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Aéraulique et COVID-19

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Google Scholar, Lens et WoS

Roca Reina, J. C., Toleikyte, A., Volt, J., Carlsson, J.
Alternatives for upgrading from high-temperature to low-temperature heating systems in existing buildings: Challenges and opportunities.
Energy and Buildings, Vol. **323**, (2024)

The decarbonisation of heating and cooling in buildings is key to achieving the European Union (EU)'s climate and energy targets. Energy consumed in buildings represents a significant proportion of the total energy consumed in the EU; improving their energy performance is therefore fundamental to achieving these targets. This paper outlines a methodology for supporting the energy transition in the sector, emphasising the substantial decarbonisation opportunities that existing buildings present, as well as the potential bottlenecks they may encounter. The impact of changing from fossil-based boilers to heat pumps is compared in typical building typologies in different climatic conditions across the EU, providing insights into the implications of switching from high to low-temperature heating systems regarding both costs and CO2 emissions. The results show that a significant reduction in CO2 emissions can be achieved by switching from gas and oil boilers to air/water heat pumps in the analysed countries. The paper also looks at the required enhancements of the hydronic facilities, and building envelope thermal insulation. Effective and well-targeted policies are needed to support the uptake and installation of clean heating systems, supporting homeowners in purchasing the right ones for their homes while supporting our climate goals.

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Agius, R. M.
A better approach to mitigate the risk of airborne infections in workplaces.
Occup Med, (2024)

In 2010, this journal highlighted the potential challenge of a pandemic in the ensuing decade [1] and so it came to pass. During the peak of the pandemic, 'Occupational Medicine' played its part both in disseminating new knowledge and in expressing authoritative opinion. Looking to the future, many observers are awaiting cues from the outcomes of the coronavirus disease 2019 (COVID-19) Public Inquiry. The Module 1 report showed that the UK Government failed its citizens with its lack of preparation or a preventive strategy [2]. The report also emphasized the need to build resilience in government, associated institutions and their plans, but it has yet to address the resilience built into traditional occupational health control measures such as ventilation [3]. Module 3 [4] might address these measures but the limitations of the Inquiry could disappoint those concerned with workplace health, such as by addressing only health and social care workplaces (HSCW). Analyses of 'lessons learned' from COVID-19 [5–7] indicate various but sufficient reasons to eschew attitudes of 'living with the virus' or of reversion to 'business as usual' when facing common airborne infections at work such as coronaviruses, influenza and respiratory syncytial virus (RSV).

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Bémer, D., Gérardin, F.
Changes in Aerosol Concentration in a Meeting Room with a Portable Air Cleaner - Mapping Fine Particle Concentrations.
Aerosol and Air Quality Research, Vol. **24**, (2024)

It is well established that fine particles are a major indoor air pollutant in industrial and tertiary sector buildings. Whether these particles are of biological origin (micro-organisms) or not, human exposure to these

air pollutants is a major health risk. Portable air cleaners are presented as one way to reduce their concentrations. Here, measurements were carried out in a real 93 m3 meeting room to determine how well such devices can reduce fine particle (PM1) concentrations. A wireless network of ten SPS30 particle concentration sensors were placed in the room in positions selected based on an optimized experimental design. Various air cleaning configurations were studied, differing based on the type of air cleaner, its flow rate, and position in the room. The data collected was used to model the instantaneous PM1 concentration at all points in the room. Overall, the concentration at all points follows the decay over time of a perfect mixture in exp(-t/t), where t is the time constant equal to Vr/Q (room volume/filtration air flowrate) at ± 15%. Although disparities in concentration were observed in this room, with no major obstacles, mixing of the cleaned air throughout the volume was quite efficient, and concentration gradients were low.

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Tan, A., Gan, W. H., Koh, D.
The COVID-19 pandemic and occupational health—transitioning to the new normal.
Occup Med, (2024)

The emergence of the SARS-CoV-2 virus in December 2019 marked the beginning of a global coronavirus disease 2019 (COVID-19) pandemic with the World Health Organization's (WHO) declaration of a Public Health Emergency of International Concern in March 2020 [1]. The subsequent years bore witness to global economic and social disruptions with a disproportionate burden on specific occupational groups, highlighting the vulnerabilities and increased occupational exposure risks faced by these workers [2]. These workers have a higher risk of getting infected, including healthcare workers, 'essential' workers performing duties critical to maintain societal infrastructure. and those living or working in overcrowded/enclosed environments [2]. Fear of infection at the workplace, increased work demands, social isolation, public stigma and discrimination, and economic uncertainty arising from job insecurities further led to heightened stress and anxiety among workers, affecting their overall psychosocial well-being and mental health [3].

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Lewandowski, D. A., Hussain, A., Chun, C., Chiang, L., Ahuja, S.
Evaluation of Surgical Site Infection Rates in Traumatic Surgical Fixation and Arthroplasty Performed in Laminar Flow Versus Non-laminar Flow Theatres During the COVID Pandemic.
Cureus, Vol. **16** n°(9), (2024)

Laminar flow (LF) in theatres has become the standard of care in orthopaedic implant surgery. Most of the evidence for laminar flow use is based on arthroplasty surgery, with early studies showing a significant reduction in infections. We conducted a retrospective comparative study to assess surgical site infection (SSI) rates in consecutive patients undergoing surgery for trauma in LF and non-laminar flow (NLF) theatres.
Methods
Due to COVID-19 safety restrictions, trauma surgery was performed in non-laminar flow theatres during the pandemic. We identified consecutive patients who had trauma surgery pre- and post-pandemic from February 2019 to June 2021 to avoid selection bias. A total of 1809 patients were identified for the study, and the relevant patient details were collected through the hospital operating theatre software (Bluespier) and patient records (Welsh Clinical Portal). There were 917 in the laminar theatre group and 892 in the non-laminar theatre group. For the purpose of this study, we recorded SSI rates within the first 90 days. The two groups were statistically similar in terms of age and gender of the patients.
Results
Nineteen patients developed surgical site infections in non-laminar flow theatres and 25 patients in laminar flow theatres. There was no significant difference between the SSI rate in laminar flow theatres (2.72%) as compared to non-laminar flow theatres (2.13%) (p=0.399). There was no link between infections and the duration of surgery. Two patients in the laminar flow group were MRSA-positive and were excluded.

Conclusion
In our study, the laminar flow theatres did not show a statistically significant reduction in surgical site infections. We conclude in the practical environment of trauma theatres the theoretical advantage of laminar flow does not translate to an observable reduction of infections.

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Hussin, N. H. M., Tay, D. D., Zainulabid, U. A., Maghpor, M. N., Ahmad, H. F.
Harnessing next-generation sequencing to monitor unculturable pathogenic bacteria in the indoor hospital building.
The Microbe, Vol. **4**, (2024)

The hospital indoor air microbiome, a diverse range of microorganisms, gains prominence amid the COVID-19 pandemic. Elevated awareness underscores implications for patient and staff well-being. Concerns about risks to indoor air quality persist due to prolonged indoor exposure, necessitating further research on specific threats within the hospital environment. In this study, an independent culture-based approach was used to analyze the baseline core microbiome present in hospital environments, utilizing amplicon sequencing on the next-generation sequencing technology to target the V3 region of the 16S rRNA gene. Firmicutes, Proteobacteria, and Actinobacteria were the main bacterial phyla that were most isolated from the wards and clinics with different orders of abundance; Firmicutes being associated more in clinics and Actinobacteriota in wards. The bacteria Niallia taxi, Methyloversatilis universalis, unclassified Rummeliibacillus, unclassified Clostridium, and unclassified Sphingomonadaceae dominated the clinic area while ward areas reported Pseudonocardia bannensis, Rubrobacter aplysinae, unclassified Brachybacterium, unclassified Bradyrhizobium, and unclassified Mycobacterium to be the top five features. While the alpha-diversity index showed no significant differences, the beta-diversity analysis showed a significant difference between clinic and ward areas ($p<0.05$). Certain bacterial species associated with opportunistic pathogens as well as normal skin flora such as Methylobacterium spp., Cutibacterium spp., unclassified Sphingomonadaceae, and Anoxybacillus B spp., were also identified across all samples. The methods described in this research aim to establish a rapid and sensitive screening process that could be valuable for disease surveillance within the healthcare setting, shedding light on the potential impacts of the hospital microbiome on human illness.

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Nicoletti, I.
Impiego di tecnologia UV led per la disinfezione: valutazione dell'efficacia battericida.
Università degli studi di Padova. Thèse 2024

La recente pandemia di COVID-19 ha dimostrato l'importanza di una corretta disinfezione degli ambienti, fondamentale come misura di prevenzione nei confronti della diffusione di agenti patogeni. Ha inoltre portato ad una maggiore attenzione e ricerca relativa alle tecniche di disinfezione tradizionalmente utilizzate e allo sviluppo di nuovi approcci più efficaci e sostenibili. Uno dei metodi oggi maggiormente utilizzato consiste nell'impiego di radiazioni ultraviolette, ed in particolare degli UV-C. A fronte della loro grande efficacia battericida e virucida, sono in grado, infatti, di determinare danni agli acidi nucleici e uccidere quindi l'agente patogeno, bisogna tenere in considerazione che non possono essere utilizzati in presenza poiché possono provocare gravi danni soprattutto ad occhi e cute. Inoltre, è appurato che gli UV-C siano cancerogeni per l'uomo. Alla luce di queste considerazioni, negli ultimi anni si stanno studiando nuovi approcci che utilizzino una lunghezza d'onda più vicina al visibile, più sicura, quindi, per l'uomo. Durante il progetto di tirocinio è stata testata l'efficacia battericida di un dispositivo messo a punto da un team di ingegneri dell'Università di Padova che utilizza proprio diverse lunghezze d'onda comprese tra gli UV e il visibile. In particolare, il dispositivo è stato testato nei confronti di E. coli e S. aureus.

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Than, T. M., Khaing, M., Hamajima, N., Saw, Y. M., Thaung, Y., Aung, T.*, et al.*
Infection prevention and control status at public hospitals and factors associated with COVID-19 infection among healthcare workers in Myanmar: A cross-sectional study.
BMC Infectious Diseases, Vol. **24** n°(1), (2024)

Hospitals should prepare for emerging diseases and protect healthcare workers (HCWs) from work-related infection. This study aims to assess public hospital preparedness for the coronavirus disease 2019 (COVID-19) a year after the Myanmar government began implementing COVID-19 prevention measures, and to identify factors associated with work-related COVID-19 infection among HCWs in Myanmar.

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Wu, X., Han, M., Chen, H.
Mitigating aerosol-induced respiratory infections in home quarantine: The role of door dynamics and ventilation in residential design.
Heliyon, Vol. **10** n°(18), (2024)

Respiratory infectious diseases, notably recurring waves of COVID-19 during autumn and winter, have significantly impacted global health and strained public health systems. Home isolation has emerged as a crucial and economical strategy to mitigate these impacts. This study investigates aerosol transmission and infection risks in home isolation environments using the Lattice Boltzmann Method with Large Eddy Simulation (LBM-LES). We focused on the impact of door operations and various natural ventilation rates on aerosol transmission and exposure risk in adjacent rooms. Our findings reveal that, without ventilation, aerosol leakage through door gaps poses a minimal infection risk to adjacent rooms, with an average probability of less than 2 ? 10?5. However, with adequate ventilation, the infection risk for individuals in adjacent rooms for over 3 h can reach 60 %?70 %. Brief door movements have limited impact on infection risk ($p \leq 0.05$, $d \leq 0.20$), with aerosol leakage mainly occurring through door gaps rather than door movements. To reduce cross-infection during home isolation, we recommend avoiding prolonged stays near downwind walls facing the door. This research provides insights into aerosol dynamics in home isolation scenarios, offering theoretical guidance for designing safe isolation spaces and practical advice for healthy family members to minimize infection risk.

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Christakis, N., Drikakis, D.
On particle dispersion statistics using unsupervised learning and Gaussian mixture models.
Physics of Fluids, Vol. **36** n°(9), (2024)

Understanding the dispersion of particles in enclosed spaces is crucial for controlling the spread of infectious diseases. This study introduces an innovative approach that combines an unsupervised learning algorithm with a Gaussian mixture model to analyze the behavior of saliva droplets emitted from a coughing individual. The algorithm effectively clusters data, while the Gaussian mixture model captures the distribution of these clusters, revealing underlying sub-populations and variations in particle dispersion. Using computational fluid dynamics simulation data, this integrated method offers a robust, data-driven perspective on particle dynamics, unveiling intricate patterns and probabilistic distributions previously unattainable. The combined approach significantly enhances the accuracy and interpretability of predictions, providing valuable insights for public health strategies to prevent virus transmission in indoor environments. The practical implications of this study are profound, as it demonstrates the potential of advanced unsupervised learning techniques in addressing complex biomedical and engineering challenges and underscores the importance of coupling sophisticated algorithms with statistical models for comprehensive data analysis. The potential impact of these findings on public health strategies is significant, highlighting the relevance of this research to real-world applications.

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Meng, H., Shiue, A., Wang, C., Liu, J., Jia, L., Leggett, G.
Particle and Bacterial Colony Emissions from Garments and Humans in Pharmaceutical Cleanrooms.
Journal of Building Engineering, (2024)

Particles and bacteria released from operators in pharmaceutical cleanrooms significantly impact the quality of pharmaceutical products. Therefore, it is necessary to study particle and bacteria emissions from operators and their garments. This paper presents the results of experimental measurements of numbers of particles and bacterial emissions from integrated and split cleanroom garments, under different movement types and laundry conditions. The experiment demonstrated that the emission rate of 0.5 µm particles from split-type garments is approximately 2.0 - 3.5 times higher than that of integrated cleanroom garments, and 7.0 - 22.7 times for 5.0 µm particles. The particle emission rate of humans is closely related to the movement types, number of laundry cycles, and garment types. The maximum particle emission rates were obtained when wearing split cleanroom garment after 100 washes and performing knee bend, with 654603 P/min for 0.5 µm and 27185 P/min for 5.0 µm particles, respectively. The particle emission rate of humans is mainly caused by personnel movement, since the emission rate of garments accounts for at most 3.89 %. The bacteria colony of humans increases with the increase of laundry cycles of cleanroom garments. The maximum bacteria colony of integrated and split cleanroom garment were 4 CFU/plate and 9 CFU/plate with the laundry cycles of 100 times. The quantitative results of bacteria and particles emitted from pharmaceutical cleanroom operators are expected to ensure drug quality during production.

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Esmaieeli-Sikaroudi, A.-M., Goikhman, B., Chubarov, D., Nguyen, H. D., Chertkov, M., Vorobev, P.
Physics-Informed Building Occupancy Detection: a Switching Process with Markov Regime.
arXiv preprint, (2024)

Energy efficiency of buildings is considered to be one of the major means of achieving the net-zero carbon goal around the world. The big part of the energy savings are supposed to be coming from optimizing the operation of the building heating, ventilation, and air conditioning (HVAC) systems. There is a natural trade-off between the energy efficiency and the indoor comfort level, and finding an optimal operating schedule/regime requires knowing the occupancy of different spaces inside of the building. Moreover, the COVID-19 pandemic has also revealed the need to sustain the high quality of the indoor air in order to reduce the risk of spread of infection. Occupancy detection from indoor sensors is thus an important practical problem. In the present paper, we propose detection of occupancy based on the carbon dioxide measurements inside the building. In particular, a new approach based on the, so-called, switching auto-regressive process with Markov regime is presented and justified by the physical model of the carbon dioxide concentration dynamics. We demonstrate the efficiency of the method compared to simple Hidden Markov approaches on simulated and real-life data. We also show that the model is flexible and can be generalized to account for different ventilation regimes, simultaneously detecting the occupancy and the ventilation rate.

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Alqahtani, N. M. S., Alqahtani, M. S. A., Albaqawi, A. S. A., Alahmadi, A. M. F., Alshahrani, A. a. M., Rashed, E. S.
Reevaluating Hygiene Best Practices During the COVID-19 Crisis: Systematic review.
Arab journal for scientific publishing, (2024)

The primary aim of this article is to assess the effectiveness of key preventive measures such as mask-wearing, hand hygiene, and social distancing in combating the spread of COVID-19.

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Gomez, P., Swarts, M.

Spatiotemporal Modeling Vertically Integrated Project.

42nd Conference on Education and Research in Computer Aided Architectural Design in Europe (eCAADe 2024), Nicosia, 11-13 September 2024

Spatiotemporal Modeling towards human-centered metrics for architecture refers to the integration of a set of parametric models, including: 3D models, building type and functions, schedules, Agent-based simulations (ABS) of human activities, and Computational-Fluid Dynamics (CFD) models of airflows. The meta-goal is to develop human-centric metrics for improving humans' quality of life. This work specifically focuses on virus spread modeling, thus we added a fifth model: The virus characteristics model, which includes the virus survival time and transmissibility through Direct, Airborne, and Fomite pathways. The objectives are to integrate the models to determine the impact of specific parameters on human-centric metrics, in this case the "risk of exposure" in certain scenarios. We developed ABS and CFD simulations in Anylogic and Eddy3D platforms, respectively. The integration of all models was implemented in Grasshopper. This paper presents three pilot studies, in the context of the Vertically Integrated Project (VIP) program, using a K-12 school project provided by Perkins&Will architecture firm. We explain the structure of the VIP, interdisciplinary research-based class, emphasizing the sub-projects, research designs, and preliminary results. The technical integration of the aforementioned models into one spatiotemporal model aims to communicate the probability of risk under specific scenarios. Examples of pilot studies under this framework include: What is the best high school schedule to reduce the probability of contagion, in a regular weekday, with/out the implementation of policies such as social-distancing?; What is the impact of a door handle on reducing contamination?; What are the safest chairs in which to sit in a classroom in relation to the HVAC system configuration? among others. The analyses for specific scenarios helps propose general solutions for spaces, behaviors, and protocols, to increase human safety inside buildings.

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López, L., Rodó, X.

Stochastic network to model the global spreading of respiratory diseases: From SARS-CoV-2 to pathogen X pandemic.

Ecol Inform, (2024)

The recent COVID-19 pandemic has underscored the vulnerability of global health systems. Emerging in November 2019 in Hubei, China, COVID-19 has had far-reaching consequences, affecting every corner of the globe. The impact has been particularly severe, causing widespread collapse of public health systems and contraction of the world economy. The imposition of stringent sanitary restrictions by the majority of countries, in response to SARS-CoV-2, disrupted various economic sectors on a massive scale. The existing gap between developed and underdeveloped countries further complicates the global scenario, raising uncertainties. This concern is amplified when considering the potential threat of other infectious diseases with dynamics akin to SARS-CoV-2, such as a new recombining H5N1 flu strain. Such a strain, if easily transmissible among humans, could lead to another pandemic. In this study, we introduce a stochastic network model designed to assess control strategies on a global scale. This model enables us to project how new variants, evading immunity, might respond to either a coordinated global response from governments or a complete lack of coordination. Our connectivity model between countries is based on a network of contacts derived from actual commercial air connectivity data. The disease dynamics within each country are simulated using a population-based approach with differential equations. The epidemiological model is fine-tuned using real SARS-CoV-2 data reported by various countries from 2019 to 2023.

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Wiśniewski, A., Skarżyński, K., Pracki, P., Krupiński, R., Wolska, A., Wisełka, M.*, et al.*

Surface Disinfection Systems with UV-C Lamps – Verification Measurements and Design Procedure Proposal.
LEUKOS, (2024), 1-16 p.

Ultraviolet radiation in the UV-C range is widely applied to disinfect surfaces, air, and water. UV-C (germicidal) lamps are commonly used, and their application is reliable, scientifically proven, and efficient to inactivate various types of bacteria, viruses, and fungal spores, including the SARS-CoV-2 virus. This research aims to develop a UV-C irradiance design procedure for germicidal devices disinfecting surfaces in rooms. This procedure considers the required values of UV-C radiation doses that disinfect rooms efficiently. For this purpose, it has been proposed to apply the DIALux evo software to design the appropriate UV-C irradiance on disinfected room surfaces using different germicidal devices. The measurements verified the accuracy of the simulation performed in the DIALux evo software, which also considered the reflection of the ultraviolet radiation from the principal planes of the room. Two rooms with different dimensions were selected to verify the computational accuracy of the developed design procedure for the disinfection system. Ultraviolet lamps were placed in the rooms, and irradiance measurements were taken at the selected measuring points. The results of the irradiance measurements were compared. The comparative analysis of the disinfection device proved that it was possible to adapt the DIALux evo software to make the calculations for designing room disinfection systems. The research made it possible to determine a suitable design procedure for surface disinfection systems, which prevents errors in proper surface disinfection after implementing UV-C lamps in the room.

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Kuwazuru, T., Ishimaru, T., Ando, H., Odagami, K., Hino, A., Tateishi, S.*, et al.*
Trends in the Implementation of Workplace COVID-19 Measures in Japanese Companies: A One-Year Prospective Cohort Study.
Journal of UOEH, Vol. **46** n°(3), (2024), 241-250 p.

This study evaluated trends in the implementation of workplace measures against COVID-19 by Japanese companies. We conducted a prospective cohort study, using data from December 2020 and December 2021, with 13,419 respondents participating in the follow-up survey. We evaluated nine workplace measures against COVID-19 (e.g., encouraging mask-wearing at work) and used the McNemar test and the Chi-square test for trend in the analysis. Small-sized companies (1–9 employees) exhibited a significant increase in the implementation of all the measures, with a rate of increase ranging from 8.4% to 16.1% (P-value: <0.001). Medium-sized companies (10–49 employees) also showed significant improvements in nearly all the measures (rate of increase: 3.5% to 10.5%, P-values: <0.001 to 0.004), except for one specific measure. Larger companies (more than 50 employees) displayed a mixed pattern, with some measures increasing and others decreasing. A persistent gap was observed between smaller (fewer than 50 employees) and larger companies in the implementation rates of these measures. The findings revealed a positive shift in workplace measures against COVID-19 among smaller companies in Japan over 1 year, although gaps between them and larger companies persisted.

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