THE CARDIOPULMONARY EFFECT OF A HEAT AND MOISTURE EXCHANGE MASK ON COPD PATIENTS DURING COLD EXPOSURE

John G. Seifert, PhD
Department of Health & Human Development
Movement Science/Human Performance Laboratory, MSU, Bozeman, MT
john.seifert@montana.edu

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Background

It has been well established that cold air inhalation exacerbates cardiopulmonary stress in Chronic Obstructive Pulmonary Disease (COPD) patients. The frequency of exacerbations increases during the winter which will, ultimately, decrease pulmonary function. As pulmonary function decreases, there is a concomitant decrease in the quality of life because most outdoor activities are eliminated. Thus, minimizing cold air inhalation is an important factor in maintaining functional capacity of these patients. A heat and moisture exchange mask (HME) warms and humidifies cold, dry inspired air via latent heat exchange. However, it is not known if COPD patients would benefit from such a mask.

The purpose of this study was to investigate the influence of an HME on the cardiopulmonary responses in COPD patients during 60 minutes of cold exposure.

Methods

Following Institutional Review Board approval, nine COPD patients (stage I: n=6, stage II: n=3) consented to participate in this study. Three subjects were also being treated for hypertension.

Each subject completed three experimental trials. Subjects completed one trial at room temperature (21^{o}C; RT) and two trials at -7^{o}C. Patients wore an HME or no mask (NM) during the cold exposure trials. For each trial, subjects completed 4 intervals of cycling for 5 minutes followed by 10 minutes of seated rest. Subjects cycled at 30W for the exercise portion of the interval. This study was completed in a crossover design. Pulmonary function was assessed immediately pre- and 5 minutes post trial. Both measurements were collected at room temperature conditions by a Jones Spirometer. Blood pressure was measured at 15 minute intervals during the 60 minute exercise (Omron BP cuff). Subjects were dressed in an insulated jacket, winter hat, mittens, insulated pants, and warm boots for the cold trials. The RT trial was completed in a lightweight shirt (t-shirt) and pants.

An ANOVA and paired t-tests were used to analyze data. Alpha level of significance was set at $p<.05$.

Results

Pulmonary data are given in Table 1. Percent change from baseline to 60 minutes was significantly different in the HME and RT trials compared to the NM trial for Forced Vital Capacity and Forced Expiratory Volume at 1 second. Forced Expiratory Volume at 0.5 seconds was significantly greater for HME than NM. No difference was noted between RT and NM for FEV.5. No differences in pulmonary function were observed between HME and RT.

Absolute systolic blood pressure values are given in Figure 1. Percent change in systolic blood pressure was significantly lower at 60 minutes during the HME (3.0±4.0%) and RT (1.5±6.7%) trials compared to NM (14.2±6.1%). Absolute systolic pressures at pre-test for HME, RT, and NM were 122.1, 119.5, and 122.4 mmHg, respectively. At 60 minutes, systolic blood pressures were 125.7, 121.6, and 139.9 mmHg for the HME, RT, and NM trials.

Mean arterial pressure data can be viewed in Figure 2. All three trials resulted in a consistent MAP through 30 minutes of exercise. However, trends occurred at 45 minutes with a significant difference occurring at 60 minutes. At this point, MAP for HME and RT was significantly lower than the NM. Percent change from baseline for MAP during the HME, RT, and NM trials were 3%, 1%, and 9%, respectively.

Anecdotally, one subject was unable to complete the exercise under the NM trial in the cold, but was able to complete all four intervals during the HME and RT trials.

Conclusions

Wearing an HME significantly improved cardiopulmonary function in the COPD patient compared to not wearing a mask during cold exposure. Similar cardiopulmonary results were observed between exercise at room temperature and during cold exposure when subjects wore the HME. These results indicate that functional capacity can be maintained, similar to that in thermal neutral conditions, when an HME is worn during cold exposure. The evidence suggests that an HME used by COPD patients should be considered as preventative treatment during cold exposure.

What sets this study apart from previous investigations that have been conducted was that subjects exercised at a low intensity during their trials. This is in contrast to

previous work where subjects simply remained seated during the cold exposure. Whereas differences in previous studies were observed at about 30 minutes of exposure, the delay in observing significant changes in blood pressure was certainly a function of the exercise. However, the changes were still evident at the end of the cold exposure. Most surprising, results were similar between the HME and RT. This would suggest that functional capacity can be maintained when subjects wear the HME during cold exposure.

Future work certainly is needed in terms of expanding the subject pool (i.e. increasing the number of subjects), testing under resting conditions to allow for comparison to previous work with hypertensive patients, to study the physiological mechanisms of cold exposure and inhalation of cold air, and what allows the patient to maintain responses similar to those observed at room temperature when they are wearing the HME.

Table 1. Percent change from pre- to post-test pulmonary function (n=9)

	FVC	FEV1	FEV1%	FEV.5
HME	3.3 (4.5)	5.0 (6.8)	2.2 (3.6)	6.2 (8.3)
NM	-5.3 (5.4) *	-7.1 (12.0) *	-2.7 (8.6)	-8.9 (13.7) **
RT	9.0 (11.8)	8.0 (12.5)	2.6 (7.3)	3.4 (17.0)

Mean (±SD)
*: Significantly different from HME and RT
**: Significantly different from HME
No significant differences were observed between HME and RT

Figure 1. Systolic Blood Pressure.

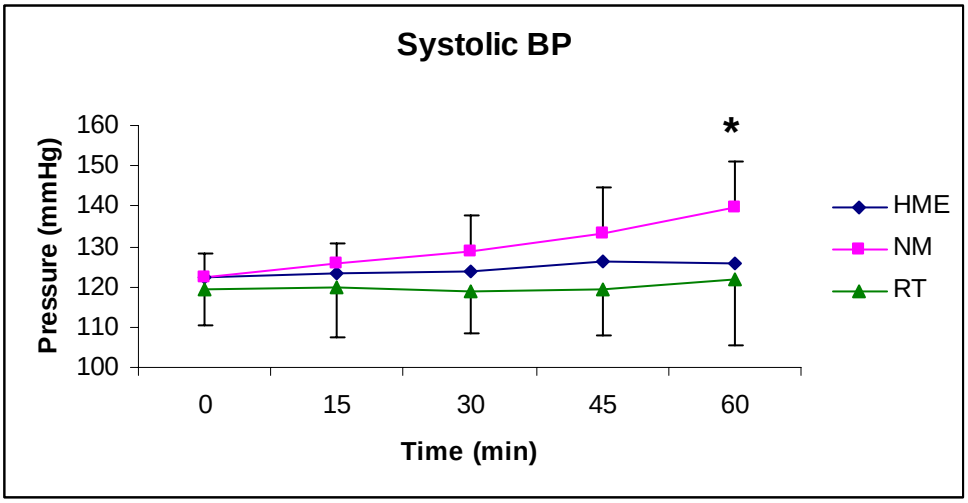
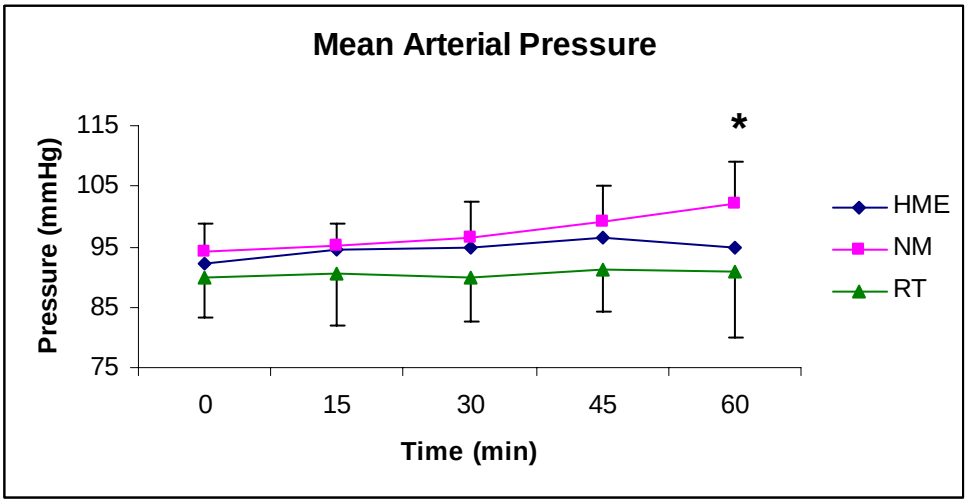


Figure 2. Mean Arterial Pressure.



Data are Mean ±SD
*: NM Significantly different from HME and RT