

Physiologic Effects of Elastomeric Half-Mask Respirator Use with or Without a Surgical Mask in Healthcare Workers

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INTRODUCTION

- Elastomeric half-mask respirators (EHMRs) have seen increased use in healthcare settings during the COVID-19 pandemic.
- Due to concern for asymptomatic shedding of SARS CoV-2 virus via the exhalation port of an EHMR, some have proposed covering it with a surgical mask (SM).
- However, the physiologic effects of wearing a SM over the exhalation port of an EHMR are unknown.

METHODS

- Twelve healthy healthcare worker volunteers (Table 1) participated in simulation sessions in groups of 4.
- Subjects completed a 30-minute series of simulated healthcare-related tasks (Table 2A) for 3 rounds, while wearing different mask configurations – SM only, EHMR only, and EHMR with SM covering the exhalation port. Mask order was randomized for each group.
- During CPR, each subject was assigned an activity sequence (Table 2B) that was maintained in each round.
- Transcutaneous CO₂ (tcPCO₂), oxygen saturation (SpO₂), and heart rate (HR) were continuously monitored via a transcutaneous sensor (Sentec Inc.).
- Subjects scored their rate of perceived exertion (RPE) and perceived comfort level in the preceding round.
- Results were analyzed using mixed linear models with a fixed effect for mask type, activity, age, BMI, gender, and CPR task sequence. SpO₂ data was winsorized to manage outliers. RPE and perceived comfort scores were compared using mixed linear models.

Figure 1: Subjects perform proning and CPR (EHMR+SM)



RESULTS

Table 1: Subject demographics

Subject #	Gender	Age (years)	BMI (kg/m ²)
1	F	31	21.3
2	F	55	23.5
3	F	25	19.4
4	F	26	19.5
5	M	28	31.2
6	F	38	34.1
7	F	34	17.5
8	F	29	29
9	F	43	31.2
10	F	35	24.8
11	F	33	22
12	F	33	18.3

Table 2: Simulation protocol

A. Simulated task series and description

Task	Time (min)	Description
Rest (Control)	2	Sit at rest wearing surgical mask only
Don Mask	1	Put on test mask configuration
Rest (Test)	2	Sit at rest wearing test mask configuration
Read	1	Read the "Rainbow Passage" aloud
Walk	1	Walk in place, and every 10 steps, squat to ground and simulate picking up an object
Prone and Supine	7	Prone and supine a simulation manekin weighted to 172 pounds, and repeat
CPR (See Table 2B)	16	Divided into eight 2-minute periods of chest compressions on a simulation manekin, resting, bagging, and counting compressions aloud
Break	15	Complete subjective assessments and rest

B. CPR sequence assignments

	Subject A	Subject B	Subject C	Subject D
Period 1	Compress	Rest	Bag	Count
Period 2	Rest	Bag	Count	Compress
Period 3	Bag	Count	Compress	Rest
Period 4	Count	Compress	Rest	Bag
Repeat the above for periods 5-8.				

Figure 2: Physiological parameters by mask and activity

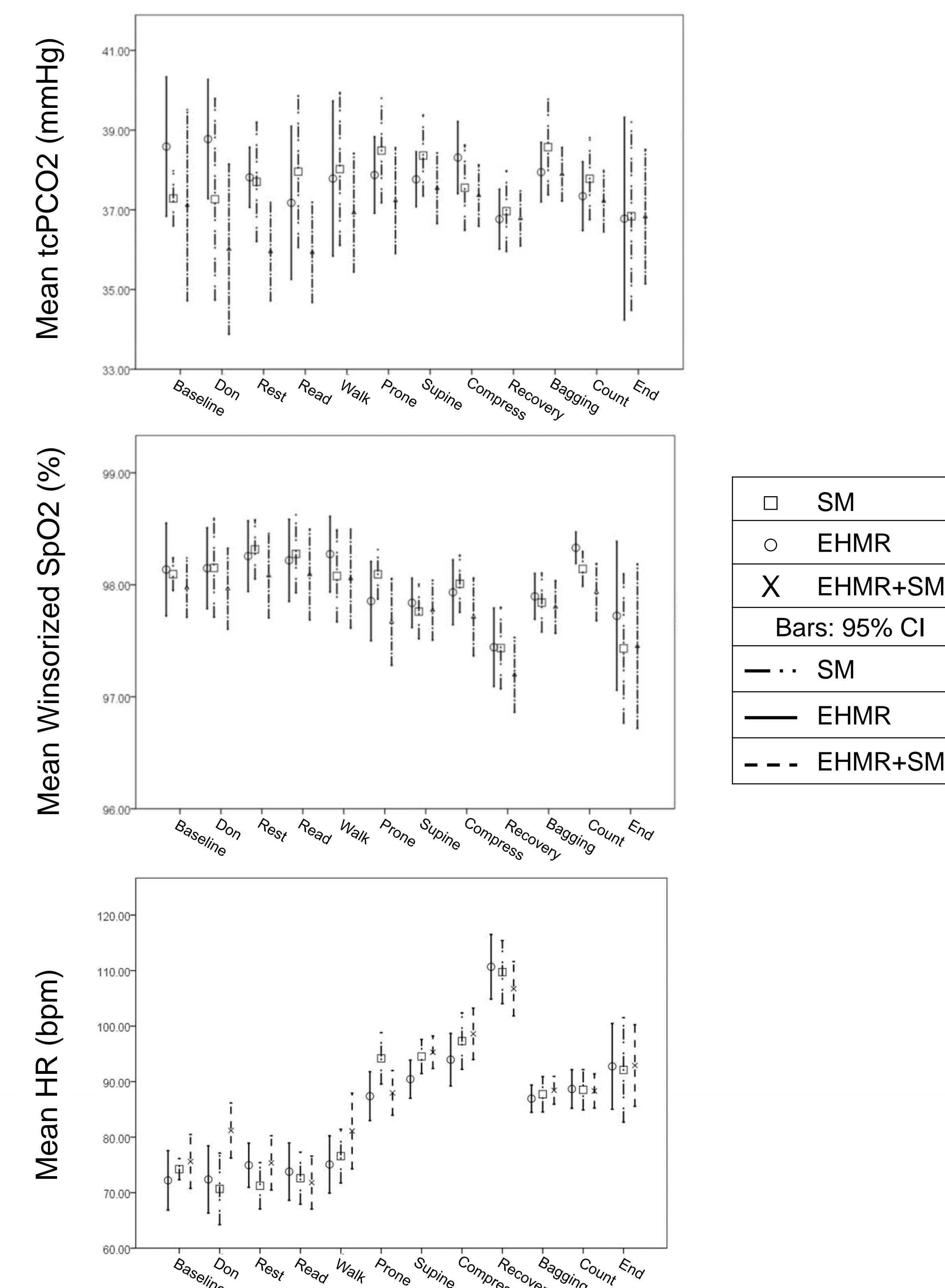


Table 3: Subjective assessments

A. RPE scores (6-20)

Mask Type	Mean (Std Error)	P
SM	11.37 (0.58)	0.004*
EHMR	13.08 (0.58)	-
EHMR+SM	13.54 (0.58)	0.41

B. Perceived Comfort Scores (1-5)

Mask Type	Mean (Std Error)	P
SM	1.25 (0.18)	<0.01*
EHMR	2.17 (0.18)	-
EHMR+SM	2.42 (0.18)	0.23

RESULTS

- Figure 2 shows unadjusted mean tcPCO₂, SpO₂, and HR values by mask type and activity.

Using multivariate linear regression models:

- When wearing EHMR+SM vs EHMR only, there are statistically significant **decreases** in adjusted mean tcPCO₂ (40.68 vs 41.40 mmHg, P < 0.01) and SpO₂ (96.55 vs 96.75 %, P < 0.01).
- There was no significant change in HR attributable to wearing EHMR+SM vs EHMR only.
- There was no significant impact of age or BMI as continuous or categorical variables, gender, or CPR sequence.
- Table 3 shows that subjects reported no significant difference in perceived exertion or perceived comfort when wearing EHMR+SM vs EHMR only.

CONCLUSIONS

- There is **no clinically significant** impact on tcPCO₂, SpO₂, or HR associated with wearing a SM over the exhalation port of an EHMR while performing healthcare-related activities.
- While there are some statistically significant changes, the magnitude is small and not clinically relevant, and values fall in normal ranges.
- There was no significant difference in reported RPE and perceived comfort level while wearing EHMR+SM compared to EHMR only.

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