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Google Scholar, Lens et WoS

Beggs, C. B., Abid, R., Motallebi, F., Samad, A., Venkatesan, N., Avital, E. J.
Airborne Transmission of SARS-CoV-2: The Contrast between Indoors and Outdoors.
Preprints, (2024)

Covid-19 is an airborne disease, with the vast majority of infections occurring indoors. By comparison, little transmission occurs outdoors. Here, we investigate the airborne transmission pathways that differentiate the indoors from outdoors, and conclude that profound differences exist, which help to explain why SARS-CoV-2 transmission is much more prevalent indoors. Near and far-field transmission pathways are discussed along with factors that affect infection risk, with aerosol concentration, air entrainment, thermal plumes, and occupancy duration all identified as being influential. In particular, we present the fundamental equations that underpin the Wells-Riley model, and show the mathematical relationship between inhaled virus particles and quanta of infection. A simple model is also presented for assessing infection risk in spaces with incomplete air mixing. Transmission risk is assessed in terms of aerosol concentration using simple 1D equations, followed by a description of thermal plume-ceiling interactions. With respect to this, we present new experimental results using Schlieren-visualisation and Computational Fluid Dynamics (CFD) based on the Eulerian-Lagrangian approach. Pathways of airborne infection are discussed, with the key differences identified between indoors and outdoors. In particular, the contribution of thermal and exhalation plumes is evaluated, and the presence of near-field/far-field feedback loop postulated, which is absent outdoors.

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An, I.-H., Park, S.-H., Lee, Y.-H., Lee, C.-H., Seo, S.-B., Cho, S.-H.*, et al.*
Comparison of Local Mean Age of Air between Displacement Ventilation System and Mixing Ventilation System in Office Heating Conditions during Winter.
Buildings, Vol. **14** n°(1), (2024)

A novel displacement ventilation system (DVS) was designed using a four-way cassette fan coil unit (FCU) and air purifiers (APs) for supplying clean air. The proposed DVS in this study involved drawing indoor air through the FCU and diffusers installed in the ceiling, controlling air temperature using the FCU, and then discharging it back into the office through the APs placed on the floor. The comparative ventilation system considered was the typical mixing ventilation system (MVS) that intakes and exhausts indoor air using diffusers installed on the ceiling. The local mean age of air was used as an index to compare indoor air quality between DVS and MVS under winter heating conditions. It was found that the DVS was more effective in improving indoor air quality in winter than the MVS. Moreover, compared to the MVS, utilizing the DVS designed in this study resulted in the advantage of a much more uniform air temperature variation in the office space. Therefore, it is anticipated that modifying the structure of an indoor space with an FCU installed in the ceiling and APs on the floor to use the DVS designed in this study would greatly assist in enhancing indoor air quality.

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Agius, R.
COVID-19 in Workplace Settings: Lessons Learned for Occupational Medicine in the UK.
Med Lav, Vol. **114** n°(6), (2023)

This paper addresses lessons learned from the COVID-19 pandemic from a UK Occupational Medicine perspective to permit comparison with other national accounts. In spite of good prior research and statute, the necessary resources to protect workers' health were seriously lacking when the pandemic struck. Weak

public health guidance, which did not recognise dominant airborne transmission, was applied to workplaces, leaving workers and others unprotected, especially in respect of Respiratory Protective Equipment (RPE). The Health and Safety Executive (HSE) as regulator was lacking, for example, in not producing guidance to protect HealthCare Workers (HCW) who were amongst the most at risk. The UK COVID-19 Public Inquiry should address shortcomings such as these, but recommendations must be accompanied by robust means to ensure appropriate implementation. These should range from substantial measures to improve indoor air quality, to a permanent pandemic management organization with adequate resources. The enforcing authority has to be obliged to publish more specific workplace guidance than the public health authorities. Occupational Medicine as a discipline needs to be better prepared, and hence to assert its responsibility towards high standards of workers' health protection. Future research has to include investigating the best means of mitigation against airborne infection and the management of post-acute covid sequelae.

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Amir, F., Rizal, S., Thaib, R., Umar, H., Ikramullah, I., Abdullah, N. A., Rizal, T. A.
Energy conservation of HVAC systems in isolation rooms using heat pipe heat exchangers.
Heliyon, Vol. **10** n°(2), (2024)

Isolation rooms are crucial in healthcare facilities to prevent the spread of infectious diseases. Infectious diseases can be transmitted to humans from humans or through animals known as zoonoses. With the increase in the number of COVID-19 cases, isolation rooms have become one of the most critical facilities in hospitals. Maintaining the correct temperature and humidity in these isolation rooms is a challenge, considering the heating, ventilation, and air conditioning (HVAC) systems that continuously consume large amounts of energy. With the application of energy conservation methods, the total energy consumption of HVAC systems can be reduced. Many studies have shown that the heat pipe heat exchanger (HPHE) technology can contribute significantly to energy savings using HVAC systems. In this study, the effectiveness of an HPHE on an HVAC system in an isolation room was examined, and the total energy reduction was quantified. The HPHE consisted of two rows with ten heat pipes in each row, arranged in a staggered configuration with fresh air temperature and mass flow variations. The inlet fresh air temperatures varied at 32, 35, 37, and 40 C and fresh air velocities at 1.2, 1.6, 2.2, and 2.6 m/s. Using a chiller, the inlet fresh air was cooled to a comfortable temperature zone, approximately 24.4–25.2 C, in the isolation room. Notably, higher velocities decreased the effectiveness of the HPHE. An increase in the flow rate enhanced the system, thereby improving the heat recovery value. The increase in the inlet fresh air temperature from 32 C, that yielded an energy saving of 1.23 W, to 40 °C, resulted in a further energy saving of 1.85 W. The application of the HPHE in the HVAC system in isolation rooms represents a significant innovation that contributes to a reduction in total energy consumption.

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Khaliq, K. A., Mohamad, S., Edwards, A. J., Noakes, C., Kemp, A. H., Thompson, C.*, et al.*
Environmental data monitoring and infection risks in UK care-homes in the context of COVID-19.
Building and Environment, Vol. **250**, (2024)

The COVID-19 pandemic drew attention to the critical role of building ventilation as a measure for controlling infection transmission. With the substantial number of COVID-19 outbreaks in care homes worldwide, the effectiveness of ventilation is an important consideration for infection control and wider exposure to indoor air pollutants. In this study, we used IoT-based sensors in two residential care homes to evaluate ventilation in various areas, including bedrooms, corridors, and communal spaces. Our monitoring focused on carbon dioxide (CO2) levels as a proxy for ventilation, as well as temperature and humidity, during the spring of 2022. We also developed a ventilation model using the software CONTAM and coupled it with an infection risk model to assess airborne transmission risks under different weather and occupancy conditions. Our results suggest that ventilation is generally adequate based on UK COVID-19 guidelines at the time, with CO2 below

800 ppm for the majority of the time, and opening windows in communal spaces in elderly care environments can help preserve indoor ventilation during periods of high occupancy. However, modelling data suggests that low CO2 values may be indicative of low occupancy in many spaces and therefore ventilation rates may not be sufficient to mitigate infection transmission. Encouraging positive ventilation behaviours in staff and residents, potentially supported by visible CO2 monitors, and taking additional precautions such as using air cleaners, enabling additional window openings or staff wearing masks during outbreaks and periods of high disease prevalence is likely to be beneficial for resident and staff health.

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Holliday, R., Allison, J. R., Currie, C. C., Edwards, D. C., Bowes, C., Pickering, K.*, et al.*
Evaluating contaminated dental aerosol and splatter in an open plan clinic environment: Implications for the COVID-19 pandemic.
Journal of Dentistry, Vol. **105**, (2021)

Objectives Identify splatter/aerosol distribution from dental procedures in an open plan clinic and explore aerosol settling time after dental procedures. Methods In two experimental designs using simulated dental procedures on a mannequin, fluorescein dye was introduced: (1) into the irrigation system of an air-turbine handpiece; (2) into the mannequin's mouth. Filter papers were placed in an open plan clinic to collect fluorescein. An 8-metre diameter rig was used to investigate aerosol settling time. Analysis was by fluorescence photography and spectrofluorometry. Results Contamination distribution varied across the clinic depending on conditions. Unmitigated procedures have the potential to deposit contamination at large distances. Medium volume dental suction (159 L/min air) reduced contamination in the procedural bay by 53%, and in other areas by 81-83%. Low volume suction (40 L/min air) was similar. Cross-ventilation reduced contamination in adjacent and distant areas by 80-89%. In the most realistic model (fluorescein in mouth, medium volume suction), samples in distant bays (≥5 m head-to-head chair distance) gave very low or zero readings (< 0.0016% of the fluorescein used during the procedure). Almost all (99.99%) of the splatter detected was retained within the procedural bay/walkway. After 10 min, very little additional aerosol settled. Conclusions Cross-infection risk from dental procedures in an open plan clinic appears small when bays are ≥ 5 m apart. Dilution effects from instrument water spray were observed, and dental suction is of benefit. Most settled aerosol is detected within 10 min indicating environmental cleaning may be appropriate after this. Clinical Significance: Aerosols produced by dental procedures have the potential to contaminate distant sites and the majority of settled aerosol is detectable after 10 min. Dental suction and ventilation have a substantial beneficial effect. Contamination is likely to be minimal in open plan clinics at distances of 5 m or more.

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Li, H., Lan, Y., Wang, Z., Kong, X., Fan, M.
Experimental study on the cross-infection control performance under intervention cascade ventilation in the post-epidemic era.
Sustainable Cities and Society, (2024)

The ventilation system plays a key role in maintaining a healthy environment in an enclosed space. To seek a reasonable air distribution method and improve indoor air quality, the air change efficiency, exposure risk and infection risk under heating conditions are explored in a comparative experimental study under ICV, stratum ventilation (SV) and mixing ventilation (MV). The results demonstrate that with the same amount of air (94 l/s) and designed room temperature (22°C), the air change efficiency of ICV is 9.8% and 24.3% higher than SV and MV, indicating the excellent ability to form a clean and healthy breathing layer. During the pandemic, ICV can reduce the infection risk of COVID-19 by 5% and 22.1% in four hours relative to SV and MV. Exposure risk distribution research results demonstrate that ICV can maintain a reduction in exposure level of 9.64-44.44% even at a location farther from the air inlet and provide a safer environment where people sit frequently. The

conclusions obtained in this study can provide a new approach for ventilation to address COVID-19 and indoor air quality problems during heating season.

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Sabanskis, A., Vidulejs, D. D., Telicko, J., Virbulis, J., Jakovics, A.
Numerical Evaluation of the Efficiency of an Indoor Air Cleaner under Different Heating Conditions.
Atmosphere, Vol. **14** n°(12), (2023)

For an efficient indoor air purification, it is important to know the detailed airflow distribution in the room. A series of numerical simulations are carried out for five heating regimes using an air-air heat pump, capillary mat on the ceiling, capillary mat on the walls, heated floor, and radiator. The most homogeneous temperature field is obtained for the case with the heated floor. The highest velocity is obtained for the air-air heat pump, while the lowest is obtained for the capillary mat on the ceiling. A portable air cleaner based on the prototype device is introduced into the model and its influence on the velocity and temperature distributions is calculated. Our simulations additionally consider is the transport of an infectious aerosol and its purification inside the air cleaner. The time dependency of the concentration is exponential, and the purification rate depends on the air cleaner's orientation and heating regime. The efficiency is higher for a purifier with flow in the upwards direction compared to in a horizontal one. In the experimental part, an NaCl solution is dispersed into the air, and the efficiency of purification in the case of the air-air heat pump is evaluated by measuring the time-dependent particle concentrations. These experimental results corroborate the numerical model.

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Ijaz Fazil Syed Ahmed, K., Mohan Kumar, G., Eddie Yin-Kwee, N.
Optimizing Mixed-Mode Ventilation during Epidemics: An Investigation.
In: Indoor Environmental Quality and Health. IntechOpen; 2024. 5 p.

This chapter provides a detailed analysis of the Operation of mixed-mode ventilation during epidemics, concentrating on the pivotal role of Indoor Air Quality (IAQ). It underlines the importance of ventilation and pressure intake in IAQ management, particularly for airborne infection control. We explore Singapore and international ventilation standards, laying emphasis on various Ventilation strategies. However, our principal focus is mixed-mode ventilation, a combined approach of natural and mechanical methods, which we highlight as a promising and potentially energy-saving solution for IAQ management and airborne disease control. Our examination includes multiple case studies in diverse environments, such as a negative-pressure isolation ward, a residential master bedroom, and an office building, each evaluated through different methods, including computational fluid dynamics and experimental approaches. Our observations illustrate the significant role of efficient ventilation in improving IAQ, mitigating airborne infection risks, and enhancing occupant comfort, especially during epidemics.

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Lu, F. T., Laumbach, R. J., Legard, A., Myers, N. T., Black, K. G., Ohman-Strickland, P.*, et al.*
Real-World Effectiveness of Portable Air Cleaners in Reducing Home Particulate Matter Concentrations.
Aerosol and Air Quality Research, Vol. **24** n°(1), (2024)

Portable air cleaners (PACs) equipped with HEPA filters are gaining attention as cost-effective means of decreasing indoor particulate matter (PM) air pollutants and airborne viruses. However, the performance of PACs in naturalistic settings and spaces beyond the room containing the PAC is not well characterized. We conducted a single-blinded randomized cross-over interventional study between November 2020 and May 2021 in the homes of adults who tested positive for COVID-19. The intervention was air filtration with PAC operated with the HEPA filter set installed ("filter" condition) versus removed ("sham" condition, i.e., control). Sampling was performed in 29 homes for two consecutive 24-hour periods in the primary room (containing

the PAC) and a secondary room. PAC effectiveness, calculated as reductions in overall mean PM2.5 and PM10 concentrations during the filter condition, were for the primary rooms 78.8% and 63.9% (n = 23), respectively, and for the secondary rooms 57.9% and 60.4% (n = 22), respectively. When a central air handler (CAH) was reported to be in use, filter-associated reductions of PM were statistically significant during the day (06:00-22:00) and night (22:01-05:59) in the primary rooms but only during the day in the secondary rooms. Our study adds to the literature evaluating the real-world effects of PACs on a secondary room and considering the impact of central air systems on PAC performance.

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Annadurai, G., Joseph Mathews, A., Krishnan, E. N., Simonson, C. J.
A review of experimental methods to determine bioaerosol transfer in energy recovery ventilators.
Applied Thermal Engineering, Vol. **240**, (2024)

Increasing ventilation is an effective method to reduce indoor airborne disease transmission. An Energy recovery ventilator (ERV) is a passive energy recovery device used to reduce the energy consumption of heating, ventilation and air-conditioning (HVAC) systems for conditioning the ventilation air. It preconditions the ventilation air by transferring energy from building exhaust air. Therefore, the ventilation and exhaust air streams interact directly/indirectly in the ERV for energy transfer. It is surmised that the ERV may transfer bioaerosols (with pathogens) from the exhaust air to ventilation air, resulting in the spread of infectious diseases. Consequently, many pandemic HVAC guidelines recommend that the use of ERVs be limited. This is a highly unsustainable direction given the increased energy requirements associated with the high ventilation provision advocated for pandemic operation. It must be noted that no validated experimental evidence exists in literature for bioaerosol transfer in ERVs. Hence, it is necessary to conduct extensive bioaerosol transfer research before adopting the unsustainable practice of limiting the utilization of ERVs. The main objective of this review study is to summarize the experimental methods and instrumentation for bioaerosol transfer research in ERVs. This comprehensive article provides a detailed overview of the generation, sampling, and analysis of bioaerosols for conducting the experiments. Further, it explains the possible mechanisms for bioaerosol transfer in various types of ERVs based on which the ERVs that need immediate attention are identified. The main contribution of this research paper is that it provides a novel experimental method which encompasses the biosafety aspects, instrumentation, performance parameters and uncertainties in conducting virus contained bioaerosol transfer study in ERVs. The findings from this review will be helpful in designing bioaerosol transfer experiments and developing future ERV test standards for such experiments.

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Jalaldehi, P. A., Yavarian, J., Golbabaei, F., Kalantary, S., Foroushani, A. R., Abbaslou, H.
Risk Assessment of Airborne Transmission of a Viral Infection in a Healthcare Center in Tehran: A Cross-sectional Study of Covid-19 During the Pandemic.
Journal of Health and Safety at Work, Vol. **13** n°(4), (2024), 779-796 p.

Introduction: The COVID-19 pandemic has been a significant global health challenge. Primary care services, such as screening health centers, were crucial in identifying infected individuals. However, these centers were often crowded and posed a high risk to staff and non-COVID-19 patients. This study aims to assess the risk of airborne transmission of SARS-CoV-2 in such settings through simulation.
Material and Methods: In this study, waiting and sampling rooms of a COVID-19 healthcare center were simulated using different scenarios. Then, the Quanta emission rate was estimated using the viral load in the sputum of infected individuals. Finally, the airborne transmission risk of SARS-CoV-2 was determined using the Wells-Riley method for scenarios of wearing and without masks.
Results: The study showed that the Quanta emission rate in an unmodulated speaking activity was higher than other expiratory activities in both units ($p < 0.001$). Also, the total amount of Quanta was slightly higher in the sampling room than in the waiting room, which was not statistically significant. On the other hand, the

calculation of transmission risk showed that the probability of airborne virus transmission in the sampling room was higher (about 2 to 8%). In addition, wearing masks reduced the possibility of airborne transmission of the virus significantly (77 to 81%).
Conclusion: This study shows that the level of risk in the sampling and waiting rooms is moderate. Masks also significantly reduce the possibility of airborne transmission of SARS-CoV-2. Taking appropriate health and safety measures such as avoiding crowds, wearing masks, whispering, and monitoring social distancing can reduce the plausibility of airborne transmission of the SARS-CoV-2 virus.

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Hui, L., Zhang, J.
Safe-duration based ventilation and air conditioning system control strategy.
Sustainable Cities and Society, (2024)

The COVID-19 outbreak has shown the significance of ventilation and air conditioning systems in mitigating the transmission of the virus. Increasing air supply volume and utilizing indoor air purifiers are both effective measures to reduce the risk of infection. However, the specific air volume requirements in primary return air systems considering the impact of air purifiers installed within these systems have not been extensively studied. In this paper, the pathogenic aerosol emission rate was utilized to evaluate inhalation probability, taking into account the air purifier's removal efficiency. The notion of safe duration was additionally introduced as a criterion for quantifying indoor health and safety. A novel ventilation calculation method for different airborne infections to adjust safe duration was also presented. The findings suggested that the safe duration was mostly influenced by human-related factors, specifically occupant density and the effectiveness of facial masks in providing protection. When occupant density exceeded 0.35 people/m2, wearing facial masks with a higher protection coefficient was more effective in improving indoor safety and health than reducing occupant density. Moreover, enhancing the filtration efficacy of the air conditioning system's purifier can provide a level of protection comparable to wearing a regular mask.

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Li, Z., Ma, X., Liao, Y.
Spatial and temporal distribution of bioaerosols produced by patients with different postures in a negative pressure isolation ward under different ventilation modes.
Indoor and Built Environment, (2024)

The high concentration of viral bioaerosols within the negative pressure isolation wards could pose a challenge to preventing potential cross-infection amongst healthcare workers (HCWs) and patients. Using the Euler?Lagrange methodology, this study numerically simulated the spatial and temporal distribution characteristics of bioaerosols in a typical negative pressure isolation ward as well as determined the interaction of ventilation mode and patient posture on ward ventilation performance. The removal effect of particle groups produced by two respiratory behaviours (breathing and coughing) was quantitatively analyzed, and the effect of exhaust air ratio and air exchange rate on particle distribution was discussed. The results showed that the migration characteristics of bioaerosol particles were sensitive to both the ventilation pattern and patient posture, which showed significant interactions. On this basis, the ventilation pattern with the best ventilation performance was evaluated, showing a particle removal effect of 70?85%. Due to the initial momentum difference, the diffusion behaviour of cough and breath particles was not consistent, but optimizing the airflow distribution near the exhaust outlet could improve their removal efficiency in the meantime. Further studies found that equal exhaust air velocity ratio facilitated the removal of aerosol particles, and an appropriate increase in the air exchange rate could also reduce the particle content.

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Singh, V., Barik, A., Mishra, M., Diwakar, K., Choudhary, A., Mehta, N.

Study of the Vertical Transmission of COVID-19 by Using the World Health Organisation Protocol in a Tertiary Care Hospital in Eastern India.
Cureus, Vol. **16** n°(1), (2024)

Background: The World Health Organisation (WHO) has established criteria to diagnose vertical transmission in severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2). This study aimed to determine the incidence of vertical transmission of SARS-CoV-2 using WHO criteria in a tertiary care centre in eastern India.
Methods: A hospital-based prospective observational study was conducted from June 2021 to February 2022 on women admitted for delivery with a positive nasopharyngeal (NP) swab and a SARS-CoV-2 real-time reverse-transcriptase polymerase chain reaction (RT-PCR) test. Following the delivery, the amniotic fluid (AF) and swab from the placenta were tested for SARS-CoV-2 by the Truenat test. The umbilical cord and maternal blood were analyzed to detect immunoglobulin M (IgM) and immunoglobulin G (IgG). The nasopharyngeal swabs of the newborns were tested for SARS-CoV-2 by RT-PCR.
Results: Forty-eight SARS-CoV-2-positive asymptomatic women were included in the study. Twenty-eight (58.3%) were delivered via cesarean section. Preterm delivery occurred in 13 (27.1%) cases. In only one case, vertical transmission was confirmed as the neonate had a positive nasopharyngeal SARS-CoV-2 RT-PCR test and the cord blood was IgM positive (suggesting an immune response in the neonate). The placenta was positive in three cases, and amniotic fluid was positive in two. However, vertical transmission was deemed unlikely in these cases as there was no evidence of immune response or viral persistence according to the WHO criteria. There was one stillbirth, and it tested negative for SARS-CoV-2.
Conclusion: This study strengthens the evidence of vertical transmission in COVID-19-positive asymptomatic mothers. The data suggest a low transmission rate.

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Li, H., Cui, Q., Kong, X., Fan, M.
Study on the infection control performance under interactive cascade ventilation: A focus on a conference room environment.
Building and Environment, Vol. **250**, (2024)

With the rise of respiratory infectious diseases, many scholars focus on finding an appropriate ventilation method to effectively improve the indoor environmental protection effect, especially for crowded spaces, which can cause a widespread spread of the epidemic. Interactive cascade ventilation (ICV), as a recently proposed ventilation method, has presented advantages in thermal comfort, infection control and energy consumption. This study discusses the effect of the outlet/inlet locations on infection control performance under interactive cascade ventilation in a conference room with an experimentally verified model. Ninety-five simulations are carried out by considering changes in the location of the outlet/inlet opening and infection source. Particle removal efficiency (ε), predicted infection risk (Pi) and contaminant dispersion index (CDI) are introduced to evaluate the infection control performance comprehensively. The simulation results show that double-side supply air outlets coupled with double-side return air inlets can reduce Pi by 51.1 % compared with other ventilation strategies investigated in this paper. It indicates that ventilation zoning design is more effective for reducing cross-infection in dense spaces. The findings in this study can efficiently provide new insights for the actual application of ventilation strategies in conference rooms under epidemic normalization.

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