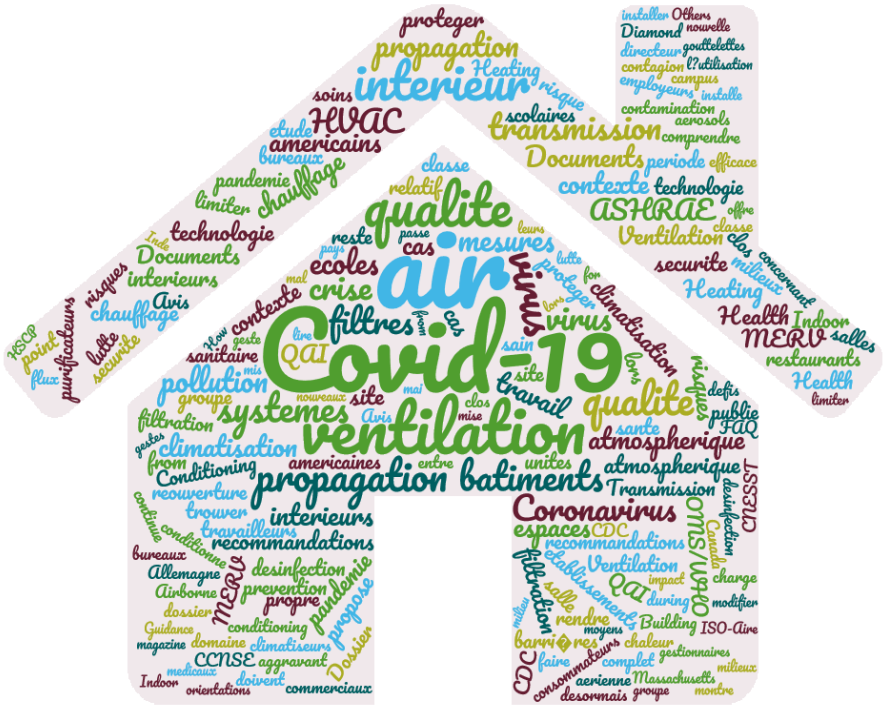

Bulletin de veille AéroCovid
N°106 - 18/12/2024

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

La validation des informations fournies (exactitude, fiabilité, pertinence par rapport aux principes de prévention, etc.) est du ressort des auteurs des articles signalés dans la veille. Les informations ne sont pas le reflet de la position de l'INRS. Les éléments issus de cette veille sont founis sans garantie d'exhaustivité.

Les liens mentionnés dans le bulletin donnent accès aux documents sous réserve d'un abonnement à la ressource.

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Google Scholar, Lens et WoS

Machida, M., Dai, K., Nakamura, I., Inoue, S.

Causes of COVID-19 Outbreaks During Sports and Exercise: A Systematic Review.

Sports Med, (2024)

Physical activity is beneficial for preventing non-communicable and infectious diseases, such as pneumonia. Physical activity is also a potential protective factor for reducing coronavirus disease 2019 (COVID-19) severity. Conversely, outbreaks of respiratory viral infections are more likely to occur owing to group activities, opportunities for contact with individuals and vocalisations. Since the onset of the COVID-19 pandemic, several cases of COVID-19 outbreaks during various sports and exercise have been reported. However, the common causes underlying these outbreaks remain unclear.

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Gittins, M., Wels, J., Rhodes, S., Demou, E., Shaw, R. J., Hamilton, O. K. L., *et al.*

COVID-19 risk by work-related factors: pooled analysis of individual linked data from 14 cohorts.

Occup Environ Med, (2024)

Background SARS-CoV-2 infection rates vary by occupation, but the association with work-related characteristics (such as home working, keyworker or furlough) are not fully understood and may depend on ascertainment approach. We assessed infection risks across work-related characteristics and compared findings using different ascertainment approaches.Methods Participants of 14 UK-based longitudinal cohort studies completed surveys before and during the COVID-19 pandemic about their health, work and behaviour. These data were linked to the National Health Service digital health records, including COVID-19 diagnostic testing, within the UK Longitudinal Linkage Collaboration (UK LLC) research environment. Poisson regression modelled self-reported infection and diagnostic test confirmed infection within each cohort for work-related characteristics. Relative Risk (RR) were then combined using random effects meta-analysis.Results Between March 2020 and March 2021, 74 757 individuals completed 167 302 surveys. Overall, 15 174 survey responses self-reported an infection, whereas 3053 had a linked positive test. Self-reported infection risk was greater in keyworkers versus not (RR=1.24 (95% CI 1.17, 1.31), among non-home working (1.08 (0.98, 1.19)) or some home working (1.06 (0.97, 1.17)) versus all home working. Part-time workers versus full time (0.94 (0.89, 0.99)) and furlough versus not (0.93 (0.88, 0.99)) had reduced risk. Results for the linked positive test outcome were comparable in direction but greater in magnitude, for example, a 1.85 (1.56, 2.20) in keyworkers.Conclusion The UK LLC provides new opportunities for researchers to investigate risk factors, including occupational factors, for ill-health events in multiple largescale UK cohorts. Risk of SARS-CoV-2 infection and COVID-19 illness appeared to be associated with work-related characteristics. Associations using linked diagnostic test data appeared stronger than self-reported infection status.Data may be obtained from a third party and are not publicly available. The data is available on request from the UK LLC (https://ukllc.ac.uk/). The analysis codes including detailing how variables were derived for each longitudinal cohort study are available from https://github.com/UKLLC/llc_0007.

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Rada, E. C., Vignali, C., Bellazzi, S., Carnevale Miino, M., Abbà, A., Szabo, M., *et al.*

Disinfection of Indoor Air for the inactivation of SARS-CoV-2: Review of Effectiveness of UV-C Technology and Gaps of Research.

Frontiers in Built Environment, Vol. **10**, (2024)

The last coronavirus disease is caused by the severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2). In indoor environments, a structured strategy is needed to reduce the risk of infection. In addition to maintaining proper ventilation and wearing face masks, the development of effective technologies for limiting transmission of SARS-CoV-2 through infectious respiratory particles (IRPs) has been studied. UV-C devices have already proved to be effective for other types of microorganisms and have been investigated also for the inactivation of SARS-CoV-2. This work aims to review and discuss these results, presenting also some possible tips for future research. Based on available data, UV-C proved to be effective in the inactivation of airborne SARS-CoV-2 or surrogates. The main gaps of the research have been also highlighted and some outlooks for future studies have been suggested. In some studies, surrogate with a higher susceptibility to UV-C than airborne SARS-CoV-2 or the simply count of total bacteria count could have led to misleading results. The question "how much variables affect the inactivation rate by UV-C of airborne SARS-CoV-2 in indoor environment?" is still unsolved considering that the number studies about the inactivation of this virus in real indoor environments is quite limited. The outcomes of this study can be useful for the scientific community, the technical stakeholders (e.g., managers in the healthcare and transport sectors), and the common people, providing important information about the performance of these technologies to improve the quality of air in indoor environments.

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Barrera, A. I. P., Peralta, L. M. R.

Enhancing Indoor Air Quality Assessment in Mexico with Big Data & ML.

Coloquio Interdisciplinario de Posgrado UPAEP, Vol. n°(11), (2024)

In this study spanning 2022 and 2023, we developed predictive models to forecast indoor air pollutant levels (CO2, TVOC, PM2.5, PM10) using environmental variables from Puebla and Morelos, Mexico, including temperature, humidity, occupancy, and ventilation. Employing Machine Learning Models—Regression Forest and Gradient-Boosted Tree—with the Gradient-Boosted Tree model showing the best performance, and statistical analyses (Levene test, ANOVA, correlation), we identified significant influences on air quality, aiming to mitigate respiratory diseases (like COVID-19) and Sick Building Syndrome (SBS). Our analyses confirmed that the ideal temperature for indoor environments is between 18 and 28 °C, with a relative humidity range of 30 to 50%, to maintain optimal air quality. The research underscores the importance of these optimal environmental conditions and continuous monitoring to prevent poor indoor air quality, following Environmental Protection Agency guidelines. These findings offer a novel approach for policy-making and indoor air quality standards, demonstrating the feasibility of predicting hazardous levels of indoor pollutants to enhance public health.,

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Bankapalli, V., Jha, N. K., Dhariwal, J., K, S. R., Srirangarajan, S.

Implications of the spatiotemporal distribution of CO2 on Indoor Air Quality: A field study with reduced-order modeling.

Building and Environment, (2024)

ABSTRACT We conducted a field study to monitor CO_2 concentrations spatiotemporally in a lecture theatre, to explore its implications for Indoor Air Quality (IAQ), particularly in relation to airborne pathogen transmission. It is widely recognized that ensuring adequate ventilation in buildings can reduce the probability of airborne transmission, with indoor CO_2 levels serving as a valuable indicator of ventilation effectiveness. While the temporal evolution of CO_2 concentrations has been well-documented in the literature, to the best of our knowledge, the spatiotemporal distribution remains less understood, especially in large spaces (>10 m) that are poorly ventilated (air change rates below approximately 1.0 h^{-1}) and air-conditioned buildings. Hence, we analyzed spatiotemporal CO_2 variations across four cases with different occupancy levels and seating arrangements using field study data. Our data reveal how factors such as number of people and their seating configurations, asymmetrical airflow vents in a tiered seating-designed room, and buoyancy-driven ventilation flow through an open doorway influenced spatiotemporal CO_2

variations for a given room geometry of our testbed. Moreover, we developed a spatiotemporal reduced-order model that can simulate the spatiotemporal distribution of pathogen quanta using real-world spatiotemporal data of CO2 concentrations. This derived model presented a linear relationship between CO_2 concentrations and pathogen dispersion. Moreover, we explore the IAQ-energy trade-off by using airborne infection probability as a proxy for health outcomes and sensible ventilation load as a proxy for energy demand. Based on this analysis, we propose design guidelines that aim to balance IAQ with energy.

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Yousaf, J., Harsenoa, R. W., Yee, J.-J.

Next-generation indoor air quality management: An integrated IoT-and deep learning-based approach for real-time monitoring and prediction.

SSRN, (2024)

This study proposed ICTAir, an innovative system approach that leverages Internet of Things (IoT) and deep learning for the real-time monitoring and prediction of indoor air pollutants. By employing low-cost sensors and a microcontroller connected to cloud computing, ICTAir tracks crucial parameters, such as temperature, humidity, CO2, PM2.5, and PM10, enabling comprehensive air quality monitoring across all seasons. Calibration and reliability assessments underscored the high accuracy of our sensors, with calibration tests yielding coefficients of determination (R2) of 0.9449, 0.6612, 0.6675, 0.6751, and 0.6428 for temperature, CO2, humidity, PM2.5, and PM10, respectively. For reliability, cross-correlation methods were used with peak values of 0.9751, 0.9321, 0.9465, 0.9719, and 0.9325 for temperature, CO2, humidity, PM2.5, and PM10, respectively. Continuous data collection allows real-time visualization and long-term analysis on an IoT cloud platform, revealing significant seasonal air quality fluctuations. Autumn and spring show high variability in particulate matter due to activities, whereas winter and summer face challenges of low humidity and high temperatures. Real-time pollutant predictions were made using a Long Short-Term Memory (LSTM) model that was updated every 5 min and processed time-series data for all parameters. Analysis across seasons showed that a 3-day training window with a 1-h prediction interval yielded optimal accuracy. The LSTM model achieved RMSEs of 9.74, 0.0002, 0.0192, 0.2237, and 1.1663 for CO2, temperature, humidity, PM2.5, and PM10, respectively. These findings highlight the effectiveness of real-time deep learning in enhancing indoor air quality management, which is crucial for advancing smart building technologies., Yee, Jurng-Jae and Yousaf, Jamal and Harseno, Regidestyoko Wasistha, Next-Generation Indoor Air Quality Management: An Integrated Iot- and Deep Learning-Based Approach for Real-Time Monitoring and Prediction. Available at SSRN:

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Basher, A. K., Biswas, M. a. a. J., Rahman, A., Rahman, M., Chowdhury, F., Hassan, M. Z.

Occupational risk of SARS-CoV-2 infection among healthcare workers in Bangladesh: a multicenter hospital-based study and lessons for future epidemics.

Trop Med Health, Vol. **52** n°(1), (2024), 92 p.

Frontline healthcare workers (HCWs) were particularly vulnerable to contracting SARS-CoV-2 infection as a result of occupational exposure. There is a scarcity of data characterizing the risk of SARS-CoV-2 infection among HCWs, particularly in low-income hospital settings. This study aimed to assess the prevalence of COVID-19 among HCWs and identify associated risk factors.

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Altwijri, O., Javed, R., Algabri, Y. A., Fakhouri, A., Alqarni, K., Altamimi, R.*, et al.*

Optimal Air Flow Modeling in Real Healthcare Facilities for Quick Removal of Contaminated Air.

Processes, Vol. **12** n°(12), (2024)

Background: Contaminated air can have a negative impact on patient recovery, leading to longer hospital stays, higher healthcare costs, and even death. Objective: Our study focuses on improving indoor air quality for patient recovery in healthcare facilities. Methods: We conducted computational analysis using the finite element modeling (FEM) technique to investigate the flow of contaminated air exhaled by a patient. Distinct models were examined: a neonatal intensive care unit (NICU) with two-beds and a coronavirus isolation room (CIR). Using ANSYS, we designed models using actual and real specifications of both NICUs and IRs from local hospitals. We determined the optimal dimensions and locations of outlet vents in NICUs and CIRs using simulations with ANSYS software drawing on our designed modeling of air flow. Outlet vent dimensions and locations were modified to achieve optimal air flow for quickly venting out contaminated air from a patient in a room. Results: The results show a substantial improvement in directly venting out the contaminated air from the patient. Conclusions: It can be concluded that the optimal design of outlet vent locations and dimensions using ANSYS simulation results in finding the optimal path for the quick removal of contaminated air flow from the patient in an NICU and CIR.

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

Particle Transport Predictions in a Generic Room: Comparison of URANS and RANS with Experiments.

24th STAB-Symposium 2024 in Berlin. 13-14 november 2024. Regensburg, Deutschland

The SARS-CoV-2 pandemic highlighted the need to understand aerosol transport and associated disease transmission and motivated many numerical flow studies using different numerical approaches for the prediction of Lagrangian particle transport for infection risk modeling with different levels of accuracy and computational costs. To evaluate the trade-off between these different flow simulation approaches, we compare particle concentration predictions based on the solutions of steady and unsteady Reynolds-averaged Navier-Stokes (RANS) equations with experimental data. A generic train entrance region is selected since it is an easy setup for experiments and numerical flow simulations. Two heated manikins are placed in this ventilated room, one of them exhaling aerosol. The RANS approach predicts significant particle accumulations that are neither observed in the experiments nor in the URANS simulations. However, the averaged absolute deviation from the experimental data decreases by a factor of 2.4 if URANS simulations are performed, albeit at an eight-fold increase in computational cost.,

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Boone, S. A., Ijaz, M. K., Mckinney, J., Gerba, C. P.

Resuspension and Dissemination of MS2 Virus from Flooring After Human Activities in Built Environment: Impact of Dust Particles.

Microorganisms, Vol. **12** n°(12), (2024)

Resuspended particles from human activities can contribute to pathogen exposure via airborne fomite contamination in built environments. Studies investigating the dissemination of resuspended viruses are limited. The goal of this study was to explore viral dissemination after aerosolized resuspension via human activities on indoor flooring. Nylon carpet or wood flooring was seeded with virus (MS2) or virus laden dust then evaluated after activities, i.e., walking and vacuuming. Statistically significant differences were found in dispersal of virus laden dust after vacuuming carpet (p-value = 5.8 × 10−6) and wood (p-value = 0.003, distance > 12 in/30 cm). Significant differences were also found between floor materials and virus laden dust dispersal vacuuming (p = 2.09 × 10−5) and walking (p = 2.68 × 10−2). A quantitative microbial risk assessment (QMRA) scenario using Norovirus and a single fomite touch followed by a single hand-to-mouth touch indicated a statistically significant difference associated with virus laden dust particles and vacuuming carpet(p < 0.001). Infection risks were 1 to 5 log10 greater for dust exposure. The greatest risk reductions from fomites were seen across vacuuming carpet no-dust scenarios for surfaces <30 cm from flooring. More research is needed to determine the role resuspension plays in exposure and transmission of potentially infectious agents.

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Levintow, S. N., Remch, M., Jones, E. P., Lessler, J., Edwards, J. K., Brinkley-Rubinstein, L.*, et al.*

Transmission models of respiratory infections in carceral settings: A systematic review.

Epidemics, (2024)

Note We provided an abstract of no more than 100 words at the time of submission, as required in Editorial Manager, but we were unable to find an abstract word limit on the journal website. We have included here the original 350-word abstract (if permitted). The prevention and control of infectious diseases in jails and prisons face unique challenges. We conducted a systematic review of transmission models of respiratory infections in these settings. Forty-six studies were identified, with tuberculosis modeled in 24 (52%), SARS-CoV-2 in 20 (43%), influenza in one (2%), and varicella-zoster virus in one (2%). Models were used to estimate intervention impacts in 32 (70%) studies, with the remainder forecasting the status quo or examining theoretical aspects of transmission. Increased attention to calibration, validation, and the practical aspects of interventions could improve translation of model estimates into tangible benefits for vulnerable incarcerated populations. Background The prevention and control of infectious disease outbreaks in carceral settings face unique challenges. Transmission modeling is a powerful tool for understanding and addressing these challenges, but reviews of modeling work in this context pre-date the proliferation of outbreaks in jails and prisons during the SARS-CoV-2 pandemic. We conducted a systematic review of studies using transmission models of respiratory infections in carceral settings before and during the pandemic. Methods We searched PubMed, Embase, Scopus, CINAHL, and PsycInfo to identify studies published between 1970 and 2024 that modeled transmission of respiratory infectious diseases in carceral settings. We extracted information on the diseases, populations, and settings modeled; approaches used for parameterizing models and simulating transmission; outcomes of interest and techniques for model calibration, validation, and sensitivity analyses; and types, impacts, and ethical aspects of modeled interventions. Results Forty-six studies met eligibility criteria, with transmission dynamics of tuberculosis modeled in 24 (52%), SARS-CoV-2 in 20 (43%), influenza in one (2%), and varicella-zoster virus in one (2%). Carceral facilities in the United States were the most common focus (15, 33%), followed by Brazil (8, 17%). Most studies (36, 80%) used compartmental models (vs. individual- or agent-based). Tuberculosis studies typically modeled transmission within a single facility, while most SARS-CoV-2 studies simulated transmission in multiple places, including between carceral and community settings. Half of studies fit models to epidemiological data; three validated model predictions. Models were used to estimate past or potential future intervention impacts in 32 (70%) studies, forecast the status quo (without changing conditions) in six (13%), and examine only theoretical aspects of transmission in eight (17%). Interventions commonly involved testing and treatment, quarantine and isolation, and/or facility ventilation. Modeled interventions substantially reduced transmission, but some were not well-defined or did not consider ethical issues. Conclusion The pandemic prompted urgent attention to transmission dynamics in jails and prisons, but there has been little modeling of respiratory infections other than SARS-CoV-2 and tuberculosis. Increased attention to calibration, validation, and the practical and ethical aspects of intervention implementation could improve translation of model estimates into tangible benefits for the highly vulnerable populations in carceral settings.

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