



# Evaluation of Knowledge, Awareness, and Approach of Healthcare Personnel in the Operating Room Towards the Prevention and Control of Hospital-Acquired Infections (HAI)

Ameliyathanede Çalışan Sağlık Personelinin Hastane Enfeksiyonlarının Önlenmesi ve Kontrolü Konusunda Bilgi, Bilinç Düzeyleri ve Yaklaşımları

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## Abstract

**Objective:** The current level of knowledge and awareness among operating room personnel regarding hospital-acquired infections (HAI) has not been thoroughly investigated. This study aims to assess the knowledge, level of awareness, and practices of health personnel working in the operating room regarding HAI and its management.

**Material and Methods:** This was a descriptive questionnaire study conducted online. The responses were evaluated using a scoring system, and a net score was calculated for each participant. The scores were then converted to a 100-point system to determine the level of proficiency. A score of >75 was considered indicative of good proficiency.

**Results:** Three hundred and seventy healthcare personnel working in the operating rooms participated in the study. Of the participants, 62.2% were female and the median age was 35.5 (23-50) years. The occupational distribution of the participants was as follows: 40.5% were specialist physicians, 31.1% were residents, and 28.4% were nurses. Of the respondents, 58% had undergone training on HAI, and the mean duration of the training was 9.48 ± 12.72 (1-70) hours. The mean duration in the profession was 11.88 ± 7.87 (1-28) years. The participants had a sufficient level of knowledge about the definition of HAI and risk factors, and the importance of hand hygiene. However, the results indicated that there was insufficient knowledge among the participants regarding the definitions of different types of HAI, sources and routes of transmission, the

## Öz

**Giriş:** Hastane enfeksiyonları (HE) ile ilgili geniş literatür verisine karşın, ameliyathane personelinin HE konusunda bilgi düzeyleri ve farkındalıkları yeterince araştırılmamıştır. Bu çalışma ile ameliyathanede görev yapan sağlık personelinin HE ve kontrolü konusunda bilgi, bilinç düzeyi ve yaklaşımlarının belirlenmesi amaçlanmıştır.

**Gereç ve Yöntemler:** Çalışma tanımlayıcı nitelikte bir anket çalışması olarak planlanmış ve çevrim içi olarak uygulanmıştır. Katılımcılar mesleki branşlarına göre gruplandırılmış ve karşılaştırmalar bu gruplar üzerinden yapılmıştır. Yanıtlar bir puanlama sistemine göre değerlendirilerek net puan hesaplanmıştır. Puanlar yüzdelik sisteme çevrilmiş ve yeterlilik düzeyi belirlenmiştir. İyi düzeyde yeterlilik >75 puan olarak kabul edilmiştir.

**Bulgular:** Çalışmaya ameliyathanelerde görev yapan 370 sağlık personeli katıldı. Katılımcıların %62.2'si kadın ve medyan yaş 35.5 (23-50) yılı. Meslek dağılımı %40.5 uzman hekim, %31.1 asistan ve %28.4 ameliyathane hemşiresi idi. Ankete katılanların %58'i HE ile ilgili bir eğitimden geçmişti, alınan eğitimin süresi ortalama 9.48 ± 12.72 (1-70) saattir. Meslekteki çalışma süresi ortalama 11.88 ± 7.87 (1-28) yılı. Katılımcıların HE tanımı ve risk faktörleri ile el hijyeni konularında yeterli bilgi düzeyine sahip oldukları görüldü. Ancak HE türlerine yönelik tanımlamalar, HE kaynakları ve bulaş yolları, enfeksiyon bulaşında ellerinin önemi, el hijyeni uygulamaları, kişisel koruyucu ekipman kullanımı, sterilizasyon/

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importance of hand hygiene in infection prevention, personal protective equipment usage, sterilization and disinfection practices, isolation precautions, management of invasive devices, pre-and post-surgery precautions, waste management, sharps injuries, rational antibiotic use, and the significance of surveillance. Statistical analysis revealed a significant increase in the scores obtained with an increase in the duration of the participants' professional experience ( $p=0.03$ ). The mean score obtained using the percentile system was  $61.6 \pm 0.97$  (ranging from 41.8 to 76.7). Based on the assessment of competency level, 10.8% of the participants were classified as weak, 85.1% as moderate, and 4.1% as good.

**Conclusion:** Healthcare professionals working in the operating room had insufficient knowledge and inadequate approach towards HAI control. Therefore, it is essential to review the training of health personnel on hospital infection control and develop effective plans to enhance practical applications by increasing awareness and knowledge, which can help reduce the risk of hospital-acquired infections.

**Keywords:** Hospital-acquired infections, control, operating room personnel, knowledge, level of awareness

## Introduction

Hospital-acquired infections (HAI) increase the length of hospital stay, the cost of treatment, and the loss of labor, and threaten the health of health workers as well as patients (1,2). HAI is a significant problem in Türkiye, as in many other parts of the world. While complete prevention may not be possible, it is achievable to reduce and control HAI rates with simple precautions and methods (3). Control methods such as hand hygiene, disinfection, sterilization, patient isolation, and cleaning, especially surveillance, constitute the basis of the prevention and control of HAI (3,4). However, to effectively control HAI in a hospital, it is essential to apply these methods together, using a holistic approach continuously. During the implementation of this holistic approach, the role of individual awareness, level of knowledge, and approaches is critical (5,6).

Due to the complexity of the environment and the diverse range of health practices involved, operating rooms (ORs) are considered to be one of the high-risk areas for HAI in healthcare (7,8). It is crucial to assess the knowledge and awareness levels of healthcare personnel, who form the backbone of such high-risk environments, regarding the necessary practices for preventing HAI and the approaches they adopt towards them. The current literature provides substantial information on nosocomial infections, but there is a lack of research on healthcare professionals' behaviors and practices regarding hospital-acquired infection (HAI) prevention in ORs (9-14). Examining the key determinants of healthcare personnel's behaviors and practices related to HAI control in ORs can facilitate the development of effective interventions for preventing and controlling HAI. The objective of this study is to evaluate the knowledge, awareness, and approaches of healthcare personnel working in ORs towards HAI control.

## Materials and Methods

This was a descriptive survey study conducted between July 1, 2020, and January 1, 2022, among healthcare personnel

dezenfeksiyon uygulamaları, izolasyon türüne yönelik önlemler, invaziv araç kullanım ve bakımı, ameliyat öncesi ve sonrasında alınacak önlemler, atık yönetimi, kesici-delici alet yaralanmaları, akılcı antibiyotik kullanımı ve sürveyansın önemi konularında yeterli bilgi düzeyinin olmadığı görüldü. Meslekte çalışma süresi arttıkça alınan puanlarda anlamlı bir artış olduğu görüldü ( $p=0.03$ ). Yüzdeler sistemine göre ortalama puan  $61.6 \pm 0.97$  ( $41.8-76.7$ ) iken, yeterlilik düzeyinin değerlendirilmesinde katılımcıların %10.8'i zayıf, %85.1'i orta ve %4.1'i iyiydi.

**Sonuç:** Ameliyathanede çalışan sağlık personelinin HE önlenmesi ve kontrolü konusunda bilgi ve yaklaşımlarında eksiklikleri vardır. Sağlık personelinin HE ile ilgili eğitimleri gözden geçirilmeli, farkındalığı ve bilgiyi artırarak pratik uygulamaları geliştirmeye yönelik etkin planlamalar yapılmalıdır.

**Anahtar Kelimeler:** Hastane enfeksiyonu, kontrol, ameliyathane personeli, bilgi, bilinç düzeyi

working in ORs. The study sample included actively working physicians and nurses who agreed to participate in the study. According to the 2022 statistics, a total of 204,910 interventional procedures, comprising 30,751 daily interventions and 174,159 operations, were carried out in 131 ORs in our hospital.

An anonymous questionnaire consisting of 50 items, which took approximately 20 minutes to complete, was developed and administered online due to the COVID-19 pandemic coinciding with the study period. The survey was created using GoogleForms and sent to the hospital's ORs personnel via email and Whatsapp. Responses submitted after the study period were not accepted. The questionnaire began with preliminary information that explained the study's purpose and emphasized that participation was voluntary. Participants were then asked questions to determine their socio-demographic characteristics (age, gender, etc.) and working status (branch, duration of active practice, etc.). Following these questions, participants were presented with a series of multiple-choice (23 items) and true-false questions (20 items), where only one option could be selected. These questions aimed to assess participants' knowledge and approach towards HAI. The decisive questions about HAI focused on the following topics: HAI definition, types of HAI, transmission routes, risk factors, standard prevention methods (such as hand hygiene practices, use of personal protective equipment, sterilization, and disinfection techniques, management of infected waste, and rational use of antibiotics), isolation methods, precautions for specific infections (invasive device usage, recommended duration, prevention of contamination, pre-and post-operative measures to prevent HAI), sharps injuries, and the importance of the Infection Control Committee (ICC) and surveillance in HAI prevention. Participants were divided into occupational groups for comparative analysis. Group I consisted of specialist physicians, group II included residents, and group III comprised OR nurses. A scoring system was used to evaluate the questionnaire responses, with one point awarded for each correct answer. Incorrect and "no idea" responses

were deemed ineffective. The first seven questions, which pertained to demographic information, were excluded from the scoring. To determine proficiency, the number of correct answers was multiplied by 100 and divided by the total number of questions, which were 43. The resulting scores were then categorized based on the proficiency classification, and proficiency levels were determined. Scores below 50 were considered poor, scores ranging from 50-75 were moderate, and scores above 75 were deemed good.

The statistical analysis of the data was conducted using the SPSS v25 software package (IBM Corp., Armonk, New York, USA). Categorical data were presented as numbers (n) and percentages (%), while continuous data were presented as mean  $\pm$  standard deviation (SD). The Chi-square test was used to analyze categorical data, and the one-way ANOVA or Kruskal Wallis test was used for continuous data depending on the normality of the data distribution and the number of groups. Pearson or Spearman Rank correlation coefficient was utilized to analyze the relationship between numerical measurements, depending on the distribution of data. A p-value of  $<0.05$  was considered statistically significant.

## Results

A total of 370 healthcare professionals working in the ORs participated in this study. Among the participants, 230 (62.2%) were female, 140 (37.8%) were male, and the median age was 35.5 (ranging from 23 to 50) years. The occupational distribution was as follows: 40.5% were specialist physicians, 31.1% were residents, and 28.4% were nurses. The mean duration of active practice was  $11.88 \pm 7.87$  (1 to 28) years, while the mean duration of working in the ORs was  $9.33 \pm 7.44$  (0.5 to 26) years. Notably, these durations were significantly shorter among residents ( $p= 0.02$  for active practice duration;  $p= 0.006$  for the working duration in ORs). Of the respondents, 58% had undergone HAI training, with a mean duration of  $9.48 \pm 12.72$  (1 to 70) hours. The rate of training was significantly higher among nurses (90.5%) than among specialist physicians (53.3%) and residents (34.8%) ( $p= 0.001$ ). When asked about their self-evaluation of HAI knowledge, 28.4% of the respondents answered "good", 59.5% answered "moderate", 10.8% answered "insufficient", and 1.4% had "no idea".

Regarding the question about the definition of HAI, the correct answer was selected by 95.9% of the participants, while 4.1% chose the incorrect definition, and all of them were nurses ( $p= 0.019$ ). Similarly, for HAI risk factors, 96% of the respondents chose the correct option, and only 4% chose the incorrect answer, all of whom were nurses as in the previous question ( $p= 0.016$ ). In the assessment of the most common transmission route for HAI, only 37.8% chose the correct answer, and in the subgroup evaluation, incorrect answers were selected significantly more often by specialist physicians ( $p= 0.028$ ). The most important factor in transmission was identified as "hands of the

staff" by 74.3% of the participants, while "hand hygiene" was marked by 95.9% as the most critical measure in preventing HAI. The appropriate situations for hand washing were chosen correctly by 92%, and 82.4% were aware of misapplications related to hand washing. The reasons for preferring sterile gloves were correctly answered by 96% of the respondents, and there was no statistically significant difference between the groups in any of the questions about hand hygiene and the use of sterile gloves.

In the sterilization/disinfection questions, only 4.1% of the participants knew the suitable duration for sterilized dressing set usage, and the correct method used for sterilizing heat-sensitive instruments was identified by 68.9% of the respondents. There was no significant difference between the occupational groups in these questions. The disinfection method for floors, walls, and sinks was answered correctly by 36.5% of the participants. Specialist physicians had a significantly higher rate of correct answers for this question ( $p< 0.001$ ), while nurses had a higher rate of incorrect answers ( $p= 0.001$ ).

Regarding the precautions required during entry and exit from the room of a patient with HAI, 90.5% of the participants marked the correct answer. In questions regarding invasive device use and care, only 30% of the participants knew the recommended duration of peripheral catheter usage and only 10.2% knew the recommended duration of central catheter usage. There was no statistically significant difference between the occupational groups in the answers given to both questions. The recommended removal time for a urinary catheter was identified correctly by 73% of the responders. Necessary measures to prevent urinary catheter contamination were known by only 36.5% of the participants. There was no significant difference between the occupational groups in the urinary catheter-related questions.

The correct answer rates for the questions about HAI precautions before, during, and after surgery were suboptimal. Only 12.2% of participants knew the most appropriate method for preoperative hair removal. Although incorrect answers were given by specialist physicians and nurses, no statistical significance was found. Precautions during surgery for a patient with HAI were known correctly by 67.6% of participants. The duration of effective skin antisepsis was accurately known by only 17.6% of participants. Misapplications that increase the risk of infection in surgical incision dressing were known by 56.8% of participants.

The analysis of the questionnaire responses revealed that 75.7% of the participants correctly identified the priority approach after a sharps injury. Additionally, 83.8% of the respondents were aware of the impact of rational antibiotic use on HAI. Specialist physicians had a lower level of awareness on this issue (58.3%), although the difference between the occupational groups was not statistically significant. The distribution of cor-

rect and incorrect responses to the true-false questions is presented in Table 1.

The mean of correct answers to all questions in the questionnaire was  $26.5 \pm 3.6$  (18-33) in total. The distribution by

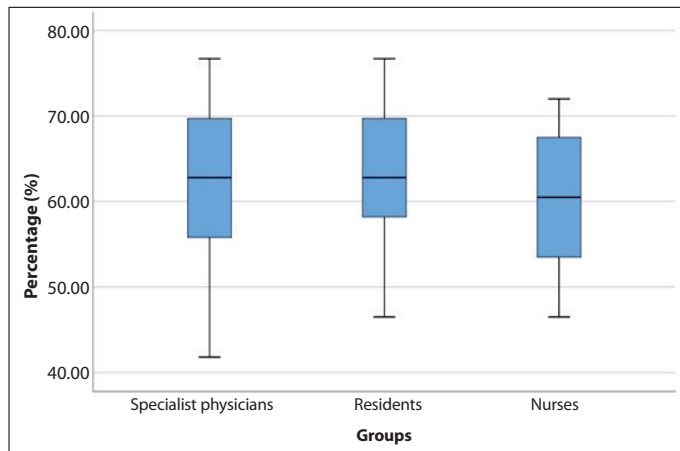
**Table 1.** The correct answers given to the true-false questions according to the groups

Question	Specialist physicians n (%)	Residents n (%)	Nurses n (%)	Total n (%)	p
The difference in HAI incidence between adult and pediatric patients	55 (14.9)	45 (12.2)	30 (8.1)	130 (35.1)	0.479
Source of HAI	55 (14.8)	44 (11.9)	89 (24)	188 (50.8)	<0.0001*
Role of visitors in HAI	81 (21.9)	82 (22.1)	48 (13)	211 (57)	0.429
High-risk units for HAI within the hospital	136 (36.7)	116 (31.4)	91 (24.6)	343 (92.7)	0.374
Post-operative duration defined for SSI	96 (25.9)	90 (24.3)	59 (15.9)	245 (66.2)	0.134
Effect of SSI on length of hospital stay	112 (30.2)	89 (24)	96 (25.9)	297 (80.2)	0.103
The effectiveness of hand washing in preventing HAI	115 (31)	84 (22.7)	82 (22.2)	281 (76)	0.912
Use of non-sterile gloves	135 (36.5)	88 (23.7)	102 (27.6)	337 (91.1)	0.639
Indication for use of sterile gloves	109 (29.5)	80 (21.6)	97 (26.2)	286 (77.3)	0.212
Disinfection application for balloon valve mask	150 (40.5)	105 (28.4)	105 (28.4)	360 (97.3)	0.102
Infected waste management	65 (17.6)	20 (5.4)	15 (4.1)	100 (27.1)	0.032*
Precautions for HAI transmitted by contact	60 (16.2)	65 (17.4)	25 (6.7)	149 (40.3)	0.002*
Precautions before inserting a CVC	94 (25.4)	93 (25.2)	78 (21.1)	265 (71.7)	0.651
Risk of developing HAI of the extremity where the CVC is inserted	138 (37.3)	79 (21.4)	83 (22.4)	300 (81.1)	0.231
The importance of closed suction systems in preventing HAI					
Precautions before surgery for HAI	34 (9.2)	0	50 (13.5)	84 (22.7)	<0.001*
Surgical incision care in the prevention of HAI in the postoperative period	123 (33.2)	99 (26.8)	96 (25.9)	318 (86)	0.724
Role of nurses in the prevention of HAI	50 (13.5)	50 (13.5)	45 (12.2)	145 (39.2)	0.826
Role of infection control committee in HAI prevention	136 (36.8)	114 (30.8)	101 (27.3)	351 (94.8)	0.133
Role of surveillance in the prevention of HAI	63 (17)	66 (17.8)	36 (9.7)	165 (44.6)	0.171

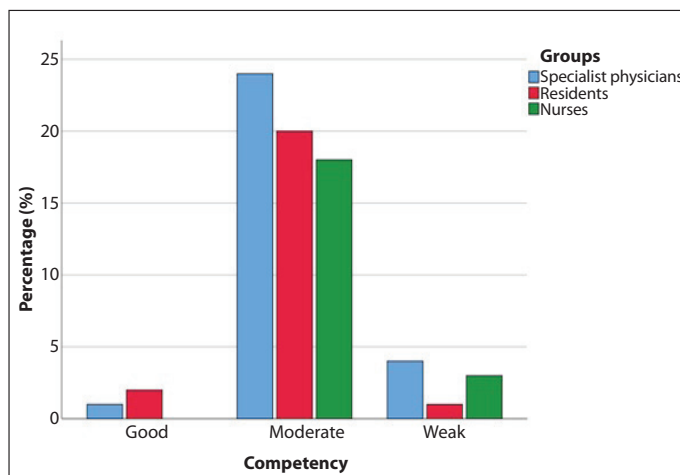
CVC: Central venous catheter, HAI: Hospital-acquired infection, SSI: Surgical site infection.

\*: Statistically significant.

occupational groups was  $26.5 \pm 3.9$  (18-33) for specialist physicians,  $27 \pm 3.4$  (20-33) for residents, and  $25.9 \pm 3.4$  (20-31) for nurses, and there was no difference between the groups. Similarly, a statistical difference was not found for incorrect and "no idea" answers. A correlation was not detected between the duration of the previous HAI training and the means of correct, incorrect, and "no idea" responses. The mean total score was  $61.6 \pm 0.97$  (41.8-76.7) in the percentile system, and the distribution according to groups was  $61.6 \pm 1.7$  (41.8-76.7) in specialist physicians,  $62.8 \pm 1.6$  (46.5-76.7) in residents, and  $60.3 \pm 1.7$  (46.5-72) in nurses. There was no statistical difference between the groups for percentile scores obtained ( $p=0.06$ ). The distribution of the scores obtained on the percentage by groups was shown in Figure 1. In the assessment of the competency level, 10.8% of the participants were at a weak level, 85.1% at a moderate level, and 4.1% at a good level. While no statistical difference was found between the groups in this classification, none of the nurses were found to have a good level of competence (Figure 2). A statistical significance was not found between the duration in the profession and the level of competency. Although the proportion of



**Figure 1.** The distribution of the scores on the percentage system by groups.



**Figure 2.** Distribution of competency level classification by groups.

those with moderate competency who received an Infection Control Committee (ICC) training was higher than those who did not, it was not statistically significant. Similarly, no significant relationship was found between the duration of previous HAI training and the level of competency.

## Discussion

Hospital-acquired infections pose a significant public health problem with preventable consequences that impact society as a whole (7). Given their occurrence in healthcare settings, it is crucial for healthcare professionals to possess a high level of awareness, adequate knowledge, and appropriate practices to prevent and control HAI (15). ORs are particularly high-risk areas for HAI, as multiple healthcare workers interact with various patient groups during interventions and healthcare practices. As such, healthcare professionals working in ORs should prioritize HAI prevention and control measures. Despite the extensive literature on HAI prevention and awareness among various healthcare professional groups, studies specific to OR personnel are limited. The present study is significant as it allows for the identification of malpractices that facilitate HAI and their prevention among OR personnel comprising specialist physicians, residents, and nurses. The inclusion of diverse healthcare professionals in the study enables valuable comparisons to be made.

The results of our study revealed that the mean number of correct answers was  $26.5 \pm 3.6$ , and the mean score in the percentile system was  $61.6 \pm 0.97$ . A majority of the participants, around 85%, demonstrated a moderate level of competency in the assessment. These findings indicate that healthcare professionals working in the ORs of our hospital are lacking in their knowledge and skills in preventing and controlling HAI. Thus, there is a pressing need for additional planning and intervention to improve their competency in this area. It is worth noting that the knowledge and attitude deficiencies identified in our study are not unique to our hospital or country. Several other studies have reported similar findings among healthcare professionals worldwide (14,16-18).

In a previous multicenter survey involving 1000 nurses, the impact of professional experience on HAI prevention practices was evaluated, and a significant correlation was found between nurses' knowledge and years of professional experience (19). In line with these findings, our study also showed a correlation between the duration of work experience in the profession and the level of knowledge. While there was no significant difference between occupational groups in the classification of competence levels, none of the nurses were found to have a good level of competence. However, we did not identify a significant relationship between the duration of work experience in the profession and the level of competency in our study.

The effectiveness of HAI training on infection control is undeniable. However, there is currently no standardized training for the prevention and control of HAI worldwide. The standardization of infection control training for healthcare workers is an issue that is currently being addressed by Europe. Within the European Union, efforts are being made to establish an agreement for the implementation of an educational strategy for infection control (20,21). However, due to the lack of globally accepted and standardized instructions, it is recommended that healthcare workers follow local guidelines and receive regular refresher training (22). In our hospital, infection control training is provided to healthcare personnel by ICC nurses and physicians. The training is given before and at regular intervals after starting work, in response to any increase in HAI rates or epidemics, and when new regulations related to HAI prevention are introduced. In our study, we found that 58% of healthcare professionals received HAI training after starting work at the hospital, with a mean training duration of  $9.48 \pm 12.72$  hours. Notably, the rate of HAI training was highest among nurses, with 90.5% reporting having received such training. Our study found that specialist physicians had an HAI training rate of 53.3%, while residents had a significantly lower rate of 34.8% compared to other groups. These findings suggest that there is a need to increase HAI training for both residents and specialist physicians in our hospital and ensure that all personnel across different groups receive adequate training.

Previous studies have highlighted specific areas of inadequacy in addition to the general findings on the knowledge levels of healthcare workers (6,23). In the sub-results of our study, participants demonstrated sufficient levels of knowledge and awareness about the definition and risk factors of HAI, as well as the importance of hand hygiene and infection control practices. However, their knowledge was found to be inadequate in areas such as identifying the types of HAI, understanding transmission routes and resources, and implementing appropriate infection control measures including the use of personal protective equipment, sterilization/disinfection, isolation precautions, management of invasive devices, necessary precautions in the pre-and post-surgery period, waste disposal, prevention of sharps injuries, rational antibiotic use, and the importance of HAI surveillance. These results suggest that the effectiveness of HAI training content is more important than its duration in improving knowledge and reducing infection rates. To maximize the effectiveness of HAI education and achieve desired outcomes, training programs should be regularly reviewed, reinforced, and delivered consistently over time.

Prevention and control of hospital-acquired infections HAI require increasing individual knowledge and awareness and implementing effective infection control measures in healthcare settings. Developing and delivering effective and accu-

rate training programs based on HAI prevention strategies is essential to ensure adequate knowledge, raise awareness, and foster positive behavior change. A comprehensive prevention strategy should encompass a scientifically-based education program on best practices, provision of quality learning resources, and use of information-based applications. Numerous studies have demonstrated that effective training methods and practices have a positive impact on improving infection control measures (15,24). Developing effective HAI prevention training programs requires consideration of the role and significance of healthcare workers in both the development and prevention of infections. To address areas of insufficiency and reduce the risk of HAI, training programs should prioritize topics based on the needs and responsibilities of healthcare workers at all levels. In the 2016 guide published by the World Health Organization, team and task-based strategies were proposed for infection control training, emphasizing the need for all healthcare workers, regardless of their position, to receive comprehensive training (25). Furthermore, periodic evaluations of training effectiveness and personnel knowledge levels are necessary to ensure continued improvement in infection control and prevention measures. Our study evaluated the infection control and prevention training programs provided at our hospital, specifically among operating room personnel. However, it is important to note that our study provides local data and may not be generalizable to the broader population. To promote effective infection control measures, future studies should examine all aspects of healthcare safety, including infection control, and develop solid, qualified, and sustainable strategies based on the data obtained.

**Ethics Committee Approval:** Ethical approval was obtained from Ankara City Hospital 1<sup>st</sup> Clinical Research Ethics Committee (Decision no: E1-20-822, Date: 25.06.2020).

**Informed Consent:** Patient consent was obtained.

**Peer-review:** Externally peer-reviewed.

**Author Contributions:** Concept- SKY, TB; Design- SKY; Supervision- TB; Resource- SKY; Data Collection and/or Processing- SKY; Analysis and/or Interpretation- SKY; Literature Search - SKY; Writing- SKY; Critical Review- TB.

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