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Infection, Disease & Health xxx (xxxx) xxx

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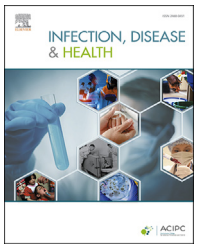

Discussion paper

Standard precautions should include 'safe ventilation' to minimise far-afield airborne transmission in health and social care settings

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Received 21 September 2022; received in revised form 2 November 2022; accepted 2 November 2022

KEYWORDS
SARS-CoV-2;
Nosocomial COVID-19;
Air change per hour;
Ventilation;
Standard precautions

Highlights

- Nosocomial COVID-19 is identified as a major threat for inpatients.
- Particles < 5 μm produced by humans are responsible of far-afield transmission.
- The risk of far-afield transmission cannot be known for each clinical area.
- Safe ventilation should be incorporated into standard precautions to minimize this risk.
- Clinical areas should include ventilation indicators and instructions for safe ventilation.

Almost from the start of the pandemic nosocomial COVID-19 was identified as a major threat for inpatients. In United Kingdom between March and July 2020 it was identified that approximately 15–20% cases of inpatients infected by SARS-Cov-2 had nosocomial COVID-19 [1,2], though this rate can vary between clinical units [3]. The Omicron surge is associated with a significant increase in hospital-onset SARS-CoV-2 infections [4]. Importantly higher mortality rate was reported in nosocomial cases in comparison to community-acquired cases, particularly in elderly or immunosuppressed patients [3].

Prior to the pandemic, respiratory pathogens were thought to be transmitted via direct physical contact, indirect contact (fomites), and droplet or aerosol sprays. Droplets (particles >5 μm) sprayed on mucous membranes on the face while aerosols (particles < 5 μm) infect people by being inhaled [5]. There is in fact a continuum in the sizes of particles produced by humans and pathogens predominate in small particles < 5 μm that are immediately respirable by exposed individuals [6]. Therefore, there is a risk of not only near-source transmission but also a far-airfield transmission due to these particles within enclosed spaces and inadequate ventilation [7–9]. Strong evidence of predominantly airborne transmission of SARS-CoV-2 via virus-laden aerosols has emerged, particularly in indoor settings [9].

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https://doi.org/10.1016/j.idh.2022.11.001

Please cite this article as: M. Martinot, Standard precautions should include 'safe ventilation' to minimise far-afield airborne transmission in health and social care settings, Infection, Disease & Health, https://doi.org/10.1016/j.idh.2022.11.001

Within a clinical area, human factors such as the number of patients and their behavior (e.g., coughing, shouting, and wearing a mask) and medical procedures (e.g., kinesitherapy or intubation ...) can major the production of aerosols and lead to infection of non-COVID-19 patients particularly the most susceptible ones (e.g.,immunosuppressed or not fully vaccinated). Physical factors (e.g., humidity, temperature, ultraviolet (UV) radiation) can affect the viability and sustainability of virus in aerosol. Ventilation and filtration procedures help to reduce or remove the number of virus-laden aerosols, thereby resulting in a determined volume of air changes per hour (ACH) [7,10,11]. Therefore, in most cases, factors affecting infectivity are impossible to assess and there is a need for simple methods that can be implemented by healthcare workers (HCWs) to evaluate the risk of airborne transmission within their clinical areas and precautions to implement to reduce far-afield transmission.

Standard precautions are applied to the care of all patients in healthcare settings regardless of the presence of infectious pathogens. In contrast, transmission-based precautions, such as airborne or droplet precautions, are only implemented in case of known or suspected cases [12], which can be very difficult to identify for COVID-19 due to a high frequency of asymptomatic, pauci-symptomatic or pre-symptomatic forms. In most cases these transmission-based precautions are thus limited to suspected or documented cases and to the use of a private room for infected patients and individual protection equipment (PPE), including adapted masks [13], which are however, not 100% efficient [14,15]. Since we cannot precisely know what the risk is for each clinical area and we cannot always identify which patients are infectious, some transmission-based precautions i.e., safe ventilation, must be changed to standard precautions, to minimize far-afield airborne transmission in healthcare and social care settings. However, the notion of ventilation and thus ACH is in most cases not integrated or identified by HCWs, with the exception of specific rooms such as operating rooms, or specific isolation rooms with positive or negative pressure. The COVID-19 pandemic resulted in numerous clusters affecting a huge number of patients and HCWs [16] and underscored the limits of such organizations and the necessity to implement new ways to control the risk of airborne-pathogen transmission. Ventilation of clinical areas is crucial to control this risk because it affects the quantity of bioaerosols within the affected area [17] for all patients, HCWs and thus should be considered as a key element of standard precautions.

Ventilation systems can be divided into two types: natural ventilation and mechanical ventilation. Natural ventilation from the outdoor air results in a very low ACH of approximately <1 volume per hour and is present in households and older medical structures or long-term care facilities (LTCF). Mechanical ventilation with recirculation of filtered air is present in more modern structures, and enables a much higher ACH (>2 volume per hour) through directional flow and filtration systems that reduce aerosols [11].

Mapping ACH within actual medical structures is a way, to inform both HCWs and administrative or engineer teams on the airborne risk of hospitalized patients for nosocomial airborne infections, especially COVID-19, and to implement corrective actions in case of low ACH. Medical structures with natural ventilation and low ACH represent most hospitals and LTCFs built during the twentieth century and are challenging because methods to increase ACH are mostly limited to opening windows [18]. This procedure is easy to perform but is also limited by meteorological parameters, such as low or high temperatures and necessity to keep door closed in isolation rooms. Therefore, in these structures, localization of COVID-19 units and non-COVID-19 units should be organized carefully, at best with fixed quickly removable partitions stopping aerosols or, if impossible, by control of airflow patterns. Thus, HCWs including ancillary staff should be educated on how to improve ACH when necessary, by implementing standard precautions and procedures, including through opening of windows and controlling airflow to prevent transmission of airborne infections between patients. Each clinical area should have a visual indicator of the nature of ventilation and instructions for HCWs on what to do (e.g., how and when to open windows, shut doors and how to localize patients with airborne infections in the area). Isolation rooms with air handling systems (i.e., negative or positive pressure), as well as operating rooms should have specific processes defined by Infection Prevention and Control (IPC) personnel.

Use of air disinfection devices, such as exhaust fan [19], portable room air cleaners with HEPA [14] should be discussed for structures with low ACH and or accepting multiple patients, such as emergency departments or dialysis rooms, although such measures can be expensive and necessitate a high degree of expertise. Medical units with mechanical ventilation enabling the highest ACH are the most fitted to prevent airborne contamination issued from symptomatic or asymptomatic patients, HCWs, and visitors. However, the rate of ACH is greatly variable, even in newer structures, and a minimum of six ACH is proposed for the prevention of airborne infections. Nonetheless, research is necessary to define the real impact of these ventilation systems on the emergence of nosocomial airborne infections.

Ventilation is only one element to prevent nosocomial COVID-19 and should always be associated with other measures, such as a) screening of inpatients at admission b) use of a private room whenever possible, c) use of PPE for HCWs, including masks d) respect of standard especially hand-hygiene measures, and e) immunization of the general population and also during hospitalization for inpatients not immunized sufficiently [14].

In conclusion, the pandemic has exposed the need for optimizing ventilation to minimize far-afield infection risks of airborne pathogens, such as COVID-19, as part of an everyday safety precautions. To achieve this, each clinical area should have a visual indicator of the nature of the ventilation and instructions for HCWs on what to do to ensure safe ventilation. Additionally, IPC staff and aerosol scientists should always be included in the planning or design of healthcare facilities, thereby ensuring that inadequate ventilation is less of a concern when considering the risks of transmission of airborne pathogens in the future.

Authorship statement

MM conceived, designed and drafted the manuscript.

Funding

None.

Ethics

Ethics approval not required as this is a discussion paper.

Conflict of interest

None.

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