Rapport de veille n° 64

Aéraulique et COVID-19

15/03/2023

Les bulletins de veille sont disponibles sur le portail documentaire de l'INRS. L'abonnement vous permet de recevoir une alerte mail lors de la publication d'un nouveau bulletin (bouton « M'abonner »).

Google Scholar, Lens et WoS

Cepinski, W., Szalanski, P.
Air Filtration and Sterilization in Ventilation Systems According to the New Paradigm.
Journal of Ecological Engineering, Vol. **23** n°(10), (2022), pp. 25-34

The paper deals with the subject of increasing the efficiency of air purification in ventilation systems in situations of unusual hazardous indoor air pollutants. It analyzes possible locations of additional filtering and sterilizing elements in the installation to eliminate their return to the rooms. The quantities of pollutants in particular parts of the system were determined for a given fan configuration in the air handling unit and a possible leakage in the heat recovery system. Guidelines were proposed for the design and construction of systems to enable rapid modification of systems in the event of unusual contamination or pathogens in the indoor air.

****

Hobeika, N., García-Sánchez, C., Bluyssen, P. M.
Assessing Indoor Air Quality and Ventilation to Limit Aerosol Dispersion—Literature Review.
Buildings, Vol. **13** n°(3), (2023)

The COVID-19 pandemic highlighted the importance of indoor air quality (IAQ) and ventilation, which researchers have been warning about for years. During the pandemic, researchers studied several indicators using different approaches to assess IAQ and diverse ventilation systems in indoor spaces. To provide an overview of these indicators and approaches in the case of airborne transmission through aerosols, we conducted a literature review, which covered studies both from before and during the COVID-19 pandemic. We searched online databases for six concepts: aerosol dispersion, ventilation, air quality, schools or offices, indicators, and assessment approaches. The indicators found in the literature can be divided into three categories: dose-, building-, and occupant-related indicators. These indicators can be measured in real physical spaces, in a controlled laboratory, or modeled and analyzed using numerical approaches. Rather than organizing this paper according to these approaches, the assessment methods used are grouped according to the following themes they cover: aerosol dispersion, ventilation, infection risk, design parameters, and human behavior. The first finding of the review is that dose-related indicators are the predominant indicators used in the selected studies, whereas building- and occupant-related indicators are only used in specific studies. Moreover, for a better understanding of airborne transmission, there is a need for a more holistic definition of IAQ indicators. The second finding is that although different design assessment tools and setups are presented in the literature, an optimization tool for a room's design parameters seems to be missing. Finally, to efficiently limit aerosol dispersion in indoor spaces, better coordination between different fields is needed.

****

Matsui, H., Ueda, C., Nakajima, E., Suzuki, Y., Endo, H., Sugamata, M.*, et al.*
Assessment of environmental surface contamination with SARS-CoV-2 in concert halls and banquet rooms in Japan.
Journal of Infection and Chemotherapy, (2023)

Background Although crowds are considered to be a risk factor for SARS-CoV-2 transmission, little is known about the changes in environmental surface contamination with the virus when a large number of people attend an event. In this study, we evaluated the changes in environmental surface contamination with SARS-CoV-2. Methods Environmental samples were collected from concert halls and banquet rooms before and

after events in February to April 2022 when the 7-day moving average of new COVID-19 cases in Tokyo was reported to be 5000–18000 cases per day. In total, 632 samples were examined for SARS-CoV-2 by quantitative reverse transcription polymerase chain reaction (RT-qPCR) tests, and RT-qPCR-positive samples were subjected to a plaque assay. Results The SARS-CoV-2 RNA detection rate before and after the events ranged from 0% to 2.6% versus 0%–5.0% in environmental surface samples, respectively. However, no viable viruses were isolated from all RT-qPCR-positive samples by the plaque assay. There was no significant increase in the environmental surface contamination with SARS-CoV-2 after these events. Conclusions These findings revealed that indirect contact transmission from environmental fomite does not seem to be of great magnitude in a community setting.

****

Abdul Bari, S., Sultana, Q., Jalily, Q. A., Dinesh Eshwar, M., Dodda, S.
Assessment of the Occupational Risk of Tuberculosis & Air Borne Infection Control in High-Risk Hospital Wards and Its Implications on Healthcare Workers in a Tertiary Care Hospital in South India.
Cureus, Vol. **15** n°(1), (2023)

Introduction The indoor air in hospitals could play a significant role in the transmission of a wide array of infections, especially in respiratory intensive care units, pulmonary outpatient departments, and other areas. Unprotected coughing and sneezing may facilitate the release of aerosols and contaminate the indoor environment. The majority of infections transmitted through these modes include viral diseases, including tuberculosis (TB), influenza, and measles, among several others. Moreover, the possibility of direct and indirect transmission of microbes by air has been underestimated in hospital settings, especially in developing countries. This studytherefore was carried out to assess the burden of microbes in the air of selected wards in a tertiary care hospital and evaluate the occupational risk of some infections among healthcare workers (HCWs). Methods This study was carried out between September 2019 and February 2021 at a tertiary care teaching hospital in South India. A total of 30 symptomatic healthcare workers (HCWs) were included in the study and were screened for present and past tuberculosis (TB) as well as other lower respiratory tract infections. A tuberculin skin test, chest X-ray, and sputum acid-fast staining were performed on all the HCWs who were negative for other bacterial infections and were symptomatic. The study was conductedin coordination with the pulmonology department. Active monitoring of air was performed by microbiological air sampler in the respiratory intensive care unit (RICU) and other high-risk areas including the pulmonology outpatient department (OPD), the radiology OPD, and the microbiology department. Results Sputum for tuberculousbacteriawas positive in four (16.6%) HCWs. The chest X-ray showed radiological findings suggestive of TB in five (20.8%) HCWs. Three (12.5%) HCWs who were screened for extrapulmonary TBrevealed one (33.3%) was positive for TB of the hip joint. Among the HCWs, eight (33%) returned positive tuberculin tests. Assessment of the hospital air in theRICU revealedthe bacterial count (288 CFU/m3) exceeded the normal limit (≤50 CFU/m3). The COVID-19 isolation ward showed the lowest bacterial count (06 CFU/m3) and no fungi. The predominant bacterial isolates were gram-positive cocci in clusters (Methicillin-sensitive Staphylococcus aureus). After proper disinfection and correction of ventilation techniques, the resampling results noted microbial colonies under normal limits. Conclusion A high burden of TB was noted among the HCWs. The airborne infection control strategies are essential to minimize the risk ofnosocomial infections and occupational TB risk to HCWs. Most microbes are transmitted through the airborne route and therefore it is extremely important to take measures to control the transmission of such pathogens in hospital settings.

****

Adjidé, C. C.
Bactériologie de l'environnement : risque de biocontamination, risque infectieux, développement durable.
Revue Francophone des Laboratoires, Vol. **2023** n°(550), (2023), pp. 20-32

La bactériologie de l'environnement, ou bactériologie d'environnement, est une sous-spécialité de la microbiologie d'environnement et un outil de gestion de la fraction bactériologique des risques biologiques. Dans un établissement de soins, son objectif est, entre autres, d'identifier les réservoirs et/ou les sources potentielles des bactéries d'intérêt, d'étudier les activités biologiques, la dissémination et la persistance des bactéries ou de leurs éléments génétiques mobiles dans un environnement, la formation des biofilms et la réactivité avec des composés inorganiques, d'estimer le risque/opportunité associé à ces bactéries ainsi qu'à leurs éléments génétiques mobiles, de sélectionner les procédures et les méthodes de surveillance des bactéries du microbiote ou flore microbienne environnementale afin de permettre la mise en place de solutions techniques et/ou technologiques appropriées en vue de prévenir les transferts de contamination entre humains, animaux et environnement. En dehors de l'évaluation du risque de biocontamination, la bactériologie d'environnement, comme la microbiologie d'environnement toute entière, est un outil d'évaluation des opportunités associées à la biotechnologie et au développement durable. La mise en œuvre de la bactériologie d'environnement exige des compétences humaines, une organisation pragmatique dans un écrin de démarche qualité aboutie et un financement ad hoc.

****

Markowska-Szczupak, A., Paszkiewicz, O., Yoshiiri, K., Wang, K., Kowalska, E.
Can photocatalysis help in the fight against COVID-19 pandemic?
Current opinion in green and sustainable chemistry, Vol. **40**, (2023)

Mould fungi are serious threats to humans and animals (allergen) and might be the main cause of COVID-19-associated pulmonary aspergillosis. The common methods of disinfection are not highly effective against fungi due to the high resistance of fungal spores. Recently, photocatalysis has attracted significant attention towards antimicrobial action. Outstanding properties of titania photocatalysts have already been used in many areas, e.g., for building materials, air conditioner filters, and air purifiers. Here, the efficiency of photocatalytic methods to remove fungi and bacteria (risk factors for Severe Acute Respiratory Syndrome Coronavirus 2 co-infection) is presented. Based on the relevant literature and own experience, there is no doubt that photocatalysis might help in the fight against microorganisms, and thus prevent the severity of COVID-19 pandemic.

****

Ting, M., Molinari, J. A., Suzuki, J. B.
Current SARS-CoV-2 Protective Strategies for Healthcare Professionals.
Biomedicines, Vol. **11** n°(3), (2023)

Severe acute respiratory syndrome coronavirus-2 (SARS-CoV-2) is responsible for the Coronavirus disease 2019 (COVID-19). COVID-19 was first reported in China in December 2019. SARS-CoV-2 is highly contagious and spread primarily via an airborne route. Hand hygiene, surgical masks, vaccinations and boosters, air filtration, environmental sanitization, instrument sterilization, mouth rinses, and social distancing are essential infection control measures against the transmission of SARS-CoV-2. This paper aims to provide healthcare professionals with evidence-based protective strategies.

****

Kermenidou, M., Koulaouzidou, E., Chasoglou, V., Anesti, O., Tolidis, K., Karakitsios, S.*, et al.*
Determination of Particulate Matter in Dental Clinics: The Effectiveness of Different Air Purifiers and the Central Ventilation System.
Indoor Air, Vol. **2023**, (2023)

The purpose of this study was to measure the number and concentration of airborne particulates occurring in a dental clinic while performing dental procedures, with and without the simultaneous use of air purifier

systems and a central ventilation system. The initial background concentrations of airborne particulates recorded during dental procedures, i.e., grinding of natural teeth and metals, without the use of air purifier systems, and with closed windows, reduced by 68% for PM10, 77% for PM2.5, and 81% for PM1 when the same procedures were carried out with the simultaneous use of air purifying systems. In addition, measurements taken during patient treatment showed that an operating central ventilation system contributes to the reduction of airborne particles by a significant 94% for PM10, 94% for PM2.5, and 88% for PM1 compared to dental procedures performed without the simultaneous use of air purifiers. Air purifying systems were also observed to contribute to the further reduction of airborne particulates when dental procedures were performed in combination with an operating central ventilation system. The majority of particles captured had diameters of 0.25-0.30 µm, 0.5 µm, and 1.0-4.0 µm, while particles with diameters of >5.0 µm were the least commonly observed in all experiments. Finally, a statistically significant difference between concentrations of particulate matter was recorded during dental procedures carried out with and without the simultaneous operation of air purifiers and central ventilation system increasing the risk of SARS-CoV-2 virus contamination in dental clinics due to the aerosols emitted by the use of common dental instruments during standard treatments.

****

Parker, J. E., Rodriguez, R. A.
Development of a charged model of the SARS-CoV-2 viral surface.
Biochimica et biophysica acta. Biomembranes, Vol. **1865** n°(4), (2023)

A recent study provided experimental evidence of inactivation of viral activity after radio-frequency (RF) exposures in the 6-12GHz band that was hypothesized to be caused by vibrations of an acoustic dipole mode in the virus that excited the viral membrane to failure. Here, we develop an atomic-scale molecular dynamics (MD) model of the severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) viral surface to estimate the electric fields necessary to rupture the viral membrane via dipole shaking of the virus. We computed the absorption spectrum of the system via unbiased MD simulations and found no particular strong absorption in the GHz band. We investigated the mechanical resiliency of the viral membrane by introducing uniaxial strains in the system and observed no pore formation in the membrane for strains up to 50%. Because the computed absorption spectrum was found to be essentially flat, and the strain required to break the viral membrane was >0.5, the field strength associated with rupture of the virus was greater than the dielectric breakdown value of air. Thus, RF disinfection of enveloped viruses would occur only once sufficient heat was transferred to the virus via a thermal mechanism and not by direct action (shaking) of the RF field oscillations on the viral membrane.

****

Lobanov, L. M., Chalaev, D. M., Goncharov, P. V., Goncharov, T. L., Paschin, M. O., Goncharova, O. M.*, et al.*
Development of equipment for air decontamination in the ventilation and air conditioning systems of public buildings with the use of the photocatalysis and plasmochemistry methods.
Science and Innovation, Vol. **19** n°(1), (2023), pp.71-85

Introduction. Seasonal waves of SARS outbreaks, including COVID-19, necessitate the development of measures to create health-safe conditions in crowded places.Problem Statement. The existing supply and exhaust systems of the centralized heating, ventilation and air conditioning (HVAC) do not protect against infection, moreover, they serve as a source for the accumulation and spread of pathogenic microorganisms. Finding effective ways to clean the air in places of mass gathering of people as a component of anti-epidemic measures is an urgent task. Purpose. The purpose of this research is to develop and create equipment for cleaning and disinfecting air from airborne pathogenic microflora in the HVAC systems, which can be installed in the centralized ventilation systems of buildings without their reconstruction and modifications in technological parameters. Material and Methods. A complex of physical and chemical methods, which

includes analytical and experimental techniques with the use of the theory of electrogas dynamics of dispersed systems and the raster scanning microscopy methods, and the methods for comparing the same quality indicators of specimens and initial samples have been used.Results. To study the efficiency of both the individual plasma-chemical , photocatalytic modules, as well as the equipment as a whole under the operating conditions that simulate those of the centralized ventilation system, an experimental stand has been created. The optimal technological parameters of the processes for raising the efficiency of air disinfection and purification in the HVAC systems by the plasma photocatalysis methods have been determined. Technical solutions for increasing the energy efficiency of the experimental stand for the complex air purification and disinfection from a wide class of air pollutants in the supply and exhaust ventilation systems of buildings have been proposed.ent, as well as to determine the required level of innova-tion factor by maximizing the hidden innovation capacity.Conclusions. Air disinfection by the method of combined plasma-photocatalytic effect on the air flow with a system for catalytic-thermal decomposition of excess ozone ensures effectively removing pollutants and allows reducing the microbiological contamination of the air to a safe level.

****

Na, H., Kim, H., Kim, T.
Dispersion of droplets due to the use of air purifiers during summer: Focus on the spread of COVID-19.
Building and environment, Vol. **234**, (2023)

Coronavirus disease (COVID-19), which emerged in 2019, has induced worldwide chaos. The main cause of COVID-19 mass infection indoors is the spread of virus-containing droplets via indoor airflow, which is affected by air conditioners and purifiers. Here, ten experimental cases were established to analyze how use of air purifiers affects the spread of virus-containing droplets. The experiments were conducted in a school classroom with an air conditioner in summer. In the droplet dispersion experiment, paraffin oil was used as the droplet substance. Two main scenarios were simulated: (1) an infected student was seated in the back of the classroom; and (2) the teacher, standing in the front of the classroom, was infected. The results were expressed using two parameters: peak concentration and loss rate, which reflect the degree of direct and indirect infection (airborne infection), respectively. The air purifier induced a peak concentration decrease of 42% or an increase of 278%, depending on its location in the classroom. Conversely, when the air purifier was operated in the high mode (flow rate=500 CMH; cubic meters per hour), the loss rate showed that the amount of droplet nuclei only decreased by 39% and the droplet amount decreased by 22%. Thus, the airborne infection degree can be significantly reduced. Finally, the use of air purifiers in the summer may be helpful in preventing group infections by reducing the loss rate and peak concentration if the air purifier is placed in a strategic location, according to the airflow of the corresponding room.

****

Parra, B., Contreras, A., Mina, J. H., Valencia, M. E., Grande-Tovar, C. D., Valencia, C. H., *et al.*
The Entrapment and Concentration of SARS-CoV-2 Particles with Graphene Oxide: An In Vitro Assay.
Nanomaterials, Vol. **13** n°(2), (2023)

Previous studies have suggested that graphene oxide (GO) has some antiviral capacity against some enveloped viruses, including SARS-CoV-2. Given this background, we wanted to test the in vitro antiviral ability to GO using the viral plaque assay technique. Two-dimensional graphene oxide (GO) nanoparticles were synthesized using the modified Hummers method, varying the oxidation conditions to achieve nanoparticles between 390 and 718 nm. The antiviral activity of GO was evaluated by experimental infection and plaque formation units assay of the SARS-CoV-2 virus in VERO cells using a titrated viral clinical isolate. It was found that GO at concentrations of 400 mu g/mL, 100 mu g/mL, 40 mu g/mL, and 4 mu g/mL was not toxic to cell culture and also did not inhibit the infection of VERO cells by SARS-CoV-2. However, it was evident that GO generated a novel virus entrapment phenomenon directly proportional to its concentration in the suspension. Similarly, this effect of GO was maintained in assays performed with the Zika virus. A new application for GO

nanoparticles is proposed as part of a system to trap viruses in surgical mask filters, air conditioning equipment filters, and air purifier filters, complemented with the use of viricidal agents that can destroy the trapped viruses, an application of broad interest for human beings.

****

Mao, Y., Xie, H., Liang, J., He, J., Ren, J.
Experimental study on the control effects of different strategies on particle transportation in a conference room: Mechanical ventilation, baffle, portable air cleaner, and desk air cleaner.
Atmospheric Pollution Research, (2023)

To control the spread and transmission of airborne particles (especially SARS-CoV-2 coronavirus, recently) in the indoor environment, many control strategies have been employed. Comparisons of these strategies enable a reasonable choice for indoor environment control and cost-effectiveness. In this study, a series of experiments were conducted in a full-scale chamber to simulate a conference room. The control effects of four different strategies (a ventilation system (320 m3/h) with and without a baffle, a specific type of portable air cleaner (400 m3/h) and a specific type of desk air cleaner (DAC, 160 m3/h)) on the transportation of particles of different sizes were studied. In addition, the effects of coupling the ventilation strategies with five forms of indoor airflow organization (side supply and side or ceiling return, ceiling supply and ceiling or side return, floor supply and ceiling return) were evaluated. The cumulative exposure level (CEL) and infection probability were selected as evaluation indexes. The experimental results showed that among the four strategies, the best particle control effect was achieved by the PAC. The reduction in CEL for particles in the overall size range was 22.1% under the ventilation system without a baffle, 34.3% under the ventilation system with a baffle, 46.4% with the PAC, and 10.1% with the DAC. The average infection probabilities under the four control strategies were 11.3–11.8%, 11.1–11.8%, 9.1–9.5%, and 18.2–19.7%, respectively. Among the five different forms of airflow organization, the floor supply and ceiling return mode exhibited the best potential ability to remove particles.

****

Deeb, S., Rehan, H., Hamameh, H., Schwentner, I., Wolpert, S., Becker, S.
Exploring the effects of ventilation and air-conditioned environments, on droplet and airborne transmission of SARS-COV-2.
International Journal of Innovative Research and Scientific Studies, Vol. **6** n°(2), (2023), pp. 301-309

To assess the implications of air conditioning and ventilation on droplet and airborne transmission of SARS-COV-2, several scientific research databases were searched and cross-referenced. Then, an analysis was conducted on the findings pertinent to interaction between several environmental variables affected by HVAC systems and their effect on Virus transmission. The results suggest that airflow velocity may interfere with the trajectories of large respiratory droplets and aerosols. Lower relative humidity provided suitable conditions for virus survival whereas higher temperatures increased aerosol formation, but were detrimental to virus survival. Suboptimal temperatures and humidity can compromise pathogen filtration functions in the nose, while proper use of HVAC functions can help preserve them. Transmission of SARS-COV-2 is not affected solely by the virus's internal properties. Ambient conditions, whether natural or modified by HVAC systems can have a significant effect on the transmissibility and virulence of both the virus and virus-related sickness. The current infection prevention measures, such as social distancing, need to be revised in certain scenarios where natural ventilation or HVAC systems are involved. This will offer, hopefully, higher protection from infections with SARS-COV-2 and similar pathogens.

****

Houben, F., Den Heijer, C. D., Dukers-Muijrers, N. H., Daamen, A. M., Groeneveld, N. S., Vijgen, G. C.*, et al.*

Facility-and ward-level factors associated with SARS-CoV-2 outbreaks among residents in long-term care facilities: a retrospective cohort study.
International Journal of Infectious Diseases, (2023)

Background
Long-term care facilities (LTCFs) have been disproportionately impacted by COVID-19. Yet, the reasons why certain LTCFs are affected more by outbreaks are poorly understood.
Objective
To identify facility- and ward-level factors associated with SARS-CoV-2 outbreaks among LTCF residents.
Methods
We conducted a retrospective cohort study of multiple Dutch LTCFs (N=60; with 298 wards providing care for ~5600 residents) from September 2020-June 2021. A dataset was constructed linking SARS-CoV-2 cases among LTCF residents to facility- and ward-level factors. Multilevel logistic regression analyses examined the associations between these factors and the likelihood of a SARS-CoV-2 outbreak among residents.
Results
During periods of the classic variant, mechanical recirculation of air was associated with significantly increased odds of a SARS-CoV-2 outbreak. During periods of the alpha variant, factors associated with significantly increased odds included large ward size (≥21 beds), wards providing psychogeriatric care, fewer restrictions on staff movement within and between facilities, and a greater number of cases among staff (>10 cases).
Conclusions
Policy and protocols on reducing resident density, staff movement, and mechanical recirculation of air in buildings are recommended to enhance outbreak preparedness in LTCFs. The implementation of low-threshold preventive measures among psychogeriatric residents is important since they appear as a particularly vulnerable group.

****

Gong, X., Bu, Z.
Field study on ventilation rate and COVID-19 infection risks in an office building in Shenzhen, China.
Research Square Preprints, (2023)

The current cases and studies show that the aerosol propagation of COVID-19 is possible in the office building. Reduction of the staff' exposure risk of severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) in the office building, i.e., daily office area and conference room is of prime importance during pandemic and the normalization. In this study, the main influencing factors of the exposure risk of SARS-CoV-2, including working density, dwell time and fresh air volume per person, were field measured in three office areas and three conference rooms of an office building in Shenzhen, China. And the field monitored CO2 data were used to estimate the possibility of COVID-19 infection in offices and conference rooms. The conference room with working density of 2.84 ~ 4.86m2/per presents a more crowded environment than the office area with working density of 7.7 ~ 10.15m2/per, twice the design working density. The ventilation rate of the office building is far lower than the rate of CO2 exhaled by people, resulting in the continuous accumulation of CO2 concentration, and the fresh air volume of 30 m3/(h·per) in the office building is verified to be in line with the actual situation in the paper. The conference room with an average infection risk of 2.77 × 10 − 2 is larger than the office with an average infection risk of 1.53 × 10 − 2 when the mask is not worn, and the infection risk in the office building can be reduced by 74% when the mask is worn. The results show that the number of staff, ventilation rate and office hours are all important factors affecting the infection risk of workers in office building environment, but the existing literature rarely considers these three points at the same time. On the contrary, the paper adopts the method of assessing the infection risk from place to place, time to time and person to person in the building environment, providing early warning for office buildings and helping to control the spread of airborne diseases.

****

Guinez-Viveros, R., Bobadilla-Moreno, A., Munoz-Viveros, C. A.
The impact of the covid-19 confinement on the concentration levels of co2 inside social housing in chile.
Revista Habitat Sustentable, Vol. **12** n°(2), (2022), pp. 98-111

More than ever before, the COVID-19 crisis and the need to spend longer periods of time in our places of residence, have highlighted the need to improve indoor air quality (IAQ) and ventilation to reduce the risks of airborne virus transmission. Added to the need to progressively improve the energy performance of our buildings to achieve carbon neutrality is this completely contrary new requirement, which forces reconsidering the ventilation issue, its standards, and technological solutions to improve IAQ and limit the risks of contagion inside our homes, without losing sight of the goals that climate change imposes on us. Chile is seeking strategies to generate sustainable, energy-efficient, and comfortable housing, which must be reconsidered in light of Covid-19. Greater permanence inside the home revealed the precariousness of the lifestyles the most vulnerable families face; sometimes exposing them to environments that are risky for their health. The objective of this research was to estimate the impact of Covid-19 on CO2 indoor air concentrations, as a result of the intensity of use (occupation) of the home, considering envelopes with different levels of airtightness. Using an experimental methodology, based on simulations with the DesignBuilder software, the CO2 concentrations of four types of social housing, located in the commune of Coronel, Biobio, Chile, were quantified. The results showed that confinement increased CO2 levels by 16.4%, while the change from the original condition of the envelope to more airtight levels generated an increase of more than 83% in normal use and 97% for periods of confinement.

****

Saeedi, R., Ahmadi, E., Hassanvand, M. S., Mohasel, M. A., Yousefzadeh, S., Safari, M.
Implemented indoor airborne transmission mitigation strategies during COVID-19: a systematic review.
Journal of Environmental Health Science and Engineering, (2023)

The COVID-19 pandemic has inflicted major economic and health burdens across the world. On the other hand, the potential airborne transmission of SARS-COV-2 via air can deeply undermine the effectiveness of countermeasures against spreading the disease. Therefore, there is an intense focus to look for ways to mitigate the COVID-19 spread within various indoor settings. This work systematically reviewed articles regarding airborne transmission of SARS-COV2 in various indoor settings since the onset of the pandemic. The systematic search was performed in Scopus, Web of Science, and PubMed databases and has returned 19 original articles carefully screened with regard to inclusion and exclusion criteria. The results showed that the facilities, such as dormitories and classrooms, received the most attention followed by office buildings, healthcare facilities, residential buildings, and other potential enclosed spaces such as a metro wagon. Besides, the majority of the studies were conducted experimentally while other studies were done using computer simulations. United States (n = 5), Spain (n = 4) and China (n = 3) were the top three countries based on the number of performed research. Ventilation rate was the most influential parameter in controlling the infection spread. CO2 was the primary reference for viral spread in the buildings. The use of natural ventilation or a combination of mechanical and natural ventilations was found to be highly effective in the studies. The current work helps in furthering research on effective interventions to improve indoor air quality and control the spread of COVID-19 and other respiratory diseases.

****

Qin, C., He, Y., Li, J., Lu, W.-Z.
Mitigation of breathing contaminants: Exhaust location optimization for indoor space with impinging jet ventilation supply.
Journal of Building Engineering, (2023)

Densely occupied spaces (e.g., classrooms) are generally over-crowded and pose a high risk of cross-infection during the pandemic of COVID-19. Among various ventilation systems, impinging jet ventilation (IJV) system might be promising for such spaces. However, the exhaust location of the IJV system used for densely occupied classrooms is unclear. This study aims to investigate the effects of exhaust location on the removal of exhaled contaminants in a classroom (15 × 7 × 5 m3) occupied by 50 students. Exhaled contaminants are modeled by a tracer gas released at the top of each manikin. The reference case has three exhausts evenly distributed in the ceiling. The results indicate that: a) a recirculation airflow entraining exhaled contaminants exists above the occupied zone; b) this recirculation air flow entrains contaminants and accumulates them at the upper part of the room near the diffuser; c) locating merely one exhaust on the same side of the supply diffuser leads to the best indoor air quality, i.e., it reduces the mean age of air from 278 s to 243 s, the mass fraction of CO2 from 753 ppm to 726 ppm, and the concentration of tracer gas from 305 ppm to 266 ppm; d) this layout still performs the best when the supply velocity drops to 0.5 m/s. It is worth noting that the proposed layout has fewer exhausts than the reference case but performs better. These results conclude that the exhaust for large spaces is not evenly distributed but depends on the indoor airflow pattern: the key is locating the exhaust near the region with high contaminant concentration. Factors determining the recirculation airflow are suggested to be further studied.

****

Panfilov, I., Beskopylny, A. N., Meskhi, B.
Numerical Simulation of Heat Transfer and Spread of Virus Particles in the Car Interior.
Mathematics, Vol. **11** n°(3), (2023)

The epidemic caused by the coronavirus infection SARS-CoV-2 at the beginning of 2022 affected approximately 500 million people in all countries. The source of infection is the particles of the virus, which, when breathing, talking, and coughing, are released with the respiratory droplets and aerosol dust of an infected person. Actions aimed at combating and minimizing the consequences of coronavirus infection led to taking measures in scientific areas to investigate the processes of the spread of viral particles in the air, in ventilation, and air conditioning systems of premises and transport, filtration through masks, the effect of partitions, face shields, etc. The article presents a mathematical model of the spread of viral particles in technological transport. Air intake diverters and the operator's respiratory tract are the sources of the virus. The Euler-Lagrange approach was used to simulate liquid droplets in a flow. Here, the liquid phase is considered as a continuous medium using Navier-Stokes equations, the continuity equation, the energy equation, and the diffusion equation. Accounting for diffusion makes it possible to explicitly model air humidity and is necessary to consider the evaporation of droplets (changes in the mass and size of particles containing the virus). Liquid droplets are modeled using the discrete-phase model (DPM), in which each particle is tracked in a Lagrange coordinate system. The DPM method is effective, since the volume fraction of particles is small relative to the total volume of the medium, and the interaction of particles with each other can be neglected. In this case, the discrete and continuous phases are interconnected through the source terms in the equations. The averaged RANS equations are solved numerically using the k-omega turbulence model in the Ansys Fluent package. The task was solved in a static form and in the time domain. For a non-stationary problem, the stabilization time of the variables is found. The simulation results are obtained in the form of fields of pressures, velocities, temperatures and air densities, and the field of propagation of particles containing the virus. Various regimes were studied at various free flow rates and initial velocities of droplets with viral particles. The results of trajectories and velocities of particles, and particle concentrations depending on time, size, and on the evaporability of particles are obtained.

****

Chilibeck, P. D.
Prevention of COVID-19 during youth ice hockey.
Applied Physiology, Nutrition, and Metabolism, (2023)

Ice hockey players are susceptible to COVID-19 because of close contact, and poor arena ventilation. Preventive strategies include reducing arena crowding, practice strategies that reduce clustering of players, at-home rapid tests, symptom screening, and facemask or vaccine recommendations for spectators, coaches, and players. Facemasks have little effect on physiological responses or performance and reduce COVID-19 transmission, but shifts should be shortened later in periods to reduce perceived exertion and players should be encouraged to assume a classic “hockey stance” when puck handling to improve peripheral vision. These strategies are important to prevent cancelation of practices or games, which have important physical and psychological benefits.

****

Cohen, R., Rybak, A., Squinazi, F.
Qualité de l’air intérieur: nous sommes loin de l’idéal, mobilisons-nous….
Médecine & enfance, Vol. **43** n°(1), (2023), pp. 5-8

L' amélioration de l'hygiène individuelle et collective (eau potable, égouts, assainissement) a joué un rôle considérable dans la réduction de la mortalité et de la morbidité liées aux maladies infectieuses et, par-delà, dans l'allongement de la durée de vie. En revanche, peu d'attention a été portée à la qualité de l'air que nous respirons dans nos lieux de vie. Pourtant, des épidémies virales apparaissent tous les hivers dans l'hémisphère Nord et tous les étés dans l'hémisphère Sud, la saison froide incitant à vivre davantage à l'intérieur, ce qui favorise la promiscuité et les transmissions d'agents infectieux par voie aérienne. L'amélioration de la qualité de l'air intérieur doit constituer le nouveau paradigme de la prévention des épidémies hivernales (et a fortiori des pandémies)

****

Khan, S. B., Maboza, E., Vally, N., Taliep, A.
Surveillance of specific pathogens on mobile phones in aerosol and non-aerosol generating dental clinics during the COVID pandemic.
South African Dental Journal, Vol. **78** n°(01), (2023)

Following COVID-19 protocols implemented globally, it is prudent to extend this to mobile phones, regarded as carriers of microbes, as these are used extensively in clinical settings for learning and patient care. Was to determine types of microbes harbored on mobile phones and related hygiene practices whilst using these in aerosol and non-aerosol generating dental settings. This cross-sectional study was conducted in two parts: A laboratory study to determine the prevalence of microbes on mobile phones and a questionnaire survey to determine the related knowledge and behavior of phone users in both aerosol and non-aerosol generating dental clinics. All proper protocols (consent, ethics) were adhered to. A small percentage (27.2%) of swabs of mobile phones yielded a positive bacterial culture, of these 72% were from the AGP dental setting. Gram positive and negative microorganisms were distinguishable, indicating a diverse group of microbes. Students and staff indicated good mobile phone hygiene practices, but there is place for improvement. Their related knowledge of disinfectants and use were acceptable, but not having mobile phone coverings was problematic. Faculty protocols for disinfecting mobile phones and standardized guidelines for its use in aerosol or non-aerosoclinics is recommended.

****

De Crane D’heysselaer, S., Parisi, G., Lisson, M., Bruyère, O., Donneau, A.-F., Fontaine, S.*, et al.*
Systematic Review of the Key Factors Influencing the Indoor Airborne Spread of SARS-CoV-2.
Pathogens, Vol. **12** n°(3), (2023)

The COVID-19 pandemic due to the Severe Acute Respiratory Syndrome Coronavirus 2 (SARS-CoV-2) has been plaguing the world since late 2019/early 2020 and has changed the way we function as a society, halting both economic and social activities worldwide. Classrooms, offices, restaurants, public transport, and other enclosed spaces that typically gather large groups of people indoors, and are considered focal points for the spread of the virus. For society to be able to go “back to normal”, it is crucial to keep these places open and functioning. An understanding of the transmission modes occurring in these contexts is essential to set up effective infection control strategies. This understanding was made using a systematic review, according to the Preferred Reporting Items for Systematic reviews and Meta-Analyses statement (PRISMA) 2020 guidelines. We analyze the different parameters influencing airborne transmission indoors, the mathematical models proposed to understand it, and discuss how we can act on these parameters. Methods to judge infection risks through the analysis of the indoor air quality are described. Various mitigation measures are listed, and their efficiency, feasibility, and acceptability are ranked by a panel of experts in the field. Thus, effective ventilation procedures controlled by CO2-monitoring, continued mask wearing, and a strategic control of room occupancy, among other measures, are put forth to enable a safe return to these essential places.

****

Tan, H., Wong, K. Y., Othman, M. H. D., Kek, H. Y., Nyakuma, B. B., Ho, W. S.*, et al.*
Why do ventilation strategies matter in controlling infectious airborne particles? A comprehensive numerical analysis in isolation ward.
Building and Environment, Vol. **231**, (2023)

A proper ventilation strategy in an isolation ward could promote better indoor air quality for the occupants. This could also reduce the risk of immunocompromised patients contracting healthcare-associated infections (HAI) or airborne diseases such as COVID-19, tuberculosis, and measles among others. This study aims to propose and examine appropriate ventilation strategies in a single-patient isolation ward that can reduce particle settlement in patients. A simplified CFD model of the isolation ward was developed and well-validated against established data. An RNG k-epsilon model and discrete phase model (DPM) were used to simulate airflow and particle transportation. The study examined the airflow and particle dispersion under a baseline case and four proposed ventilation strategies. Results showed that the baseline case study, which used the ceiling-mounted air curtain was insufficient to prevent the particles from dispersing into the vicinity of the patient. Likewise, the dilution effect under the baseline case and case 4 (wall-mounted air supply diffuser) were relatively weak due to the low air change rate (ACH) of 4/hr and 9/hr respectively. The ventilation strategy in case 4 has a negligible effect on reducing the particles (14%) settling on the patient although the ACH in case 4 was 2-times the baseline case. The present finding ascertains that utilising the combination of ceiling-mounted air diffuser and air curtain jet (case 3) results in zero particle settlement on both patient's and the patient's bed. It also reduced 57% of particles in the vicinity of the medical staff's breathing zone compared to the baseline case.

****