


Research Brief

The effect of surgical face masks on oxygenation and respiratory rate in hospitalized patients with coronavirus disease 2019 (COVID-19)

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Coronavirus 2019 (COVID-19) continues to spread globally, particularly in low- and middle-income countries where vaccination efforts have lagged. A major priority of health systems is to minimize the risk of nosocomial spread and healthcare worker (HCW) infection. In one study, HCWs were 7 times as likely to have severe COVID-19 as those in other professions.¹ Studies have demonstrated high viral loads and active viral replication in the upper respiratory tract within the first week of illness, when patients are more likely to be hospitalized.² Some procedures, such as noninvasive ventilation, may generate higher aerosolization of virus.³ The consistent and proper use of personal protective equipment (PPE), including N-95 masks, has been advocated to decrease HCW transmission, but the availability of PPE equipment may be limited, especially in low-resource settings.⁴

Wearing surgical masks decreases spread of respiratory particles and decreases severe acute respiratory coronavirus virus 2 (SARS-CoV-2) transmission.⁵ Using surgical masks on hospitalized patients may provide an additional low cost and easy to implement physical barrier to minimize HCW exposure risk, but its effect on oxygenation is unclear. The literature is limited and primarily involves healthy volunteers. In a study of 24 volunteers, use of a surgical mask worn over a nasal cannula was beneficial for oxygenation and possibly decreased aerosol dispersion.⁶ Another study of 16 volunteers showed negligible differences in FiO_2 with a surgical mask worn above or below supplemental oxygen.⁷ The purpose of this study was to assess the effect of wearing a surgical mask on respiratory status and subjective work of breathing in hospitalized patients with COVID-19, who required supplemental oxygen (6–15 L/min oxygen) through a face mask or non-rebreather mask (FM/NRB).

Methods

We conducted a prospective before-and-after study at a COVID-19–designated hospital in the United Arab Emirates from May 15, 2021, through June 30, 2021. The hospital instituted a mask mandate for HCWs and visitors but not for patients. At the time of the study, most hospitalized patients had the delta variant of the virus.

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Participants were nonintubated patients with COVID-19 and acute hypoxemic respiratory failure requiring oxygen supplementation. All consecutive adult patients aged 18–75 years with COVID-19 confirmed by nasopharyngeal polymerase chain reaction (PCR) were screened and considered eligible if they (1) required oxygen supplementation with face mask or non-rebreather (6–15 L/min oxygen) and (2) had a stable oxygen saturation (not requiring increasing levels of supplemental oxygen) and no increase in respiratory rate for at least 2 hours prior to participation. The main exclusion criteria were impaired consciousness or worsening respiratory status. After obtaining baseline vital signs, a surgical mask was placed on the patient above (intervention 1) and then underneath (intervention 2) the FM/NRB, by a trained physician researcher blinded to the study hypothesis. Respiratory rate and oxygen saturation and patient comfort and ease of breathing were assessed 20 minutes after each intervention. The primary outcomes were change in respiratory rate or oxygen saturation from baseline. Secondary outcomes included patient subjective comfort levels, as determined by a questionnaire, which compared comfort level and work of breathing between baseline and wearing the mask, for each intervention. Adverse events were monitored for 1 hour after the interventions. The study was approved by the Abu Dhabi Health COVID-19 Research Ethics Committee (DOH/NCVDC/2020/1051). Written informed consent was obtained from each patient.

Statistical analysis was performed using SPSS version 26 software (IBM, Armonk, NY). Mean \pm standard deviation were used to summarize the distribution of variables. A paired *t* test was used to assess differences between baseline and interventions. The Shapiro-Wilk test was conducted to determine whether the data were approximately normally distributed; when they were not normally distributed, a nonparametric test was executed to confirm the result of the parametric test. Density plots were used to visualize the distribution of variables.

Results

Among 60 eligible patients, 53 agreed to participate (88% response rate). Participant demographics are listed in Table 1. Most were male (39 of 53, 73.6%) with a mean age of 50 ± 10.5 years. There was no significant change in breaths per minute (bpm) when the surgical mask was worn above the FM/NRB (24.40 ± 6.28 vs 24.92 ± 5.55 ; $P = .38$). Mean respiratory rate increased when

Table 1. Study Population

Participant Demographics	No. (%)
Age, median y \pm SD	50 \pm 10.5
Sex, no. (%)	
Men	39 (73.6)
Women	14 (26.4)
Comorbidities, no. (%)	
None	22 (41.5)
Obesity	12 (22.6)
Hypertension	13 (24.5)
Diabetes	10 (18.9)
Chronic renal disease	2 (3.8)
Chronic lung disease	3 (5.7)

Note. SD, standard deviation.

Table 2. Oxygen Saturation, and Respiratory Rate With Surgical Mask Interventions (N = 53)

Variable	Mean \pm SD	Comparison	Mean Difference (95% CI)	P Value
Oxygen saturation, %				
Baseline	97.02 \pm 2.12	Baseline vs intervention 1	-0.49 (1.10-0.12)	.11
Intervention 1	97.51 \pm 2.38	Baseline vs intervention 2	1.47 (0.71-2.22)	<.001
Intervention 2	95.56 \pm 2.82	Intervention 1 vs intervention 2	1.96 (1.25-2.66)	<.001
Respiratory rate, breaths per minute				
Baseline	24.40 \pm 6.28	Baseline vs intervention 1	-0.53 (-1.73 to 0.67)	.381
Intervention 1	24.92 \pm 5.55	Baseline vs intervention 2	-2.45 (-4.58 to -0.33)	.02
Intervention 2	26.85 \pm 7.03	Intervention 1 vs intervention 2	-1.92 (-3.65 to -0.20)	.03

Note. SD, standard deviation; Intervention 1- Surgical mask above FM/NRB; intervention 2- Surgical mask below FM/NRB.

the surgical mask was placed below the FM/NRB (26.85 \pm 7.03; $P = .024$) (Table 2). There was a statistically significant decrease in oxygen saturation when the surgical mask was placed below the supplemental oxygen (97.51% \pm 2.38% vs 95.56% \pm 2.82%; $P < .001$). Most patients (39 of 53, 73.6%) reported greater subjective discomfort and dyspnea when wearing the surgical mask below the FM/NRB.

Discussion

Throughout the COVID-19 pandemic, infection and illness have posed a significant threat to HCWs. Hospitals worldwide have implemented multipronged strategies, including enhanced surveillance and outbreak management.⁸ These interventions require substantial investment in terms of cost, manpower, and bed allocation,⁸ and they cannot be implemented in many countries. Our study shows that hospitalized patients with acute hypoxemic respiratory failure, requiring oxygen therapy via a face mask or NRB, can safely wear a surgical mask without compromising respiratory status. This practice can serve as an additional protective measure to minimize risk of nosocomial and HCW infection. Wearing the mask below the FM/NRB caused a small but significant decrease in oxygenation and increase in respiratory rate from baseline and caused significantly more subjective discomfort. Therefore, we recommend placing the mask above the FM/NRB.

Study limitations include single center with small sample size, primarily male participants, and limited follow-up duration. Nonetheless, our findings can help inform infection prevention measures, particularly in low-resource settings. Further studies with larger sample sizes assessing surgical mask use with different oxygen modalities and effects on aerosolization of virus particles are warranted.

Supplementary material. To view supplementary material for this article, please visit <https://doi.org/10.1017/ice.2021.470>

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Conflicts of interest. All authors report no conflicts of interest relevant to this article.

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