To the Editor:

Current evidence, from observational studies to systematic reviews and epidemiologic modeling, supports the use of masks by the public, especially surgical masks, for mitigating coronavirus disease (COVID-19) transmission and deaths (1–5). However, public mask use has been heavily politicized with inconsistent recommendations by authorities leading to divided public opinion. Despite evidence to the contrary, an online UK/U.S. survey found that only 29.7–37.8% of participants thought that wearing a surgical mask was “highly effective” in protecting them from acquiring COVID-19 (6). Another reason commonly argued against mask use involves safety concerns, as mask discomfort has been attributed to rebreathing CO₂ and hypoxemia, with some even considering that masks are lethal (7).

Objective
To evaluate whether gas exchange abnormalities occur with the use of surgical masks in subjects with and without lung function impairment.

Methods and Findings
To demonstrate the changes in end-tidal CO₂ and oxygen saturation as measured by pulse oximetry before and after
Table 1. Physiologic parameters measured in study volunteers before and after surgical mask use

| Parameter          | Healthy house staff | Subjects with severe COPD |
|--------------------|---------------------|---------------------------|
| **Baseline values without mask** |                     |                           |
| HR (x\(\text{min}^{-1}\)) | 72.5 ± 10.0 (61 to 88) | 117.2 ± 2.5 (103 to 121) |
| RR (x\(\text{min}^{-1}\)) | 20.2 ± 1.0 (18 to 21) | 39.1 ± 6.0 (33 to 43) |
| \(\text{SpO}_2\) (%) | 97.5 ± 1.2 (96 to 100) | 77.2 ± 15.1 (54.4 to 99.6) |
| \(\text{ETCO}_2\) (mm Hg) | 36.0 ± 2.3 (31 to 40) | 36.1 ± 3.3 (29.7 to 43.6) |
| \(\text{PO}_2\) (mm Hg) | 0.12 ± 0.3 (95 to 100) | 0.14 ± 0.7 (90 to 70) |
| **Change from baseline** |                     |                           |
| HR (x\(\text{min}^{-1}\)) | 0.50 ± 3.8 (−5.0 to 6.0) | −0.28 ± 0.7 (−1.0 to 1.0) |
| RR (x\(\text{min}^{-1}\)) | 0.12 ± 3.8 (−6.0 to 4.0) | −0.17 ± 1.4 (−1.0 to 3.0) |
| \(\text{SpO}_2\) (%) | 0.10 ± 0.6 (−1 to 1.0) | 0.87 ± 2.1 (−2.0 to 5.0) |
| \(\text{ETCO}_2\) (mm Hg) | 86.0 ± 9.8 (72 to 100) | 8.13 ± 4.2 (−10 to 2.0) |
| \(\text{PO}_2\) (mm Hg) | 3.30 ± 6.2 (−3.0 to 10.0) | 4.80 ± 7.3 (−190 to 5.0) |

Discussion

Although we did not measure changes in tidal volume or minute ventilation, these data find that gas exchange is not significantly affected by the use of surgical mask, even in subjects with severe lung impairment. Our results agree with a prior observation on 20 healthy volunteers using a surgical mask for 1 hour during moderate work rates, in which mild increases in physiological responses also deemed to be of no clinical significance were observed (8). The discomfort felt with surgical mask use has been ascribed to neurological reactions (increased afferent impulses from the highly thermosensitive area of the face covered by the mask or from the increased temperature of the inspired air) or associated psychological phenomena such as anxiety, claustrophobia, or affective responses to perceived difficulty in breathing (8). These findings are in contrast to the use of N-95 masks, in which carbon dioxide tension/partial pressure (\(\text{PCO}_2\)) may increase in lung-healthy users but without major physiologic burden (9).

We did not intend to compare healthy versus diseased individuals but rather aimed to assess the effect of using a surgical mask in two distinct populations. We acknowledge that our observations may be limited by sample size; however, our population offers a clear signal on the nil effect of surgical masks on relevant physiological changes in gas exchange under routine circumstances (prolonged rest, brief walking). Other studies studying surgical or N-95 masks have used samples of 6–10 individuals per group (8–11). We focused on subjects wearing a surgical mask, we used a convenience sample of 15 house staff physicians without lung conditions (aged 31.1 ± 1.9 yr, 60% male) and 15 veterans with severe chronic obstructive pulmonary disease (COPD) (aged 71.6 ± 8.7 yr, forced expiratory volume in 1 second [\(\text{FEV}_1\)] 44.0 ± 22.2%, 100% male). The patients needed to have a postbronchodilator \(\text{FEV}_1\) <50% and \(\text{FEV}_1/\text{forced vital capacity} <0.7 and were enrolled from the pulmonary function laboratory during a scheduled 6-minute walk test ordered to assess the need for supplemental oxygen. In our institution, the 6-minute walk tests are done with arterial blood analysis before and immediately after the walk to assess the need for long-term oxygen. Because of the COVID-19 pandemic, the 6-minute walk tests are done with subjects using a surgical mask. As this was a clinical observation study, exemption from the local institutional review board was obtained. Baseline measures on room air without a mask were performed noninvasively using a Life Sense monitor (model Ls1-9R; Nonin Medical), followed by continuous monitoring using a surgical mask.

At 5 and 30 minutes, no major changes in end-tidal \(\text{CO}_2\) or oxygen saturation as measured by pulse oximetry of clinical significance were noted at any time point in either group at rest (Table 1). With the 6-minute walk, subjects with severe COPD decreased oxygenation as expected (with two qualifying for supplemental oxygen). However, as a group, subjects with COPD did not exhibit major physiologic changes in gas exchange measurements after the 6-minute walk test using a surgical mask, particularly in \(\text{CO}_2\) retention.
with severe COPD because they are at a higher risk of CO2 retention compared with subjects with COPD of milder severity or other pulmonary conditions. As shown, we observed a small drop in oxygen pressure/tension in this group, expected based on their disease severity, but not a rise in Pco2 after walking. An ideal setting would have been to allow these individuals to walk without a mask; however, because of the current epidemic, this was not allowed in our institution at the time of the evaluation. The nature of our veteran population precluded us from enrolling women with COPD; however, we do not expect major sex-related physiologic responses when using a surgical mask.

It is important to inform the public that the discomfort associated with mask use should not lead to unsubstantiated safety concerns as this may attenuate the application of a practice proved to improve public health. As growing evidence indicates that asymptomatic individuals can fuel the spread of COVID-19 (12), universal mask use needs to be vigorously enforced in community settings, particularly now that we are facing a pandemic with minimal proven therapeutic interventions. We believe our data will help mitigate fears about the health risks of surgical mask use and improve public confidence for more widespread acceptance and use.

Author disclosures are available with the text of this letter at www.atsjournals.org.

Rajesh Samannan, M.D.
Jackson Memorial Hospital
Miami, Florida
Gregory Holt, M.D., Ph.D.
Rafael Calderon–Candelario, M.D.
Mehdi Minaei, M.D.
Michael Campos, M.D.*
University of Miami Miller School of Medicine
Miami, Florida
and
Miami Veterans Administration Medical Center
Miami, Florida
ORCID ID: 0000-0001-5485-9062 (M.C.).

*Corresponding author (e-mail: mcampos1@med.miami.edu).

References

1. Eikenberry SE, Mancuso M, Iboi E, Phan T, Eikenberry K, Kuang Y, et al. To mask or not to mask: modeling the potential for face mask use by the general public to curtail the COVID-19 pandemic. Infect Dis Model 2020;5:293–308.

2. Greenhalgh T, Schmid MB, Czyzynia K, Bassler D, Grue L. Face masks for the public during the covid-19 crisis. BMJ 2020;369:m1435.

3. Liang M, Gao L, Cheng C, Zhou Q, Uy JP, Heiner K, et al. Efficacy of face mask in preventing respiratory virus transmission: a systematic review and meta-analysis. Travel Med Infect Dis 2020;36:101751.

4. Lyu W, Wehby GL. Community use of face masks and COVID-19: evidence from a natural experiment of state mandates in the US. Health Aff (Millwood) 2020;39:1419–1425.

5. Worby CJ, Chang HH. Face mask use in the general population and optimal resource allocation during the COVID-19 pandemic [preprint]. medRxiv; 2020 [accessed 2020 Jul 06]. Available from: https://www.medrxiv.org/content/10.1101/2020.04.04.20052696v1.

6. Geldzetter P. Use of rapid online surveys to assess people’s perceptions during infectious disease outbreaks: a cross-sectional survey on COVID-19. J Med Internet Res 2020;22:e18790.

7. CNN. Angry residents erupt at meeting over new mask rule. 2020; [accessed 2020 Jun 24]. Available from: https://www.cnn.com/videos/politics/2020/06/24/mask-mandate-florida-anger-erupts-coronavirus-vpx.cnn.

8. Roberge RJ, Kim JH, Benson SM. Absence of consequential changes in physiological, thermal and subjective responses from wearing a surgical mask. Respir Physiol Neurobiol 2012;181:29–35.

9. Roberge RJ, Coca A, Williams WJ, Powell JB, Palmiero AJ. Physiological impact of the N95 filtering facepiece respirator on healthcare workers. Respir Care 2010;55:569–577.

10. Roberge RJ, Coca A, Williams WJ, Palmiero AJ, Powell JB. Surgical mask placement over N95 filtering facepiece respirators: physiological effects on healthcare workers. Respir Vol 2010;15:516–521.

11. Sinkule EJ, Powell JB, Goss FL. Evaluation of N95 respirator use with a surgical mask cover: effects on breathing resistance and inhaled carbon dioxide. Ann Occup Hyg 2013;57:384–398.

12. Li R, Pei S, Chen B, Song Y, Zhang T, Yang W, et al. Substantial undocumented infection facilitates the rapid dissemination of novel coronavirus (SARS-CoV-2). Science 2020;368:489–493.

Copyright © 2021 by the American Thoracic Society