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Research Article

CURRENT LEVEL OF KNOWLEDGE AND AWARENESS OF HEALTHCARE PERSONNEL IN BASIC AND ADVANCED LIFE SUPPORT IN ARREST CASES WITH AND WITHOUT COVID-19 INFECTION

Arzu Babacan[1]

[1] Health Sciences University, Ankara, Dr. Abdurrahman Yurtaslan Oncology Training and Research Hospital, Emergency Service
Orcid1: https://orcid.org/0000-0002-0540-8975
Correspondence Author: babacan.ar@hotmail.com

Abstract: *The knowledge of healthcare professionals about life support is crucial for saving lives. It was aimed to evaluate the knowledge and awareness level of healthcare professionals about advanced life support. Our study was conducted between 15.02.2021 and 15.03.2021 in healthcare personnel working in a tertiary education and research hospital in Ankara. Data were collected by the questionnaire method. The researcher prepared the survey questions according to the European Resuscitation Council COVID-19 guidelines and American Heart Association Advanced Cardiac Life Support algorithms updated in 2020. The study included 265 healthcare personnel (physicians, physician assistants, family physicians, nurses, health officers, and anesthesia technicians). Demographic characteristics of the participants (gender, age, duration of service, duties, duty stations), training and practice status, and level of knowledge were evaluated. 67.2% of the participants were female, and 32.8% were male. The majority of the participants were nurses working in the inpatient clinics. 49.9% had a tenure of 1-5 years. 52.0% had received advanced cardiac life support training, and 19.6% had obtained and used automatic external defibrillators. 63.8% had performed advanced cardiac life support on a patient. In this study, the ACLS knowledge level of healthcare workers was low; their knowledge of ACLS application differences in COVID-19 patients was outdated and confused with adult ACLS. There was no significant difference in advanced cardiac life support scores in terms of gender, age, occupation, workplace, and tenure (p=0.604; p=0.986; p=0.927; p=0.982; p=0.295, respectively). In terms of their duties, physicians had higher rates of correct answers to ACLS questions in patients with COVID-19. Providing in-service resuscitation training to healthcare workers in line with current guidelines and supporting them with practical applications can provide quality knowledge and skills and increase their awareness of their responsibilities.*

Keywords: *Healthcare professionals, Advanced life support, Knowledge, Awareness*

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1. Introduction

The most crucial goal of all medical interventions is to keep patients alive. Cardiopulmonary arrest is the sudden cessation of spontaneous respiration and circulation due to various causes [1]. Cardiopulmonary resuscitation (CPR) is the maintenance of airway patency, respiration, and circulation in a patient whose respiration and circulation have ceased due to any cause. In CPR, two levels are defined as Basic Life Support (BLS) and Advanced Cardiac Life Support (ACLS) [1].

ACLS involves specialized treatment modalities administered by physicians and specially trained medical staff. Its basis includes good BLS, manual defibrillation, airway management during CPR, oxygenation and ventilation, circulation, monitoring, and medications to be administered [1, 2].

Resuscitation has been an important subject of scientific studies for many years, and information in this field has been regularly updated with guidelines published by international organizations [2]. The latest guidelines were published by the American Heart Association (AHA) and the European Resuscitation Council (ERC) in 2020 [3, 4]. The SARS-CoV-2 pandemic started in January 2020 and has led to many changes from community life to patient care. COVID-19 is a highly contagious disease caused by the SARS-CoV-2 virus. Cardiopulmonary resuscitation procedures are risky procedures. Neither the ERC nor the AHA Basic Life Support (BLS) and Advanced Cardiac Life Support (ACLS) guidelines include guidance for the COVID-19 pandemic. Due to this situation, both organizations have introduced new recommendations for the pandemic [4]. During the pandemic, frontline healthcare personnel have played a critical role in diagnosing, treating, and monitoring the disease, and many have been infected, treated, and even died from COVID-19 [5]. The recently published CPR guidelines needed some changes to ensure the continuity of care and the safety of healthcare workers, especially for cardiac arrest patients needing emergency care. In the basic and advanced cardiac life support guidelines, various application differences have been proposed for COVID-19 cases [4]. The recommended changes formed the basis of our study.

Although CPR training is mandatory in healthcare institutions, this training should be periodically updated with guidelines. Healthcare personnel participating in training should have high knowledge and awareness levels and up-to-date information about life support [3,5]. Since COVID-19 is highly contagious, especially during resuscitation, and carries a high risk of morbidity and mortality, procedures have been proposed to ensure the best possible chance of survival without compromising the safety of rescuers [5]. This study aimed to evaluate the level of ACLS knowledge of healthcare workers and the currency of their knowledge in adults and possible/infected COVID-19 patients in line with current guidelines.

2. Materials and methods

Type of the Study

This descriptive study was conducted between 15.02.2021 and 15.03.2021 at the University of Health Sciences, Ankara, Dr. Abdurrahman Yurtaslan Oncology Training and Research Hospital.

2.1. Study Population and Sample Selection

The study population consisted of 375 healthcare personnel in this hospital who participated in resuscitation training. Before the participation, the participating healthcare personnel were informed that this was not an exam, that all of the data would be used for scientific study, and that the answers would not affect their professional life and future in any way. They were explained that each question consisted of statements with four options and that only one option was correct. Three hundred healthcare personnel (specialist physicians, assistant physicians, general practitioners, family physicians, nurses, health officers, and anesthesia technicians) participated in the study, and their verbal consent was obtained.

2.2. Instruments for Data Collection

Data were collected using a questionnaire. Participants were asked to answer the questionnaire within 30 minutes. The researcher prepared the survey questions based on the resuscitation guidelines updated in 2020. Participants were asked three questions about demographics, ACLS training, and practice status, and ten questions with multiple-choice statements highlighting changes and updates to the 2020 adult ACLS and guidelines for possible/probable COVID-19 patients. It was calculated out of

10 points, with 1 point for a correct answer and 0 points for an incorrect answer. Using an interval scale, a score range of 0-4 points was evaluated as low knowledge, 5-7 points as moderate knowledge, and 8-10 points as good knowledge. The study was completed with 265 participants. Thirty-five participants who gave incomplete answers and/or checked more than one option and left their demographic information blank were excluded from the study. The level of knowledge about ACLS was analyzed in terms of gender, duty station, length of service, and duties.

2.3. Statistical Analysis

All analyses were performed with SPSS 25.0 (IBM, USA). The findings of the study were expressed as frequencies and percentages. Normality analysis was performed using the Kolmogorov-Smirnov test. Age variables not normally distributed were presented as the median and interquartile range (IQR) and 25^{th}-75^{th} percentiles. Numerical dependent variables that were not normally distributed were compared with the Kruskal-Wallis test for more than two groups. Correct answer rates between groups were compared using the Chi-Square test. Possible correlations of variables with life support scores were analyzed using Spearman correlation. $P< 0.05$ was accepted for statistical significance.

Ethical procedures

This work was approved by the Health Sciences University Research Ethics Committee. Approval number and date: 2021/01-933; 27.01.2021

3. Results and Discussion

The median age was 33.0 years, and the majority were female. When analyzed in terms of occupational groups, approximately 60% of them work as nurses. The most frequently working units were emergency services and inpatient clinics. Approximately half of the participants have worked in our hospital for 1-5 years. The demographic characteristics of the participants are shown in Table 1.

Table 1. Demographic features of the participants (N=265)

	N/%
Gender	
Female	178(67.2)
Male	87(32.8)
Age (median: IQR,25^{th}-75^{th})	33.0 (17.0)
Place of duty	
Outpatient clinic	48(18.1)
Inpatient clinics	78(29.4)
Inpatient clinics during pandemic	11(4.2)
Intensive care unit/pandemic	7(2.6)
Intensive care units	22(8.3)
Emergency service	76(28.7)
Operation rooms	23(8.5)
Task duration	
1-5 years	119(49.9)
6-10 years	28(10.6)
11-15 years	29(10.9)
16-20 years	32(12.1)
21-25 years	26(9.8)
>25 years	31(11.7)

IQR: Interquartile range

The percentages of theoretical and model-based practical training related to ACLS in our hospital are presented in Table 2. When examining the ACLS training status of healthcare personnel, 60.3% of the participants received theoretical ACLS training, 63.8% performed ACLS on an adult patient, and 19.6% received and applied AED (Automated External Defibrillator) training.

Table 2. Survey questions about the life support training history of the participants (N=265)

1. Have you had theoretical and practical training on a model in our hospital about advanced cardiac life support?	**N/%**
No, I have not.	105(39.7)
Yes, I had theoretical education and practical training on a model once.	87(32.8)
Yes, I had theoretical education and practical training on a model several times.	51(19.2)
Yes, I had theoretical education once but had no practical training in a model.	16(6.0)
Yes, I had theoretical education many times, but I had no practical training in a model	6(2.3)
2. Have you ever performed advanced cardiac life support for an adult patient?	**N/%**
No, I have never performed advanced cardiac life support on an adult patient.	83(31.3)
Yes, I have performed advanced cardiac life support on an adult patient.	169(63.8)
Yes, I have performed advanced cardiac life support on a model.	13(4.9)
3. Have you had training about autonomic external defibrillators? Have you ever used it?	**N/%**
No, I have not had training, and I have not used it.	90(34.0)
Yes, I have had training but have not used it.	105(39.6)
Yes, I have had training and used it.	52(19.6)
No, I have not had training, but I have used it.	18(6.8)

The ACLS general knowledge level was assessed with ten questions; 1 point was given for correct answers and 0 for incorrect answers Table 3. The median ACLS score was 3.0 (2.0-5.0). In all ten questions regarding ACLS knowledge in general (questions 1, 2, 3, 5) and possible/certain COVID-19 (questions 4, 6, 7, 8, 9, 10) patients, correct response rates were below 50%, and healthcare workers were evaluated as unsuccessful in general. There were no significant differences in gender, age, occupation, place of work, or task duration (p=0.604; p=0.986, p=0.927, p=0.982, p=0.295, respectively).

Table 3. Correct answer rates for the questions about advanced cardiac life support

Question	**Correct Answer (N/%)**	**Wrong Answer (N/%)**
1. Which of the following is incorrect about medications and doses used in advanced cardiac life support?	66(24.9)	199(75.1)
2. Each effort to ensure survival during a sudden cardiac arrest has been defined as a life-saving chain. Which of the following correctly describes the intra-hospital survival chain?	80(30.2)	185(69.8)
3. Which of the following is one of the recommendations for qualified CPR criteria in adults?	34(12.8)	231(87.2)
4. Which of the following is not a recommendation for providing airway patency and respiration?	76(28.7)	189(71.3)
5. The use of physiological parameters such as arterial blood pressure and end-tidal CO2 is recommended for monitoring CPR quality; end-tidal CO2 is a prognostic marker for recovery of spontaneous circulation (ROSC). Which of the following is correct about end-tidal CO2	88(33.2)	174(65.7)
6. Which one of the following is not a high-risk resuscitation intervention in a patient with COVID-19?	118(44.5)	147(55.5)

Table 3 Continued.

Question	Correct Answer (N/%)	Wrong Answer (N/%)
7. Which statement is false for suspected or known adult cardiac arrest patients with COVID-19?	77(29.1)	188(70.9)
8. Considering the procedures to be applied to suspected or known adult COVID-19 patients and the virus's transmission routes, three different levels of personal protective equipment have been defined for three different transmission routes. Which of the following is wrong about transmission and personal protective equipment?	114(43.0)	150(56.6)
9. Which of the following is incorrect regarding the procedures to be applied to the patient and the personal protective equipment (PPE) to be used?	118(44.5)	147(55.5)
10. Which of the following is not one of the recommendations for the Advanced Life Support algorithm in a patient with cardiac arrest and suspected or known COVID-19?	100(37.7)	164(61.9)

The response rates to the last five questions about advanced cardiac life support, knowledge about high-risk resuscitative procedures, balloon mask application, risk of contamination, and use of personal protective equipment in a patient with COVID-19 were relatively higher. When the correct response rates for the other ACLS questions were evaluated in terms of occupational groups, such as physicians and other healthcare professionals, the correct response rate for the general knowledge level of ACLS (Question 1), the use of capnography (Question 5), the correct response rate for the drug and dose information related to high-risk resuscitation intervention in a patient with COVID-19 (Question 6) was higher in the physician group (respectively $p<0.001$), $p<0.01$ and $p=0.011$), and the correct response rate for the question about PPE use (Question 9) was higher in the other healthcare professional group ($p=0.045$). Correct answer rates in terms of occupational groups are given in Table 4.

Table 4. Correct answer rates of advanced cardiac life support questions

Questions	Doctors (N=82) N / %	Other health professionals (N=183) N / %	p
1.	31 (37.8)	25(13.6)	**<0.001**
2.	29(35.3)	51(27.8)	>0.05
3.	8(9.7)	26(14.2)	>0.05
4.	25(30.4)	51(27.8)	>0.05
5.	39(47.5)	49(26.7)	**<0.01**
6.	46(56.0)	72(39.3)	**<0.05**
7.	18(21.9)	59(32.2)	>0.05
8.	33(40.2)	81(44.2)	>0.05
9.	29(35.3)	89(48.6)	**<0.05**
10.	34(41.4)	66(36.0)	>0.05

4. Discussion

Resuscitation has been an important subject of scientific research for many years. The term "Lifesaving Chain" describes the stages of treatment for a patient who develops an arrest [6]. For a successful resuscitation, all links in this chain must be established quickly, sequentially, continuously, and effectively. ACLS is the link in the life-saving chain between BLS and postcardiac care [6]. ACLS interventions include manual defibrillation, airway management during CPR, oxygenating and ventilating, circulating, monitoring, and administering medications [7]. The COVID-19 pandemic,

which started in January 2020, has necessitated some modifications during CPR, especially for the safety of rescuers. The World Health Organization and ILCOR (International Liaison Committee on Resuscitation) have classified chest compression and CPR (tracheal intubation, positive pressure ventilation) as aerosol and droplet-generating procedures [5]. The latest guideline recommended procedures to ensure the best possible chance of survival without compromising the safety of rescuers because COVID-19 is highly contagious, especially during resuscitation, and carries a high risk of morbidity and mortality [5].

Most of the participants in this study received training and practiced ACLS. However, the overall ACLS knowledge level is low, with a correct response rate of 12.8%-44.5%. No difference was found in terms of knowledge level according to age, gender, place of duty, and length of service, but the correct response rates of the physician group (9.7%-56.0%) were found to be higher, as expected from other healthcare (13.6%-48.6%) professionals. However, it was found that the general knowledge level of ACLS ranged between 6%-77% in similar studies conducted using previous guidelines [8]. In the study of Güven et al. [9], nurses' knowledge level about CPR was 43.5%. Kımaz et al. [10] found that the rate of physicians answering ACLS questions correctly was 35%, and it was determined that age, gender, tenure, and place of duty did not affect knowledge levels. In the study by Örsal et al. [11], the mean ACLS knowledge score was found to be 2.20±0.6 over 17 points, and it was found that the ACLS knowledge scores of nurses working in emergency and surgical intensive care units were significantly higher than those working in other services. In the study of Kartal et al.[11], it was found that the ACLS knowledge level of nurses was not adequate, and no statistically significant difference was found in the correct answer rates in terms of age and gender. The results of our study were parallel with those of previous studies.

Current information on CPR and practice recommendations are published in the guidelines. Following these guidelines is important to increase resuscitation success [12]. In our study, the correct answer rate of “Atropine 1 mg” to the 1st question, “Which of the following drugs and doses used for ACLS is incorrect?” is 24.9%. The rate of correct answers was higher in the physician group compared to other healthcare personnel, and the statistical difference was significant. However, in the AHA 2015 CPR guideline, it is recommended to repeat 1 mg adrenaline 1 mg IV/IO every 3-5 minutes in cases of NEA and asystole in ACLS, and atropine application is not recommended; this recommendation remains in the latest guideline [3, 12]. The knowledge level of healthcare professionals for this question was not up-to-date. Each effort to ensure survival in the event of CPA is defined as the "Lifesaving Chain." This chain is divided into out-of-hospital and in-hospital and is defined as six links in the 2020 guidelines. In Question 2, “Which links of the in-hospital lifesaving chain are correctly identified?”, the correct response rate is 30.2% as “Early recognition and prevention - activation of emergency response system - quality CPR - defibrillation - post-cardiac arrest care - recovery”. The most important part of the prevention of in-hospital cardiac arrests is early recognition of patients with deteriorating conditions. The survival rate can be increased by training the staff, monitoring the patients, recognizing the severity of the disease, and early recognition and notification of patients with deteriorating conditions [6]. In this question, most participants marked the answer as an out-of-hospital lifesaving chain consisting of five links, and the knowledge level of all health workers was not up to date. Questions 3 and 5 asked for suggestions on quality CPR criteria. In the 3rd question related to compression fraction, the correct response rate was 12.8%, answered as “In case of arrest, CPR should be performed with a chest compression fraction of at least 60%”. Most of the participants marked the statement “In the presence of 2 or more rescuers, it is recommended to change the compression/ventilation ratio to 15/2 every 2 minutes” in this question. In the 5th question related to monitoring, 33.2% of the correct answers were “It is recommended that end-tidal CO2 should be at least 10 mmHg and ideally >20 mmHg during CPR”. The knowledge level of all healthcare personnel was low in both questions, but the correct

response rate of physicians in question 5 was 47.5%, and the statistical difference was significant. In the guideline recommendations, position, compression fraction and pauses, compression depth and rate, and monitoring were accepted as determiners of quality CPR criteria. Recommendations on compression fraction and pauses in CPR: Pauses in chest compressions before and after shock in adult cardiac arrest should be as short as possible. The paramedic rescuer should minimize the rhythm assessment and pulse assessment time (no more than 10 s for pulse). In the presence of 2 or more rescuers, the rescuer performing chest compressions should be changed every 2 minutes (after every 5 cycles with a compression ventilation ratio of 30:2). In case of cardiac arrest in adults, it is appropriate to perform CPR with a chest compression fraction of at least 60%. Recommendations on monitoring: If possible, physiological parameters such as arterial blood pressure and end-tidal CO2 are recommended for monitoring and optimizing CPR quality. Systemic reviews have shown that end-tidal CO2 is a prognostic marker for return of spontaneous circulation (ROSC); below 10 mmHg, it is associated with poor outcome, whereas above 20 mmHg, it is a better predictor for ROSC. Therefore, an end-tidal CO2 of at least 10 mmHg but ideally >20 mmHg is recommended during CPR. [2,14]. The compression/ventilation ratio was updated in the 2010 guideline and changed to 30/2 for all rescuers, while in the 2015 guideline, it was emphasized that "a chest compression fraction of at least 60% should be provided". While in this guideline, "a chest compression fraction of at least 60% should be provided" [2,14]. In this question, it was concluded that the information was outdated.

Because of the COVID-19 pandemic caused by the SARS-Cov-2 virus, some practice differences have been recommended in cardiac arrest patients [3, 5]. ACLS, which involves close patient contact and practices that increase aerosol dispersal, increases the risk of infection transmission to healthcare workers [5]. It aims to protect the safety of healthcare professionals in terms of infection risk and provide an effective ACLS for suspected/infected patients in the 2020 ACLS guideline [5]. Medications, defibrillation doses, and CPR quality used during ACLS for possible or definite COVID-19 patients do not differ from standard algorithms for COVID-19 patients. It is recommended that the resuscitation team should not perform chest compressions or airway procedures if they are not wearing level 3 PPE [5]. In our study, the correct response rate to the question "Airway patency and respiration are not among the recommendations" as "Respiration in a patient with COVID-19 is evaluated using the look-listen-feel method" was 28.7%. In the CPR algorithm, the "look-listen-feel" method is recommended to evaluate respiration, but it was emphasized that respiration in patients with COVID-19 should be visually assessed [3, 5]. The rate of correct responses to question 6, which asked about "knowledge of high-flow resuscitative procedures," was 44.5% for "Defibrillation." Physicians have the highest response rate to this question; the statistical difference is significant. In this question, most participants answered "high-flow nasal cannula application". According to the guidelines, defibrillation is not a high-risk resuscitation procedure, and there is no need to wear PPE [5]. The correct response rate to the 7 questions asking the "incorrect statement for cardiac arrest patients with COVID-19" was 29.1%, which was answered as "Compression should not be interrupted during intubation". In the ACLS protocol, it is recommended not to pause compressions during intubation, but in the patient with probable/certain COVID-19, the guideline states, "The intubation procedure carries a high risk of aerosolization and transmission. Therefore, chest compressions may be paused for a period of time to minimize failed intubation attempts" [5]. In question 8, which asked about the incorrect statement in the knowledge of "different transmission routes and personal protective equipment", the correct answer rate is 43.0%, which is answered as "Level 2- In droplet transmission - gloves, surgical mask, long-sleeved gown, eye and face protection are recommended". "Use of FFP2 or N95 masks" was recommended for droplet transmission. Personal protective equipment has become an ever more important and sensitive issue during the COVID-19 pandemic caused by the novel coronavirus. The virus is mainly spread by droplet and contact, the route of transmission and the use of appropriate equipment are important to reduce risk

[5]. The correct response rate to Question 9, which asked about the wrong statement in "Procedure-PPE knowledge", was 44.5%, which was answered as "Level 2 PPE should be worn for balloon mask application". In this question, other healthcare personnel answered correctly at a higher rate, and the statistical difference is significant. The guideline recommends that the resuscitation team intervening in a patient with possible/uncertain COVID-19 should not perform chest compressions or airway procedures (intubation, balloon-mask application) without Level 3 PPE [5]. The correct response rate to Question 10, "It is not one of the ACLS recommendations in a patient with COVID-19" is 37.7%, which is answered as "If the rhythm is a shockable rhythm, defibrillate by shocking, start CPR without checking the rhythm and wear PPE". In the guideline, "In the presence of a shockable rhythm in a possible/infected patient, it is recommended that up to 3 shocks can be defibrillated". PPE should be worn during this procedure, and CPR should be started [1, 3, 7]. It was concluded that the level of knowledge of ACLS application differences in COVID-19 patients was outdated and confused with adult ACLS.

With the publication of guidelines, healthcare professionals are typically expected to update their knowledge about these changes. It is not likely that the need to follow current information about CPR will be the same in healthcare professional groups with different working areas and responsibilities [13]. The extent to which healthcare professionals have up-to-date CRP information and the extent to which revised and old information are confused is also an important question [13]. There is no similar study in the literature comparing the response rates we obtained in our study. It was concluded that the ACLS knowledge level of healthcare workers is low; their knowledge of ACLS application differences in COVID-19 patients is outdated and confused with adult ACLS. Healthcare workers already have a considerably higher risk of contracting the disease compared to the normal population due to the environment they are in and the obligations they undertake during the diagnosis and treatment phase in patients with COVID-19. The presence of aerosol and droplet-generating applications in resuscitation in patients with COVID-19, the risk of contact with the patient's body fluids, the risk of contact with the patient's body fluids, multiple rescuers working close to each other and the patient, and the lack of PPE increase the risk for healthcare workers. Matching COVID-19 with the routes of transmission, types, and features of PPE, as well as the isolation measures they should use, significantly reduces the risk of transmission for healthcare workers.

The presence of aerosol and droplet-generating applications in resuscitation in patients with COVID-19, the risk of contact with the patient's body fluids, the risk of contact with the patient's body fluids, multiple rescuers working close to each other and the patient, and the lack of PPE increase the risk for healthcare workers.

The fact that the training was interrupted for a while due to the pandemic and the training organized afterward was not sufficiently attended due to the risk of transmission may be related to our results. The initiation of BLS, defibrillation when necessary, and application of ACLS by healthcare workers who witness cardiopulmonary arrest can result in the success of saving lives. Therefore, healthcare workers should have a certain level of theoretical and practical knowledge in these areas. Evidence-based knowledge and practices in resuscitation medicine are evolving and changing over time. In some unique and unexpected situations, such as the COVID-19 pandemic, guidelines are revised urgently, and differences in practice emerge. For this reason, it is important to determine the level of knowledge of healthcare workers, especially physicians, on CPR and the currency of existing knowledge [16]. Healthcare workers should receive CPR training at regular intervals following current guidelines. The content of BLS and ACLS training and who should receive it are described in detail in the 2005 ERC resuscitation guidelines [2]. A study by Chamberlain et al. showed that repeated training every six months effectively maintained knowledge and skills [17]. In contrast, Moser et al. [18] recommended

short refresher training every 3-6 months and annual refresher training. The 2010 guidelines recommend that physicians should be trained more frequently than every six months [19].

5. Conclusion

Healthcare workers should have adequate and up-to-date knowledge of CPR to increase their chances of survival in case of arrest. Providing in-service resuscitation training in line with current guidelines and supporting them with practical applications can provide quality knowledge and skills, reduce risk, and increase their awareness of their responsibilities.

Limitations:

Our study has some weak limitations; firstly, the level of knowledge was assessed theoretically. Since it was a questionnaire study, it was answered depending on thoughts, memories, and experiences.

Ethical statement:

This work was approved by the Health Sciences University Research Ethics Committee. Approval number and date: 2021/01-933; 27.01.2021

Conflict of interest:

The author declares no conflict of interest.

Authors' Contributions:

One-author study

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