Bulletin de veille AéroCovid
N°116 – 21/05/2025

Objectif : *Air intérieur, ventilation, climatisation et propagation du Covid-19*

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Google Scholar, Lens et WoS

Webner, F., Shishkin, A., Schmeling, D., Wagner, C.

Airborne SARS-CoV-2 in aircraft cabins: new inactivation data significantly influences infection risk predictions.

CEAS Aeronautical Journal, Vol. **16** n°(2), (2025), 427-432 p.

We predict the SARS-CoV-2 infection risk in aircraft cabins by simulating the aerosol transport with computational fluid dynamics and taking medical parameters into account. A recently presented new measurement technique allows us to measure the rapid virus inactivation after exhalation with high temporal resolution. In addition, much higher airborne SARS-CoV-2 inactivation rates than in previous studies were obtained. This raises the question of how the new knowledge of SARS-CoV-2 stability affects the prediction of infection risk. To answer this question, we evaluated 70 Lagrangian particle simulations with an index person sitting in all possible seats in an aircraft cabin. We then estimated the infection risk for the other passengers based on the old and new SARS-CoV-2 stability data. For typical transmission events, we found that the predicted infection risk is reduced by about 50% for the new stability data at low CO$$_2$$(500 ppm). However, elevated ambient CO$$_2$$concentrations of 3000 ppm protect the virus from inactivation and increase infection risk by about 50% compared to low CO$$_2$$. In addition, a high relative humidity of the ambient air, e.g., from exhaled breath, delays the rapid inactivation by a few seconds, increasing the risk of infection for immediate neighbors.

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Lu, K., Zhang, J., Li, Z., Li, Y.

Bioaerosols in Various Working and Living Environments and Their Control Measure: A Review.

Current Pollution Reports, Vol. **11** n°(1), (2025), 24 p.

This review aims to reveal the pollution characteristics of bioaerosols across various working and living environments and evaluate existing control technologies. This will help enhance public awareness of bioaerosol pollution and the available control methods, and promote the diversity, efficiency, and operability of these technologies.

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Acharya, T., Banerjee, A., Parrotte, C., Bhattacharjee, B.

A Computational Study of Hospital Isolation Room Environment to Assess the Spread of Airborne Contaminants.

Progress in Energy and Environment, Vol. **31** n°(1), (2025), 1-16 p.

The safety of healthcare workers and patients in hospitals is a matter of paramount importance. Therefore, the significance of adequate ventilation in hospital rooms towards controlling airborne infections cannot be ignored. Although several reports discuss natural and mechanical ventilation in hospital isolation rooms, conflicting opinions recommend one ventilation method. There is also a paucity of information that relates engineering evaluation of hospital room ventilation to the design standards laid down by established public health agencies in the United States. This research aims to study hospital isolation room ventilation performance using natural and mechanical ventilation methods and assess certain guidelines on hospital room ventilation. Computational Fluid Dynamics is used to evaluate the concentration of contaminated air following a coughing event within a hospital isolation room using natural and mechanical ventilation. A novel technique employing a mechanical exhaust tube is proposed that may substantially reduce contaminant concentration. Within the same hospital isolation room, the normalized maximum concentration of contaminated air is much lower with two different mechanical ventilation methods (0.2% and 0.25%) than with the natural ventilation method (0.6%), suggesting that mechanical ventilation methods are more effective in reducing the concentration of contaminated air. In addition to established design parameters such as Air Change per Hour (ACH) and ventilation volume per patient, closer proximity to the vent from the contaminant source may also play a critical role in reducing contaminant concentration.

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Begum, S. M., Ansari, M. U., Km, M. Y. A., Sultana, J.

Identification and Speciation of Aspergillus in Clinical and Environmental Samples using Culture-Based Methods: A Laboratory-based Study in Hyderabad.

Perspectives in Medical Research, Vol. **13** n°(1), (2025)

Background: Aspergillosis is increasingly recognized as a serious opportunistic infection, particularly among immunocompromised patients. Accurate species-level identification of Aspergillus is critical for selecting appropriate antifungal therapy and implementing effective infection control measures. This study aimed to identify and characterize Aspergillus species isolated from both clinical specimens and indoor air samples at a tertiary care hospital in Hyderabad, Telangana, India. Methods: Over a one-year period, a total of 709 specimens—including nasal mucosa swabs, tissue biopsies (lung, FESS), blood samples, nail clippings, and passive indoor air settle plates—were processed in the microbiology laboratory. Direct microscopic examination was performed using KOH mount, periodic acid–Schiff stain, and calcofluor white stain. Specimens showing filamentous fungi were cultured on Sabouraud dextrose agar, potato dextrose agar, corn meal agar, Czapek medium, and malt extract agar, and incubated at 25–30 °C for 7–10 days. Species identification was based on detailed assessment of colony morphology and microscopic features (conidiophore structure, vesicle shape, phialide arrangement, and conidial ornamentation), following CLSI guidelines. Results: Out of 709 specimens, Aspergillus species were isolated from 239 samples (33.7%). Thirteen species were identified, with A. flavus being the most common (33.4%), followed by A. niger (26.7%), A. fumigatus (19.2%), A. nidulans (4.6%), A. glaucus (3.3%), A. terreus (2.9%), A. versicolor (2.1%), A. calidoustus (1.7%), A. glabrata (1.7%), A. parasiticus (1.2%), A. clavatus (1.3%), A. ochraceus (0.8%), and A. tanneri (0.8%). A. flavus predominated among both clinical and environmental isolates. Conclusion: Conventional morphological methods combined with the use of multiple culture media proved effective for species-level identification of Aspergillus. Routine surveillance of Aspergillus species in both clinical and environmental samples can guide targeted antifungal therapy and support proactive infection control in healthcare environments.

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Liu, S., Wang, Y., Xiao, Y., Guo, W., Li, Y., Lu, Y., *et al.*

Impact of occupancy density and source location on inhalational exposure of infectious respiratory particles in a naturally ventilated fever clinic.

Building and Environment, Vol. **276**, (2025)

Infectious respiratory particles (IRPs) exhaled by infected patients significantly influence the safety of susceptible patients in fever clinic waiting areas. Understanding the impact of occupancy density (OD) on the IRPs transmission is essential. This study employed real-time CO2 monitoring to assess fever clinic ventilation performance. The findings revealed an average air change per hour (ACH) of 2.2, below the recommended 6 ACH for infection control. The effects of high, medium, and low OD on the IRPs transmission were analyzed using computational fluid dynamics at 2.2 ACH, considering scenarios where the infected patient was located upstream, downstream and in the seating area of the waiting area. The results showed that IRPs released from the upstream infector had the highest suspension rates, ranging from 14 % to 20 %, while IRPs from other locations had suspension rates below 5 %. Further analysis indicated that the maximum and upper quartile intake fraction (IF) in susceptible populations caused by upstream infectors decreased as OD decreased. At high OD, the upper quartile IF was 0.1 %, which was

1.5 and 2.1 times higher than at medium and low OD, respectively. This decreasing trend was not observed for downstream and seating area infectors. Significance test revealed that IF at high OD was significantly higher than at medium OD only at seating area infectors, with no significant difference in other scenarios. In conclusion, fever clinics with insufficient ventilation should prioritize increasing ventilation rates over merely reducing OD to control infection risks.

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Fong, M.-L. A., Wai Kit, C.

Natural Ventilation Technique of uNVeF in Urban Residential Unit Through a Case Study.

Preprints, (2025)

The scientific technique of urban residential units with natural ventilation is a critical aspect of sustainable architecture and urban planning for enhancing indoor air quality and reducing airborne disease transmission in a built urban environment. This technique involves an urbanized Natural-Ventilation effectiveness Factor (uNVeF) combined with the regression analysis of all corresponding parameters of wind direction with its velocity, achievable air change rate per hour, openable window combination, and height of urban residential unit. Through 25 scenarios of the case study, it demonstrates and evaluates the effectiveness of natural ventilation in an urban residential unit with 13.9 m^2 located on the thirty-fifth floor in the Hong Kong public residential building. The results confirmed the statutory compliance with the local statutory requirement of a minimum natural ventilation rate(Practice Note for Authorized Persons, Registered Structural Engineers and Registered Geotechnical Engineers). A maximum 60.1 air change rate per hour (ACH) was measured when 75% of the opened windows, which corresponds to a uNVeF of 0.953. Notably, the fully opened windows scenario resulted in a lower natural ventilation rate due to undetermined external factors. Lower floor level can still achieve 1.5 ACH with modification of several window opening scenarios at the lowest floor. It indicated that occupants should pay attention to adjusting the window opening strategies. The achievable natural ventilation can reduce the COVID-19 infection risk by 96.1% at 35/F and 93.4% at 1/F (lowest floor) compared to the 1.5ACH baseline condition. The higher the natural ventilation rate correspond to lower the COVID-19 infection risk. These findings highlighted the uNVeF technique can optimize window opening area and the effectiveness of natural ventilation in addressing health concerns.

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Guo, Y., Zhao, Y., Zhang, G., Tang, J., Ma, C., Xing, X.*, et al.*

Prediction of airborne bacterial concentrations and identification of critical factors in contaminated waste facilities: Insights into interpretable machine learning models.

Journal of Hazardous Materials, Vol. **494**, (2025)

The efficient prediction of airborne bacterial concentrations is crucial for better understanding and management of environmental sanitation risks in waste facilities. Traditional linear models have proven inadequate in capturing the complex relationships governing the formation of airborne microorganisms. This study developed four machine learning (ML) models to estimate airborne bacterial concentrations in waste facilities regarding the combined dataset as input features. The results revealed that integrating environmental factors, gaseous pollutants, and microbial datasets as input features yielded an improved testing R2 of 0.7369, with a random forest (RF) model identified as the best-performing algorithm. The bacterial populations on the surfaces and handles of waste containers were identified as the most influential parameters in the RF model. The optimal ranges of temperature (32–36 °C) and relative humidity (62 %-80 %), the optimal concentrations of ammonia (< 0.15 mg/m3) and particulate matter 2.5 (0.01–0.07 mg/m3), and the effective disinfection measures of slightly acidic electrolyzed water were recommended for controlling airborne pollution in waste facilities. Overall, the research demonstrates that ML methods have the potential in the prediction of airborne bacterial concentrations in waste facilities. By identifying critical factors with the interpretability analysis, this study offers valuable insights for targeted airborne microorganisms' risk management strategies.

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Deldoost, Z., Nasiri, F., Haghighat, F.

Real-time analysis of pathogen dispersion patterns resulting from a moving infectious person.

Building and Environment, Vol. **280**, (2025)

Maintaining indoor air quality is particularly challenging in shared spaces where both healthy and infectious persons may be present. Thus, it is essential to continuously monitor such spaces and take preventive action (ventilating) to mitigate infection transmission among other users. This study proposes a novel method for real-time detection of infectious persons and dynamic modeling of pathogen dispersion during and after their presence. The objective is to inform building operators to take appropriate action such as providing more ventilation. The method must meet two key requirements: 1) It must continuously track the infectious person's location using real-time data from sensors and cameras without relying on predefined movement paths, and 2) it must provide simulation results with computational times close to real-time, enabling immediate decision making based on pathogen concentration levels. To reduce computation time, the person is modeled as a virtual pathogen-emitting zone. Results show this abstraction only affects airflow within 1-m of the source, with minimal impact beyond, aligning with previous studies. This approach by decoupling of equations significantly speeds up simulations. In the presented case study, the simulation required 3.84 s to model 1 s of real-time pathogen dispersion, with an acceptable error margin of 3.8 %, using a personal computer. This approach offers a practical and efficient solution for real-time infection risk assessment in shared indoor environments.

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Shinohara, N., Tatsu, K., Naito, W., Murashima, Y., Sakurai, H., Kizu, T., *et al.*

Reducing the airborne infection risk in tourist buses using medium-efficiency filters in air-conditioning systems.

Building and Environment, (2025)

To reduce the airborne infection risk in tourist buses, medium-efficiency filters with a minimum- efficiency reporting value (MERV) of 11 or 13 are installed in the air-conditioning (AC) system inlets on the ceilings of three tourist buses, and the equivalent air-exchange rates (AERs) of artificial droplet nuclei and their behavior within buses are evaluated. Without filters, the equivalent AERs in the ventilation and internal air circulation modes are 12 and 1.5–5.2 /h, respectively, at the lowest air-flow, and 21 and 7.8–11 /h, respectively, at the highest air-flow. With filters installed and the AC system operating in the internal air circulation mode, the equivalent AERs are 10–15 and 27–42 /h at the lowest and highest airflows, respectively, demonstrating a droplet nuclei removal performance similar to or better than that of the ventilation mode. In the internal air circulation mode without filters, artificial droplet nuclei spread throughout the bus and decay slowly, even after emission ceases. Notably, with the source located in the center seat, the average in-vehicle concentration is higher when the AC system operates in the internal air circulation mode without filters than when it is turned off. Conversely, operating the AC system in the internal air circulation mode with a medium-efficiency filter considerably suppresses the spread of artificial droplet nuclei. Based on the advective spread of artificial droplet nuclei, the estimated average relative airborne infection risk in the bus is reduced to 52–79% in the ventilation mode and 25–50% in the internal air circulation mode with filters, normalized with that when the AC system is turned off.

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