Letters

RESEARCH LETTER

Training and Fit Testing of Health Care Personnel for Reusable Elastomeric Half-Mask Respirators Compared With Disposable N95 Respirators

The demand for disposable respiratory protective devices needed to protect health care personnel may exceed supply during large outbreaks of respiratory infectious diseases.[1,2] Concerns are growing over global shortages of respiratory protective devices during the novel coronavirus disease 2019 (COVID-19) pandemic.[3] A reusable alternative to N95 respirators for which health care personnel can be rapidly assessed for fit (fit testing) and trained for use is needed. Elastomeric half-mask respirators (EHMRs), which provide the same level of respiratory protection as N95 respirators, are one alternative[4] (eFigure in Supplement 1). These reusable respirators are used in construction and manufacturing, but not widely used in health care[4] because of uncertainty about disinfection methods and upfront costs.[5] The goal of this demonstration study was to test the feasibility of rapidly training and fit testing health care workers to EHMRs.

Supplemental content

Methods | In 2019, 2 US health care organizations (Emory University and University of Texas Health [UTHealth] Science Center at Houston) conducted an outbreak simulation in which health care personnel, who were randomized to EHMR (80%) or N95 (20%) groups, were rapidly fit tested and trained. The institutional review boards at UTHealth, Baylor College of Medicine, and Emory University approved this study. Written informed consent was obtained at recruitment. Fit testing was performed to assess respirator fit to face, checking for leaks, using an Occupational Safety and Health Administration qualitative fit testing process.[6] The number of fit testing attempts and testing time were recorded. Both groups were trained using a 9-minute video. The EHMR group was assessed 3 times consecutively for 26 performance indicators in the following 6 key areas: (1) inspection, (2) donning, (3) positive-pressure user seal check, (4) negative-pressure user seal check, (5) doffing, and (6) disinfection. Trainers scored participants based on the degree of assistance needed to complete each step (1 indicated physical assistance; 2, verbal assistance; 3, no assistance). A total score for each area consisted of a sum of 4 or 6 individual performance indicators (3 points each) ranging from 12 or 18, with a possible overall score of 78 points. Mean differences for time to completion of fit testing between groups was calculated using *t* tests, differences in the number of attempts to achieve proper fit were calculated using χ^2 tests, and ANOVA with post hoc and 2-sided pairwise comparisons were used to compare EHMR performance scores by attempts with $\alpha = .05$. No sample size calculation was performed. Additional

Table 1. Participant Demographic Characteristics, Respirator Wear Experience, and Fit Assessments in a Study Comparing Elastomeric Half-Mask Respirator and N95 Respirators (N = 153)

	Participants, %	
	EHMR (n = 124)	N95 (n = 29)
Age, mean (SD), y	38.19 (11.19)	38.59 (10.65)
Sex		
Men	21.0	34.5
Women	79.0	65.5
Occupation		
Nurse	41.1	41.4
Physician/physician assistant/nurse practitioner	16.1	13.8
Respiratory therapist	12.9	24.1
Nurses' aide/patient sitter	6.5	6.9
Social worker	7.3	0.0
Medical student	1.6	0.0
Other ancillary workers	14.5	13.8
Hospital unit		
Medical/surgical units	25.8	13.8
Emergency department	21.8	13.8
Intensive care unit	26.6	37.9
All units (float)	10.5	10.3
Other units	7.3	20.7
Administrative	8.1	3.4
Type of respirator previously used[a]		
None	9.7	27.6
EHMR	0.8	3.4
N95	88.7	69.0
PAPR	9.7	13.8
Years of experience wearing respirators		
0	9.7	27.6
1-5	33.9	20.7
6-10	25.8	10.3
11-20	16.9	24.1
>20	13.7	17.2
Qualitative fit testing attempts to pass[b,c]		
1	92.2	88.5
2	6.1	7.7
3	1.7	3.9
Time to complete qualitative fit testing, mean (95% CI)[c,d]	6 min 47 s (6 min 26 s to 7 min 8 s)	6 min 29 s (5 min 46 s to 7 min 13 s)

Abbreviations: EHMR, elastomeric half-mask respirator; PAPR, powered air-purifying respirator.

[a] Not mutually exclusive (could select more than 1 respirator type).

[b] Difference in number of attempts to pass fit testing in the EHMR vs N95 groups: $P = .76$. Fisher exact was used to test collapsed categories (1, >1); $P = .54$.

[c] Excluded 10 participants in the EHMR group and 3 in the N95 group because of missing time data.

[d] Mean difference in time between EHMR vs N95 group, 0 min 18 s (95% CI, −0 min 31 s to 1 min 6 s).

Table 2. Mean Elastomeric Half-Mask Respirator Performance Scores for 6 Key Areas and 26 Individual Indicators (N = 124)

Performance area	Performance score[a,b] Mean			Mean difference (95% CI)	
	1st attempt	2nd attempt	3rd attempt	1st vs 2nd attempt	2nd vs 3rd attempt
Total performance score	72.0	76.4	77.4	−4.34 (−5.33 to −3.35)[c]	−1.01 (−2.00 to −0.02)[c]
Inspecting respirator	11.26	11.81	11.92	−0.54 (−0.75 to −0.33)[c]	−0.12 (−0.34 to 0.09)
Face piece	2.78	2.96	2.97		
Head straps	2.89	2.98	2.98		
Exhalation valve	2.77	2.93	2.99		
Filters	2.82	2.94	2.98		
Donning respirator	11.75	11.93	11.97	−0.18 (−0.28 to −0.07)[c]	−0.04 (−0.14 to 0.06)
Face piece	2.93	2.99	2.98		
Head harness	2.98	3.00	3.00		
Neck strap	2.98	2.98	3.00		
Adjust straps	2.86	2.96	2.98		
Positive-pressure user seal check	11.43	11.82	11.96	−0.40 (−0.57 to −0.22)[c]	−0.14 (−0.31 to 0.04)
Cover exhalation valve and exhale	2.90	2.95	3.00		
Check for leaks	2.92	2.98	2.99		
Readjust respirator	2.88	2.99	3.00		
Repeat user seal check	2.73	2.90	2.97		
Negative-pressure user seal check	11.62	11.88	11.95	−0.26 (−0.40 to −0.12)[c]	−0.07 (−0.21 to 0.07)
Palms over filter intakes and inhale	2.94	2.97	2.99		
Check for slight face piece collapse	2.89	2.98	2.98		
Readjust respirator	2.92	2.99	3.00		
Repeat user seal check	2.87	2.94	2.98		
Doffing respirator	10.47	11.44	11.79	−0.98 (−1.24 to −0.72)[c]	−0.34 (−0.61 to −0.86)[c]
Hand hygiene and gloves	2.40	2.66	2.88		
Unhook neck strap	2.88	2.95	2.97		
Remove without touching respirator face piece	2.51	2.91	2.98		
Place on pad	2.69	2.92	2.97		
Cleaning/disinfecting respirator	15.45	17.49	17.80	−2.04 (−2.4 to −1.6)[c]	−0.30 (−0.70 to 0.09)
Hand hygiene and gloves	2.73	2.94	2.98		
Hold inside and wipe outside	2.44	2.91	2.98		
Prepare clean pad or surface	2.47	2.91	2.95		
Hand hygiene and gloves	2.67	2.91	2.95		
Wipe inside of respirator	2.72	2.96	3.00		
Remove gloves and hand hygiene	2.44	2.86	2.92		

[a] Key EHMR performance areas are the sum of individual indicators (3 points each), with total possible scores of 12 or 18.

[b] Individual indicator scores are degree of assistance needed to complete (1 indicates physical assistance; 2, verbal; 3, none).

[c] Mean differences (95% CI) between attempts (P<.05).

details are available in the protocol (Supplement 2). Analyses were conducted using SPSS, version 25.

Results | Of 193 health care personnel randomized, 153 (79%) participated in the study (124 in the EHMR group and 29 in the N95 group) (**Table 1**). The majority of participants were women (77%), with a mean age of 38 years. Overall, 87% of participants had at least 1 year of experience wearing a respiratory protective device; 9.7% of participants in the EHMR group vs 27.6% in the N95 group had no prior experience. Few participants (1.3%) had prior experience using an EHMR.

In the EHMR group, 92.2% passed fit testing during the first attempt compared with 88.5% in the N95 group (P = .76); all participants passed by the third attempt. The mean time to complete fit testing for the EHMR group, including total number of attempts (6 min 47 s), was not significantly different than the N95 group (6 min 29 s) (difference, 0 min 18 s [95% CI, −0 min 31 s to 1 min 6 s]; P = .48). Participants' performance scores

for EHMR use significantly improved from the first to second attempts overall and in all areas, with a significant improvement from the second to third attempt in 1 area (**Table 2**).

Discussion | This study found that health care personnel can be rapidly fit tested and trained to use the reusable EHMR. Time to achieve fit with EHMRs was not significantly different than with N95 respirators. High EHMR performance was demonstrated. EHMR participants had prior experience using other forms of respiratory protection, which may have influenced their high performance. Limitations include the simulated emergency, small number of participants, and lack of data on actual use of EHMRs. No information was available to inform sample size calculations; *P* values may not be meaningful. Better understanding about the efficacy and feasibility of disinfection methods are key. Combined with an Occupational Safety and Health Administration respiratory protection program,[6] the EHMR may serve as a suitable alternative to disposable N95 respirators during public health emergencies.

Lisa A. Pompeii, PhD
Colleen S. Kraft, MD, MSc
Erik A. Brownsword, MPP
Morgan A. Lane, MPH
Elisa Benavides, MPH
Janelle Rios, MPH, PhD
Lewis J. Radonovich Jr, MD

Author Affiliations: ;Department of Pediatrics, Baylor College of Medicine, Houston, Texas (Pompeii); Department of Pathology and Laboratory Medicine, Emory University, Atlanta, Georgia (Kraft); Division of Infectious Diseases, Emory University, Atlanta, Georgia (Brownsword, Lane); Department of Pediatrics, Baylor College of Medicine, Houston, Texas (Benavides); Department of Epidemiology, Genetics and Environmental Sciences, University of Texas Health Science Center at Houston, Houston (Rios); National Institute for Occupational Safety and Health Centers for Disease Control and Prevention, Pittsburgh, Pennsylvania (Radonovich).

Corresponding Author: Lisa A. Pompeii, PhD, Department of Pediatrics, Center for Epidemiology & Population Health, Baylor College of Medicine, 1 Baylor Plaza, BCM 622, Houston, TX 77030-3411 (lisa.pompeii@bcm.edu)

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Concept and design: Pompeii, Kraft, Brownsword, Rios, Radonovich.
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Drafting of the manuscript: Pompeii, Kraft, Brownsword, Lane, Rios, Radonovich.
Critical revision of the manuscript for important intellectual content: Pompeii, Kraft, Brownsword, Benavides, Rios, Radonovich.
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