





Impact of wearing personal protective equipment on the performance and decision making of surgeons during the COVID-19 pandemic

An observational cross-sectional study

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Abstract

During the coronavirus disease 2019 (COVID-19) pandemic, the mandatory use of personal protective equipment (PPE) has resulted in a significant reduction in the infection rate among health care workers (HCWs). However, there are some ongoing concerns about the negative impact of using PPE for prolonged periods.

This study examined the impact of wearing PPE on surgeons' performance and decision making during the COVID-19 pandemic.

In this cross-sectional study, an anonymous online questionnaire was created and disseminated to surgeons all over the Eastern Province of Saudi Arabia. The questionnaire included the demographic data, the local hospital policies, the non-technical skills (e.g., communication, vision, and comfort) and the technical skills, and the process of decision making.

From June 2020 to August 2020, 162 surgeons participated in this questionnaire. Of them, 80.2% were aged from 26 to 45 years, 70.4% have received a special training for PPE, and 59.3% of participants have operated on COVID-19 confirmed cases. A negative impact of wearing PPE was reported on their overall comfort, vision, and communication skills (92.6%, 95.1%, and 82.8%, respectively). The technical skills and decision making were not significantly affected (60.5% and 72.8%, respectively). More preference for conservative approach, damage control procedures, and/or open approach was reported.

Despite its benefits, PPE is associated with a significant negative impact on the non-technical skills (including vision, communication, and comfort) as well as a non-significant negative impact on technical skills and decision making of surgeons. Extra efforts should be directed to improve PPE, especially during lengthy pandemics.

Abbreviations: COVID-19 = coronavirus disease 2019, HCWs = health care workers, MOH = Ministry of Health, PPE = personal protective equipment, SARS-CoV2 = severe acute respiratory syndrome coronavirus 2.

Keywords: COVID-19, decision making, N95, non-technical skills, performance, personal protective equipment, surgeon, technical skills

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The study was approved by the Institutional Review Board, Imam Abdulrahman Bin Faisal University.

All participant physicians consented and agreed to contribute to this online questionnaire.

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All data generated or analyzed during this study are included in this published article [and its supplementary information files].

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1. Introduction

In March 2020, the World Health Organization declared the coronavirus disease 2019 (COVID-19), which was caused by the severe acute respiratory syndrome coronavirus 2 (SARS-CoV2), a pandemic.^[1] Since then, the Saudi government has implemented many strategies and protocols to increase the readiness of all sectors, especially the healthcare sector. Early March 2020, the Ministry of Health (MOH) has announced the first case of COVID-19 in Saudi Arabia.^[2] Initially, the MOH implemented many specific protocols within the healthcare system to ease the predicted stress on the healthcare system and health care workers (HCWs) including, but not limited to postponing all elective surgical procedures in the governmental hospitals, transitioning to virtual online clinics whenever possible, requiring all HCWs to always wear different levels of personal protective equipment (PPE) according to the infection control protocols regardless of dealing with suspected or confirmed cases to protect the HCWs, conducting multiple training workshops for proper donning and doffing of the PPE, increasing the numbers of the screening tests to early detect and isolate any asymptomatic patients, and ensuring sufficient supply of PPE. These protocols were subjected to continuous revision and modification according to the local progression of the pandemic.^[2]

The most crucial strategy of the MOH declared protocol was that all HCWs have been mandated to wear different kinds of PPE as a standard practice while dealing with suspected or confirmed cases to protect themselves as a frontline defense. Although elective surgical procedures were canceled or postponed, surgeons continued to perform emergency surgical procedures on patients regardless of their SARS-CoV2 status.

Some studies have started the discussion on the drawbacks of using PPE and its impact on the HCWs, especially with the prolonged use during the COVID-19 pandemic, such as de-novo headache and anxiety.^[3–5] However, only few studies have specifically addressed the impact of PPE on surgeons' performance.^[6,7] During surgery, many aspects can be affected including technical skills (e.g., tactile movements and handling of the instruments) and non-technical skills (e.g., vision, visual field, communication, overall comfort, and fatigability). Moreover, the psychological stress (e.g., feeling of insecurity even while wearing the PPE) may alter the process of decision making and the performance while dealing with suspected or confirmed cases.^[8,9]

In this paper, we aimed at specifically studying the subjective impact of wearing PPE on the surgeons' performance and decision making through an anonymous online-based subjective questionnaire. This study can help the healthcare system to deal with this pandemic or any upcoming outbreaks or pandemics.

2. Methods

As a cross-sectional observational study, we created an anonymous online-based subjective questionnaire through Google Forms with a total of 37 questions divided into 5 parts. The first part included the demographic data and the level of surgical experience. The second part included the local hospital policies of routine patients screening, type of PPE while dealing with cases, and the training programs of HCWs for the appropriate use of PPE. The third part included questions about non-technical skills as communication, vision, overall comfort, and fatigability; technical skills as tactile movements and instrumental handling; and the process of decision making.

The fourth part represented the outcome, from the surgeons' perspective, including patients' safety and complication rates and self-infection with SARS-CoV2. The questionnaire was then revised and modified by 3 independent professors affiliated with multiple universities to check its integrity, coherence, and relevance.

The sample size consisted of 132 surgeons using a non-probability convenience method. After being approved by the Institutional Review Board of Imam Abdulrahman Bin Faisal University, the questionnaire was distributed as a sharable hyperlink to surgeons with different levels of experience in different hospitals all over the Eastern Province of Saudi Arabia through emails, and different social media platforms such as WhatsApp and Twitter. Inclusion criteria included any surgeon working at any hospital in the Eastern Province of Saudi Arabia where COVID-19 patients are being admitted. Physicians of non-surgical specialties were excluded from the study.

The analysis of data was performed using Statistical Package for Social Science (IBM SPSS) version 20. The qualitative data collected were presented in the form of numbers and percentages. The quantitative data were presented as mean (\pm standard deviation) for variables with normal distribution, and median (range) for variables with the non-parametric distribution. Both Chi-Square and Fisher exact tests were used to test the statistical significance of association between categorical variables. The confidence interval was set to 95%, the margin of error accepted was set to 5%, and the *P* value was considered significant at *P* < .05.

3. Results

During the period between June 2020 and August 2020, 162 surgeons agreed to participate in this anonymous online survey by accepting the consent at the beginning of the questionnaire. All participants were surgeons of different specialties who worked at hospitals where confirmed cases of COVID-19 were admitted. Approximately, 80.2% of the participants were aged from 26 to 45 years. Surgeons from different levels of experience have participated (junior and senior residents, registrar, and consultants) (Table 1).

Most of the participants reported receiving special training for proper methods of donning and doffing of PPE (70.4%, *P* < .0001). Most of them encountered confirmed or suspected cases (88.9%, *P* < .0001), and 59.3% of the participants have operated on confirmed cases. Most surgeons reported routine screening tests for patients before any surgical procedures

Table 1
The first part of the questionnaire: demographic data (age and seniority level) of the participants.

	Number of participants (%)
Age	
<26	4 (2.5)
26–35	106 (65.4)
36–45	24 (14.8)
46–55	16 (9.9)
>56	12 (7.4)
Level	
Junior resident	64 (39.5)
Senior resident	32 (19.8)
Registrar/senior registrar	28 (17.3)
Consultant	38 (23.5)

Table 2**The second part of the questionnaire: local hospital policies, training programs of the HCWs and load of cases.**

		Number of participants (%)	P value
Receiving a special training for proper method of donning and doffing PPE	Yes	114 (70.4)	<.0001*
	No	48 (29.6)	
Average number of on call per week	(Mean ± SD)	2.81 ± 2.03	
Did you encounter a positive COVID-19 patient?	Yes	122 (75.3)	<.0001*
	Suspected cases only	22 (13.6)	
	No	18 (11.1)	
Did you operate on a positive COVID-19 patient?	Yes	28 (34.6)	.203
	Suspected cases only	20 (24.7)	
	No	33 (40.7)	
COVID-19 screening test before assessing a patient	Routine	62 (38.3)	.035*
	Not routine	100 (61.7)	
COVID-19 screening test before performing a procedure	Routine	108 (66.7)	.003*
	Not routine	54 (33.3)	
Type of the performed surgical procedure	Emergency	98 (60.5)	<.0001*
	Elective	4 (2.5)	
	Both elective and emergency	18 (11.1)	
	No	42 (25.9)	

COVID-19 = coronavirus disease 2019, HCW = health care workers, PPE = personal protective equipment.

* Statistically significant results at $P < .05$.

(66.7%, $P = .003$), and no routine screening test before assessing a new patient (61.7%, $P = .035$). In addition, 60.3% of the participants reported performing only emergency surgical procedures ($P < .0001$) (Table 2).

Regarding surgical performance, a significant number of participants reported a negative impact of wearing PPE on their overall comfort (92.6%, $P < .0001$). In terms of their vision, it was affected with either fogging, the affection of the visual field or both (95.1%, $P < .0001$). Moreover, communication with other colleagues or patients was negatively affected (82.8%, $P < .0001$). In contrast, handling of instruments was not significantly affected by wearing the PPE (60.5%, $P < .0001$), and the tactile movements showed no statistically significant difference. Similarly, the decision making process was not significantly affected by wearing the PPE (72.8%, $P < .0001$). However, some participants reported more preference of conservative approach rather than surgical approach, damage control procedures rather than definitive procedures, and an open approach rather than minimally invasive approaches and/or postponing all non-emergency procedures. Moreover, 91.4% of the participants reported no changes in the postoperative complications when performing a surgical procedure wearing the PPE (Table 3).

At the end of the questionnaire, an additional comments section was provided for suggestions on how to improve the performance while wearing the PPE. Some participants suggested measures, such as using anti-fog lotion or anti-fog masks, contact lenses instead of glasses, well-fitted, ventilated, and light-weighted PPE suits. In addition, they recommended providing a better working environment, such as providing better air conditioning, using electronic devices for communications as headphones, and switching to damage control procedures. Finally, some participants requested more training workshops for the PPE donning and doffing.

4. Discussion

During the era of the COVID-19 pandemic, the HCWs were at a clear higher risk of getting infected with the SARS-CoV2, and

therefore, their protection was crucial to maintain the healthcare sector and prevent its collapse.^[10] The mandatory use of PPE has resulted in a significant reduction in the infection rate among HCWs.^[10,11] In the Saudi healthcare system, all HCWs are obliged to always wear different levels of PPE according to the infection control protocols whether dealing with suspected or confirmed cases. The PPE can be classified in different ways and includes at least wearing a pre-fitted appropriate size N95 face

Table 3**The third part of the questionnaire: the different aspects of surgeons' performance.**

		Number of participants (%)	P value
Comfort	Yes	118 (72.8)	<.0001*
	Sometimes	32 (19.8)	
	No	12 (7.4)	
Vision	Fogging of the googles	74 (45.7)	<.0001*
	Affection of the visual field and fogging of the googles	44 (27.2)	
	Affection of the visual field	12 (7.4)	
	Sometimes	24 (14.8)	
Communication	No effect	8 (4.9)	<.0001*
	Yes	96 (59.3)	
	Sometimes	38 (23.5)	
Handling of instruments	No	28 (17.3)	<.0001*
	Yes	42 (25.9)	
	Sometimes	22 (13.6)	
Tactile movements	No	98 (60.5)	.495
	Yes	48 (29.6)	
	Sometimes	50 (30.9)	
Decision making	No	64 (39.5)	<.0001*
	Yes	14 (8.6)	
	Sometimes	30 (18.5)	
Rate of complications	No	118 (72.8)	<.0001*
	Decreased	0	
	No change	148 (91.4)	
	Increased	14 (8.6)	

* Statistically significant results at $P < .05$.

masks, gloves with or without protective eyewear (well-fitted goggles or face-shield), and gowns.^[11]

Despite the safety provided by PPE, some drawbacks have been observed especially with the prolonged uncertain pandemic status and the extensive and prolonged use of PPE for the first time.^[4] These drawbacks may lead to suboptimal compliance of the HCWs and misuse of the PPE. Consequently, these drawbacks can decrease HCWs protection level and increase their infection rate.^[12] In addition, these drawbacks may affect the physicians' performance in a way that may negatively affect the outcome and safety of the patients.^[13] Nevertheless, the literature lacks extensive discussion of the drawbacks and negative impact of using PPE on the HCWs.^[6,7]

Counter to other medical specialties, the competence in surgical management, especially in emergencies, depends on the surgeon's ability to take a safe and right decision in a timely manner; the surgeon's appropriate technical skills based on his/her background and experience; and the surgeon's ability to perform an appropriate history-taking and clinical examination. Yet, the surgeons have confronted a unique situation during the COVID-19 era for the first time, for instance: they have been mandated to work in different work environments as medical wards, triaging clinics, emergency rooms, and even the intensive care units; they were required to perform surgical procedures, which might carry exceptional hazards as the emergency situations may not allow time to investigate the patient's COVID-19 status; they performed minimally invasive procedures that are considered high risk procedures for aerosol-generating particles;^[11,14,15] their technical and non-technical skills may be negatively affected by the prolonged wearing of the PPE; and their prompt decision making skill may be negatively affected by the observed associated overall fatigability, discomfort, anxiety due to fear of unsafety, limited movements, headache, and decrease in the visual fields, etc.^[6,7]

In this study, we focused on different aspects, during the COVID-19 era, concerning the prolonged use of the PPE by surgeons, including the surgeons' performance and decision making. The anonymous, online questionnaire was created after our previous observations and was further modified by 3 independent senior professors affiliated with multiple universities to ensure its validity and capability for generalization. The questionnaire focused on understanding the different entities that may affect the surgeon's performance (both technical and non-technical skills), and decision making from a surgeon's perspective. In our study, all participants worked in hospitals that cared for COVID-19 patients. There was a significant negative impact of wearing the PPE on the non-technical skills: overall comfort, visual impairment, and communication difficulties (92.6%, 95.1%, and 82.8%, respectively). However, the technical skills and decision making were not significantly affected by the use of PPE. Fortunately, more than 90% of the participants reported no change in the rate of postoperative complications.

The study by Yáñez Benítez et al^[6] is the only published study, to the best of our knowledge, which specifically discussed the surgeons' performance while wearing PPE. The authors created an online, 67-question questionnaire using Survey-Monkey, which was distributed using emails and social media platforms. The total number of participants was 134 with a 20% response rate and only 57% of the participants performed surgical procedures on COVID-19 patients. Unlike their questionnaire, we included other surgical specialties as orthopedic surgeons, neurosurgeons, and others to provide a panoramic view of

surgeons' performance. Similar to the results of this study, Yáñez Benítez et al reported the negative impact of wearing PPE on surgeons' comfort (66%), fatigability (82%), communication (54%), vision (63%), and decision making (48%).

Previously, other reports also highlighted the negative impact of PPE on communication in the operating room.^[11,16,17] In his study, Hampton et al^[18] reported a significant difference in speech discrimination scores, and difficulties of communication and understanding while wearing the PPE that may affect patient's safety. In another study, Radonovich et al^[17] studied the causes of intolerability of HCWs of different kinds of masks, and they reported that N95 masks were only tolerated for 4.1 to 7.7 hours. The authors attributed its intolerability to impaired visibility caused by fogging, discomfort, pressure, pain, burning eyes, itching, heat, light refraction, and feeling dizzy. Intermittent frequent breaks were recommended to decrease fatigue.^[19] However, such recommendation was not feasible due to the current pandemic situation as HCWs may easily get infected.

Similarly, stress has been previously discussed as a risk factor that affects the surgeons' performance and decision making abilities.^[5,8,9] Anxiety, feeling of unsafety, fatigability, sleeping disturbance, family concerns, and increased on-call hours are among the triggering factors of stress during the pandemic era. These factors are further augmented by discomfort, heat stress, impaired visibility, eye fatigue, and communication difficulties while wearing the PPE. Consequently, patients' safety may be highly affected. Castle et al^[13] reported decreased performance levels while wearing PPE in the form of long duration and a higher rate of unsuccessful attempts for endotracheal intubation or intravenous cannulation.

In addition to the above reported findings of this study, the open-ended questions at the end of our questionnaire allowed the participants to express their ideas and thoughts, which may be considered as areas for more discussion and further research. Most participants suggested improving the quality of the suits by using light-weighted and well-fitted suits, overcoming visual impairment by using anti-fog masks, and overcoming communication difficulties by using electronic devices, such as headphones.

The drawbacks of this study are few and do not affect its results. First, the sampling method may not allow for external generalization of our results. Still, we assume that 162 participants are a representable sample size. Second, despite that we focused on surgeons working in Saudi Arabia to ensure the consideration of similar circumstances and infection control protocols; however, the study's results can be generalized to surgeons working all over the world. Finally, another limitation of the current study is the complete dependence on subjective reporting rather than on objective measurement.

5. Conclusion

The impact of prolonged use of the PPE on the surgeons' performance is not extensively discussed. In our study, we called attention to the significant negative impact of the prolonged use of PPE on the non-technical skills of surgeons including vision, communication, and overall comfort. Also, the current study highlighted the non-significant negative impact on technical skills, decision making, and patients' safety. Further studies are recommended to objectively assess these negative impacts. Moreover, extra efforts should be directed to improve the PPE, especially during lengthy pandemics.

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References

- [1] Lockhart S, Duggan L, Wax R, Saad S, Grocott HP. Personal protective equipment (PPE) for both anesthesiologists and other airway managers: principles and practice during the COVID-19 pandemic. *Can J Anaesth* 2020;67:1005–15.
- [2] Algaissi A, Alharbi N, Hassanain M, Hashem AM. Preparedness and response to COVID-19 in Saudi Arabia: building on MERS experience. *J Infect Public Health* 2020;13:834–8.
- [3] Rodriguez R, Medak A, Baumann B, et al. Academic emergency medicine physicians' anxiety levels, stressors, and potential stress mitigation measures during the acceleration phase of the covid-19 pandemic. *Acad Emerg Med* 2020;27:700–7.
- [4] Ong J, Bharatendu C, Goh Y, et al. Headaches associated with personal protective equipment - a cross-sectional study among frontline healthcare workers during COVID-19. *Headache* 2020;60:864–77.
- [5] Alenazi T, BinDhim N, Alenazi M, et al. Prevalence and predictors of anxiety among healthcare workers in Saudi Arabia during the COVID-19 pandemic. *J Infect Public Health* 2020;13:1645–51.
- [6] Yáñez Benítez C, Güemes A, Aranda J, et al. Impact of personal protective equipment on surgical performance during the covid-19 pandemic. *World J Surg* 2020;44:2842–7.
- [7] Foula MS, Nwesar FA, Oraby EH, et al. Does wearing personal protective equipment affect the performance and decision of physicians? A cross-sectional study during the COVID-19 pandemic. *Ann Med Surg* 2021;67:102488.
- [8] Wetzel C, Kneebone R, Woloshynowych M, et al. The effects of stress on surgical performance. *Am J Surg* 2006;191:5–10.
- [9] Orri M, Farges O, Clavier P, Barkun J, Revah-Lévy A. Being a surgeon-the myth and the reality: a meta-synthesis of surgeons' perspectives about factors affecting their practice and well-being. *Ann Surg* 2014;260:727–9.
- [10] Wu Z, McGoogan J. Characteristics of and important lessons from the coronavirus disease 2019 (covid-19) outbreak in china: summary of a report of 72314 cases from the Chinese center for disease control and prevention. *JAMA* 2020;323:1239–42.
- [11] Stewart C, Thornblade L, Diamond D, et al. Personal protective equipment and COVID-19. *Ann Surg* 2020;272:e132–8.
- [12] Neves H, Souza A, Medeiros M, Munari DB, Ribeiro LCM, Tipple AFV. Safety of nursing staff and determinants of adherence to personal protective equipment. *Rev Lat Am Enfermagem* 2011;19:354–61.
- [13] Castle N, Owen R, Hann M, Clark S, Reeves D, Gurney I. Impact of chemical, biological, radiation, and nuclear personal protective equipment on the performance of low- and high-dexterity airway and vascular access skills. *Resuscitation* 2009;80:1290–5.
- [14] Veiziant J, Bourdel N, Slim K. Risks of viral contamination in healthcare professionals during laparoscopy in the Covid-19 pandemic. *J Visc Surg* 2020;157:S59–62.
- [15] Cano-Valderrama O, Morales X, Ferrigni C, et al. Acute Care Surgery during the COVID-19 pandemic in Spain: changes in volume, causes and complications. A multicenter retrospective cohort study. *Int J Surg* 2020;80:157–61.
- [16] Ellis R, Hay-David A, Brennan P. Operating during the COVID-19 pandemic: how to reduce medical error. *Br J Oral Maxillofac Surg* 2020;58:577–80.
- [17] Radonovich L. Respirator tolerance in health care workers. *JAMA* 2009;301:36.
- [18] Hampton T, Crunkhorn R, Lowe N, et al. The negative impact of wearing personal protective equipment on communication during coronavirus disease 2019. *J Laryngol Otol* 2020;134:577–81.
- [19] Engelmann C, Schneider M, Kirschbaum C, et al. Effects of intraoperative breaks on mental and somatic operator fatigue: a randomized clinical trial. *Surg Endosc* 2011;25:1245–50.