

RESEARCH NOTE

Optimizing clinical productivity in the otolaryngology clinic during the COVID-19 pandemic

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KEYWORDS

clinic productivity, COVID-19, nasal endoscopy, otolaryngology, airborne contaminant removal, SARS-CoV-2

Aerosol generation and air exchange has garnered significant attention during the coronavirus disease 2019 (COVID-19) pandemic, due to suspected airborne transmission of the novel severe acute respiratory syndrome-coronavirus-2 (SARS-CoV-2).¹ The Centers for Disease Control and Prevention (CDC) recommend a minimum of 6 air changes/hour (ACH) for airborne contaminant removal in the outpatient setting.² This requirement has significantly impacted room turnover time and clinic productivity. Many clinics have incorporated high-efficiency particulate air (HEPA) filters in order to boost air filtration within the clinics. However, there is limited information on routine use of HEPA filters in the outpatient setting and a lack of practical information on how ACHs are calculated.^{1,3,4} The goal of this study was to examine the impact of airflow volume in an otolaryngology clinic room air distribution system on room turnover and evaluate the impact of the HEPA filter on clinic productivity.

MATERIALS AND METHODS

This study was determined exempt by the Institutional Review board (IRB), because it does not meet the definitions of human subject research (IRB#00138135). The airflow volume in an otolaryngology clinic room air distri-

bution system with positive airflow and standardized size (1049 ft³) and temperature was (70.5°F) was measured. The Alnor Balometer- (TSI Incorporated, Shoreview, MN) flow hood was used to measure the clean air delivery rate (CADR) as cubic feet per minute (ft³/minute [cfm]).⁵ CADR was determined at baseline and using a fan filter unit (FFU) HEPA filter (Clean Rooms International, Grand Rapids, MI) at both low and high settings. This HEPA filter boasts a minimum efficiency reporting value (MERV) of 17, which removes >99.97% of aerosols down to a size of 0.3 μm.⁷ Baseline measurements were made in the presence of an American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE) fibrous filter with a MERV of 14, which removes aerosols down to 0.5 μm with an efficiency of 95%.⁶ Using known room volume, CADR was then used to calculate ACM, ACH, and room turnover time needed to achieve 6 air changes (Table 1). The number of patients that can be examined at baseline (no HEPA filter) and with low and high HEPA settings in a single clinic room was modeled based on a 15-minute return patient visit (RPV) and 30-minute new patient visit (NPV). For the purpose of this work, room turnover time was defined as the time, in minutes, required to achieve 6 air changes in a clinic room. Consequently, room turnover countdown started once the visit began rather than after it ended.

TABLE 1 Sample calculation of ACH, ACM, and room turnover time*

Filter status	CADR	ACM CADR/room volume		Room turnover (6 air changes/ACM) (minutes)	Total time per RPV (minutes) ^a	Total time per NPV (minutes) ^a
		ACH (60 minutes ACM) ^a	ACH (60 minutes ACM) ^a			
No HEPA filter	50 cfm	0.05	2.9	120	120	120
HEPA low	225 cfm	0.22	12.9	27	27	30
HEPA high	500 cfm	0.48	28.6	12.5	15	30

*Room conditions: room volume = 1049 ft³; room temperature = 70.5°F.

^aTotal estimated time per NPV and RPV is based on room turnover that, as defined in the Methods section of this article, starts counting down as soon as the clinic visit starts, rather than after the clinic visit ends.

ACH = air changes per hour; ACM = air changes per minute; CADR = clean air delivery rate; cfm = cubic feet per minute; HEPA = high-efficiency particulate air filter; NPV = new patient visit; RPV = return patient visit.

TABLE 2 Impact of filter status and room turnover on number of patients seen in clinic—predicted based on 1 room

Filter status	<u>½-Day clinic (240 minutes)</u>		<u>1-Day clinic (480 minutes)</u>		<u>6-Month clinic (based on 3 clinic days/week: 34,560 minutes)</u>		<u>Room utilization (patients/hour)^a</u>	
	<u>Return visit (240/total time per RPV)^b</u>	<u>New visit (240/total time per NPV)^c</u>	<u>Return visit (480/total time per RPV)</u>	<u>New visit (480/total time per NPV)</u>	<u>Return visit (34,560/total time per RPV)</u>	<u>New visit (34,560/total time per NPV)</u>	<u>Return visit</u>	<u>New visit</u>
	No HEPA filter	2	2	4	4	288	288	0.5
HEPA low	8.9	8	17.8	16	1280	1152	2.2	2
HEPA high	16	8	32	16	2304	1152	4	2

^aRoom utilization based on 1 day of clinic (480 minutes).

^bReturn visit based on 15-minute visit.

^cNew visit based on 30-minute visit.

HEPA = high-efficiency particulate air filter; NPV = new patient visit; RPV = return patient visit.

RESULTS

CADR, ACH, ACM

The CADR was calculated at baseline, HEPA filter on low setting, and HEPA filter on high setting, yielding 50, 225, and 500 cfm, respectively (Table 1). The CADR was then used to determine the following ACH and ACM values at these same settings: 2.9, 12.9, and 28.6 ACH, respectively, and 0.05, 0.22, and 0.48 ACM, respectively (Table 1). Room turnover time needed to achieve 6 air changes in these 3 scenarios was 120, 27, and 12.5 minutes, respectively (Table 1).

Impact of HEPA filtration on clinic productivity

Based on 15-minute RPV and 30-minute NPV, the following number of possible clinic visits per hour were determined in the 3 filtration scenarios: 0.5, 2.2, 4 and 0.5, 2, 2, respectively (Table 2). This translated into the follow-

ing increase in percent room utilization for RPV in 1 day of clinic use: 340% (HEPA low vs no HEPA), 700% (HEPA high vs no HEPA), and 82% (HEPA high vs HEPA low), respectively. Similarly, it resulted in the following percent increase in room utilization for NPV's: 300%, 300%, and 0%, respectively.

DISCUSSION

Anecdotally, outpatient otolaryngology clinic room turnover times have increased in the setting of COVID-19 in order to achieve the CDC-recommended 6 ACH for airborne contaminant removal. Several institutions have adopted the use of HEPA filters in order to decrease room turnover time. However, the impact of HEPA filtration on the outpatient clinic air distribution system, room turnover time, and clinic productivity is unknown. Herein, we modeled outpatient clinic room air filtration scenarios with positive flow at standardized room conditions and demonstrated a significant decrease in room turnover time with the use of a FFU HEPA filter. This, in turn,

resulted in an up to 700% increase in clinical productivity per hour, depending on the visit type and HEPA setting.

During a time that providers are struggling to maintain the same clinical volume as prior to the COVID-19 era, the findings from our work may be used to inform providers on strategies to improve this variable. Moreover, the incorporation of the HEPA filter into routine outpatient clinical care, where the risk of COVID-19 transmission has been theorized to be the greatest, may be another risk mitigation strategy to increase provider safety.

Limitations to this study include the implementation of a mathematical model, rather than real time assessment, to determine the impact of airflow on room turnover time and clinic productivity. Clinic productivity was based on RPVs taking 15 minutes and NPVs taking 30 minutes; this does not reflect the time it takes to see all return and new clinic patients. Clinic productivity was based on entire days where only return or new patients were seen; however, in practice, each clinic day is a mixture of return and new patients. Mathematical modeling demonstrates that supplementation of an outpatient clinic air distribution system with a HEPA filter can significantly increase clinical productivity during the COVID-19 era.

CONFLICT OF INTEREST

J.A.A.: OptiNose and GlycoMira (consultant); K.K.: Tetrad (financial).

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How to cite this article: *How to Cite this Article:* Gill AS, Oakley G, Error M, Kelly K, Orlandi R, Alt JA. Optimizing clinical productivity in the otolaryngology clinic during the COVID-19 pandemic. *Int Forum Allergy Rhinol*. 2021;11:1121-1123. <https://doi.org/10.1002/alr.22766>