IONIZING AIR PURIFIER

RECOMMENDATION

We recommend against the use of ionizing air purifier to reduce COVID-19 transmission in the community. *(Low quality of evidence; Strong recommendation)*

Consensus Issues

One of the studies noted that when an area is inhabited, reducing the particulate matter becomes insignificant once people move within the household, which consequently makes the ionizing air purifier ineffective. The panel also recognized that the harm caused by this intervention outweighs its benefit because one of the apparent disadvantages of ionizers is the emission of ozone, a powerful oxidant that may inflict health hazards through long-term or high-dose exposure.

EVIDENCE SUMMARY

Is an ionizing air filter effective in reducing SARS-CoV-2 virus transmission in public spaces with sustained community transmission?

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Key Findings

No direct evidence was found assessing the effectiveness of ionizing air filters in reducing SARS-CoV-2 infections. Five experimental studies reported using an ionizing air purifier in reducing airborne particles, mostly in uninhabited laboratory settings. Ionizing air purifiers can efficiently remove the fine and ultrafine particles. However, its effectiveness in eliminating airborne organisms for infection control is lacking. Ozone, a dangerous respiratory irritant produced by some ionizing air purifiers, is a health risk to users. Overall quality: Most of the studies were at high risk of bias, with common issues on selecting tested ionizing air purifiers and the assessor's blinding.

Introduction

Ion air generators are among the variety of portable air cleaners used to improve indoor air quality [1]. Their operating principle is ion emission through corona discharge. Aerosol particles are repelled and become heavier as they attract negatively charged ions emitted by the air purifier, causing them to precipitate onto surfaces [2].

Review Methods

After a thorough search on PUBMED, the Cochrane CENTRAL, ChinaXiv, MedRxiv, National COVID-19 Clinical Evidence Task Force, COAPLiving Evidence on COVID-19, NIH. US National Library of Medicine. ClinicalTrials.gov, and Chinese Clinical Trial Registry, there was a systematic review and five experimental studies. No randomized controlled trials reporting the effects of ionizing air filters on quarantined individuals were found after a comprehensive literature search of various electronic databases last January 31, 2021. We also excluded studies that used other air filters (e.g., high-efficiency particulate air (HEPA) filter), articles not written in English, and other types of articles (e.g., abstracts, posters, review articles, book chapters, letters, guidelines, points of view).

Results

No clinical studies were found assessing the effectiveness of ionizing air filters in preventing or reducing COVID-19 infections. Five experimental studies reported using ionizing air purifiers in reducing airborne particles, mostly in uninhabited laboratory settings. Although ionizing air purifiers were efficient in removing fine and ultrafine particles, none of these studies reported its effects on reducing SARS-CoV-2 viral load, either in laboratory or actual clinical settings [2–6]. Appendix 2 summarizes the ionizing air purifier's benefit (i.e., particle removal efficiency) and harm (i.e., ozone development).

One of the 5 experimental studies reported that commercial ionizing air purifiers in a residential apartment did not significantly reduce the particulate matter (PM) size, with an average indoor/outdoor mass concentration ratio from 1.03 to 0.73 for most PM size fractions [2]. In experimental chambers, however, ionizing air purifiers alone or with heating, ventilation, and air conditioning (HVAC) effectively reduced PM concentrations [2–5]. Ion emission increased the filter collection efficiency for bacteriophage MS2 virus [4], bacteria (*B. subtilis, E. coli*) by as much as 3 to 4 times and for viable fungal spores (*A. versicolor, A niger*) by a factor of 2 [6]. Units with higher ion emission rates provided higher particle removal efficiency [3–5]. Due to its high ion emission rates, bipolar ions are better by 1.7x than unipolar ions in removing PM [4].

One disadvantage of ionizers is ozone emission, a powerful oxidant that may harm health by long-term or high-dose exposure. Factors found to be associated with higher ozone levels include longer duration of exposure, higher ion emission, and use of bipolar ions. Compared with unipolar ions, bipolar ions can emit up to 30 ppb compared to unipolar ion's 2-10 ppb ozone concentration [4]. Ozone exposure was found to be negligible within 2 hours, but significantly increased to > 77 ppb after 8 hours of exposure [2]. Ozone levels also varied across different commercially available ionizer models despite similar exposure times [5].

Recommendations from Other Groups

No guideline or agency has explicitly recommended the use of ionizing air purifiers. The US-CDC acknowledged bipolar ionizers as emerging technologies used in HVAC systems or portable air cleaners, but mentioned limited research supporting its effectiveness outside laboratory conditions [7].

Research gaps

No study reports the effects of ionizing air purifiers in reducing or eliminating SARS-CoV-2 in the community. No on-going studies are addressing this research gap.

References

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[7] US EPA. Air Cleaners, HVAC Filters, and Coronavirus (COVID-19) [Internet]. 2021. Available from: https://www.epa.gov/coronavirus/air-cleaners-hvac-filters-and-coronavirus-covid-19#:~:text=Central%20furnace%20or%20HVAC%20filters,virus%20that%20causes%20COVID%2D19.

Appendix 1. Characteristics of Included Studies

Author, year	Particle/Bioaerosols	Ionizer air purifier	Comparator	Outcomes
Hyun et al. (2017)(4)	Aerosolized bacteriophage MS2	Carbon-fiber ionizer of a medium air filter	NA	Overall filtration efficiency Pressure drop Antiviral efficiency Ozone concentration
Shi et al. (2016)(5)	Particles	4 wearable ionizers	NA	Ozone concentration $PM_{2.5}$ concentration Particle size distribution Mass removal rates
Huang et al. (2008)(6)	B-subtilis, E. coli, A. versicolor, A. niger	Ionizer and HVAC	NA	Aerosol concentration Removal efficiency
Berry et al. (2007)(2)	Particles	Commercially available ionic air cleaner	NA	Indoor/outdoor airborne particle number Mass concentration ratios Indoor ozone levels Ion concentration levels
Grinshpun et al. (2005)(3)	NaCl, PSL, Pseudomonas fluorescens bacteria	five ionic air purifiers (two wearable and three stationary	NA	Concentration decay of respirable particles Particle removal efficiency

Appendix 2. Ionizing air purifier's benefit and harm

Outcomes	Study	Basis	Effect Estimate	Level of evidence
Particle removal efficiency (household)	4, experimental	Grinshpun et al, 2005 (3)	Model 1: 15% in 15 min, 30–40% in 1 h, 50% after 1.5 h, 80% after 3 h	Low[1]
			Model 2: 50% in 15 min, 100% in 1.5 h	
			Model 3: almost 90% within 5-6 min, 100% within 10-12 min	
Particle removal efficiency (commercially available wearable air purifier)		Shi et al., 2016 (5)	$PM_{2.5}$ mass removal rates:	
			AC1: 1.85 h^{-1}	
			AC2: 0.48 h^{-1}	
			AC3: 1.52 h^{-1}	
			AC4: 5.37 h^{-1}	
Particle removal efficiency: (with low efficiency HVAC)		Huang et al. 2008 (6)	B-subtilis: 16.4±5.3 to 80.4±14.3%	
			E. coli: 17.6±4.2 to 73.3±11.1%	
			A. versicolor: 83.1±12.3%	
			A. niger: 96.5±10.1%	
			Filter only: 9.09±4.84%	
Particle removal efficiency (unipolar vs. bipolar)		Hyun et al, 2017(4)	Unipolar ions: 46.1% at 15 min, 78.8% at 30 min, and 83.7%, at 45 min	
			Bipolar ions:	
			64.3% at 15 min	
			89.1% at 30 min	
			97.4% at 45 min	
Ozone levels (unipolar vs. bipolar)	3, experimental	Hyun, 2017 (4)	Unipolar air ions emit 2-10 ppb ozone, whereas bipolar air ions emit 30 ppb ozone.	Low[1]
		Shi, 2016 (5)	The 10-h average ozone emission rates:	

Outcomes	Study	Basis	Effect Estimate	Level of evidence
			AC1: 0.67 $mg.h^{-1}$ AC2: 3.40x 10^{-2} $mg.h^{-1}$ AC3/AC4: negligible.	
		Berry, 2007 (2)	Negligible ozone emissions in 2 hours	
			1st hour: 13-19 ppb in the 1st hour	
			≥8 hours: 77 ppb	

1 The studies offered indirect evidence and inconsistent findings on the effects of ionizers in laboratory and real-environment settings. The tested ionizers were not systematically selected. Assessors were not blinded to ionizers used; however, the included studies used objective outcome measures.

Legends: HVAC, heating, ventilation aircon; ppb, part per billion; h^{-1}, the number removal rates of total particles measures in size range from 18.1 to 289 nm