High Efficiency Particulate Air (HEPA) filters

RECOMMENDATION

We suggest the use of HEPA filter as an option to improve air quality for COVID-19 prevention and control in indoor spaces with inadequate ventilation. *(Low quality of evidence; Conditional recommendation)*

Consensus Issues

A conditional recommendation was made because of indirect evidence showing the benefit of HEPA filter in improving air quality. HEPA filters may be useless in public spaces with uncontrolled airflow and should be used only in areas where air exchange is compromised. To ensure that HEPA filters serve their purpose, the amount of air that can be filtered per hour by the machine must be matched with the size of the room. Proper installation and regular maintenance are likewise important to avoid contaminated air from recirculating back to the room and to maximize the machine's lifespan. In spite of the use of HEPA filters, minimum health standards should still be observed.

EVIDENCE SUMMARY

Are high efficiency particulate air (HEPA) filters effective in infection prevention and control of COVID-19 in public spaces and locations with sustained community transmission?

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Key Findings

No direct evidence was found assessing the effectiveness of HEPA filters in preventing and controlling COVID-19 infection in public spaces and locations with sustained community transmission. Low quality evidence from 3 laboratory experiments and 1 case series demonstrated that HEPA filters appear to significantly improve air quality.

Introduction

Airborne transmission of the COVID-19 virus is possible under circumstances and settings where aerosol generating procedures are performed [1]. Ventilation, filtration and air cleaners such as the high efficiency particulate air (HEPA) filter are believed to assist in reducing the risk of

transmission of infectious diseases by removing the particles or large droplets to which pathogens may be attached [2,3,4].

Review Methods

We searched for published studies on February 21, 2021 on MEDLINE, Cochrane CENTRAL, pre-print databases, primary trial registries, and guideline sites such as the NICE, WHO, USPSTF and Canadian Task Force on Preventive Health. We used keywords “HEPA,” “HEPA filtration,” “HEPA filter,” or “air purifier” together with specific search words for COVID-19. We included both clinical trials or non-clinical experiments that measured the efficiency of HEPA filters.

Results

We found no direct evidence assessing the effectiveness of HEPA filters in preventing and controlling COVID-19 infections in public spaces and locations with sustained community transmission. There were, however, indirect evidence from 3 laboratory experiments [3,5,7] and 1 case series [6] showing its potential benefit. Majority of the studies were about specific devices that incorporated HEPA filters as a component of the entire mechanism, or as a co-intervention. Outcomes measured included particle concentrations or capture/filtration efficiency. The quality of this body of evidence was rated low primarily due to indirectness and imprecision.

A case series from India [5] reported using HEPA filters in a hospital setting for 6 COVID-19 patients with tension pneumothorax who warranted chest tube thoracostomy. Two closed underwater drainage systems (CUDS) were joined together, then a HEPA filter was added to the port of the second CUDS to reduce high concentrations of SARS-CoV-2 from intrapleural air that passes through the CUDS. Although the study reported that no hospital staff were infected with COVID-19 during the 15-day study period, sufficient information was not available in the article to allow appraisal.

One non-clinical, repeated measures experimental study done in Hong Kong following earlier outbreaks of SARS and avian flu demonstrated significant reductions in particle concentration levels with the use of a portable HEPA filter in a 6.7m x 6.0m x 2.7m (LxWxH) room [3]. Another laboratory experiment assessed the efficacy two HEPA filter configurations, together with 4 other modifications to personal protective equipment (PPE) consisting a standard helmet, hood and gown “spacesuit” draped on a mannequin. Particulate testing (range of particles were 0.3-1.0 micrometer) was the outcome measure. Results showed that the configurations with modified HEPA filters had lowered the mean percentage particulate penetrations compared to its counterparts by 20% [6] .

A technical memorandum by the US - National Aeronautics Space Administration reported on the filtration efficiency of HEPA-rated media filters through its ability to capture particles of various sizes across its multi-layered media [7]. Larger particles are captured by the filter’s mechanism of inertial impaction and interception, while smaller particles are captured in the inner layers via particle diffusion. Moreover, filtration efficiency of HEPA filters were significantly enhanced when airborne particles were smaller, to diameters below the most penetrating particle size (MPPS),

which was typically 120 nm. HEPA filters were concluded to have efficient filtration across the spectrum of different-sized particles, down to the very smallest airborne particles or MPPS [7].

Recommendations from Other Groups

The American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE) maintains that HEPA filters are more than 99.97% efficient at capturing airborne viral particles associated with SARS-CoV-2 [2].

The Centers for Disease Control (CDC) (9 Feb 2021) has enlisted the use of portable HEPA fan/filtration systems to help enhance air cleaning, particularly in higher risk settings such as health clinics, medical testing locations, workout rooms, or public waiting areas, where there is an increased likelihood of COVID-19 and/or increased risk of getting COVID-19 [8].

WHO (28 Mar 2020) considers the use of single-space air cleaners with HEPA filters for health care facilities without adequate natural or mechanical ventilation, provided that they are appropriately selected, deployed and maintained [1]. No specific recommendation related to community use was made.

Guidelines from PSMID, PHICS, and PCP (17 May 2020) state that HEPA filters provide additional benefit in improving air quality especially in settings where adequate ventilation cannot be achieved. The guideline maintained that HEPA filter use must follow the manufacturer's operating protocols, including configuration, maintenance and replacement of the HEPA filters [4].

Research Gaps

Clinical studies that directly investigate the effectiveness of HEPA filters in preventing COVID-19 infections are still lacking.

Ongoing Studies

In Australia, there is an ongoing review by the National COVID-19 Clinical Evidence Taskforce on evidence of the levels of ventilation and portable air cleaning devices. No additional information has been indicated in the website concerning details of the said review [9].

References

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Appendix 1. Characteristics of Included Studies

Study	Population	Intervention	Control	Outcome	n
Qian et al., (2010)	Laboratory study	HEPA filter	HEPA filter and HVAC (heating, ventilation and air-conditioning) system	Particle concentration Air change rate	6 beds
Gedic & Alar (2020)	Patients diagnosed with COVID-19 (+) tension pneumothorax For chest tube thoracostomy (CTT)	closed underwater drainage systems (CUDS) with HEPA filter	None	Clinical outcomes Healthcare workers who developed COVID-19	6 patients
Gibbons et al., (2021)	PPE configurations	PPE configuration with HEPA filter material	PPE configuration without HEPA filter material	Mean percentage particulate penetration	6 configurations
[NASA] Perry et al. (2016)	Not mentioned	HEPA filter	Not mentioned	Filtration efficiency	Not mentioned