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ORIGINAL ARTICLE

Knowledge of isolation precautions among the healthcare workers in the emergency department of a university hospital

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ABSTRACT

Objectives: Prevention and control of healthcare-associated infections are important for patients and personal safety and for fighting against antimicrobial resistance. In order to achieve the goal of zero infection, it is necessary to know and apply standard and transmission-based precautions. The aim of this study was to evaluate the knowledge of healthcare professionals working in the Adult Emergency Department of university hospital about isolation precautions.

Methods: A cross-sectional study was conducted in the Emergency Department of Hacettepe University Hospital between May 16, 2023 to June 23, 2023. Data were collected electronically with a standardized data collection form specially prepared for this study to examine the knowledge about isolation precautions. Each correct answer was calculated as one point. Participants could receive a score between a minimum of 0 and a maximum of 20.

Results: The 90 healthcare workers who agreed to participate in the study had a median age of 24 years and 40% were male. The median knowledge score was 13 (IQR = 4). The knowledge score of two pregnant healthcare workers was significantly higher than non-pregnant ones (p=0.04). 93.3% of the participants stated that they received education for isolation precautions. There was no significant difference in knowledge scores between those who received education and those who did not (p=0.02). Knowledge of isolation precautions to be followed in clinical scenarios (1.1% - 54.4%) and personal protective equipment to be used correctly (3.3% - 21.1%) was low.

Conclusion: The knowledge of healthcare professionals working in the Adult Emergency Department of university hospital about isolation precautions is at a moderate level. Periodical education programs on clinical scenarios is important regarding raising awareness.

Keywords: Healthcare provider, knowledge, emergency room, patient isolation, infection prevention precautions.

INTRODUCTION

The development of concepts such as employee safety, patient safety, pandemics, and antimicrobial resistance interest in the prevention and control of infectious diseases in hospitals is of great interest [1, 2]. "Zero" is targeted in hospital infections [3]. Infection prevention and control are important in all units of hospitals. However, emergency departments are different because they are units where new patient applications are high, a significant number of patients are transferred to the inpatient wards and intensive care units of the hospital, fast turnover of patients and healthcare workers, and provide uninterrupted healthcare services [4]. From the first moment the patients enter the emergency room triage is performed, healthcare professionals should quickly review the risks regarding infection transmission, and take isolation precautions for transmission-based infections when necessary, especially standard precautions [5].

Exploring knowledge of healthcare professionals on isolation precautions would provide robust data to guide in-job trainings (as needed), besides boosting their awareness on importance of this topic. This study aimed to determine the knowledge of the employees working in Adult Emergency Department of Hacettepe University Hospital about isolation precautions and the factors associated with their knowledge.

METHODS

This cross-sectional study was conducted in Adult Emergency Department of Hacettepe University Hospital between May 16, 2023 to June 23, 2023. Hacettepe University Hospital is an institution that serves many patients from Türkiye and abroad. The emergency room has a critical care area that can serve 17 patients at the intensive care level, an emergency care area (yellow area) with nine monitored follow-ups, one Chemical Biological Radiological Nuclear Threats (CBRN) room, one seclusion room, one psychiatric interview and follow-up room, three interventional procedure rooms where surgical interventions can be performed, three resuscitation rooms where all kinds of resuscitative procedures can be performed and six examination rooms where rapid care patients are evaluated. The number of patients applied daily is around 200-250.

During data collection, it was aimed to reach all employees working in the adult emergency room (physicians, nurses, paramedics, emergency medical technicians, secretaries, cleaning, and auxiliary services, etc.). No sample was selected. A standardized data collection form consisting of 33 questions specially designed for this study was used for data collection. Participants' age, gender, time in the profession and working time in emergency room, school of graduation, occupation, having children, pregnancy, having care patients in their homes, having chronic diseases and immunosuppressive diseases, having a member of the infection control team in the family were reviewed. They were asked about their status of education on isolation precautions, if they received education which course they received, when they received the last course, whether they found their knowledge on isolation precautions sufficient, their compliance with isolation precautions, the reasons for non-compliance, contracting an infection for which isolation precautions should be taken, warning someone else for not complying with isolation precautions, and whether the warned person considered the warning.

The frequency of access to personal protective equipment and tools available at the bedside for hand hygiene practice was obtained using a five-point Likert scale (always, frequently, occasionally, rarely, never). They were asked how many patients they had been involved in the care process in the last week for whom contact, droplet and, airborne precautions were applied.

Five multiple-choice (two out of five, three out of three), two premise, and eight two-choice (true-false) questions were asked Supplementary Table 1 and 2. There were five scenarios (patient colonized with carbapenem-resistant Enterobacterales discharged 24 hours ago, patient with disseminated zona zoster, patient with hepatitis B, patient with hemorrhagic fever, patient with influenza) in which the isolation precaution(s) to be taken and personal protective equipment(s) to be used were selected Supplementary Table 3. The US Centers for Disease

Prevention and Control (CDC)[6], the Turkish Ministry of Health's "Crimean-Congo Hemorrhagic Fever (CCHF) 2020"[7] and the "Hacettepe Hospitals Standard Precautions and Isolation Instructions" were taken as a reference when deciding on the accuracy of the answers. Answers were considered correct if all required options were selected and those not required were not selected. Each question was evaluated as one point and the lowest score was "0" and the highest score was "20".

Data were collected through an electronic form. The link address was shared in the instant messaging groups of the employees in the emergency room. No identifying information was collected.

Since the number of participants per group was small, the school of graduation was combined into three groups high school, associate degree/ bachelor's degree, medical school/master's degree - medical specialty/doctorate. The duty in the emergency service was handled in 5 groups: resident, intern doctor, nurse-paramedic-emergency medical technician, patient caregivers-service assistant personnel.

Statistical Analysis

All continuous variables were non-normally distributed and analyzed using the Mann Whitney U or Kruskal-Wallis test and expressed as median (interquartile range = IQR). Categorical variables were presented as percentages (%). No data imputation was performed. Statistical significance was accepted for $p<0.05$ (two-sided). The statistical analysis was performed with Statistical Package for the Social Sciences (IBM SPSS, Armonk, New York, USA) version 23.

Ethical Considerations

This study was ethically approved by the Hacettepe University Non-Interventional Clinical Research Ethics Committee (Approval date: April 18, 2023, register number: 2023/07-42). There was written information at the beginning of the electronic data collection form. Participants were able to continue if they gave their consent to participate in the research. They could stop answering when they wanted. In accordance with ethical responsibility, the results of the study were shared with the Hospital Infection Control Committee and the Department of Emergency Medicine.

RESULTS

The Department of Emergency Medicine informed that approximately 190 people worked in Adult Emergency Department between June and July 2023. There were 90 (approximately 47.4%) healthcare professionals who accessed and responded to the data collection form electronically. The median age of the participants was 24 years (IQR = 4.25) and 40% were male. Among the participants, 38.9% were intern doctors, 31.1% were residents, 25.6% were nurses, paramedics, and emergency medical technicians, and 4.4% were auxiliary workers (Table 1).

It was observed that gender, occupation, graduated school, having a child, having chronic or immunosuppressive disease, and having a member of the infection control team in the family were not statistically significantly different on the knowledge scores of the participants. However, the median knowledge score of two pregnant participants was 16, while the median knowledge score of 52 non-pregnant participants was 14 (IQR=2.8). The difference in scores between the two groups was statistically significant (p=0.04). The median knowledge score of two participants who cared for patient at home was 9, and the median knowledge score of the other 88 participants was 13.5 (IQR = 4), and there was a significant difference (p=0.02) (Table 2).

There was no correlation between the knowledge level score of the healthcare workers who participated in the study regarding receiving education on isolation precautions and the source from which they received the course. Of the 76 healthcare workers who had received education on isolation precautions, 75 of them reported that a median of 6 (IQR= 8) months had elapsed since the last course they received. There was no statistically significant correlation between the knowledge score and the time elapsed (p=0.013, p=0.92). No statistically significant correlation was found between the knowledge score and self-sufficient in isolation knowledge, complying with isolation precautions, warning another one for not complying with isolation precautions, having an infection because of not complying with isolation precautions, and considering isolation precautions necessary for the prevention and control of infectious

Table 1. Demographic characteristics of participants

	Mean ± SD	Median (IQR)
Age (years) (n=90)	24.6 ± 4.0	24.0 (4.25)
Time in the profession (years) (n=90)	3.4 ± 4.2	2.0 (3.0)
Time in the emergency room (years) (n= 90)	2.3 ± 2.9	1.4 (2.8)
	n	%
Gender		
Female	54	60.0
Graduated school		
High school	21	23.3
Associate degree	5	5.6
Bachelor's degree	28	31.1
Master's degree / Medical School	35	38.9
Doctorate / Specialist in medicine	1	1.1
Occupation		
Intern doctor	35	38.9
Emergency medicine resident	28	31.1
Nurse	16	17.8
Paramedic	6	6.7
Patient caregiver	3	3.3
Emergency medicine technician	1	1.1
Service assistant personnel	1	1.1

SD: standard deviation, IQR: interquartile range

diseases. Fifty-five (61.1%) participants reported that they warned a co-worker for not following isolation precautions. Of the 55 participants who stated that they warned, 47 (85.5%) were intern doctors, 31 (56.4%) were auxiliary staff, 28 (50.9%) were cleaning staff and residents, 26 (47.3%) were paramedics and intern doctors, 22 (40. 0%) were trainee nurses, 14 (25.5%) were emergency medical technicians, 11 (20.0%) were general practitioners, six (10.9%) were lecturers and four (7.3%) were faculty members. Of the participants who warned a co-worker for not following isolation precautions, 23 (41.8%) were stated that the warned people complied with warning, 29 (52.7%) were sometimes complied, and three (5.5%) could not remember. Due to non-compliance with isolation precautions, 18 participants reported getting Coronavirus 2019 Disease (COVID-19), four reported influenza, and one each tuberculosis and diphtheria. Two of these participants contracted both COVID-19 and influenza. Healthcare workers who reported

Table 2. The distribution of knowledge scores of the participants by demographic characteristics and their occupations

	n	Knowledge score	
		Median (IQR)	*p*
Gender			0.11
Female	54	14.0 (3.0)	
Male	36	12.0 (4.8)	
Graduated school			0.21
High school	21	14.0 (3.0)	
Associate / Bachelor's degree	33	14.0 (4.0)	
Medical school / Specialist in medicine / Postgraduate	36	13.0 (4.0)	
Occupation			0.41
Intern Doctor	35	13.0 (4.0)	
Emergency medicine resident	28	13.0 (4.8)	
Nurse/paramedic/emergency medicine technician	23	14.0 (3.0)	
Patient caregiver / assistant service personnel	4	12.5 (2.5)	
With children	12	14.0 (2.8)	0.21
Without children	78	13.0 (4.0)	
Pregnant	2	16.0 (-)	**0.04**
Not pregnant	52	14.0 (2.8)	
Caregiving at home	2	9.0 (-)	**0.02**
No caregiving at home	88	13.5 (4.0)	
With chronic disease	16	14.0 (3.3)	0.16
Without chronic disease	74	13.0 (4.0)	
With immunosuppressive disease	2	11.0 (-)	0.41
Without immunosuppressive disease	88	13.0 (4.0)	
Family member of the infection control team	8	13.0 (5.8)	0.91
No family member of the infection control team	82	13.5 (4.0)	

IQR: Interquartile range

knowing the location of all personal protective equipment had a significantly higher knowledge score than those who did not (p=0.02) (Table 3).

Regarding the witnessing transmission-based precaution taken in the emergency room in the last week, 69 of the participants made a statement for contact, 68 for droplet, and 70 for airborne precaution. Participants reported that a median of 3 (IQR = 4) contact, 2 (IQR = 3) droplet, and 1 (IQR = 2) airborne precautions were applied to patients during the week.

Table 3. Distribution of knowledge scores of the participants by training, complying with isolation precautions, and warning the non-compliant employees

	n	Knowledge score	
		Median (IQR)	*p*
Educated	76	14.0 (3.8)	0.18
Non-educated	6	11.5 (4.5)	
Source of education			
Theoretical education in the pre-graduate period	72	14.0 (4.0)	0.60
No theoretical education in the pre-graduate period	4	13.5 (2.5)	
Practical education in the pre-graduate period	58	13.5 (4.0)	0.51
No practical education in the pre-graduate period	18	14.0 (2.5)	
Education given by Infection Control Team	59	13.0 (4.0)	0.18
No education given by Infection Control Team	17	14.0 (3.5)	
Education in courses, meetings, symposiums, and congresses	20	13.0 (3.8)	0.088
No education in courses, meetings, symposiums, and congresses	56	14.0 (3.0)	
Self-sufficient in isolation precaution knowledge	33	13.0 (4.0)	0.54
Self-partially sufficient in isolation precaution knowledge	49	13.0 (3.0)	
Self-insufficient in isolation precaution knowledge	8	12.0 (5.5)	
Always comply with isolation precautions	36	14.0 (3.5)	0.47
Often comply with isolation precautions	51	13.0 (4.0)	
Never comply with isolation precautions	3	11.0 (-)	
Infection due to non-compliance with isolation precautions	22	13.0 (3.0)	0.29
No infection due to non-compliance with isolation precautions	61	14.0 (3.5)	
Warn another person for non-compliance with isolation precautions	55	13.0 (3.0)	0.67
Do not warn another person due to non-compliance with isolation precautions	24	13.5 (4.0)	
Believing that isolation precautions are partially or completely unnecessary for the prevention of infectious diseases	8	13.0 (4.8)	0.47
Believing that isolation precautions are completely necessary for the prevention of infectious diseases	72	13.5 (4.0)	
Knowing the location of all personal protective equipment	75	14.0 (3.0)	0.02
Not knowing the location of all personal protective equipment	15	11.0 (4.0)	

IQR: Interquartile range

Among the 54 (60%) participating healthcare workers who did not always comply with isolation measures, the most frequently reported reasons for non-compliance were workload (96.3%), inappropriate physical conditions such as room and bed (63.0%), and lack of personal protective equipment (48.3%) (Table 4).

Regarding always having access to personal protective equipment, it was revealed that the participants had access to gloves, medical masks, gowns, respirators, caps, and eye protection, respectively. There were 20 (22.2%) participants who could access all personal protective equipment at any time. At the bedside of the patients who were in isolation, having access to the necessary tools for

Table 4. Distribution of reasons for non-compliance with isolation precautions by participants

	n	%*
Workload	52	96.3
Inappropriate physical conditions such as room-bed	34	63.0
Lack of personal protective equipment	26	48.1
Lack of knowledge	22	40.7
Inadequate conditions for hand hygiene	11	20.4
Other†	1	1.9

* It was calculated on 54 participants who reported that they did not comply with the isolation precautions. More than one answer was given.

† One person stated that there were cases where he did not comply with the isolation measures due to emergencies.

Table 5. Distribution of the frequency of access to personal protective equipment and tools required for hand hygiene by participants

Access to Personal Protective Equipment	Always n (%)	Usually n (%)	Often n (%)	Rarely n (%)	Never n (%)
Gloves	71 (78.9)	19 (21.1)	-	-	-
Medical mask	68 (75.6)	22 (24.4)	-	-	-
Respiratory mask	49 (54.4)	190 (21.1)	16 (17.8)	6 (6.7)	-
Apron	49 (54.4)	27 (30.0)	9 (10.0)	4 (4.4)	1 (1.1)
Eye protection/goggles	23 (23.6)	14 (15.6)	19 (21.1)	26 (28.9)	8 (8.9)
Head	27 (30.0)	19 (21.1)	18 (20.0)	18 (20.0)	8 (8.9)
Hand hygiene tools	Always n (%)	Usually n (%)	Often n (%)	Rarely n (%)	Never n (%)
Sink	79 (87.8)	10 (11.1)	1 (1.1)	-	-
Soap	71 (78.9)	13 (14.4)	6 (6.7)	-	-
Disposable towel	45 (50.0)	19 (21.1)	16 (17.8)	5 (5.6)	5 (5.6)
Hand sanitizer (antiseptics)	62 (68.9)	20 (22.2)	7 (7.8)	1 (1.1)	-

hand hygiene at all times was listed as sink, soap, hand antiseptic, and disposable towel, respectively. Forty-four (48.9%) of the participants stated that they always had access to all necessary tools for hand hygiene (Table 5).

Participants received a median score of 13 (IQR = 4) (minimum 8 - maximum 19) from the questions asked to examine the knowledge of participating healthcare workers about isolation precautions. Fewer than 50% of the participants knew that the statements " The patient with the airborne precautions should wear a vented-respirators during transfer. " and "Respirators should be worn in case of droplet precaution." were incorrect (Supplementary Table 2). For the isolation precautions to be taken and personal protective equipment to be used for five clinical scenarios, the best-known clinical scenario was the patient with hepatitis B infection, while less than 10% of the participants correctly answered the isolation precautions to be applied for the patient with disseminated zona zoster, the patient with hemorrhagic fever, and the patient with influenza (Supplementary Table 3).

DISCUSSION

Infection prevention and control practices in emergency rooms constitute an important step in achieving the "zero" target in nosocomial infections and protecting the health of healthcare workers [3, 5]. The first step to be taken on the way to the right practice is to have true knowledge. Within the scope of this study, the knowledge of healthcare professionals working in the Adult Emergency Department of university hospital on isolation precautions, which is a part of infection prevention and control practices, was examined. The median score of the healthcare workers on the standard knowledge questions prepared for this study was 13 out of 20, in other words, 65 points out of 100, and there is a need for improvement.

In a systematic review of 30 articles conducted between 2006 and 2021, in which the level of infection prevention and control knowledge and factors affecting compliance in healthcare workers were examined, it was reported that risk perception was associated with compliance [8]. Based on this information, the association between the knowledge score and risk perception was analyzed. Two healthcare workers stated that they were pregnant, and their knowledge scores were significantly higher. There was no statistically significant difference in the knowledge score of workers whose immune system was suppressed due to diseases or treatments, and individuals with chronic diseases. Children and home care patients are more vulnerable to the negative outcomes of infectious diseases [9]. Participants with children and home care patients are expected to have higher risk perceptions. Although there was no statistically significant difference between the participants who had children and those who did not, the knowledge score of the two healthcare professionals (intern doctors) who reported that they had home care patients was lower than the others. However, it is not known whether they

provide direct care to home care patients. In addition, their risk perception may differ from those who work long-term because they work temporarily in the emergency room. All situations in which risk perception is expected to be high are found in a small group among the participants. Considering the risk of infection and work tempo in the emergency room, workers who have a low risk of adverse outcomes of infection may have been assigned and it is called "the healthy worker effect".

In a systematic review, experience, having received education for infection control and, graduating with a bachelor's degree or higher were reported to be associated with increased knowledge [10]. In this study, no significant difference was found in graduation level. Of the participants who reported having received course for isolation precautions, 80% reported having received education after graduation. Almost all of the participants received education by the hospital infection control team. It was thought that this may be the reason why there was no association between graduation school and knowledge level. Although there was no statistical significance, it was found that personnel working in auxiliary services had a lower level of knowledge than physicians and nurses/emergency medical technicians/paramedics. In a systematic review, it was emphasized that physicians and nurses have higher responsibilities due to their better knowledge [8]. The World Health Organization declares that one of the core components of infection prevention and control is continuity of education [8]. In addition to the regular education, it is clear that the course be given by the clinic supervisors at the bedside will make a significant contribution in this context.

There were six participants (6.7%) who reported that they had not received education on isolation precautions. In the emergency rooms of two hospitals in Erzurum, it was reported that more than three-quarters of t he staff received education on isolation precautions [11]. In a study conducted with 800 healthcare workers in a region affected by infections such as Lassa and Ebola in Nigeria, it was reported that half of the participants received course on infection prevention and control [12]. Due to the small number of the group that did not receive education, no association was found between receiving education and knowledge score. Similarly, in a study conducted in Jordan to determine the knowledge score about isolation precautions among nurses, no association was found between education and knowledge score [13]. Aloush et al. [13] concluded in their study that the low nurse-patient ratio affected nurses' compliance with infection control measures and education would not increase compliance unless the workload decreased. In support of this interpretation, more than 90% of the healthcare workers participating in this study reported that workload was a barrier to compliance with isolation precautions and the knowledge score was not found to be related to compliance with precautions.

Forty percent of the participating healthcare workers reported that they complied with isolation precautions. An objective and external audit may lead to lower compliance. In a study involving 400 nurses from eight centers in Jordan, 47.3% of nurses reported that they always complied with infection control measures, similar to the participating healthcare workers in this study [13]. It was reported that the most common barriers to compliance were workload, lack of appropriate conditions for physical and hand hygiene, problems in accessing personal protective equipment, and lack of information. In a study conducted in Türkiye, it was reported that workload and lack of personal protective equipment were the most important barriers to compliance [14]. However, in a teaching hospital in Geneva, lack of knowledge and forgetting were reported to be as important barriers as workload [15]. If the centers increase their workforce and solve the time problem, it may be possible for lack of knowledge and forgetting to become the dominant problems.

In a study involving 41 centers in Türkiye, accessibility to the necessary tools for hand hygiene was examined on a weekday and a weekend day in summer and autumn, and it was found that 3-11% soap, 10-18% paper towels, and 1-4.7% hand antiseptic were not available [16]. Similarly, in the emergency room where this study was conducted, it was reported that the most common difficulty was to always have access to paper towels.

Healthcare workers are expected to warn each other for not complying with isolation precautions. However, it is observed that there is a hierarchical ranking regarding the frequency of warnings by the participants. Of course, the number of faculty members and staff is low compared to other

personnel and that they may be meticulous about isolation precautions may cause the frequency of warnings to be low, but hesitation was also considered to be effective.

One of the ultimate goal of isolation measures is to protect the health of healthcare workers [2]. More than a quarter of the participants reported getting an infection due to non-compliance with isolation precautions. Most of these people stated that they had COVID-19 and influenza with the effect of awareness. It is thought to be underreported.

It is determined that the questions answered with the lowest accuracy are the selection of isolation precautions and personal protective equipment by the clinical scenarios given. Although it is not possible to make a one-to-one comparison because the knowledge questions are not the same, in a study conducted in Nigeria, it was reported that two-thirds of healthcare workers had good isolation knowledge about standard precautions, and less than one-tenth had good knowledge about transmission-based precautions [12]. A study conducted on nurses in Jordan found better compliance with standard precautions, but less compliance with transmission-based precautions [13]. Considering the education they received before graduation, it is more difficult for people working in auxiliary and cleaning services to have a high knowledge score. However, it is thought that their knowledge score is low because physicians and nurses assign this task to the infection control team.

This study is one of the few studies addressing the level of knowledge and problems in practice for isolation precautions in the emergency room, which is one of the riskiest units for the spread of infection. On the other hand, the participation rate was below 50% and it was a single-center study reduces the external validity of the findings. The small number of participants and the lack of participation from faculty and staff members due to concerns about their identities may have caused bias. It is considered that the small number of participants may cause type 2 errors and failure to show the existing association. Since it is not a standardized scale with validity and reliability, it is not possible to compare the findings one-to-one. The data were not collected face-to-face to avoid giving "desired answers". However, collecting the data electronically may have decreased participation and may have caused the participants not to feedback about questions which they did not understand about the questions.

In conclusion, the knowledge of healthcare workers about isolation precautions in Adult Emergency Department, one of the most critical units for infection control, is at a moderate level. If educational programs provided, it will be important for effective infection control to include measures to prevent infection transmission through clinical scenarios that are likely to be encountered in emergency department conditions in the education program and to ensure the continuity of the personal protective equipment.

Author contribution

Study conception and design: AS, BÇ, GM; data collection: VA; analysis and interpretation of results: AS, VA, EK, HU, BÇ, GM; draft manuscript preparation: AS, VA, EK, HU. All authors reviewed the results and approved the final version of the manuscript.

Ethical approval

The study was approved by the Hacettepe University Non-Interventional Clinical Research Ethics Committee (Approval date: April 18, 2023, register number: 2023/07-42).

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Conflict of interest

The authors declare that there is no conflict of interest.

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Supplementary Table 1. Distribution of answers to multiple choice knowledge questions of the participants

	n	%
In which situation is it most appropriate to apply standard measures as a minimum?		
All patients (T)	69	76.7
Patients with an infection (F)	-	-
Patients with the infection suspicion (F)	16	17.8
Patients with the contagious infection (F)	5	5.6
Patients with the contagious infection suspicion (F)	-	-
Which of them are included in "the five moments for hand hygiene" according to the World Health Organization?		
Before and after touching a patient (T)	89	98.9
After using the toilet (F)	72	80.0
Before eating (F)	72	80.0
After touching a patient's surroundings (T)	90	100.0
Before and after a procedure (T)	90	100.0
Which personal protective equipment is required when approaching a patient with contact isolation?		
Apron and gloves (T)	74	82.2
Medical mask (F)	10	11.1
Respirators (F)	5	5.6
Eye protection (F)	1	1.1
Cap (F)	-	-
Which personal protective equipment is required during procedures where blood or bloody bodily fluids may splash?		
Eye protection (T)	88	97.8
Apron (T)	86	95.6
Gloves (T)	90	100.0
Respirators (F)	31	34.4
Choose the correct one for the isolation precaution with the sign.		
Contact precaution	87	96.7
Droplet precaution	78	86.7
Airborne precaution	76	84.4

Supplementary Table 2. Distribution of knowing the propositions as true or false by the participants

True propositions	**n**	**%**
Gloves should be disposable for each interventional procedure.	87	96.7
Gloves should be used for single use only when contacting mucous membranes, non-intact skin, and sterile areas.	87	96.7
The door of the patient's room should be kept closed in case of droplet precautions.	83	92.2
In the case of contact precautions, the patient's thermometer and sphygmomanometer should only be used on the patient.	84	93.3
Patients with transmission-based precautions should be placed in single-patient rooms, if available, otherwise, patients should be cohorted with the same infection.	69	76.7
False propositions		
Respirators should be worn in case of droplet precaution.	30	33.3
For each infection requiring isolation precaution, it is sufficient to take only one transmission-based precaution.	82	91.1
After applying hand hygiene, it is sufficient to wear gloves on top of each other and to remove the top glove while passing from patient to patient and use hand sanitizer.	73	81.1
The patient with the airborne precautions should wear vented-respirators during transfer.	25	27.8

Supplementary Table 3. Distribution of answers to knowledge questions for the determination of isolation precautions and personal protective equipment appropriate for the clinical scenarios

	Patient colonized with CRE bacteria was discharged the day before, n (%)	Patient with a disseminated zona zoster, n (%)	Patient with hepatitis B, n (%)	Patient with hemorrhagic fever, n (%)	Patient with influenza, n (%)
Standard precautions	41 (45.6)	34 (37.8)	63 (70.0)	48 (53.3)	32 (35.6)
Contact precautions	71 (78.9)	62 (68.9)	39 (43.3)	50 (55.6)	9 (10.0)
Droplet precautions	4 (4.4)	25 (27.8)	4 (4.4)	25 (27.8)	61 (67.8)
Airborne precautions	2 (2.2)	22 (24.4)	1 (1.1)	13 (14.4)	26 (28.9)
Total accuracy	**21 (23.3)**	**5 (5.6)**	**49 (54.4)**	**5 (5.6)**	**1 (1.1)**
Apron	68 (75.6)	56 (62.2)	29 (32.2)	58 (64.4)	23 (25.6)
Gloves	76 (84.4)	82 (91.1)	76 (84.4)	76 (84.4)	55 (61.1)
Medical mask	48 (53.3)	45 (45.0)	35 (38.9)	48 (53.3)	54 (60.0)
Respirators	12 (13.3)	25 (27.8)	1 (1.1)	31 (34.4)	33 (36.7)
Eye protection	13 (14.4)	13 (14.4)	11 (12.2)	38 (42.2)	15 (16.7)
Total accuracy	**11 (12.2)**	**3 (3.3)**	**19 (21.1)**	**9 (10.0)**	**12 (13.3)**

CRE: Carbapenem-resistant *Enterobacterales*

