Title:

Barrier devices during CoVID19 pandemic - the need of the hour!

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The Severe Acute Respiratory Syndrome Coronavirus 2 (SARS-CoV- 2) pandemic has infected over 59.8 million people worldwide, causing unprecedented morbidity and mortality rate amongst those affected, and in particular within the healthcare worker population. New analysis by Amnesty International has found that at least 7,000 health workers have died around the world after contracting COVID-19 till September 2020[1].

SARS-Cov-2 is an Airborne contagious disease and the virus size varies from 40 to 160 nanometer that is reported to remain in air for about 3 hours[2]. Kutter JS et al reviewed evidence of virus transmission routes predating the SARS-CoV-2 pandemic. A number of careful studies have shown that airborne transmission was most probably responsible for a number of SARS-CoV-1 and MERS outbreaks. Airborne transmission can occur (a) at short range through direct contamination with larger droplets, e.g. produced by an infected person during speech, coughing or sneezing, or (b) at long range through inhalation of aerosols consisting of droplets or virus particles that are so small that they can stay suspended in the air for an unlimited period. Aerosol generation during hospital-based procedures was also recognised as important sources of virus transmission and, should be considered as a major risk factor for healthcare workers[3]. The risk of transmission of viral diseases such as SARS increases six folds during anaesthetic procedures such as endotracheal intubation[4]. Wang D et al found 41% cross infection rate in the hospital premises of which 29% were hospital staff and 12.3% other patients[5].

Virus transmission depends on the presence of infected persons, and environmental factors such as ventilation rates, air humidity and temperature etc., as well as crowding of people and host susceptibility. Air movements between spaces within buildings are caused by pressure and temperature differences within and between rooms, and Micro-environment of the premises. Pressure differences between rooms maintained by fans and extracts or wind-induced pressure differences; air flow between rooms occurs from high to low pressure. Temperature differences caused by differences in temperature settings in spaces and cause buoyancy driven current with warm air at lower levels having the tendency to rise, whereas colder air generally drops to lower levels[6]. Thermal stratification within rooms can lead to conditions that inhibit or modify air currents. Micro-environments with transient air flows at smaller scale within spaces are induced by the occupants through ordinary activities, including movements, such as gestures, walking and running, as well as respiratory activity (inhalation, exhalation and conversation), or movement of equipment[7].

Chan KH et al described that SARS-Cov transmission through aerosols may persist as fomites on surfaces for over 5 days at temperatures of 22–25°C and relative humidity of 40–50%, that is, typical air-conditioned environments[8]. Studies have shown that the SARS-Cov-2 may spread from source of Aerosol generation in positive pressure treatment rooms and pollute adjacent area. Guo Zhen et al collected swab samples from potentially contaminated objects in Intensive Care Units (ICU) and general wards, and also sampled indoor air and the air outlets to detect SARS-CoV-2 aerosol exposure for two weeks between February 19 and March 2, 2020. The study observed 40.6% rate of virus positivity near the patient, and 12.5% in the doctor's office which was at a distance of 4 meters[9]. Buonanno G et al looked at Quantitative assessment of the risk of airborne transmission of SARS-CoV-2 infection through prospective and retrospective applications[10]. This study examined the characteristics of the airborne spread of exhaled droplet nuclei indoors between two persons indoors with horizontal airflow distribution, and advised in one application removal of contaminants right from the source to reduce the transmission.

A study of environmental factors involved in the March 2003 SARS-CoV-1 outbreak in Amoy Gardens, Hong Kong was carried out by Yu and co-workers. The distribution of cases according to date of onset and location within the building complex was examined. Virus-laden aerosols were generated in vertical soil stacks and re-entered the building through defective seals in floor drain traps. Detailed computational modelling showed how the contaminated air subsequently spread to other parts of the building due to pressure-differences maintained by fans and extracts and also due to buoyancy-driven air currents in a vertical air shaft running through the building. Windborne spread of aerosols between adjacent buildings was shown to be significant during the period of the outbreak[11].

Qian H et al experimentally modelled the transmission of infectious agents between patients in hospital wards and demonstrated the importance of ventilation strategies to minimise cross-infection in hospital wards[12]. Li Y et al reported that there was conclusive evidence to support the hypothesis that there is a relationship between the ventilation and air movements within buildings and the transmission/spread of infectious diseases such as measles, tuberculosis, chickenpox, influenza, smallpox and SARS[13].

Under normal circumstances, we use positive pressure treatment rooms where atmospheric pressure is kept around 15 kPa. This positive pressure drives the air inflow in through these rooms which then eventually goes out through venting ducts, in addition to this, an air flow is established with adjacent corridors and rooms. A constant supply of clean air via Hepa filters reduces the overall infection to the patients being treated through inhibiting contaminated air entry from adjacent areas into the positively pressurised operation theatres.

Negative pressure rooms are used for the management of airborne contagious diseases. These rooms work on the principles of air change rate and achieve over 90 percent efficiency in 25 to 30 minutes when the air change rate is 14-15 per hour[14]. The relative negative pressure in these rooms aid in removal of air and from within the room to outside the hospital via venting ducts. This arrangement prevents the spread of contaminant air from treatment rooms escaping to the adjacent rooms or corridors, thereby reducing indoor pollution. In the absence of negative pressure treatment rooms, SARS-CoV-2 virus may spread and escape to the adjacent areas, increase the indoor pollution, and make healthcare workers more vulnerable. Scarcity of such facilities has most likely impacted on the high infection rates seen within the healthcare worker population during the CoVID19 pandemic[1].

An experimental study on mannequins in this issue of SJA, looked into the effect of barrier devices for laryngoscopy and intubation, comparing two types of barrier devices. The Authors highlighted a few draw backs with such devices, including restricted operator's manoeuvrability that may compromise airway management. (Comparative Evaluation of Intubation Performances Using Two Different Barrier Devices used in the COVID-19 era: A Manikin Based Pilot Study Ref will be inserted when available from SJA)

It would be prudent to develop a device which encompasses both effective isolation and evacuation of aerosol functionality to help reduce the exposure of contaminant air to healthcare workers and others in vicinity. Further, as observed by the authors (name of authors of Comparative Evaluation of Intubation Performances Using Two Different Barrier Devices used in the COVID-19 era: A Manikin Based Pilot Study) provisions should be made to increase operator's comfort in performing airway management procedures, a critical step in adequate deliver of safe and standard practice. Tiwari RL et al have demonstrated use of one such portable Infection Control Assist Device (ICAD) that is based on the principles of air change rate, and designed using Fluid mechanics to reduce fomites deposition[15]. Studies are required to establish the evidence of effectiveness of such devices in providing effective prevention of infection amongst the health care workers and improve public health. The cost of a negative pressure room was estimated at roughly $ 40000 to 50000 in 1988[16], whilst the cost of a 'barrier device' is around $ 120. It is therefore quite evident to see, this simple invention is promising to be a cost effective measure to protect the health care workers from exposure to airborne contagious diseases such as the SARS-CoV-2 virus. Protecting the health of valuable health care workers should be a priority in this major pandemic and public health crisis.

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