The approach was tested in two Hong Kong office buildings, comparing UVGI with ordinary filters against disabled UVGI with antimicrobial filters. Air sampling upstream and downstream measured viable microorganism levels via culturing and counting. The antimicrobial filters outperformed UVGI, achieving 8.1–93.3% greater microbial reduction. They also eliminated 2,700W and 750W of UVGI power per floor, saving the buildings 574,000 kWh and 344 tonnes of carbon annually. Global adoption could save 2,358.5 million kWh and reduce CO2 by 1.07 million tonnes yearly. This strategy offers superior performance, lower costs, and significant carbon reduction, confirming antimicrobial filters as a viable alternative to in-duct UVGI.

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Latour, K., Asteur, A., Vaes, L., Paralovo, S. L., Lazarov, B., Stranger, M.*, et al.*

Assessing the role of ventilation and indoor air quality in SARS-CoV-2 transmission risk in Belgian nursing homes: the AIR-CO study.

Archives of Public Health, (2026)

Indoor air quality (IAQ) and ventilation are important factors influencing the transmission of airborne respiratory viruses such as SARS-CoV-2. However, limited evidence exists on ventilation characteristics and IAQ in nursing homes (NHs), where residents are particularly vulnerable to infection. The COVID-19 pandemic highlighted the need for improved evidence to inform ventilation strategies in long-term care settings.

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Wild, O., Adzic, F., Malki-Epshtein, L.

Balancing Ventilation, Thermal Comfort and Energy Efficiency in Urban Buses: Evidence from Long-Term Monitoring of Operational London Buses.

SSRN, (2026)

London’s public transport provides metropolitan mobility that is widely depended on as a socioeconomically accessible and energy efficient alternative to private vehicles. The COVID-19 pandemic prompted enhanced ventilation strategies on public transport to reduce airborne disease transmission. However, the implications of these interventions on energy consumption remain unclear. This study evaluates a natural ventilation strategy implemented by Transport for London (TfL) on all London buses in May 2021 to impose partially open windows with fixed blocks. 15 operational London buses were monitored for temperatures and CO2 concentrations on the passenger cabins over a five-month period spanning summer and winter, to quantify periods of poor air quality, and associated triggering of the heating and cooling systems. Elevated CO_2 concentrations were found to be strongly associated with rush hours, representing 20% of operational time and generating 70% of high CO_2 episodes (>1500 ppm). During these highly occupied periods, window blocks reduced the occurrence of high-range CO_2 episodes by up to 55%, improving passenger air quality. However, the increased natural ventilation affected thermal regulation. During summer and winter, buses fitted with window blocks experienced more frequent episodes of extreme temperatures, increasing reliance on onboard heating and cooling systems as set by the buses’ HVAC strategy. These findings reveal a clear trade-off between ventilation performance, thermal comfort, and energy efficiency, and recommends adopting adaptive ventilation strategies to preserve the operational range of electric bus fleets. The study has informed TfL’s bus ventilation strategy, which was implemented on all electric buses in London.

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Yang, H., He, S., Yao, Z., Li, H., Feng, Q., Huang, S.*, et al.*

Bioaerosols in the atmospheric environment of oil exploitation sites: spatial and temporal distribution, sources, influencing factors, health risks, and reduction efficiency of masks.

Environ Pollut, Vol. **409**, (2026)

Particle-bound microorganisms have attracted increasing attention due to their health effects and pollutant metabolic activity. However, the characteristics of airborne microbes in oil exploitation sites with heavy particulate matter and volatile organic chemicals (VOCs) pollution remain unclear. This study collected bioaerosol samples in a city polluted by oil exploitation in the Beijing-Tianjin-Hebei region of China, and investigated the spatial and temporal distributions, sources, influencing factors, health risks, and filtration efficiency of bioaerosols. The results showed that the average culturable and total bioaerosol levels in autumn were significantly higher than in summer, whereas microbial activity exhibited an inverse seasonal trend. Higher concentrations were found in steel plants, inland oilwell, and chemical industry park, suggesting that industrial activities may increase bioaerosol levels. No significant correlation was observed between microbial activity and concentration. The microbial communities' diversity and abundance varied significantly between seasons, with crude oil degradation bacteria, Anoxybacillus and Curtobacterium as dominant bacteria, Cladosporium and Alternaria as dominant fungi. SourceTracker analysis showed that airborne bacteria were primarily derived from leaf surface, while the contribution of leaf surface and soil communities to atmospheric fungi is more prominent. Airborne bacteria were more influenced by VOCs, while environmental factors have greater impact on fungal community structures. The hazard quotient (<1) of inhaling bioaerosols was negligible, but long-term exposure to dominant pathogens, Bacillus and Mycobacterium, could be harmful. Actual wearing masks could only remove 13.7% of bioaerosols, far lower than laboratory-measured values. In summary, this study elucidates the influence of oil exploitation activities on shaping the airborne microbial community, offering practical insights for risk assessments and control of bioaerosols in oil exploitation sites.

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Williams, C. E.

Breathing Beneath the Surface: A Review of Airborne Toxins in Indoor Pools.

Scholarly review . Vol. **Scholarly Debut** n°(Summer 2026), (2026)

Indoor pool facilities rely on chemical disinfection and mechanical ventilation systems to maintain water and air quality, but these same processes can generate harmful byproducts that threaten public health. This literature review synthesizes research on disinfection by-products, including their formation, behavior, and associated health effects. Studies consistently demonstrate that disinfection by-products contribute to the increased risk of respiratory irritation and asthma in swimmers. The more drastic effects have linked disinfection by-product exposure to the elevated risk of cancer, with elite athletes and children identified as the most vulnerable groups. Ventilation effectiveness and pool occupancy rate significantly influence airborne DBP concentrations. Although alternative treatment methods such as ozonation and UV radiation can reduce disinfection by-product levels, they introduce new challenges, including increased chlorine demand. These findings highlight the need for improved treatment technologies and stricter air quality policies to mitigate health risks in enclosed aquatic environments for pool users and employees.

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Ray, S., Singh, M.

Cold-Chain Aerosols as Microbial Vectors: Listeria–Particulate Interactions in Food Storage Air.

In: From Sky to Soil: The Ecological Journey of Particulate Pollution and Pathways to Sustainable Airscapes. Springer Nature Switzerland; 2027. 187–207 p.

The pathogen(s) Listeria sp are a group of prominent microorganisms that has a history of causing encephalitis in livestock animals and may act like an abortifacient, causing miscarriage or immature termination of pregnancy in domesticated mammals. In 1981, it was first reported to cause foodborne illness from contaminated animal feed, fodder and silage, where the main responsible species were Listeria

monocytogenes and Listeria ivanovii. Since the outbreaks often lead to fatality, food handlers have to maintain stringent control and implement regulatory practices to eradicate this entity, especially maintaining the air quality of the food handling areas. It can travel through the water droplets present in air particulates when they flow over soil, water bodies or any contaminated as well as healthy animal or human which may unknowingly carry them in their skin or clothes. Through air, it spreads very quickly onto food-contact or non-contact surfaces, deli utensils or equipment, hands, skin surfaces and ultimately to foods. Refrigerated foods may also harbour this microorganism in viable condition, and it remains alive for a very long period. Thus, food processing, cooking or serving areas may colonize Listeria and contaminate food, causing Listeriosis, which is a deadly disease affecting people with compromised immune systems, such as pregnant women or the elderly. This chapter gives narrative overviews about airborne microbe transmission in cold storage leading to food poisoning with particular reference to Listeria sp on illustrations based on previously published constructive literature reviews.

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Wang, Y., Liu, Z., Li, Z., Shi, Z., Lu, X., Li, H.*, et al.*

Coupling effect of equipment layout and ventilation configuration on aerosol exposure risk in an ABSL-3 laboratory.

Building and Environment, (2026)

Infectious bioaerosols generated by accidental leaks in high-level biosafety laboratories pose a continuous threat to personnel safety. The coupling effects of equipment layout and ventilation strategies have not been systematically revealed. This study focused on ABSL-3 labs and selected two labs with typical equipment configurations: a single-sided centralized layout (A10) and a double-side dispersed layout (A12). We combined three ventilation schemes—Upward supply & upward exhaust (UU), Upward supply & low exhaust (UL), and Upward supply with upward & low exhaust (UUL)—to create six operational conditions. This research combines tracer experiments with Serratia marcescens and numerical calculation to study the diffusion, deposition, and personnel exposure risk of bioaerosols. Results indicate that the ventilation layout dominates the macro-flow pattern, while the equipment layout creates local disturbances through boundary effects. The overall aerosol decay coefficient for the UU layout is the highest (0.02380, 0.02427). But the directional exhaust efficiency of the UL layout is optimal, improving by 33.32% compared to UU. The floor and downstream walls are identified as key deposition locations. Risk assessment shows that the infection probability in the breathing zone for the A12-UL combination is nearly an order of magnitude lower than that for the A10-UU configuration. In addition, in the A12-UL setup, high-risk areas are effectively confined to the downstream area of the contamination source. This study provides a quantitative design basis for optimizing equipment arrangement and differentiated airflow control strategies in biosafety laboratories.

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Pertegal, V., Correia, S. E., Rodríguez-Gómez, A., Fernández-Marchante, C. M., Rodrigo, M. A., Sáez, C.*, et al.*

A Design and Life Cycle Assessment Framework for Electrochemical Ozone-based Indoor Air Treatment in Hospitals.

Environmental Processes, Vol. **13** n°(3), (2026)

Understanding and managing environmental processes governing indoor air quality in healthcare facilities is essential for mitigating health risks associated with airborne microorganisms. This study proposes an integrated experimental and life cycle assessment (LCA) framework to support sustainability-oriented process design and decision-making for indoor air disinfection systems, using electrochemically generated ozone as a representative case study. A proton exchange membrane (PEM) electrochemical reactor was used to generate controlled ozone gas streams (0.00, 0.24 and 1.16 mg min− 1), which were applied to the continuous treatment of simulated hospital bioaerosols containing antibiotic-resistant Gram-negative (Escherichia coli) and Gram-positive (Staphylococcus aureus) bacteria under conditions representative of

ventilation and air-handling systems. Disinfection performance was interpreted through mechanistic analyses, including membrane permeability alteration, DNA damage and attenuation of antibiotic resistance genes (mecA and blaTEM). Experimental data were subsequently integrated into a scalable cradle-to-gate LCA model designed to evaluate environmental impacts across different room configurations, ventilation rates and energy supply scenarios. Environmental performance was assessed in terms of global warming potential, water footprint, human toxicity (non-cancer) and freshwater ecotoxicity. Electricity consumption was identified as the dominant contributor to most impact categories (80–89%), highlighting energy demand as a key environmental driver of indoor air treatment processes. Coupling the system with renewable electricity sources reduced the carbon footprint by up to 80% without compromising disinfection effectiveness. By linking disinfection performance with sustainability assessment, this work provides transferable insights for the evaluation and optimization of indoor air disinfection technologies in healthcare environments, supporting informed environmental and engineering decision-making.

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Corbita Jr, N. T., Pabilona, L. L., Closas, A. A., Magomnang, A. a.-S. M., Cañete, J. M.

Design Simulation and Data Analysis of an Air Handling System in Wards and COVID-19 Enclosure Using Computational Fluid Dynamics.

Mindanao Journal of Science and Technology, Vol. **24** n°(2), (2026), 199–227 p.

Air Handling Units (AHUs) play a critical role in mechanical systems, conditioning and circulating air as part of heating, ventilating, and air conditioning (HVAC) systems. These systems are essential in hospital settings to ensure comfort and maintain high indoor air quality for patients, staff, and visitors. The design of HVAC systems in hospitals must meet stringent requirements, including optimal temperature distribution, thermal comfort, and effective contaminant removal. This study evaluates the indoor air quality (IAQ) of the AHU design at the Northern Mindanao Medical Center Hospital using Computational Fluid Dynamics software. The HVAC system was modeled and simulated in SOLIDWORKS, focusing on thermal comfort parameters such as airflow velocity (0.15–0.25 m/s), temperature (21–23.5 °C), and relative humidity (40–50%). The simulation results demonstrated compliance with ASHRAE 55 and ISO 7730 standards, with Predicted Mean Vote (PMV) values between –0.5 and +0.5 and Predicted Percentage of Dissatisfied (PPD) below 20%. Contaminant Removal Effectiveness (CRE) values exceeded 1.0 across all rooms, while the Local Air Quality Index (LAQI) ranged from 1.1 to 1.9. These findings underscore the efficacy of the designed AHU in ensuring a comfortable and safe indoor environment in the hospital.

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Adib, M., Ningsih, N. S., Suharno, S., Herlina, R., Ihsan, B. M.

Efektivitas Sistem Ventilasi Mekanik (Exhaust Fan) Terintegrasi Klorinasi untuk Mengurangi Koloni Bakteri di Ruang Perawatan Gigi (Effect of a mechanical ventilation system (exhaust fan) integrated with chlorination on reducing bacterial colonies in dental treatment rooms).

Jurnal Riset Kesehatan Poltekkes Depkes Bandung, Vol. **18** n°(1), (2026), 351–360 p.

Background: Microbial air contamination (bioaerosols) in dental treatment rooms poses a significant risk for the transmission of Healthcare-Associated Infections, particularly during aerosol-generating procedures. Limited studies have evaluated integrated ventilation and disinfection systems to control airborne bacteria.

Objective: This study aimed to evaluate the effectiveness of a mechanical ventilation system (exhaust fan) integrated with calcium hypochlorite disinfection in reducing airborne bacterial colonies.

Methods: A quasi-experimental study with a pretest–posttest design was conducted under four conditions: P1 (before ventilation), P2 (after ventilation), P3 (outlet without disinfection), and P4 (outlet with calcium hypochlorite). Air sampling was performed using the settle plate method with five Nutrient Agar plates exposed for 15 minutes at a height of one meter. The exhaust fan was operated for one hour prior to sampling. Each condition was repeated 15 times. Bacterial colonies were quantified and converted into CFU/m^3 using the Omeliansky formula.

Results: The baseline bacterial concentration was 211.04 CFU/m³. Ventilation significantly reduced bacterial colonies to 100.63 CFU/m³ ($p = 0.015$). No significant difference was observed between indoor and outlet air ($p = 0.297$). The addition of calcium hypochlorite significantly reduced bacterial colonies to 16.07 CFU/m³ ($p < 0.001$).

Conclusion: Mechanical ventilation reduces airborne bacterial load, and integration with calcium hypochlorite disinfection effectively minimizes microbial contamination before air is released into the environment.

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Michalski, M., Bogdan, A., Kwiecińska, D.

Impact of human-induced disturbances and supply air temperature on air-velocity distribution in a surgical microenvironment under unidirectional and mixing ventilation systems.

Journal of Hospital Infection, (2026)

Maintaining high indoor air quality in operating rooms is an important element of surgical site infection prevention. Although ventilation system performance may be assessed using both at-rest and operational measurements, airflow-related tests used for commissioning and acceptance procedures are commonly conducted under controlled conditions without patients or medical staff present. The aim of this study was to evaluate the influence of medical staff presence, patient presence, patient sex, and supply air temperature on air velocity within the surgical microenvironment. Experiments were conducted in a laboratory operating room equipped with unidirectional airflow (UDAF) and mixing ventilation (MV) systems. Sixteen experimental scenarios were analysed, including at-rest conditions, thermal manikins representing medical staff, real volunteers representing patients (female and male patient groups) and supply-air temperatures of 19 °C and 26 °C. Air velocity was measured at five locations within the surgical microenvironment, with the sensors positioned 0.35 m above the operating table surface. The presence of occupants significantly altered local air velocity in both ventilation systems. Depending on the measurement location, differences between occupied and unoccupied conditions reached up to 50% under UDAF ventilation and up to 65% under MV ventilation. The observed changes indicated a redistribution of airflow within the surgical microenvironment rather than a uniform reduction in velocity. Patient sex influenced airflow conditions, particularly under UDAF ventilation at a supply-air temperature of 19 °C. Increasing the supply-air temperature from 19 °C to 26 °C generally reduced air velocity in both systems.

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Donskey, C. J.

In search of the holy grail of environmental cleaning and disinfection: Effective and safe continuous air and surface disinfection technologies.

American Journal of Infection Control, Vol. **54** n°(9, Supplement), (2026), S25–S33 p.

Background There is a need for development of effective and safe continuous air and surface disinfection technologies that can be used as an adjunct to routine cleaning and surface disinfection in health care settings. Methods The published English literature was searched for articles on continuous air and surface disinfection technologies. Results Far-ultraviolet-C (UV-C) light is a promising candidate for continuous air and surface disinfection in occupied spaces, but additional evidence is needed regarding long-term safety and efficacy. Delivery of far UV-C only when people are outside the area of exposure (ie, the lamps off when motion is detected) could provide the benefits of far UV-C while minimizing safety concerns. Several studies suggest that air cleaning technologies that produce reactive oxygen species, hydroxyl radicals, or hydrogen peroxide gas may reduce air or surface contamination, and in 2 studies, reductions in health care-associated infections were reported. However, higher-quality laboratory and clinical studies are needed to confirm these findings. Glycol vapor has re-emerged as a candidate air and surface disinfection technology that is actively being evaluated. Conclusions There are several promising candidate technologies that could provide continuous or intermittent low-level disinfection of air and surfaces in health care settings.

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Ronge, D., Gaikwad, A. S., Maurya, R. S., Gavali, S., More, V.

Investigation of Airborne Contamination Spread and Indoor Air Quality in Operation Theater by Numerical Approach.

Techno-Societal 2024

Preventing the spread of surgical site infection is the biggest challenge for all operation theaters during operations in progress. Work is based on a better understanding of airflow patterns in a surgical site, bacterial spreading and tracking their path, prepare some modifications in the operation theater ventilation system so that bacteria particles, odor, and chemicals are removed and maintain indoor air quality. The work focuses on a steady state analysis of heat and mass transfer in Operation Theater (OT) using commercial software ANSYS Fluent. The investigation is carried out with the help of models like energy, viscous k-ε turbulence model, species transport model, and discrete phase modeling. The study is based on an analysis of a three-dimensional model of an operation theater. The numerical schemes used in the investigation are to validate experimental results. Results provide a complete picture of OT's pressure, velocity, temperature, and relative humidity distribution. A recommendation for better distribution of key parameters with the help of relocating the position of inlet and outlet vents is also presented. The investigation takes care of operational theater requirements to reduce surgical site infection and maintain a sterile field inside OT.

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Bang, J.-I., Choi, A., Rim, D., Sung, M.

Numerical evaluation of upper-room UVGI disinfection performance for bioaerosols in a full-scale airborne infection isolation room.

Building and Environment, Vol. **304**, (2026)

Airborne Infection Isolation (AII) rooms are critical healthcare facilities designed to rapidly remove internal contaminants and prevent pathogen spread through high air change rates (≥ 6 h–1) and negative pressure (≥ – 2.5 Pa). However, such ventilation conditions can elevate infection risks for both patients and medical staff by inducing localized airflow stagnation, which leads to the accumulation of bioaerosols. This study evaluates the disinfection performance of an upper-room ultraviolet germicidal irradiation (UR-UVGI) system in a full-scale AII room based on an experimentally validated Computational Fluid Dynamics (CFD) model. By coupling an Eulerian multiphase model with ray-tracing-based UV fluence rate calculations, the research reveals the transport and inactivation of 1 μm bioaerosols under two critical scenarios: infiltration from adjacent areas (out-source) and indoor generated contaminants (in-source). At commercially available irradiance levels (30–50 μW/cm2), the results demonstrate substantial disinfection efficacy at the AII room exhaust, reaching 42–55% for the out-source and 45–55% for the in-source. In contrast, the room average disinfection rates were notably lower, at 16–23% and 23–26%, respectively. This discrepancy highlights the technical limitations of conventional ventilation in controlling contaminant persistence within stagnation zones, particularly near the patient. Overall, the findings suggest that while UR-UVGI is an effective strategy, its disinfection performance depends strongly on system configuration and spatial airflow patterns. Strategic optimization of both operation and layout is therefore essential to mitigate localized ventilation deficiencies. This study provides critical physical insights and foundational data to support the development of advanced infection control strategies in critical healthcare environments.

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Dhaliwal, N.

Optimizing Building Automation System (BAS) Controls to Mitigate Respiratory Infection Risk.

Journal of Research in Science and Engineering, Vol. **8** n°(7), (2026), 40–44 p.

This research explores the intricate relationship between indoor HVAC systems and respiratory infections like COVID-19, placing much emphasis on the fundamental role that is played by ventilation and filtration together with maintenance in mitigating various forms of transmission risks. Furthermore, it also examines some of the major challenges that are posed by recirculated air together with inadequate ventilation, proposes various solutions that entail advanced technologies like UV-C germicidal irradiation and HEPA filtration. Building automation systems (BAS) offer an adaptable approach to addressing respiratory infections transmission issues. The BAS includes various components like microprocessor based programmable controllers, field sensors and control devices. BAS facilitates real time monitoring and data oriented corrective actions in HVAC equipment to reduce the spread of virus transmission through air. The investigation confines a rigorous examination of sensor technologies, control logics, and some system alteration employed in building automation to ensure an exact understanding of their impact on air transmission. It scrutinizes how automated control logic, related with real-time data, contributed to the efficient operation of HVAC systems. The research observes the alliance between automation technologies and HVAC components, highlighting their role in not only ensuring comfort conditions but also in achieving energy-efficient operation.

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Avila-Sosa, R., Munguía-Pérez, R., Toxqui-Munguía, M., Perez Perez, J. C., Marin - Castro, M. A., Huerta Lara, M.*, et al.*

Presence of Aspergillus Fumigatus and Sick Building Syndrome in a Tertiary Care Hospital in Puebla, Mexico: Implications for Hospital Biosecurity.

In: Advances in the Fight Against Aspergillus - From Bench to Clinic. IntechOpen; 2026

The assessment of indoor air quality and fungal bioaerosols in hospitals is critical due to nosocomial infections. Aspergillus, a primary opportunistic pathogen causing aspergillosis, is heavily implicated in Sick Building Syndrome (SBS). This cross-sectional study evaluated fungal contamination in critical, emergency, and transition areas of a tertiary care hospital in Puebla, Mexico, during 2025. A physical matrix of 208 environmental samples (48 active bioaerosols and 110 infrastructure surfaces) plus 50 human biological specimens was systematically analyzed, identifying 29 fungal genera. Environmental samplings revealed a consistent mycological profile dominated by Penicillium spp. (35%), followed by Aspergillus (predominantly A. fumigatus, 16%) and Cladosporium (8%). Conversely, human clinical specimens exhibited a distinct profile characterized by yeast predominance, led by Candida (C. albicans, 26%), while Aspergillus was limited to A. flavus (12%). Epidemiological evaluation using the NTP-290 valuation questionnaire confirmed that the infrastructure met sick building criteria. Shannon-Wiener index analysis showed low, stable fungal diversity in the operating theater (1.45→1.44), while high-traffic zones like the general waiting room and laboratory exhibited high diversity (up to 3.25) with marked seasonal variability. These findings demonstrate high microenvironmental exposure risks, providing essential baseline data to engineer mitigation strategies and prevent nosocomial outbreaks.

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Lo, J. Y.-T., Bong, V. N.-S., Wong, B. T.

Preventing Airborne Transmission of the Coronavirus in a University Office Space with an Effective Ventilation Strategy.

CFD Letters, Vol. **18** n°(4), (2026), 103–112 p.

The emergence of Covid-19, caused by the novel SARS-CoV-2 virus, in late 2019 resulted in a worldwide health threat and left a staggering economic impact on many countries. Evidence suggests that the main transmission mode is via the distribution of airborne virus-laden particles through air movement. Hence, strict intervention measures from social distancing to border lockdowns and closure of commercial and work premises were implemented in many countries in the early stage of the pandemic. The high infection risk related to airborne transmission modes shifted the emphasis to ventilation control which is essential to maintain acceptable air quality in the indoor environment. Guidelines from authorities such as the World

Health Organization (WHO) and the American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE) also outlined the importance of adequate ventilation in indoor settings especially during times of the pandemic. Findings from previous works suggested that ventilation strategies including inlet/exhaust locations and airflow patterns will affect the spread pattern of the virus and hence the infection risk. Therefore, this study investigates the influence of ventilation strategies in an air-conditioned office in the university to mitigate the transmission of Covid-19 by taking into consideration the effect of the placement of outlet vents on the airflow patterns. A commercial Computational Fluid Dynamics (CFD) software, ANSYS Fluent, is used in this study to assess the particle trajectory for different outlet locations. The ventilation layout plan coupled with natural ventilation, achieved with an open window, shows the best particle removal performance. In addition, the airflow path between the infected source and the outlet is also an important factor that affects the transmission risk.

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Johari, A. S., Md Salleh, S. N., Seeni, A., Othman, M. H.

Pyrrolidone-doped cellulose acetate nanofibers: a preliminary field evaluation in a mobile air filtration unit for clinical use.

Pharmacy Reports, Vol. **5** n°(3), (2026)

Airborne microbial contamination remains a persistent threat to patient safety in clinical settings, and conventional bioaerosol control strategies, particularly HEPA-based filtration, are limited by their inability to inactivate trapped microorganisms, which can continue to proliferate within the filter and recirculate into the air. This study presents a preliminary field evaluation of pyrrolidone-doped cellulose acetate (CA) nanofibers integrated into a mobile air filtration unit, aimed at reducing airborne microbial burden in a real clinical environment. The filtration unit was deployed for four weeks in an observation ward at a general hospital, and antibacterial efficacy was assessed using in situ filter sampling and active air sampling, with isolate identification performed via 16S rRNA gene sequencing. The pyrrolidone-doped CA filter achieved a significant reduction in bacterial colony counts of 51.70% at week 1 (p < 0.05), though the reduction observed at week 4 (21.68%) was not statistically significant. Active air sampling showed corresponding, non-significant reductions in airborne bacterial load of 9.52% at week 1 and 5% at week 4. Four bacterial genera were isolated from the ward air, namely Bacillus, Staphylococcus, Priestia, and Acinetobacter, including Acinetobacter baumannii, a WHO priority pathogen associated with multidrug resistance. These findings provide preliminary evidence that pyrrolidone-doped CA nanofiber filtration can meaningfully reduce short-term airborne bacterial burden in a clinical setting, while also highlighting a decline in efficacy over prolonged use that warrants further investigation into filter longevity and replacement intervals. Larger-scale, controlled studies are needed to validate this strategy as a viable adjunct for improving indoor air quality and reducing hospital-acquired infection risk.

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Silva, J. D. C., Sales, A. D.

Qualidade do ar interno em hospitais climatizados: revisão das tecnologias de monitoramento no contexto Pós-COVID-19. (Qualité de l'air intérieur dans les hôpitaux climatisés : état des lieux des technologies de surveillance dans le contexte de l'après-COVID-19).

Revista Projeção e Docência, Vol. **17** n°(4), (2026)

A qualidade do ar interno (QAI) em hospitais climatizados é estratégica para a saúde ambiental. Ela influencia diretamente a concentração e a dispersão de contaminantes físicos, químicos e biológicos. Esses contaminantes podem gerar infecções relacionadas à assistência à saúde (IRAS). Também afetam a segurança dos usuários e o bem-estar dos ocupantes. Os principais contaminantes incluem bioaerossóis (bactérias, fungos, vírus) e poluentes químicos. Sistemas de ventilação mecânica e filtragem HEPA são essenciais, juntamente com o controle de pressão diferencial. A manutenção inadequada, o design do edifício e a densidade de ocupantes são fatores críticos. A legislação brasileira, como as da Associação Brasileira de Normas Técnicas 7256:2022 e 17037:2023, e a Lei nº 13.589/2018, fornecem diretrizes

importantes. Este artigo apresenta uma revisão bibliográfica sistemática de publicações nacionais e internacionais dos últimos cinco anos (2021-2026), com o objetivo de identificar os desafios, tecnologias e estratégias de mitigação para garantir um ambiente hospitalar e edificações climatizadas segura. Conclui-se que a gestão da QAI em hospitais e edifícios climatizados exige uma abordagem multidisciplinar. São necessários investimentos em infraestrutura, monitoramento contínuo e treinamento. Essas medidas são fundamentais para a segurança do paciente, a saúde ocupacional e o bem-estar dos ocupantes. A pesquisa também revelou que a pandemia de COVID-19 intensificou a atenção sobre a transmissão aérea de patógenos. Esse contexto impulsionou a atualização de normas, o desenvolvimento de novas tecnologias e acelerou a adoção de sistemas inteligentes de monitoramento. O impacto direto recai sobre a saúde pública e ocupacional.

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Oswin, H., Morawska, L.

Real-Time Detection of Airborne Pathogens: Science Fiction or Imminent Reality?

ACS ES&T Air, (2026)

A device capable of reporting the airborne pathogen concentration within an indoor space in real time may sound fictional, but such devices have recently become a major research focus for aerobiologists across the world. Here, we aim to discuss the recent progress made toward the development of real-time airborne pathogen detection, attempting to answer the question of whether such devices could soon become a part of our day-to-day reality. After reviewing several recent publications that come close to the actual development of real-time airborne pathogen detection, we concluded that, while there remain significant technological and logistical hurdles to the implementation of this technology, it is technically feasible and could indeed be an imminent reality. However, upon consideration of practical limitations to how the devices could be used, our perspective is that the development of these devices should not be a focus of aerobiology research. The inability of the devices to respond to emerging pathogens, the cost of the devices, and the limitations to their functionality imposed by the complexity of indoor air flows mean that even if real-time airborne pathogen detection emerges beyond the realms of science fiction, it is only within limited scenarios that this significant technological leap will offer any practical benefit.

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Zachreson, C., Li, X., Kevin, K., Schofield, R., Marshall, C., Kainer, M.*, et al.*

Room-return ventilation and N95 respirator policies for reducing airborne pathogen exposure on hospital wards.

Journal of Hospital Infection, Vol. **174**, (2026), 135–145 p.

Summary Background Understanding interactions between the components of bundled mitigation measures can aid the prospective evaluation of hospital infection control programmes. This work provides a prospective, simulation-based examination of engineering controls (re-configured ventilation systems) designed to protect the healthcare workforce from airborne exposure on a ward for patients with acute respiratory infections such as coronavirus disease 2019 (COVID-19). Method We developed and applied an agent-based computational model of nosocomial SARS-CoV-2 outbreaks to evaluate the combined effects of adding return ventilation in patient rooms (room-return ventilation) and a point-of-care N95 respirator policy where healthcare workers use respirators within patient rooms but do not wear them in other clinical areas (corridors and nurse stations). Finding By simulating COVID-19 transmission in the ward environment, our study demonstrates that modifications of air return configurations to limit the transport of viral quanta from patient rooms into adjacent corridors complement the effect of point-of-care respirator use, with synergistic effects. Indicative results show an increase in the benefit of N95 respirators on the time required for 50% of the ward's healthcare staff to become infected from 14.5 days 95% confidence interval (CI) [14.4, 14.7] (+262% [+260%, +265%]) using the baseline corridor-return ventilation configuration, to 40.1 days 95% CI [39.7, 40.4] (+576% [+570%, +581%]) using the modified room-return configuration, for a synergistic effect of more than two-fold. Conclusion The benefit of bundling room-return

ventilation with the point-of-care N95 respirator policy is approximately equivalent to requiring N95 respirator use in all clinical areas (patient rooms, corridors, and nurse stations) with corridor-return ventilation.

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Qian, Y., Ji, J., Xu, S., Gao, Y., Li, Z., Jia, H.*, et al.*

Self-sustained solar-driven airborne bacterial inactivation via thermal-UV synergistic inactivation in BIPVT systems.

Energy and Built Environment, (2026)

In the context of increasing demands for both indoor health and building energy efficiency, building energy systems integrating solar heating and photovoltaic power generation with air purification show great potential. Incorporating UV inactivation can further enhance disinfection performance. However, in solar utilization systems, air temperature typically falls within a moderate range (40–60°C), and the thermal-UV synergistic inactivation of bioaerosols under such conditions remains insufficiently understood. This study systematically investigates the quantitative thermal-UV synergistic inactivation characteristics of airborne bacteria under different UV peak wavelengths and further develops two self-powered, self-purifying building envelopes. A sealed experimental chamber was constructed to measure the inactivation rate of aerosolized Escherichia coli and Staphylococcus aureus under different UV peak wavelengths (222, 254, and 365 nm) and temperatures (25–60°C). Results show that thermal and UV irradiation exhibit a synergistic inactivation effect at 222 nm and 254 nm. A four-parameter inactivation model was developed and shows good agreement with experimental results. System-level analysis indicates that incorporating UV inactivation significantly improves bioaerosol removal, increasing the daily clean air delivery for E. coli and S. aureus by approximately 2.17 and 5.27 times, respectively. Parametric analysis shows that increasing air channel depth benefits the air purification performance of the system. The findings provide new insights into solar-driven bioaerosol control. Moreover, the established thermal-UV inactivation model can be further extended to air-handling systems such as HVAC systems and heat-recovery ventilation units, offering theoretical support for improving indoor air quality.

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Affan, H. U., Lenehan, C., Fryar, S., Taylor, M., Whiley, H., Delcheva, I.*, et al.*

Surface-Engineered Filters for Wettability-Driven Collection of Airborne Fungal Spores.

Global Challenges, Vol. **10** n°(7), (2026)

Environmental sampling of fungal spores is critical for assessing exposure risks, but current methods often miss low-abundance or spatially dispersed spores, highlighting the need for more sensitive sampling methods. This study explores the use of plasma polymerization to chemically modify air filters for enhanced fungal spore capture. Polyethylene terephthalate (PET) filters are coated with nanothin films from four monomers -acrylic acid, 2-methyl-2-oxazoline (POX), 1,7-octadiene, and perfluorooctane (PFO)- and characterized using ellipsometry, X-ray photoelectron spectroscopy, and contact angle measurements to evaluate film thickness, chemistry, and wettability. A custom aerosolization chamber was used to test the capture efficiency of plasma-modified filters for airborne spores from four species: Aspergillus niger, Cladosporium sp., Penicillium roqueforti, and Rhodotorula glutinis. Quantitative analysis using hemocytometry and dry biomass measurement reveals species-specific adhesion patterns that are predominantly driven by surface chemistry. Hydrophobic PFO-coated filters achieved the highest capture of filamentous fungi, while hydrophilic POX coatings best captured the tested yeast. Coating thickness had no significant effect, highlighting the primacy of surface chemistry over film depth. These findings establish plasma polymerization as an effective strategy to tailor filter surfaces for selective fungal spore capture, providing a proof-of-concept for functionalized air filters that support improved bioaerosol monitoring in built environments.

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Sivamoorthy, K., Hui, A., Yin Mei, F., Chew Beng, S., Szu-Cheng, C., Peng Cheng, W.*, 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 × 103 to 2.88 × 103 and 7.2 × 103 to 1.3 × 104, 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.

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Luo, P., Xu, G., Wang, L., Tang, M., Sun, Z., Liang, Y.

Washable and antibacterial air filtration paper enabled by dual-functional core-shell polymer coatings.

Journal of Industrial and Engineering Chemistry, (2026)

Washable air filtration materials are crucial for sustainable public health defense against particulate matter and airborne pathogens. However, conventional antibacterial air filter media are prone to mechanical strength degradation and the rapid leaching of active components during washing, compromising both filtration efficiency and antibacterial efficacy. Here, we report a robust, roll-to-roll fabricable glass fiber filter paper that achieves washing durability and antibacterial performance via a dual-functional core–shell structured polymer binder. The polyacrylate core layer acts as a mechanical reinforcement that improves the tensile strength of the filter paper from 200 N/m to 811.7 N/m with an 8 wt% binder loading, providing the structural resilience against physical stresses of industrial pleating and washing cycles. The shell layer acts as a functional shield with surface enriched quaternary phosphonium groups and fluorinated chains, providing antibacterial property via electrostatic interaction and anti-leaching protection via hydrophobicity. The filter papers retain high filtration efficiency (>97.8 %), low air resistance (<168 Pa@5.3 cm/s) and antibacterial rates of 99.8 % against E. coli and 99.9 % against S. aureus even after ten washing cycles. This work offers a promising, scalable strategy for developing long-term reusable antimicrobial air filter media for sustainable air quality management.

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