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Si Ali, A., Vanoli, E., Smati-Lafarge, M., Boudjemaa, A., Rodriguez, C., Guyot, C., *et al.*

[Computational fluid dynamics and genotyping to explore airborne transmission of respiratory viruses in hospitals.](#)

International Journal of Infectious Diseases, Vol. **168**, (2026)

Objectives Airborne transmission of respiratory viruses in healthcare settings is often underestimated because conventional epidemiologic methods provide limited insight into aerosol dynamics and ventilation performance. Integrating aerosol simulations with viral genomic data may support the plausibility of airborne transmission pathways and help explain differences in outbreak magnitude over time. **Methods** We investigated two nosocomial SARS-CoV-2 clusters between January and April 2021 in a French university hospital. Patients and healthcare workers were screened by RT-PCR, and whole-genome sequencing was performed for samples with Ct <30. Computational fluid dynamics (CFD) simulations reproduced ventilation conditions and modeled aerosol dispersion and inter-room particle transport. **Results** Genomic sequencing identified transmission links that were not fully explained by contact tracing alone. CFD simulations showed consistent aerosol recirculation between patient rooms and corridors, with localized increases in particle concentrations in poorly ventilated areas due to an extraction failure. Spatial overlap between airflow pathways and genetically linked cases supported the plausibility of airborne transmission and helped explain differences in outbreak magnitude over time. **Conclusion** Combining CFD modeling with viral genomic sequencing provided complementary insights into airborne transmission pathways not fully captured by conventional epidemiologic investigation and can guide targeted ventilation interventions.

Dacey, R. G., Ezeala, C. C., Kennedy, T., Agnello, E., Ribbe, A., Cavaleiro, S., *et al.*

[Converting Passive Filtration Media into Active Air Biofiltration Surfaces for Airborne Viral Reduction.](#)

medRxiv, (2026)

Conventional air filtration relies on passive mechanical capture without pathogen inactivation, where viral reduction must be balanced with airflow and energy performance. We developed an Ablative Polymer Coated (APC) filtration system that converts passive filters into active pathogen-reducing surfaces while maintaining low airflow resistance. Unlike conventional approaches requiring denser, higher-resistance media, this strategy enhances biological performance at the filter surface without equivalent aerodynamic penalties. The coating incorporates benzalkonium chloride within a polyvinyl acetate/acrylate matrix for controlled ablative exposure. Performance was evaluated using transmission electron microscopy (TEM), aerosol challenge testing, and HVAC-scale filtration. Ablative exposure caused progressive structural disruption of MS2 bacteriophage, the SARS-CoV-2 simulant. In aerosol challenge testing, coated media achieved up to 99.997 % viral filtration efficiency under respiratory airflow conditions. In HVAC (Heating, Ventilation, and Air Conditioning)-scale testing, coated filters achieved >85 % viral filtration efficiency with minimal pressure-drop increase. Computational fluid dynamics modeling confirmed uniform airflow distribution without significant turbulence generation. Energy analysis suggested coated filters may reduce energy demand relative to conventional higher-resistance configurations while improving biological performance. These findings support ablative polymer-coated media as a strategy for reducing airborne viral burden without aerodynamic penalties of higher-efficiency passive filtration, suggesting an approach that complements rather than depends solely on tighter filter design.

Chen, J., Fu, X., Fei, S., Li, X., Feng, Z.

[Decoupled synergistic control of airborne infection risk and thermal comfort in open layout dental clinics: Integration of indoor airflow pattern, physical barrier, and air purifier.](#)

Journal of Hazardous Materials, Vol. **510**, (2026)

Open layout dental clinics represent a typical medical environment characterized by high bioaerosol exposure risk and stringent thermal comfort requirements. Optimization of conventional air-conditioning airflow patterns often fails to simultaneously control thermal comfort and infection risk. Moreover, existing studies have largely overlooked surface contact infection caused by bioaerosol deposition. This study proposes a decoupled synergistic optimization strategy for indoor thermal comfort and airborne infection risk, based on the integration of airflow pattern, physical barrier and air purifier. First, airflow pattern of HVAC system is optimized to ensure indoor thermal comfort. Subsequently, low-intervention pollution-control devices (physical barriers and air purifiers) are introduced to reduce indoor bioaerosol concentrations and suppress dispersion pathways without compromising thermal comfort. Based on Dose-response model, CFD-based bioaerosol surface deposition model and corresponding contact infection risk assessment method are developed. To overcome the low computational efficiency of traditional Lagrangian particle-tracking approach in air-purifier simulations, an air-purifier performance prediction model is established using Eulerian contaminant transport equation combined with customized parallel computing. Results show that optimal airflow pattern reduces indoor average Predicted Percentage Dissatisfied (PPD) to 8.5%. Under this thermal comfort scenario, the addition of 1.5-meter-high physical barrier or air purifier with output airflow rate of 0.06 m³/s reduces respiratory infection risk to below 0.1% and surface contact infection risk to below 1E-06. Meanwhile, the PPD variation remains within 12%, with slight improvement in overall thermal comfort. This study provides an engineering reference for indoor environmental optimization and infection-risk control in dental clinics and similar healthcare environments.

Macintyre, C. R., Notaras, A., Bari, N., Doolan, C., Mahmoud, M. M. A., Honeyman, D., *et al.*

[Detection of SARS-CoV-2 in aerosol and surface samples in high acuity hospital settings during community epidemic waves – implications for risk-based infection control.](#)

Respir Med, Vol. **253**, (2026)

Rationale Nosocomial transmission of SARS-CoV-2 is multifactorial and may vary between clinical sites. Objectives To measure SARS-CoV-2 in the air and on surfaces within the Intensive Care Unit (ICU) and Emergency Department (ED). Methods We conducted an air and surface-sampling study of SARS-CoV-2 in the ED and ICU of a hospital in Sydney. Measurements We sampled air, patient equipment, and personal protective equipment during two community COVID-19 epidemics. SARS-CoV-2 was detected using quantitative reverse transcription polymerase chain reaction (RT-qPCR). Carbon dioxide (CO₂) was measured simultaneously, with <800 ppm indicating good air quality. Main results SARS-CoV-2 genetic material was detected in 39% of 51 aerosol samples, with mean CO₂ levels consistently <800 ppm for positive samples. The ED had more detections than the ICU (80% vs. 20%; $p < 0.0027$) and a higher mean CO₂ level than the ICU (669 ppm vs. 522 ppm; $p < 0.05$). The ED waiting room, acute ward, and ICU staff tearoom showed higher detection rates than the ICU ward area. SARS-CoV-2 was detected in air samples in the ED a week before an outbreak was declared, and both inside and outside a COVID-19 patient's negative-pressure ICU room, where high-flow nasal prongs and a glove tested positive. Conclusion During community epidemics, SARS-CoV-2 genetic material is detected in hospital air despite good ventilation. Enhanced protection with masks, vaccines, and portable air purifiers, especially in high-risk areas, may mitigate nosocomial transmission, including among staff. Air sampling can provide an early warning of an outbreak and help identify areas that need enhanced infection control.

Ji-Yong, Y., Kyusung, H., Seung-Ho, K., Min-Hwa, L., Min-Cheol, J., Hee-Yun, J., *et al.*

[The Distribution and Characteristics of Airborne and Condensate Bacteria in Indoor Swimming Pools.](#)

Journal Of Environmental Health Sciences, Vol. **52** n°(2), (2026), 198-206 p.

Background: Indoor swimming pools are high-humidity environments where user activity and condensation-derived wet surfaces may increase microbial persistence and exposure both in indoor air and on surfaces. Objectives: To characterize culturable bacteria in airborne and condensate samples, this study compared bacterial load, richness, and genus composition and explored differences by ventilation and disinfection methods. Methods: Four indoor pools (A~D) in the South Korean city of Gwangju were surveyed five times from November 2024 to October 2025. Airborne bacteria were collected by impaction (250 L), and condensate was sampled by swabbing a 10×10 cm area. Culturable concentrations were expressed as CFU/m³. Isolates were identified to the genus level using matrix-assisted laser desorption/ionization time-of-flight mass spectrometry (MALDI-TOF MS). Results: Mean relative humidity differed among pools (A, 86.5%; D, 68.4%). Airborne bacterial loads ranged from 20 to 378 CFU/m³. They peaked in pool A in June 2025 (378 CFU/m³). Airborne richness increased from June to October. Condensate richness was lower overall, but increased in October in some pools. In total, 58 genera were identified (43 airborne; 35 condensate). In airborne samples, Staphylococcus was frequent, Bacillus contributed more in pools A and B, and Micrococcus contributed more in pools C and D. In condensate, Cupriavidus predominated in pool A, while Pseudomonas and Staphylococcus predominated in pools B~D. Total bacterial counts were weakly associated with relative humidity (R²=0.189). Ventilation/disinfection methods were associated with shifts in Sphingomonas, Staphylococcus, and Bacillus. Principal component analysis (PCA) separated pools by genus composition, explaining 72.4% of the variance. Conclusions: Airborne and condensate bacteria showed distinct, pool-specific characteristics. Management should extend beyond water disinfection to include humidity/condensation control, optimized ventilation, and hygiene for wet surfaces and HVAC-associated areas.

Wang, Y., Jiang, L., Liu, Z., Cai, D., Liu, J., Rong, R., *et al.*

[Evaluation of the aerosol transmission patterns and the airflow organization effectiveness in the respiratory outpatient clinic.](#)

Building and Environment, Vol. **300**, (2026)

In recent years, the frequent occurrence of respiratory infectious diseases has posed a severe challenge to public health systems. As a closed space for interaction between physicians and patients, outpatient clinic can easily accumulate bioaerosols carrying pathogens during patient treatment, increasing the risk of cross infection. Therefore, this study focuses on two typical examination rooms in the respiratory department: Team outpatient clinic (TC) and Private outpatient clinic (PC). Combining two scenarios of patient sitting and lying, the research employs a combination of experiments and Computational Fluid Dynamics. The dynamic diffusion process of bioaerosols generated by patient was simulated and evaluated through multiple indicators, including removal index, dispersion index, and deposition ratio. The results indicate that the layout of the clinic and the patient's position significantly influence aerosol diffusion and ventilation efficiency. The TC, with lateral supply and return, demonstrates superior overall aerosol removal and dilution capabilities compared to the PC, which uses ceiling supply and return. Aerosols are more easily expelled during sitting consultations. Aerosol deposition on walls significantly increases during supine medical examinations, especially in the PC, where the suspension time of aerosols is prolonged. In conclusion, the study reveals the limitations of airflow organization in clinic when addressing different consultation postures, providing a theoretical basis for infection control in clinic.

Gold, D., Materna, B., Brown, G., Gherga, C.

[Impact of California's Aerosol Transmissible Diseases Standard on Worker Protection from COVID-19.](#)

NEW SOLUTIONS: A Journal of Environmental and Occupational Health Policy, Vol. **36** n°(1), (2026), 21-35 p.

As the COVID-19 pandemic began, California was the only state where workers in high-risk workplaces including healthcare and prisons were protected under a comprehensive occupational health standard for aerosol transmissible diseases (ATD Standard). The ATD Standard provides clear, enforceable requirements to protect workers from an emerging, novel pathogen. Based on open access sources and public information requests, we present findings on 524 COVID-19-related enforcement inspections in certain specified industries covered by the ATD Standard from January 1, 2020 to January 1, 2024, and on the 460 inspections that resulted in citations for violations of the ATD Standard. Evidence showing that 80% of identified ATD hazards were abated demonstrates a substantial impact on worker protection. We describe citation details from acute care hospitals, skilled nursing facilities, and state prisons. Based on California's experience, we recommend enhancing enforcement staffing, updating the ATD Standard, and adopting a Federal OSHA infectious diseases standard.

Han, X., Qin, M., Li, J., Zhan, H., Yuan, X., Mahyuddin, N.

[Mitigation of Airborne Disease Transmission and Particle Capture by Ceiling Fan Ventilation in Street Stores.](#)

Urban and Building Science, Vol. **2** n°(2), (2026)

Street stores are high-density environments that are regarded as high-risk public spaces during epidemics and influenza outbreaks. The use of ceiling fans (CF) to improve airflow organization is considered an effective strategy for mitigating airborne virus transmission. While CFs offer advantages such as energy efficiency, cost-effectiveness, and ease of implementation, their effectiveness has not been quantitatively described. In this study, tracer gas diffusion experiments combined with computational fluid dynamics (CFD) simulations were conducted to evaluate various CF operation strategies in a representative street store in northern China. Occupant infection risk was further quantified using the Wells-Riley model. Results indicated that in enclosed environments, CFs could provide only short-term reductions in breathing-zone concentrations. When combined with natural ventilation (NV), particle removal efficiency increased by at least 60%. Comparative analysis revealed that low CF speeds were insufficient for particle removal, while excessively high speeds facilitated viral dispersion. Optimal control of overall infection risk was achieved when NV+CF operated at 196 RPM.

Yao, G., Liu, Z., Shi, J., Hu, L., Ding, M., Lin, C., *et al.*

[Natural antimicrobial composite membranes for effective filtration and inactivation of airborne bacteria and viruses.](#)

Journal of Hazardous Materials, Vol. **512**, (2026)

Antibacterial and antiviral air filters are critical for reducing microbial contamination. However, natural antibacterial filtration materials require further development, and their bioaerosol filtration performance remains insufficiently evaluated. This study developed a chitosan-tannic acid (CS-TA) natural composite antibacterial agent, and the M5-filter was modified by freeze-drying to fabricate CS1-TA0.5 composite aerogel medium-efficiency air filtration membranes. After screening for the optimal composite membrane based on antibacterial and antiviral performance, its bioaerosol filtration performance was comprehensively evaluated. Additionally, its inactivation performance was further quantified through filtration deposition-detachment culture tests. Finally, wind tunnel tests were conducted to validate its practical applicability. Results showed the CS1-TA0.5 composite membrane achieved over 95% inactivation against bacteria and viruses. At 20–30°C, its average bioaerosol filtration efficiency reached 74.22% while maintaining a low pressure drop. It maintained relatively high and stable performance under varying humidity, face velocity, and operating time. After 36 h of filtration deposition, almost no viable bacteria or viruses remained on the composite membrane. Additionally, wind tunnel tests further confirmed that the CS1-TA0.5 composite filter

maintained high bioaerosol filtration efficiency under realistic airflow conditions. This study provided valuable insights for the development and application of antibacterial and antiviral air filtration material, further ensuring human health and biosafety.

Hall, K.

[Open windows, air change rates and sneeze guards: Unpacking indoor exposure criteria for SARS-CoV-2.](#)

Staying with the trouble of breath, Vol. **25** n°(2), (2026), 33-67 p.

During the COVID-19 pandemic, the very air we breathe became the medium of transmission for SARS-Coronavirus-2. At the onset of the pandemic the contagiousness of pre- and asymptotically infected persons together with the lack of treatment options and effective vaccines made it necessary to trace with whom infected persons had come into contact to prevent an overburdening of the health system. The practice of contact tracing differentiates contact persons of infected cases according to the likelihood of exposure to viral aerosols and hence the risk of subsequent infection. Drawing on ethnographic research in one public health authority, this paper investigates the practice of contact tracing. I argue that the scientific controversies on indoor air quality, viral aerosols and routes of transmission worked together in shaping office landscapes and risk criteria which enacted paradoxical ontologies of airborne exposure. Contact tracers drew on their situated embodied experience of their office riskscape to make sense of contact persons' exposure narratives and to appropriately sort them into risk categories. In this way, the paper shows how in an organisational setting, street-level bureaucrats translate case criteria into decisions.

Miller, S. L., Yan, S., García, A., Wang, L. L., Zhai, Z., Aranda, J. R., *et al.*

[Potential airborne transmission of SARS-COV-2 through bathroom ventilation ducts associated with an outbreak in a residential building in Santander, Spain, 2020.](#)

PLoS One, Vol. **21** n°(5), (2026)

During the COVID-19 pandemic, airborne transmission of SARS-CoV-2 via respiratory aerosols was a critical concern in indoor environments. In the city of Santander, Spain, an outbreak in a multi-family residential building during a period of low community transmission revealed vertical clustering of 15 cases in four homes. The building's design included single interior bathrooms without windows in each home, ventilated by a shared vertical bathroom duct system. Field measurements, computational fluid dynamics (CFD) simulations, and multi-zone airflow modeling were performed to evaluate vertical disease transmission potential in the Santander building. Epidemiological and genetic data combined with the field-collected data and modeling indicated that the most plausible transmission route was the bathroom vertical ventilation duct system, which facilitated movement of infectious aerosol between vertically connected homes. Additionally, operating the kitchen exhaust fan can augment the movement of aerosols between occupied spaces increasing the potential for infection. Recommendations for mitigating future risks include the installation of forced air exhaust fans with non-return flaps in bathroom ducts.

Albert, N.

[Qualité microbiologique et risques associés aux systèmes de refroidissement à base d'eau utilisés en élevages porcins et aviaires.](#)

Université Laval, Québec. Thèse 2026

Cette étude visait à évaluer la présence d'agents pathogènes d'origine hydrique (BPOH), notamment *Legionella* sp., *Legionella pneumophila*, *Acinetobacter baumannii*, *Mycobacterium* sp., *Mycobacterium avium* et *Pseudomonas aeruginosa*, dans l'air d'élevages porcins et aviaires, ainsi que dans l'eau sur les

surfaces de SR. Des échantillons ont été prélevés entre juin et septembre 2023 et 2024 dans deux élevages porcins et deux élevages de poulets de chair utilisant ces systèmes. Les bioaérosols ont été collectés à l'aide d'un SASS® 3100 Dry Air Sampler (qPCR) et d'un SASS® 2300 Wetted-Wall Air Sampler (culture), à un débit de 300 L/min, collectant 10 m³ d'air. Des mises en culture sur milieux GVPC et Middlebrook 7H10 ont été réalisées sur un sous-ensemble d'échantillons afin d'isoler des légionelles et des mycobactéries. Tous les échantillons ont été analysés par PCR quantitative (qPCR) pour la détection et la quantification des BPOH ciblés. Aucun des genres ciblés n'a été isolé en culture. La qPCR a détecté tous les BPOH ciblés et les concentrations ont été exprimées en copies par mL, par surface ou par m³ d'air. Les résultats soulignent l'importance de surveiller les SR à base d'eau et de mettre en place des mesures d'entretien afin de réduire les risques pour la santé des travailleurs. Des analyses de culture complémentaires seraient nécessaires pour confirmer la viabilité des bactéries et évaluer les risques pour la santé des personnes exposées à ces environnements.

Ramadan, M. N. A., Ali, M. a. H., Ghazali, N. N. N., Jaber, H., Rayash, A. A., Ghazal, M., *et al.*

[**A transfer-federated learning framework integrating toxicological risk modeling for heterogeneous UAV, UGV, and IoT air-quality monitoring.**](#)

Alexandria Engineering Journal, Vol. **145**, (2026), 295-312 p.

Existing air quality monitoring systems rely on static sensors, failing to capture personal exposure dynamics and hindering secure cross-platform data sharing. To address these limitations, this study introduces a novel Transfer-Federated Learning (TFL) framework for collaborative learning among heterogeneous devices—an unmanned ground vehicle (UGV), an unmanned aerial vehicle (UAV), and fixed IoT stations—while preserving data privacy. The TFL approach uniquely adapts a pretrained model to clients with different sensor configurations through layer-wise transfer and FedAvg aggregation. Lightweight models (Tiny-TCN, TFT-lite) predict both pollutant concentrations (PM_{2.5}, PM₁₀, CO₂, CH₂O, VOCs) and mechanistic toxicological risks (inhalation dose and hazard quotient). Field tests across three industrial sites demonstrated high cross-platform accuracy (global R² = 0.984) and real-time inference (<2 s), reducing personal exposure estimation error by over 40% compared to static fixed-sensor baselines. The core contribution lies in the system-level integration of transfer learning and federated learning across heterogeneous platforms, with toxicological metrics used to translate predictions into actionable occupational risk indicators. This work establishes a new paradigm for privacy-preserving, health-aware monitoring in industrial environments.
