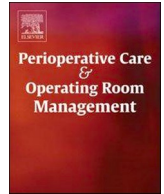




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## Observance of preventive standards against COVID-19 transmission in operating rooms: A cross-sectional study

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### ABSTRACT

**Background:** Due to the highly contagious innate of the novel coronavirus, the surgical team is exposed to the disease during surgical care of patient with confirmed covid-19. Therefore, the necessary measures should be taken to protect surgical caregivers. This study was conducted to determine the status of compliance with the preventive standards against covid-19 transmission in the operating room.

**Methods:** This cross-sectional descriptive study was conducted on 183 surgical team members working in hospitals affiliated to Tabriz university of medical sciences in 2020. Participants were selected by stratified random sampling. The required data were collected by a researcher-made questionnaire according to the standard protocols of SAGES, EAES and AORN. In the first part of this questionnaire, the level of compliance with the standards of using personal protective equipment (PPE) was evaluated and in the second part, the level of compliance with the preventive strategies in the operating room was evaluated in three phases of Pre, Intra and Post-operative. The data was analyzed using SPSS16.

**Results:** preventive standards observance against COVID-19 was in moderate ( $55.3 \pm 10.5$ ) level and The level of compliance with the standards of using PPE by the surgical team was favorable ( $61.8 \pm 8.1$ ). There was a statistically significant relationship between the level of compliance with the standards of using PPE and the type of specialty ( $P = 0.004$ ).

**Conclusion:** According to the results, the level of compliance with the principles of standards in applying protective measures against covid-19 was not favorable, so the operating room personnel is exposed to COVID-19 and the necessary measures and improvements should be considered in compliance with standards in operating room.

### 1. Introduction

The new coronavirus (SARS-CoV-2), known as COVID-19, was discovered in China in late 2019 and spread to all of the world. The wide spectrum of reported symptoms of this disease includes fever, cough, myalgia and fatigue with the most common serious manifestation being pneumonia. Less common symptoms are headache, sputum production, diarrhea, malaise, shortness of breath/dyspnea and respiratory distress

and even anosmia, hyposmia, and dysgeusia.<sup>1</sup> According to Farnoosh et al., the COVID-19 pandemic has spread around the world and affected more than 200 countries, including Iran. According to global statistics, the mortality rate for this disease has been reported to be 3.4% and is more common in people in the age range of 30–79 years.<sup>2,3</sup> The new coronavirus epidemic is more widespread and has higher transmission power than previous common coronaviruses in humans.<sup>4</sup>

Based on recent research results, the main route of transmission of

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this virus is through inhalation of infected respiratory droplets, close contact (less than six steps or 2 m) with the infected person, or contact with the patient's discharges.<sup>5,6</sup> The disease is highly contagious, even it is too early to identify the accurate reproductive number (R0) (i.e. patient's capability to spread the disease to people in contact), some studies have estimated the mean R0 in a range of 2.20–3.58. This means that each patient has been spreading the infection to 2 or 3 other people. Thus, patients with COVID-19 are more likely to transmit the virus to members of the surgical team during perioperative care.<sup>7,8</sup> Among the 31551 cases of COVID-19 disease reported to the Centers for Disease Control and Prevention (CDC) between February 12 and April 9, 9282 (19%) cases were identified among health care workers.<sup>9</sup> Thus, all surgical caregivers should be performing their clinical tasks wearing gloves, hats, and disposable surgical masks correctly. Whenever a suspected or confirmed patient is encountered, extra precautions should be taken to keep protection at a high level and all providers should utilize personal protective equipment (PPE) including fit-tested disposable N95 respirator, goggles, face shield, gowns, double-layered gloves, and protective footwear to achieve maximum droplet/contact isolation precautions.<sup>10,11</sup>

The use of PPEs is mandatory in all interventions, including surgical interventions, intubation and extubation, regional anesthesia, cannulation and catheterization.<sup>12</sup> It is also essential for all staff, including nurses and surgeons, to receive the necessary training to prevent infection when wearing and removing PPEs.<sup>11</sup> Although PPE is a prerequisite for the safety of operating room staff, especially the surgical team, it is not enough. In addition to the use of PPE, other measures should be taken before, during, and after surgery in the operating room to prevent the transmission and spread of COVID-19 virus to minimize the probability of infection of operating room staff. In the surgery of patients with or suspected of COVID-19, for example, the operating room should have a negative pressure as opposed to normal conditions, in which there is a positive pressure.<sup>13</sup> Also, in the case of using an electrocautery device including monopolar, bipolar and harmonic scalpel during surgery, to prevent excessive smoke and virus transmission through inhalation, it is recommended to use low current intensity of the device and also to use specific suction with in-line filter to evacuate the smoke.<sup>14</sup>

Other measures that should be taken to prevent the transmission of COVID-19 from patients to staff or other patients include canceling elective surgeries during pandemics,<sup>15</sup> careful hand washing after contact with patients, and their Secretions using standard disinfectants,<sup>16</sup> disinfection of surfaces, walls, floors, and air of operating room using standard methods after surgery, proper cleaning and disposal of blood, patient discharges, etc.<sup>15</sup>

Given the importance of applying protective standards during surgical care in patients with or suspected of COVID-19, which prevents the spread of this virus to operating room personnel, the researchers decided to conduct a study to investigate the observing of preventive standards against COVID-19 transmission in the operating room.

## 2. Materials and methods

### 2.1. Design and sample size calculations

This descriptive cross-sectional research was conducted on members of the surgical team (surgeons, surgical nurses, and surgical residents) working in the teaching hospitals of Tabriz University of Medical Sciences (Imam Reza, Pediatric, Shohada, Alzahra, Taleghani, Sina) for 7 months from June to December 2020. Ethical approval was obtained from the Ethics Committee Directorate for Clinical Researches (IR.TBZMED.REC.1399.518). Of note, at the next stage, by signing a written consent form, the participants gave their consents to participate in this study

Cochran's formula was used to determine the sample size in this study. Since the total number of nurses, surgeons, and surgical residents

working in operating room wards of medical training centers were 200, 44, and 55, respectively, and considering an error of 5%,  $p$  and  $q$  values of 0.5, and a  $d$  value of 0.05, sample sizes of 131, 39, and 48 were determined for nurses, attending surgeons, and residents, respectively.

$$n = \frac{\frac{z^2 pq}{d^2}}{1 + \frac{1}{N} \left( \frac{z^2 pq}{d^2} - 1 \right)}$$

According to the Stratified random sampling method used here, the sample size was calculated by the above formula, and the sample number of each center was obtained knowing the total number of surgical team members working in operating room wards of the studied hospitals. Accordingly, the estimated number of samples was divided by the total population, and the result was multiplied by the number of members of the surgical team of each center to determine the number of samples in each center. After calculating the number of samples in each center, sampling was done using a convenience random method and a table of random numbers. Out of 218 participants in the study, 135 individuals were excluded from the study due to incomplete responses to the questionnaire, thus, 183 people were considered as the final samples of the study. Inclusion criteria of the study were having an associate or higher degree for nurses, a specialized degree in various surgical specialties and residents of different surgical specialties for physicians, the experience of working in the operating room for at least 6 months, and a history of participating in the surgery of patients with or suspected of COVID-19. Unwillingness to cooperate and having a management position were also considered exclusion criteria.

### 2.2. Measuring instrument

The current study was designed based on the STROBE guidelines for observational studies.

The instruments used to collect data in this study included four sections. The first section of the questionnaire was related to demographic characteristics of the surgical team members, collected using an 7-item questionnaire. The questions of this questionnaire were related to age, gender, marital status, groups, work experience in the operating room, working hours per week and type of hospital. The second section included five questions about the history of receiving training on protection against COVID-19 in the operating room, familiarity with global guidelines on protection against COVID-19 in the operating room, and the existence of PPE, protocols, and special rules in this regard in operating room.

The third section included 23 questions about protection standards against coronavirus transmission in the operating room, which were designed using SAGES<sup>1</sup>, EAES<sup>2</sup> and AORN<sup>3</sup> standard guidelines and related articles.<sup>10,11,15</sup> It also examined the observance of the standards of protection in the operating room from the perspectives of surgical team members during the three stages of before, during, and after surgery. The questionnaire questions were scored on a 5-point Likert scale, ranging from never (zero), rarely (1), sometimes (2), most of the time (3), and always (4). The total score of the questionnaire was in the range of 0–92. Scores in the range of 0–30.99, 31–60.99, and 62–92 indicated poor observance, moderate observance, and desirable observance levels.

The fourth section included 19 questions on observing the standards of using PPE against the release of COVID-19 by members of the surgical team in the operating room. They were designed using SAGES, EAES and AORN guidelines and related articles.<sup>10,11,15</sup> It examined the level of observing PPE standards by members of the surgical team in a self-reporting manner. The questionnaire questions were scored on a

<sup>1</sup> Society of American Gastrointestinal and Endoscopic Surgeons.

<sup>2</sup> The European Association for Endoscopic Surgeons.

<sup>3</sup> Association of perioperative Registered Nurses.

5-point Likert scale, ranging from never (zero), rarely (1), sometimes (2), most of the time (3), and always (4). The total score of the questionnaire was in the range of 0–76, in which scores of 0–24.99, 25–50.99, and 51–76 indicated poor observance, moderate observance, and desirable observance levels.

The validity of the questionnaire was assessed in two stages. In the first stage, the face validity of the questionnaire was examined and approved by 10 faculty members. Then, the CVR index was used to ensure the accuracy of the content. For this purpose, the questionnaire was submitted to 10 faculty members who were asked to select one of three options of "necessary", "useful but not necessary", and "not necessary" for each of the designed items. The received answers were calculated based on the CVR formula and its numerical value was obtained at 0.70. After determining and calculating the CVR, the questionnaire was submitted again to faculty members who were asked to comment on each item in terms of specificity, simplicity and fluency, and transparency on a 4-point Likert scale (relevant, relatively relevant, relevant, and fully relevant) to calculate the CVI. To determine the reliability using the test-retest method in a pilot study, a questionnaire was submitted to 20 members of the surgical team. Three weeks later, the questionnaire was submitted to the same people to complete, and the internal consistency of the questionnaire was obtained by calculating Cronbach's alpha coefficient ( $\alpha = 0.87$ ).

### 2.3. Ethical considerations

This study was approved by the Institutional Review Board Tabriz university of medical Science (ethical code: IR.TBZMED.REC.1399.518). All participants agreed to participate in the study and signed an informed consent. The participants were assured that their information would remain confidential.

### 2.4. Data analysis

Data entered the SPSS16 software and were analyzed using descriptive statistics, independent t-test and one-way ANOVA and  $P < 0.05$  was considered as a significant level.

## 3. Results

Demographic characteristics showed that 121 (66.1%), 24 (13.1%), and 38 (20.8%) out of 183 participants were the operating room nurses, surgeons, and surgical residents, respectively. The majority of participants were female (56.8%) with less than 5 years of employment history (50.8%). The full demographic characteristics of the subjects are shown in Table 1.

Considering the main source of knowledge of the surgical team members about protective measures against the release of COVID-19 in the operating room, coworkers (38.25%) and articles and guidelines (37.7%) were introduced as the main sources of information for the participants. Moreover, workshops and educational webinars (13.66%), social networks (5.48%), and educational posters and pamphlets

**Table 1**  
Frequency distribution of participants according to demographic characteristics.

Percentage	Frequency	Variables
13.1% 66.1% 20.8%	24 121 38	Groups Surgeon Perioperative nurse Residents
43.2% 56.7%	79 104	Gender Male Female
33.3% 66.7%	61 122	Marital status Single Married
50.8% 36.1% 13.1%	93 66 24	Work experience(year) Less than 5 to 15 More than 15
10.4% 40.4% 49.2%	19 74 90	Working hours per week Less than 45 45 More than 45
39.3% 15.8% 13.7%	72 29 25 27	Hospital Imam reza Shohada
14.8% 5.5% 10.9%	10 20	Children Sina Alzahra Taleghani

(2.73%) were mentioned as the other sources of information (Fig. 1).

Based on the results of Table 2, a mean total score ( $\pm$  standard deviation) of was  $61.8 \pm 8.1$  was obtained for observing PPE standards by members of the surgical team during the surgery of patients with or suspected of COVID-19, indicating the desired level of observing PPE standards. Among these standards, handwashing after contact with the patient, patient's environment and patient discharges ( $3.8 \pm 0.39$ ), the use of appropriate gloves (preferably without powder) during contact with the patient ( $3.6 \pm 0.61$ ), and washing hands with soap and water or with standard alcohol-based disinfectants before wearing masks and other PPE ( $3.6 \pm 0.52$ ) were more observed by surgical team members. Moreover, wearing two pairs of gloves when in contact with the patient's airway, blood, urine, and other discharges ( $2.3 \pm 1.3$ ) and transferring sharp instruments indirectly (hands-free) to prevent needle sticking during the surgery of patients ( $2.8 \pm 1.2$ ) were among the procedures that received less attention.

The results suggest that there is a statistically significant relationship between the level of PPE standards against COVID-19 by members of the surgical team and the type of specialty. One-way ANOVA was used to examine the means of total scores among the three groups of attending physicians, residents, and operating room nurses, among whom there were statistically significant differences ( $P = 0.004$ ). The results of Tukey's test showed significant differences between nurses and residents ( $P = 0.006$ ) and between attending physicians and residents ( $P = 0.01$ ) (Fig. 2). No statistically significant relationships were observed between the level of PPE standards and age, gender, marital status, level of education, and the type of hospital ( $P > 0.05$ ).

Based on the results of Table 3, a mean ( $\pm$  standard deviation) of  $55.3 \pm 10.5$  for the total score of observing standards and protective measures against the spread of COVID-19 in operating rooms indicates that the level of observing PPE standards was at a moderate level. Results of the study in the preoperative stage showed that the installation of a warning or danger sign related to COVID-19 on the door of the operating room ( $2.65 \pm 1.1$ ) and preventing excessive entry and exit and overcrowding in the operating room ( $2.52 \pm 1.2$ ) were the two measures that were mostly observed in operating rooms of the studied hospitals. In addition, the presence of automatic ventilation with at least 15 air changes per hour and the presence of negative pressure in operating rooms of COVID-19 patients ( $1.4 \pm 1.2$ ) were less considered in operating rooms.

During the operation, induction of anesthesia and recovery of COVID-19 patients in the operating room ( $3.25 \pm 0.9$ ) and the use of packs, instruments, and disposable items in surgery of COVID-19 patients ( $3.17 \pm 1.1$ ) were the two measures that were considered and observed at this stage. Furthermore, the use of smoke suction devices, such as suction with a special filter for surgery-induced smoke suction ( $1.1 \pm 0.9$ ), was a measure that was less observed in the operating rooms of the studied hospitals.

In the postoperative stage, the preventive measures that were observed more than other measures included disinfecting the operating room air with plasma, UV rays, or other standard methods ( $3.8 \pm 0.4$ ) and washing, packing, and separately sending of the instruments used in surgery of COVID-19 patients to the Central Sterile and Supply Department (CSSD) ( $3.53 \pm 0.8$ ). Besides, the allocation of a special separate place to put on and take off the clothes and the PPE of the employees outside the operating rooms were the measures that received less observance than the others ( $1.9 \pm 1.5$ ).

The results of the one-way ANOVA test showed that the total means of observance of precautions and protection standards were not statistically significant among the six studied hospitals ( $P = 0.595$ ) (Fig. 3).

## 4. Discussion

The present study aimed to evaluate the level of protection against COVID-19 in operating rooms of hospitals affiliated with Tabriz University of Medical Sciences. The results obtained for the first objective of

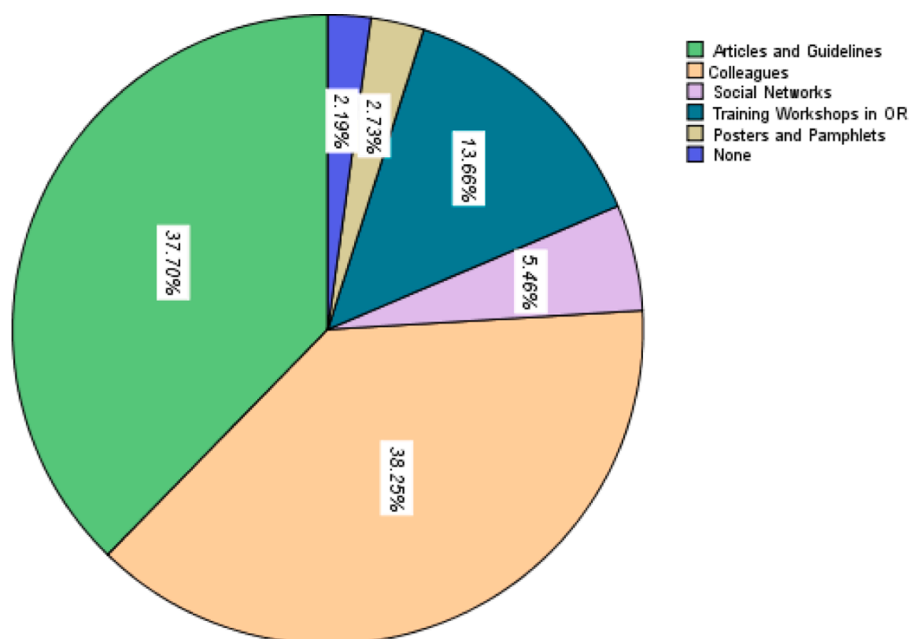


Fig. 1. Main source of knowledge of the surgical team members about protective measures against COVID-19.

the study (evaluating the observance of PPE standards by members of the surgical team against COVID-19 in operating rooms) showed a good level of observance of PPE standards by members of the surgical team during the surgery of patients with or suspected of COVID-19. In a study entitled "Assessment of observing standard principles in the use of personal protective equipment by nurses in contact with chemotherapy drugs", Kohangi et al. (15) assessed the performance of nurses at an undesirable level, which is not consistent with the results of the present study.

The present study aimed to evaluate the level of protection against COVID-19 in operating rooms of hospitals affiliated with Tabriz University of Medical Sciences. The results obtained for the first objective of the study (evaluating the observance of PPE standards by members of the surgical team against COVID-19 in operating rooms) showed a good level of observance of PPE standards by members of the surgical team during the surgery of patients with or suspected of COVID-19. In a study in the Ghana, Ashiany et al. Assessed infection prevention observance among healthcare workers against Covid-19 as Good level, which is consistent with our study.<sup>17</sup>

In a study entitled "Assessment of observing standard principles in the use of personal protective equipment by nurses in contact with chemotherapy drugs", Kahangi et al.<sup>18</sup> assessed the performance of nurses at an undesirable level, which is not consistent with the results of the present study.

In a study in the Congo, Michel-Kabamba et al. Assessed the performance of health care workers toward preventive measures against COVID-19 as poor, which is inconsistent with the present study.<sup>19</sup> also, Arnetz et al.<sup>20</sup> conducted a study to investigate the use of PPE in nurses during the COVID-19 pandemic. They assessed the performance of nurses at a moderate level, which is not consistent with the results of the present study. In the above-mentioned studies (Arnetz et al. and Michel-Kabamba et al.), the main reason for the undesirable level of observance from the perspectives of the participants was reported to be a lack of available PPE. It can be concluded that the knowledge, attitude, susceptibility, and concern of surgical team members about the risks of COVID-19 have a great impact on observing protective standards. For example, in a study conducted in Turkey in 2010, 73 chemotherapy ward nurses were studied in terms of using PPE when preparing and injecting chemotherapy drugs. The results showed that nurses did not believe much in using these protective devices to prevent side effects

from contact with chemotherapy drugs, and many of them reported that they did not fully adhere to these rules despite the existence of serious rules and regulations in this area.<sup>21</sup> This result is consistent with that of the present study as it shows that if people perceive and believe in the importance of a preventive measure, it can act as a protective measure and encourage people to pay attention to this issue and the need to observe protective measures to prevent its occurrence. However, if a person does not perceive the importance and seriousness of the issue, they may not show much interest in using them even if all the necessary facilities and protective measures are available. It can indicate that the participants in the present study were aware of the seriousness of COVID-19 disease and its severe complications

Among the PPE standards, washing hands after contact with the patient, the patient's environment and patient discharges, using appropriate gloves (preferably without powder) when in contact with the patient, and washing hands with soap and water or with standard alcohol-based disinfectants, wearing masks, and other PPE before others were more observed by the surgical team members. Observance of personal hygiene and handwashing before and after any procedure or therapeutic intervention, as a basic measure to prevent COVID-19 disease, was one of the important points about personal protection. Previous studies on the level of observing personal health, hygiene, and handwashing among nurses indicate that these issues are not among the main concerns of nurses. In a study conducted to assess the observance of handwashing after caring for patients, Garus found that only about 26% of participants washed their hands after caring for the patients.<sup>22</sup>

The results of another study revealed that only 12% of physicians washed their hands after performing care procedures.<sup>23</sup> Hence, the results of the present study are inconsistent with those of the above-mentioned studies and indicate that members of the surgical team are aware of the severity of the disease and the need to wash their hands to prevent it.

Among the PPE standards, wearing two pairs of gloves in contact with the patient's airway, blood, urine, and other discharges and transferring sharp instruments indirectly (hands-free) to prevent the surgical team from being stuck during the surgery were among the actions that received less attention. There is a risk of transmission of infectious organisms through blood and body discharges due to contact of patients' blood and body fluids with damaged skin and mucous membranes such as mucous of eyes, mouth, and nose, and injuries caused by

**Table 2**  
Frequency distribution and mean of observing personal protection standards in surgical team members.

Items	always	Most of time	Sometimes	Rarely	Never	Mean±SD*	
1-Using a standard mask tested by a leak test during invasive procedures.	79 (43.2%)	65 (35.5%)	12 (22%)	16 (8.7%)	1 (0.5%)	97.0±1.3	
2- Washing hands with soap and water or with standard alcohol-based disinfectants before wearing masks and other personal protective equipment.	121 (66.1%)	58 (31.7%)	(.2%)24	0 (0%)	0 (0%)	52.0±6.3	
3- Ensuring that the nose and mouth are completely covered with mask and there is no gap between mask and face	59 (51.9%)	52 (28.4%)	(.2%)14	26 (7.3%)	3 (1.6%)	95.0±2.3	
4- Avoid touching the mask when using it, especially after contact with the patient.	89 (48.6%)	79 (39.7%)	(.6%)6	12 (5.9%)	1 (0.5%)	7.0±4.3	
5- Replacing the mask if the mask is touched after contact with the patient	(56.3%) 103	(.3%)27 50	(.2%)14	26 (12.6%)	(.6%)3 1 (0.5%)	82.0±4.3	
6-After using the mask, remove the mask without contacting the front part of it	(45.9%) 84	(35.5%) 65	(13.7%)25	(3.3%)6	(6%/1)3	91.0±2.3	
7- Using appropriate gloves (preferably without powder) when in contact with the patient	(1%.66) 121	(28.4%) 52	(.9%)4	9 (4.1%)	(.5%)0 1 (0.4%)	61.0±6.3	
8-Wearing two pairs of gloves when in contact with the airway, blood, urine and other patient secretions	(.7%)25 47	(18.6%) 34	(32.2%)59	(11.5%) 21	(12%)22	3.1±3.2	
9-Using extreme caution and precision during surgery, to prevent injury with sharp objects by performing measures such as wearing multiple layers of gloves and moving tools indirectly (hands-free)	71 (45%)	50 (27.3%)	(15.3%)28	(.3%)9 17	(.1%)7 13	2.1±8.2	
10-Removing the gloves after use in a standard way (glove-to-glove, skin-to-skin)	(7%/60) 111	(24%)44	(.5%)11	21 (19.0%)	(.2%)2 4	(.6%)3 2.8	89.0±4.3
11-Using of standard surgical gowns during surgery	(68.9%) 126	(.3%)27 50	(8%/3)7	(0%)0	0 (0%)	55.0±5.3	
12- Using of coverall gowns during surgery	(66.1%) 121	(.4%)22 41	(.8%)3	7 (6.6%)	(0%)0 14	(.7%)7 1.1±4.3	
13- No contact with the front part of the gown while removing it and turning it upside down so that its inside is facing out.	(.7%)43 80	(.1%)25 46	(.3%)9	17 (10.4%)	(19.5%) 19	(11.5%) 21	4.1±82.2
14-Using of eye goggles and face shield during invasive procedures	(.1%)54 99	(36.1%) 66	(.3%)3	6 (5.9%)	(.3%)3 6	(.3%)3 6	94.0±3.3
15-Using face shield or goggles individually and separately	(45.9%) 84	(.2%)37 68	(13.1%)24	(2.7%)5	(.1%)2	86.0±2.3	
16- Disinfect reusable eye protectors before and after use	(35%)64 71	(.8%)38	(19.7%)36	(3.8%)7	(.7%)2 5	97.0±3	
17- Using of shoes that cover all parts of the foot and are without holes.	(9%/33) 62	(43.2%) 79	(.8%)9	18 (13.6%)	(6.6%) 12	(.6%)6 12	1.1±9.2
18- Using of long shoe covers during surgery	(59%)108 61	(.3%)33	(7.1%)13	(.5%)0 1	0 (0%)	65.0±5.3	
19- Washing hands to prevent infection after contact with the patient, the patient's environment and patient secretions.	(.9%)86 159	(.5%)11 21	(.6%)1	3 (2.5%)	0 (0%) 0 (0%)	39.0±8.3	
Total mean						1.8±8.61	

\* standard deviation

sharp objects such as needles among the health care staff. Hence, prevention of this problem is especially important during the surgery of COVID-19 patients. The preventive measures introduced by the CDC and AORN for surgical team members, especially during the COVID-19 pandemic, include the use of two pairs of gloves when in contact with the airway, blood, urine, and other patient discharges and the transfer of sharp instruments indirectly (hands-free).<sup>24</sup>

In this regard, the results showed that these items were less observed by the members of the surgical team compared to the other PPE standards. This result may suggest that members of the surgical team are not sufficiently aware of the importance of some methods to protect themselves, and it is better to provide the necessary training in various ways to improve this issue. The research results indicated that there was a statistically significant relationship between the observance of PPE standards against COVID-19 by members of the surgical team and the type of specialty so that attending physicians and operating room nurses performed better than surgical residents in observing PPE standards.

The results of a study conducted by Ateei et al.<sup>25</sup> on the knowledge, attitude, and performance of surgeons and surgical assistants in the area of standard precautions showed better performance of surgeons than surgical assistants. This result can be justified by the fact that surgeons and operating room nurses have high skills and experience in this regard.

The results obtained for the second objective of the study (evaluating the observance of protective measures and standards against COVID-19

in operating rooms) showed a moderate level of this parameter during the surgery of patients with or suspected of COVID-19. Mousavi et al.<sup>26</sup> evaluated the observance of safety standards in operating rooms, which were relatively safe in terms of infection control and unsafe in terms of staff safety. Ramezan Pour et al.<sup>27</sup> evaluated the level of safety standards in operating rooms of Mazandaran hospitals and reported that safety standards were not observed for staff protection, which is consistent with our result. The present study is more extensive in terms of investigating staff safety status than the above mentioned studies and focuses on COVID-19. Additionally, the staff protection issue is much more important and should be among the major concerns of the health system, which requires necessary steps to be taken in this regard.

Preparation against the pandemic in operating rooms involves considering different levels in the hierarchy of controls and different stages of the pandemic, including improving infrastructure and processes, management of staff and patients, infection prevention strategies, and providing clinical recommendations. The operating room is a complex environment with multiple stakeholders, including anesthesiologists, surgeons, nurses, surgical technologists, and so on. The alignment of comprehensive interests and concerns can be a major challenge. However, preventive measures are needed to optimize the quality of care provided to patients with COVID-19 and reduce the risk of transmission to other patients and the operating room staff.<sup>28</sup>

The present results at the preoperative stage showed that among the studied standards and protective measures, installation of a warning or

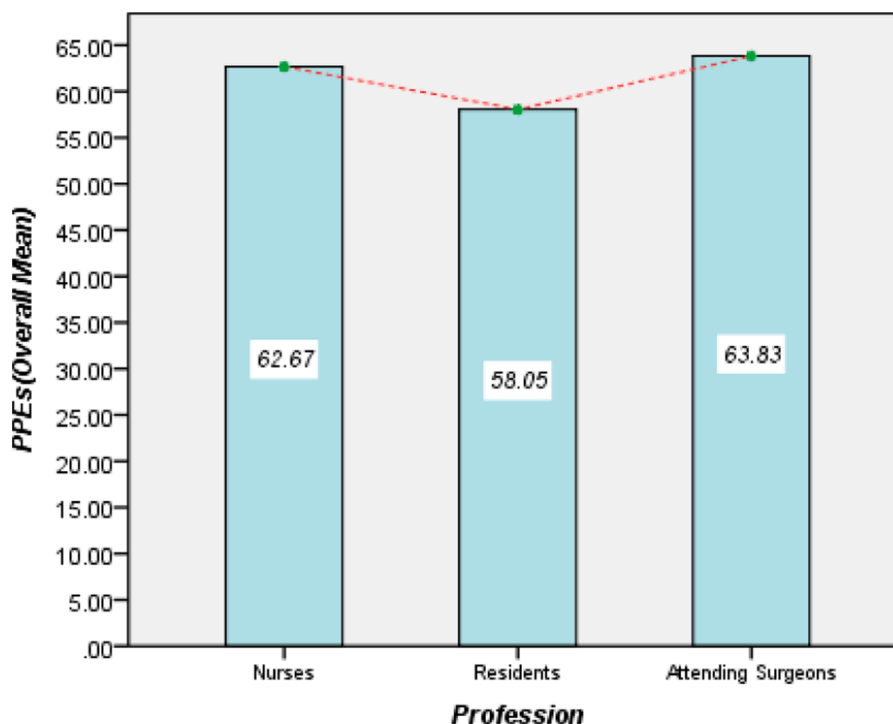


Fig. 2. Personal protection standards based on the type of specialty.

danger sign related to COVID-19 on the doors of operating rooms and preventing excessive entry, exit, and overcrowding of people in the operating room were the two measures that were mostly observed in operating rooms of the studied hospitals. Furthermore, the presence of automatic ventilation with at least 15 air changes per hour and the presence of negative pressure in operating rooms of COVID-19 patients were among the measures that were less considered in operating rooms.

One of the vital components of operating room technology is the air conditioning system, which reduces the level of air living objects by purifying, diluting, and compressing the air before preparing the required amount of air. For example, at least 15 fresh air changes per hour for at least 3 times per hour are needed to ensure air disinfection between operating rooms. In normal conditions, the entry of uncontrolled air to the operating room from the adjacent rooms should be prevented to create an area in the operating room that is free of mass and particles as far as possible. It is possible by applying the highest pressure in the operating room (positive pressure) compared to other rooms (corridors, sub-sterile rooms, etc.)<sup>29</sup> In operating rooms of COVID-19 patients, however, it is recommended that the operating room pressure be less than that of corridors and other rooms to prevent the entry of infected air of the operating room to other parts of the ward where there is a possibility of infection of staff and other patients. Moreover, unnecessary traffic and opening/closing of the operating room door disrupt the airflow and lead to the transfer of infection of COVID-19 operating rooms to other rooms.<sup>11,30</sup> The non-compliance with these principles can be attributed to no proper ventilation systems, such as laminar systems, the educational nature of these hospitals, the presence of students in the workplace, unnecessary overcrowding of people, and frequent opening/closing of the operating room door in most of the studied hospitals.

In the intraoperative stage, induction of anesthesia and recovery of COVID-19 patients in the operating room, and the use of packs, instruments, and disposable items in COVID-19 patients' surgery were the two measures that were considered and observed in the hospitals. In normal conditions, anesthesia is usually induced in patients undergoing surgery in the anesthesia room or the operating room, and after the completion of the surgical procedure, the patient is recovered in the

post-anesthesia care unit or in the recovery room. Regarding COVID-19 patients, however, it is recommended to perform these two procedures in the operating room itself since the transfer of the patient to different parts of the operating room (from the anesthesia room to the operating room and from there to the recovery room) infects other areas, probably infecting other patients and staff.<sup>10</sup> the results indicate that this issue has been observed in the studied hospitals.

It is also recommended to use disposable packs, instruments and items during surgery for COVID-19 patients. In most of the studied hospitals, reusable fabric packs and devices are used in surgeries related to normal patients, but in the case of Covid-19 patients, the results showed that the disposable packs and devices have been replaced. For example, in the case of using fabric packs, these packs should be autoclaved, sterilized again, and used in other patients. Any disruption in the sterilization process will leave infectious agents on the equipment and may infect patients, surgical team members and other personnel.<sup>30</sup>

The results of the study showed that in the intraoperative stage, the use of smoke suction devices, such as specific suction with in-line filter for surgery-induced smoke evacuation, was a measure that was less observed in operating rooms of the studied hospitals. The main reasons for this may be the lack of equipment such as specific suction with in-line filters for surgical smoke evacuation and high-efficiency particulate air filters (HEPA) in the studied operating rooms. The unawareness of staff and managers about the hazards of surgical smoke can also be another reason for this observation. Fereidouni et al. reported that most of the OR staff (93.6%) had a low level of awareness and only a small number (0.4%) had a good level of knowledge on the effects of surgical smoke.<sup>31</sup>

Surgical smoke is caused by the use of high-temperature devices, such as electrocautery, laser, ultrasonic (harmonic) scalpel, etc., which are used to cut and coagulate tissue during surgical procedures.<sup>32,33</sup> Studies suggest that surgical smoke, in addition to water and steam, contains other compounds such as cellular debris, chemicals, blood particles and tissues, viruses and bacteria.<sup>34</sup> There is not sufficient evidence to estimate the balanced risk for the infectious nature of surgical smoke. Due to the novelty of the COVID-19 pathogen and the evidence for the presence of other viruses in surgical smoke, it seems necessary to

**Table 3**  
Frequency distribution and mean level of observance of standards and protective measures in the operating room.

Stage	Item	Always	Most of time	Sometimes	Rarely	Never	Mean
Pre-operative period	1. Patients with or suspected of COVID-19 wear a mask and a warning sign when entering the operating room.	(21.3%)39	(.8%15)29	(.3%38)70	(.3%9)17	(15.3%)28	45.4±4.14
	2. The medical records and all radiological images of patients have a warning sign or risk of transmission of COVID-19 disease.	(.2%8)15	(17.5%)32	(.2%43)79	(.5%17)32	(.7%13)25	
	3. Overcrowding, entry, and exit of people who have no role in the operation process are prevented in the operating room.	((23%42)	(32.8%)60	(.1%30)55	(.6%6)12	(.7%7)14	
	4. The operating room specific for patients with or suspected of COVID-19 has circulation by automatic ventilation and, contrary to normal conditions, has negative pressure.	(.8%9)18	(.6%12)23	(.6%30)56	(.4%10)19	(.6%36)67	
	5. A warning sign related to COVID-19 is installed on the door of the operating room of COVID-19 patients.	(.2%20)37	(.6%42)78	(.1%25)46	(.7%2)5	(.3%9)17	
	6. The operating room is equipped with a thermometer and people's body temperatures are controlled before surgery.	(.5%11)21	(23%42)	(32.8%60)	(18%33)	(14.8%27)	
	7. Members of the surgical team leave the room during the patient's intubation and extubation.	(7.7%14)	(12%22)	(41%75)	(18.6%34)	(20.8%38)	
Intra-operative period During surgery	8. Unnecessary instruments and equipment are removed from the operating room and only the required tools and equipment remain therein.	(.6%24)45	(.6%42)78	(.2%14)26	(.1%7)13	(.5%11)21	41.5±3.20
	9. In surgery of COVID-19 patients, mostly disposable packs, instruments, and items are used.	(47%86)	(.1%36)66	(.4%10)19	(.5%0)1	(6%11)	
	10. As far as possible, the same operating room, anesthesia equipment, and surgical equipment are used in the surgery of patients with or suspected of COVID-19	(29.5%)54	(.8%26)49	(30.1%55)	(.6%1)3	(12%22)	
	11. If an electrocautery device is used during the surgery, the minimum power of the device is used to prevent excessive smoke.	(.2%14)26	(.5%23)43	(.7%37)69	(.4%10)19	(.2%14)26	
	12. To evacuate surgical smoke, smoke suction devices, such as suction with in-line filter for surgical smoke, are used during the surgery.	(2.7%5)	(8.7%16)	(.1%19)35	(12.4%41)	(47.1%86)	
	13- During the surgery, changing and replacing instruments should be avoided as much as possible.	(.5%23)43	(.6%42)78	(.9%27)51	(.9%4)9	(.1%1)2	
	14. To prevent infection in other parts of the operating room, induction of anesthesia and recovery of patients are done in the operating room.	(.8%50)93	(.1%30)55	(.8%15)29	(0%0)	(.3%3)6	
	15. All instruments and equipment that are widely used in the operating room, such as suction, anesthesia devices, etc., are covered with transparent plastics.	(.7%2)5	(6.6%12)	(.6%24)45	(27.3%50)	(.8%38)71	
	16. At the end of surgery, absorbable sutures are used to close the skin.	(.6%6)12	(.7%19)36	(.3%33)61	(.2%14)26	(.2%26)48	
Post-operative period	17. In the operating room, there is a separate area for the staff to put on and take off their clothes and PPE outside the operating room.	(.2%23)43	(.8%15)29	(.6%18)34	(.4%10)19	(.7%31)58	55.3±56.20
	18. On the biopsy container, in addition to the specifications, a COVID-19 label is attached and then sent to the pathology.	(.9%33)62	(.1%19)35	(.1%25)46	(.3%9)17	(.6%12)23	
	19. Surgical instruments of patients with or suspected of COVID-19 are washed separately, packaged, and sent to CSSD.	(.7%66)122	(.5%23)43	(.7%7)14	(.1%1)2	(.1%1)2	
	20. Packs, instruments, and equipment brought to the operating room and not used are considered infected and sent to the CSR for sterilization.	(41%75)	(.8%26)49	(18%33)	(6%11)	(.2%8)15	
	21. After the surgery, the operating room air is disinfected with plasma, UV, and other standard methods.	(.4%81)149	(.9%16)31	(.6%1)3	(0%0)	(0%0)	
	22. After the surgery, the surfaces, floors, and walls of the operating room are disinfected with a suitable disinfectant.	(.7%55)102	(35%64)	(8.7%16)	(0%0)	(.5%0)1	
	23. At least 2 h after surgery, no other surgery is performed in that room to completely disinfect the operating room.	(.6%30)56	(.2%20)37	(.4%28)52	(.8%9)18	(.9%10)20	
Total mean (SD)							5.10±3.55

maximize precautions during the surgery at this stage.<sup>35</sup>

Another measure that was less observed in the studied hospital was the design of a separate donning/doffing area for PPE in the operating room. These two areas should be designed so that staff participating in the surgery of COVID-19 patients can wear appropriate PPE at the entrance to operating rooms in a place called donning area according to standard principles with the help of posters installed in these areas and enter the operating room. At the end of the surgery, the patients remove PPE in a place called the doffing area, which is located in the exit area of the operating room and is separate from the donning area.<sup>28</sup> In most of the studied hospitals, these two procedures were performed in a non-standard manner inside the operating room. In general, the results of this study showed a good level of performance of surgical team members regarding observing the standards of PPE against COVID-19 in operating rooms. However, the standards and protective precautions in operating rooms were not at good levels, hence, measures should be taken in this regard to increase the level of observing standards to

protect operating room staff against COVID-19.

Lack of similar research on observing of COVID-19 protection standards in the operating room to compare and interpret the results was the main limitation of this study. Another limitation of this study emerges from the cross-sectional nature of the design, which make it difficult to draw cause-effect relationships. Also another limitation of this study was using a questionnaire, which has a self-report aspect, to collect the data. Thus, the answers might be affected by incorrect answers and staffs' lack of confidence in the implementation of research project results, leading to reduced commitment to provide honest answers to the questionnaire questions. Also the study could be limited by the fact as many of the strategies have changed over time.

## 5. Conclusion

In general, the results of this study showed that the performance of surgical team members regarding observing of standards of PPE against



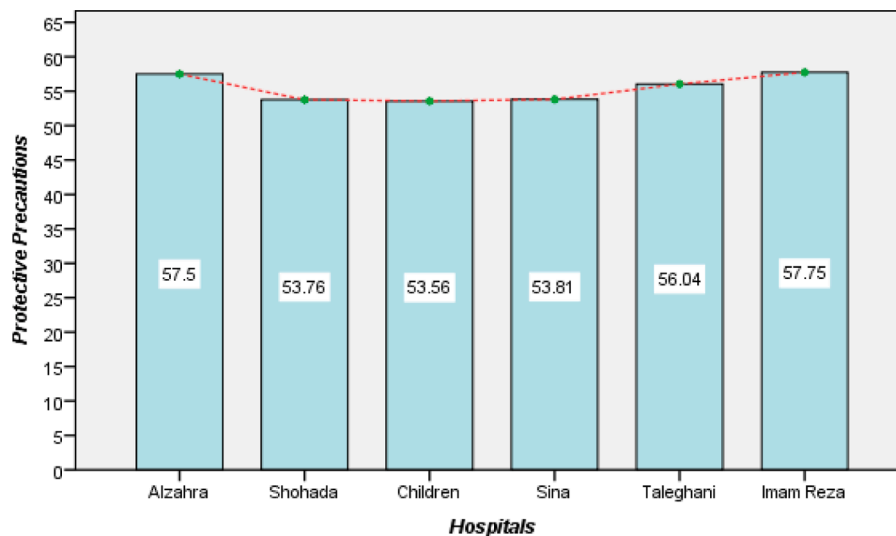


Fig. 3. preventive standards in the operating room based on the type of hospital.

COVID-19 in operating rooms was at a good level, but the standards and protective precautions in operating rooms were not at good level and measures should be taken in this regard to increase the level of observing of standards to protect operating room staff against COVID-19. The results of present study can be used in planning to prevent infection and contamination of the surgical team and operating room staffs with COVID-19 or to minimize these risks and develop evidence-based protocols.

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#### Authors' contribution

Omid Zadi Akhuleh and Mojgan Lotfi did overall supervision, material provision, study conception. Zahra Sheikhalipour and Omid Zadi Akhuleh did data accumulation. Ahmadmira Aghazadeh did statistical analysis, data provision. Omid Zadi Akhuleh did data provision, manuscript preparation. Omid Zadi Akhuleh and Vahid Zamanzadeh did manuscript preparation, final edit, study conception.

#### Declaration of Competing Interest

All authors declared no potential conflicts of interest with respect to the research, authorship, and/or publication of this article. No, there are no competing interests for any author.

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