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Original Research

Effect of Ventilation System on Spread and Control of Infections (COVID-19) in Indoor Environments: Based on Current Studies

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Transmission of infectious diseases like SARS-COV-2 by ventilation systems has become an international concern. In this study, an attempt was made to assess the role of ventilation systems in spread and control of SARS-COV-2 in indoor environments. the results showed that the ventilation system can play an important role in controlling and spreading infectious diseases in indoors environment air change per hour (ACH) is one of the most effective management and engineering strategy to reduce the risk of infection spread. It can be concluded that ventilation system can reduce and spread the infectious disease in indoor environments.

Introduction

Acute Respiratory Syndrome (SARS) in 2002 [1], and concerns about the Influenza pandemic [2] as well as the COVID-19 pandemic that caused by severe acute respiratory syndrome coronavirus (SARS-CoV-2) at the present, suggest that airborne infectious diseases pose serious health risk to human .Most people spend about 90% of their time at indoor area, such as in buildings, cars, or public transportation, which means we breathe air that we shared with others [3]. The present article describes Effect of Ventilation System on Spread and Control of Infections at indoor environment.

Airborne transmission of infectious agent

The concept of airborne infectious agent was first described by Wells and then by Riley. The Wells–Riley equation was used to evaluate the effect of ventilation, filtration on transmission of infectious agent through droplet nuclei [4]. at this equation Various factors affects the transmission of infection, such as Number of people with infection strength of infectious source, Number of particles produced per minute number of susceptible people breathing the same air, Respiratory rate of exposed individuals, Exposure time and amount of ventilation in the rooms where the exposure occurs [5].

Transmission of infectious diseases at indoor environments is more than outdoor [6-7] infection spread often occurs by contact, droplet and airborne. Contact transmission occur by handshaking or touching contaminated surfaces(direct) [8] transmission by Droplet may occur by the release of infectious droplets from the mouth by sneezing coughing or talking greater than about 5 um that settles in a short distance and remain in the air for only a short time whereas airborne transmission may occur by the release of infectious droplet nuclei smaller than about 5 um [5].

Respiratory droplets (>5 μm) also transform to droplet nuclei (<5 μm) when the environmental conditions change, which is much smaller and can exist in the ambient air for a long time in the form of airborne. some study declare fecal aerosols can cause SARS-CoV-2 infection [9]. At the beginning of outbreak of the coronavirus was assumed with warming of the air, the prevalence of this disease may decrease, but with the warming of the air in the southern regions and the use of air conditioning, the number of patients in these areas increased rapidly, given that in these areas air conditioning system used and the air inside area recirculated, and when a person coughs or sneezes or talks, the virus spreads and accumulates in indoors, and the concentration of coronavirus increases and transmitted to more people.

The COVID-19 and airborne infection

Prevalence of common cold In a Chinese university, ≥6 times in a semester was found to be higher (35% compared to 5%) among students living in dormitories with lower mean ventilation rates (1L/s (person) compared to 5L/s person) [10]. In U.S. retailstores, a self-reported common cold infection rate was lower by 43% instores where ventilation rate was greater (0.5 ACH compared to 1.2ACH) [11].

Jianyun Lu showed air conditioning system can transform covid 19 virus at restaurant [12] also Y. Li showed the The bio-aerosol concentration distribution in the ward assumed to be sufficiently agree with the spatial infection pattern of SARS cases [13-14]. Some infections that are spread through the air such as influenza [15], and Bordetella pertussis [16] respiratory syncytial virus (RSV) [17], as well as non-respiratory infections such as norovirus [18], meticillin-resistant Staphylococcus aureus (MRSA) [19]. In order to reduce the transmission of the virus in the air, EPA and ASHRAE recommends precautions, which include increasing the rate of natural and mechanical ventilation, as well as filtration with HEPA to remove more than 99.97% of all particles [20-21]. Many study showed Inadequate ACH has been associated with increase of infection in clinical and non-clinical environment Increasing of ACH suggested to be an effective management and Engineering strategy to reduce the risk of infection spread [22]. Stockwell et all concluded that the concentration of bio aerosol in ward at hospital that use natural ventilation system was much higher than the wards that use mechanical ventilation. also use of mechanical ventilation system improves indoor air quality and also reduces the risk of infection transmission [23]. Menzies et al studied the association between tuberculin conversion among HCWs and the ventilation rate in patient care areas. They found that the tuberculin conversion among HCWs was agree fairly well with inadequate ventilation rate in general patient rooms and also duration of Work staff [24]. Air conditioning systems also transmit the virus to other parts of the building by recirculating indoor air. For example, infection at non-corona wards of hospital can reveal the role of the air conditioning system. One of the important factors in reducing the concentration of airborne droplet is Air change per hour (ACH) Studies have shown that increasing the number of ACH reduces the risk of respiratory infections [25].

Ventilation as preventive or protective measure

Centers for Disease Control Organization in order to prevent the accumulation of bioaerosols recommend The rate of air change per hour for the isolated room for coronary patients is 12 times as a standard [26]. World Health Organization (WHO) advice 288 m3 per hour per person for infection control in health care system [27]. Parameters affecting indoor air quality (IAQ) during a pandemic, including Mechanical ventilation, Natural ventilation of the building Heat and energy recycling systems Air duct cleaning Air filtration UV lamp radiation Temperature and humidity Should be considered for control of covid 19 virus [28].

At normal working time, the ACH is selected so that energy consumption is optimal. Because exhaust air has energy and depending on the weather, it is cold or hot. And with increasing air exchange rates, energy consumption will also increase. But in the case of Corona pandemics, air exchange rates should reach a maximum in crowded places such as offices, companies, offices, shopping malls. And fresh air enters the places In a study by Hayashi, they concluded that humidification and ventilation control are very effective in controlling infection, and that air pollution can also affect the severity of the disease [29]. Also Yu et al (2017) revealed that increase in air change rate of indoor environment It can reduce the risk of viral infections [30]. Chau et al concluded that if the LEV system is well designed it can Effectively remove concentrations of bioaerosols and infectious droplets from the HCW respiratory area [22].

Chen Reported that 1716 HCWs have been infected with SARS-CoV-2 and the protection for HCWs in Hubei Province makeshift hospitals is necessary. Personal protective equipment and sufficient resting time as management strategy to protect of staff Therefore, they conclude the ACH in makeshift hospitals should be increased to as high as the system can supply. inadequate ACH in makeshift hospitals increase infection airborne transmission [31]. For control of infectious agent in indoor area, ventilation should be increased to prevent accumulation of bio aerosols, and for high-risk environments such as hospitals, fresh air should be increased to as high as their conditioning system can system can support, which may increase energy consumption if return air used HEPA filters should be used in the return air section.

In conclusion, however, due to the approaching cold season, the indoor temperature conditions should be taken into account and 100 fresh air cannot supply for indoors. An alternative way to do this is to use internal purification systems equipped with HEPA filter and ultraviolet Germicidal Irradiation to reduces the concentration of the virus in the air.

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