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Knowledge, attitudes, and practices of ICU head nurses regarding infection control and antimicrobial resistance in Iran: a cross-sectional study

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Abstract

Background In the intensive care unit (ICU), infections due to multidrug-resistant (MDR) bacteria lead to poor clinical outcomes, prolonged ICU and hospital stays, high mortality and morbidity rates, and higher patient care cost. This study investigated knowledge, attitudes and practices (KAP) of ICU head nurses in Iran towards infection prevention and control (IPC) measures and antimicrobial resistance (AMR).

Methods This study was conducted among 61 ICU head nurses of the 36 hospitals in Isfahan, Iran on 19th July 2023. Data was collected by self-administer questionnaires. Data analysis was performed using SPSS version 25.0 level of significance was considered to be less than 0.05 in all tests.

Results Of the 61 participants, 56 (91.8%) were female and their ages ranged from 27 to 56 years old with a mean age of 39.3 ± 5.6 years. 75.4% of participants had a bachelor's degree and 24.6% had a master's degree. The mean work experience in the ICU and duration of experience in the hospital was 8.1 and 16.2 years, respectively. The mean scores for KAP were 3.84 ± 1.86 (with a range of 0–9), 55.00 ± 12.50, 35.84 ± 4.19 (with a range of 24–48) and 21.27 ± 3.13 (with a range of 17–29), respectively. There was a significant relationship between knowledge and total years of experience ($r = 0.256$, $P < 0.048$).

Conclusion The study showed that most participants had weak knowledge, a positive attitude and weak practices. Consequently, more emphasis is needed to improve the ICU head nurses' KAP toward IPC measures and AMR, especially in areas where gaps were identified. Additionally, there is a need to an educational plan on these topics in the training of nursing programs.

Keywords Knowledge, Attitude, Practice, Infection control, Antimicrobial resistance, ICU head nurses

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Introduction

Hospital-acquired infections, also known as healthcare-associated infections (HAIs), are infections that occur while receiving health care, developed in a hospital or other health care facility that first appear 48 h or more after hospital admission, or within 30 days after having received health care. HAIs not only endanger patients but also impose significant financial burdens on healthcare systems. HAI infections include catheter-associated urinary tract infections (CAUTI), central line-associated bloodstream infections (CLABSI), surgical site infections (SSI), Hospital-acquired Pneumonia (HAP) and Ventilator-associated Pneumonia (VAP) [1, 2]. HAIs are not only dangerous for patients but also have financial burden for health care system and cause bacteria to become resistant to antibiotics. According to the World Health Organization (WHO), the estimated prevalence of HAIs ranges from 3.6 to 12% in high-income countries and from 5.4 to 19.1% in low- and middle-income countries [3]. Antimicrobial resistance (AMR) threatens the treatment of HAIs, and has been identified as a global health threat by the WHO. Hence, prevention and control of HAIs appear as an important public health problem.

It has been estimated that rising rates of multidrug-resistant bacteria (MDR) infections could lead to the death of some 10 million people and cost the world's economy USD 100 trillion by 2050 [4]. Infections by MDR isolates occur frequently in patients admitted to intensive care unit (ICU) and are associated with increased mortality, prolonged duration of ICU stay and healthcare costs [5]. In recent years, studies in Iran have shown that the prevalence of MDR specially carbapenem-resistant gram-negative bacteria in ICUs has increased significantly, and some studies have shown that some outbreaks has occurred in ICUs. Healthcare workers (HCW), especially the nurses play a unique role in spreading the infection caused by these organisms and they are considered as key members of managing and controlling the HAIs [6]. Infection prevention and control (IPC) measures are critical in preventing the risk of acquiring and transmitting HAIs. The lack of IPC practices in ICUs is a contributing factor to spread of MDR pathogens and AMR [7].

According to WHO, poor knowledge, attitude, and practice (KAP) among the HCWs are among the key predictors of HAIs [8]. Globally, a number of studies have investigated the involvement of nurses in AMR and infection prevention and control, focusing on their KAP. Individual studies among nurses have suggested that suitable knowledge and attitude can be very important factors in good infection control and prevention measures [1, 9]. Some studies have also showed that low and moderate levels of knowledge among nurses regarding AMR and of infection prevention [9, 10]. However, no study has thus far been conducted towards these issues among ICU head nurses in different hospitals.

On the one hand, the highest rate of MDR infections occurs in the ICUs of Iranian hospitals, and on the other hand, ICU supervisors are one of the most key employees of the healthcare system that play an important role in the control of HAIs due to MDR pathogens and they can also apply the rules and regulations of their department within the framework of the general policies of the hospital in any committee, this study has been conducted to examine the ICU head nurses' KAP towards AMR and infection control and prevention standards.

Methods

Study design and settings

A cross-sectional study was conducted on the 61 ICU head nurses of the 36 hospitals (including 29 governmental hospitals, 6 private hospitals and 1 social security hospitals) to assess the KAP of this group towards infection control and MDR organisms in Isfahan province on 19th July 2023. These HCWs were selected because most HAIs occur in this ward of Iranian hospitals. A paper-based survey was used to collect data and that was voluntary. Participants were requested to avoid consulting each other and searching online. In this study, all participants were included in the study because they filled out the questionnaire and no exclusion criteria were applied, as we aimed to include the entire population of ICU head nurses.

Study population

There are 59 hospitals in Isfahan province, 31 of which are in Isfahan metropolis and 28 in other cities. Of the 59 hospitals, 40 have at least one ICU (28 university hospitals and 12 hospitals affiliated to social security organizations, private, charities and semi-public). In total, these 40 hospitals have 64 ICUs, each with a head nurse. In this study, all hospitals that have at least one ICU ward were invited to participate in a one-day conference for ICU head nurses through the administrative correspondence of the Vice President of Treatment of Isfahan University of Medical Sciences.

Questionnaire design

A questionnaire was designed specifically for this study after an extensive review of previously published questionnaires and some modifications were made to the questions based on common practical knowledge in Iran. The questionnaire form is shown in the supplementary file. A pilot study with a sample size of 5 was conducted to test the validity and reliability of the questionnaire. This questionnaire includes 9 knowledge questions, 10 questions on attitude and 10 questions on practices. The questionnaire also collected data on demographic

characteristics including gender, age, educational level, work experience in the ICU and number of years of experience in the hospital. Responding to the questionnaire took between 20 and 30 min.

For knowledge-related questions ($n=9$), a correct answer was assigned a score of 1, while an incorrect or "don't know" answer was assigned a score of 0. The minimum and maximum scores in the knowledge domain were 0 and 9, respectively. Responses to questions related to attitude ($n=10$) were scored on a 5-point Likert scale from 1 to 5, Score "1" was given for the least appropriate response and "5" was given for the most appropriate answer. The minimum and maximum scores in this domain were 24 and 48, respectively. For practice-related questions ($n=10$), each correct answer was assigned a score of 1, while a wrong response was assigned a score of 0. In the end, the scores were calculated in percent. The minimum and maximum scores in this domain were 17 and 29, respectively. In this study, all domains were assessed as suitable if the related scores were >60% (For knowledge, score greater than 5; for attitude, score greater than 37; and for practice, score greater than 21).

Data collection

In this study, one person from the research team attended the meeting and provided the participants with the necessary explanations about how to fill out the questionnaire and its different parts, and then the paper questionnaires were distributed. To maintain confidentiality and anonymity and to make sure that researchers were unable to accidentally identify the participants, we delegated one administrative personnel who were not members of the research team to collect all questionnaires, and to convey them to the research team.

Statistical analysis

Statistical analyses were done using SPSS software (SPSS, Inc., Chicago, IL, USA, version 25). Descriptive data are reported as mean ± SD, or number (percent) as appropriate. Independent sample t-test, chi-square test, Fisher exact test, were used as appropriate. Pearson's correlation coefficient was used to assess relationships between continuous variables (e.g., knowledge scores and years of experience). All hypothesis testing was two tailed and level of significance was considered to be less than 0.05 in all tests.

Table 1 Demographic characteristics of participants ($n=61$)

Characteristics	
Age (year)	39.3 ± 5.6
Gender	
Male	5 (8.2)
Female	56 (91.8)
Education	
BSc	46 (75.4)
MSc	15 (24.6)
Work experience (year)	
In hospital	16.2 ± 4.8
In ICU	8.1 ± 6.4

Data presented as Mean ± SD and Number (Percent)

BSc, **Bachelor;** MSc, **Master of Science**, ICU, **Intensive care unit**

Results

The participants were invited to the study from 40 eligible hospitals (with at least one ICU). Overall, there were 64 ICU head nurses across 40 hospitals in Isfahan province. Of these, 61 head nurses (95.3% response rate) from 36 hospitals participated in the study. The participant's ages ranged from 27 to 56 years old with a mean age of 39.3 ± 5.6 years. As for the professional qualification of the participants, 75.4% of them had a bachelor's degree and 24.6% had a master's degree. Among them, (91.8%) were female, the mean work experience in the ICU and duration of experience in the hospital was 8.1 and 16.2 years, respectively (Table 1).

Table 2 shows the number of the participants with the correct answers in each knowledge statement. The mean (± SD) score for knowledge was 3.84 ± 1.86, with a range of 0–9. We found that 80.3% of the participants had good knowledge (≥ 80%correct response) about the possibility of contamination of blood sampling with *Staphylococcus epidermidis*. We found that almost half of the participants correctly responded to the knowledge statements related to classification of drug resistant bacteria (50.8%), the last line treatment for Gram-negative bacterial infection in Iran (57.4%) and the median cost of a single CRO infection in hospitals (50.8%). While fewer participants (less than 35%) correctly responded to the statements related to questions number 2, 3, 5, 6, and 7.

In relation to the attitude of nurses (Table 3), the mean score was 35.84 ± 4.19, with a range of 24–48. When asked about compliance with standard precautions, 27.9% of participants answered that it is not easy to follow (strongly agree or agree). 41% of head nurses disagreed or strongly disagreed that healthcare workers are occupationally exposed to infectious diseases. Around 80.3% strongly agreed or agreed that they feel frustrated when others neglect hand hygiene while 95.1% strongly agreed or agreed that hand hygiene could reduce the spread of infections.

In relation to the practice of nurses (Table 4), the overall mean practice score was 21.27 ± 3.13, with a range of 17–29. The majority (70.5%; 43/61) of participants stated that when a patient acquired an MDR infection, they use a warning sign above the patient's head or room to prevent its spread. Around 50% of them stated that chlorhexidine bathing in their ICUs is done every five days. A total of 17/61 (27.9%) head nurses responded that they

Table 2 Knowledge questions regarding HAIs and antibiotic resistance

No. questions and possible answers (correct answer is bold)	Correct	Incorrect	I don't know
1. Microbiology laboratory reported *Klebsiella pneumonia* **with the following resistance pattern from a patient's blood culture; which of the following definitions about this bacterium is correct?** Sensitive to: Colistin Resistant to: Meropenem, Ceftazidime, Cefepime, Ciproflixacin, Levofloxacin, Amikacin, Tazosin a) **XDR** b) Not-MDR c) PDR d) I don't know	31 (50.8)	16 (26.3)	14 (23)
2. Which bacteria are more likely to colonize in nasal mucous and gastrointestinal tract of patients in ICU, respectively? a) CRAB-MRSA b) MRSA-VRE c) **CRKP-MRSA** d) I don't know	16 (26.2)	34 (55.7)	11 (18)
3. Which of the antibiotics reported in microbial culture is used to diagnose MRSA? a) **Oxacilline/Cefoxitin** b) Methicillin c) Vancomycin d) I don't know	14 (23)	40 (65.5)	7 (11.5)
4. Which antibiotic is the last line treatment for Gram-negative bacterial infection in Iran? a) Vancomycin b) Linezolid c) **Colistin** d) I don't know	35 (57.4)	22 (36.1)	4 (6.6)
5. Which organism has the highest rate of antibiotic resistance in Iran? a) ***Acinetobacter baumannii*** b) *Klebsiella pneumoniae* c) *Staphylococcus aureus* d) I don't know	18 (29.5)	42 (68.8)	1 (1.6)
6. Which bacteria is the most common organism isolated from patients' clinical samples in Iran? a) *Escherichia coli* b)***Klebsiella pneumoniae*** c) *Staphylococcus aureus* d) I don't know	20 (32.8)	35 (57.4)	6 (9.8)
7. How much is mortality rate in patients infected with carbapenem-resistant gram-negative bacteria according to recent studies? a) 0-10% b)10-20% c) **20-70%** d) I don't know	20 (32.8)	21 (34.4)	20 (32.8)
8. How much does every infection caused by carbapenem-resistant gram-negative bacteria cost in average? a) 1000 $ b) 1000 $-5000 $ c) **20000 $- 60000 $** d) I don't know	31 (50.8)	15 (24.6)	15 (24.6)
9. Which organism is more likely to contaminate samples in unprincipled blood sampling? a) *Staphylococcus aureus* b) ***Staphylococcus epidermidis*** c) *Escherichia coli* d) I don't know	49 (80.3)	7 (13.1)	4 (6.6)

Data presented as Number (Percent).

MDR, multidrug -resistance; XDR, extensively drug-resistant; PDR, pan drug resistance; MRSA, methicillin-resistant *Staphylococcus aureus*, VRE, vancomycin-resistant enterococc; CRAB, carbapenem-resistant *Acinetobacter baumannii*; CRKP, Carbapenem-resistant *Klebsiella pneumoniae*

Table 3 Attitude of nurses about HAIs and antibiotic resistance

Questions	Strongly disagree	Disagree	Neither agree Nor disagree	Agree	Strongly agree
1. Following standard cautions is not easy.	9 (14.8)	33 (54.1)	2 (3.3)	15 (24.6)	2 (3.3)
2. Standard precautions prevent infection spread from patients to staff and vice versa.	0	0	1 (1.6)	27 (44.3)	33 (54.1)
3. It is difficult to work properly wearing personal protective equipment.	13 (21.3)	25 (41)	1 (1.6)	21 (34.4)	1 (1.6)
4. Infection Transmission can be reduced by following standard and contact precautions.	0	1 (1.6)	0	20 (32.8)	40 (65.6)
5. Washing hands with soap or hand rubbing with alcohol before and after contact with patients can reduce the infection transmission.	1 (1.6)	1 (1.6)	1 (1.6)	10 (16.4)	48 (78.7)
6. You have to worry about exposing your family and friends to HAIs when nursing a patient.	0	13 (21.3)	4 (6.6)	20 (32.8)	24 (39.3)
7. Washing hands before and after contact with patients can reduce the risk of HAIs.	0	0	9 (14.8)	23 (37.7)	29 (47.5)
8. Risk of occupational infection among health care workers is high in your workplace.	2 (3.3)	23 (37.7)	5 (8.2)	18 (29.5)	13 (21.3)
9. Stationery, telephone and door handles are not sources of infection.	31 (50.8)	29 (47.5)	0	0	1 (1.6)
10. I feel frustrated when others neglect hand hygiene.	2 (3.3)	9 (14.8)	1 (1.6)	28 (45.9)	21 (34.4)

Data presented as Mean ± SD, Number and Number (Percent)

HAIs, Healthcare-associated infections

isolated infected patient with MDR bacteria in a single room. More than half (52.5%; 32/61) of the participants responded that nurses use one glove for each patient care and one gown for each work shift. Almost 68.9% stated that HCWs in their ICU wash their uniforms or scrubs weekly. Almost most of the participants (63.9%; 39/61) stated that the monitoring of patients infected with XDR bacteria is done to prevent and control the spread of drug-resistant bacteria in their ICUs.

Data analysis showed a significant relationship between the mean of head nurses' knowledge score and their total years of experience mean ($r = 0.256$, $P < 0.048$) (Fig. 1). As can be seen in Table 5, no statistically significant association was observed between demographic and other occupational characteristics with knowledge, attitude and practice scores.

Discussion

HAIs and antibiotic resistance are one of the main problems in health care system worldwide and it helps a lot handling the problem if HCWs have adequate knowledge, attitude and practice toward this [11, 12]. The present study is the first study conducted with the aim of investigating head nurses' knowledge and practice of and attitude toward AMR and infection control and prevention standards.

In the present study only 19.7% of participants had suitable practice. In a similar study in Zabul, Iran, 2014, about nurses KAP toward standard precautions for hospital-acquired infection on 145 nurses only 22% had good knowledge about HAIs [13]. Therefore, it seems that KAP in the field of HAIs among nurses and ICU head nurses is low in Iran, and in fact, this could be one of the important factors in the high rate of hospital infections with MDR pathogens in ICU wards in Iranian medical centers. That could be explained by a lack of regular training on IPC measures and AMR. The paucity of training in the areas of IPC programs and AMR in nursing faculties contributes to the spread of MDR strains, irrational antibiotic prescribing and increased AMR.

In contrast, the findings of our result were higher than that reported in Saudi Arabia among 341 nurses, where their knowledge score about antibiotic use and prevention of AMR was 13.1% and this wasn't related to gender or any other demographic characteristics [14]. This finding stresses the need of regular AMR training of health workers. In another study conducted in Ethiopia in 2021 among nurses about Knowledge and practice toward HAIs prevention and associated factors, their knowledge was categorized into two groups: adequate and inadequate; 45.5% had adequate knowledge and this score was 53.3% among males and 38.16% among females and gender (specifically here, being male) had relationship with knowledge score [6]. In contrast, a study by Gruda et al. in Kosovo reported that 90% of the nurses exhibited an excellent knowledge toward management of HAIs which is relatively high compared to other studies, including this study [15], therefore, this could indicate the importance of training courses for nurses during education, which has increased knowledge in the field of HAIs.

In our study total years of experience had a significant relationship with mean knowledge score ($r = 0.256$, $P < 0.048$), and this indicate that with the growth of work experience, the ICU head nurses'knowledge increases. In this study 24.6% had master's degree while 75.4% had bachelor's degree and 17.39% of nurses with bachelor

Table 4 Practice questions regarding HAIs and antibiotic resistance

Questions	Answer A (%)	Answer B (%)	Answer C (%)	Answer D (%)
In your ICU, are patients with MDR bacteria labeled with a sign signaling that indicate the contagious status? a) Yes b) No	43 (70.5)	18 (29.5)	0	0
2. How often is chlorhexidine bathing done in your ICU? a) Daily b) Every 3 days c) Every 5 days d) It is not done due to lack of staff.	1 (1.6)	16 (31.1)	31 (50.8)	10 (16.4)
3. Do you use isolation rooms to isolate patients infected with MDR bacteria? a) Always b) Yes < 50% c) No, because there is no isolation room d) Only by doctor's order	17 (27.9)	16 (26.2)	11 (18)	16 (26.2)
4. Which of the following is used to obey contact precautions for a patient with a bacterial infection in your ICU? a) Wearing single-use gloves and gowns for each care b) Wearing gloves only c) Wearing gloves for each care and wearing gowns for each shift d) Not wearing gloves and gowns due to shortage	13 (21.3)	16 (26.2)	32 (52.5)	0
5. How is tracheal tube suction performed in your ICU? a) One-person tracheal suction with sterile gloves b) One-person tracheal suction with non-sterile disposable gloves c) One-person tracheal suction with sterile gas d) Two-person tracheal suction	48 (78.7)	6 (9.8)	6 (9.8)	1(1.6)
6. How is patients' oral suction done in your ICU? a) With sterile gloves b) With latex gloves c) With sterile gas d) I don't know	10 (16.4)	30 (49.2)	21 (34.4)	0
7. How often are HCWs' uniforms washed in the intensive care unit? a) Every day or every other day b) Weekly c) Every 2 weeks d) Monthly	14 (23)	42 (68.9)	2 (3.3)	3 (4.9)
8. Is chlorhexidine used your ICU for patients' mouthwash? If yes, by whom? a) Every 24 h, nurse or nurse assistant b) Twice a day, nurse or nurse assistant c) Three times a day, nurse or nursing assistant d) No	10 (16.4)	6 (9.8)	42 (68.9)	3 (4.9)
9. Is UV light or hydrogen peroxide vapor used to disinfect your ICU? How often? a) Every 3 months b) Every 6 months c) In case of outbreaks (Epidemic) d) No	17 (27.9)	2 (3.3)	29 (47.5)	13 (21.3)
10. Monitoring of patients infected with MDR bacteria is done to prevent and control the spread of drug-resistant bacteria? If yes, by whom? a) Yes - head nurse and infection control team b) Yes - control communicants in ICU and infection control team c) Yes - head nurse deputy and infection control team d) No	39 (63.9)	6 (9.8)	3 (4.9)	13 (21.3)

Data presented as Number and Number (percent).

ICU, intensive care unit; MDR, Multidrug-resistant; HCWs, Healthcare workers

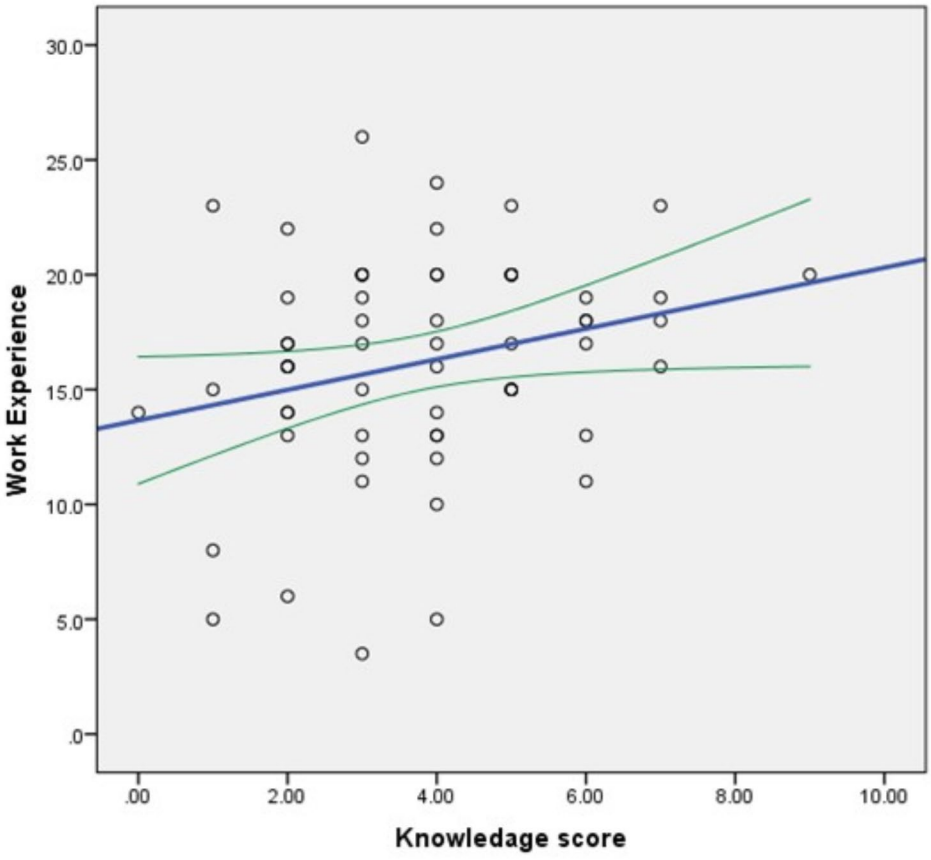

Fig. 1 Correlations between the head nurses' knowledge score and their scores on the total years of experience

Table 5 Association between knowledge, attitude and practice scores with demographic and occupational characteristics

Score		Age	Gender (F/M)	Education (BSc / MSc)	Work experience	Work experience in ICU
Knowledge	Suitable	40.4 ± 5.0	12 / 0	8 / 4	17.5 ± 3.3	8.6 ± 4.1
	Weak	39.0 ± 5.7	44 / 5	38 / 11	15.9 ± 5.0	8.0 ± 6.9
	p	0.443	0.573	0.467	0.327	0.762
Attitude	Suitable	40.9 ± 4.2	19 / 0	12 / 7	17.9 ± 2.9	8.7 ± 6.7
	Weak	38.5 ± 6.0	37 / 5	34 / 8	15.4 ± 5.2	6.8 ± 5.6
	p	0.122	0.313	0.199	0.067	0.283
Practice	Suitable	40.1 ± 5.5	12 / 0	11 / 1	17.1 ± 3.5	4.3 ± 3.9
	Weak	38.8 ± 5.7	43 / 5	34 / 14	16.0 ± 5.1	9.1 ± 6.6
	p	0.414	0.572	0.262	0.489	**0.027**

Data presented as Mean ± SD and Number

P-values calculated by Independent sample T-test, Chi-square, and Fisher exact test

F, Female; M, Male; BSc, Bachelor; MSc, Master of science

The scores of Knowledge, attitude and practice were considered suitable if they were greater than 5, 37 and 21, respectively

degree and 26.7% of nurses with master degree had good knowledge, the impact of level of education on knowledge was not significant. In Zabul work experience and level of education did not have significant effect on Knowledge [13]. This could be because the present study was conducted among ICU head nurses who usually have more work experience than regular nurses. In Saudi Arabia there was no significant association between work experience and knowledge about antibiotic use and AMR prevention but it has a strong correlation ($p < 0.001$) with working unit which was higher in specialized/critical units than ambulatory units [14]. In India 2012 a study conducted on nurses about their knowledge toward infection control practices and it shows 70% of nurses who had more than 5 years of work experience had good knowledge (80-90%) comparing to junior nurses (< 5 years of work experience) that 30% of them had good knowledge [16].

In the present study, attitude score didn't have significant correlation with any of the demographic's characteristics. This findings reported in this study were consistent with a study conducted in Zabul that revealed 37% of participants had average attitude and this score didn't have any significant relationship with any of the demographic's characteristics [13]. As expected, some ICU head nurses had not a good attitude concerning about HAIs and antibiotic resistance. One way to combat this negative attitude is to hold ongoing training classes on AMR and HAIs and also improve their knowledge in these areas. Another study in Saudi Arabia reported that 76.6% had good attitude toward AMR and prevention of it [14].

Unfortunately, most ICU head nurses in this study had weak practices toward HAIs and antibiotic resistance. The weak practices concerning HAIs and antibiotic resistance among participants could be due to their lack of training and experiences to adhere to the IPC measures. However, depending on the hospital, other important factors such as shortage of personnel, lack of equipment, lack of support from the management team, and inappropriate ICU structure can contribute to poor nurse practices. In the present study, only 19.7% of participants had suitable practice. These results were contrasted with the results of another study carried out in Ethiopia, which showed 64.8% (60.1-69.5%) of nurses had good practice toward HAI prevention [6] and this score was 76.2% in Kosovo [15]. In Ethiopia and Kosovo nurses who had BSc degree and above had better practice and the impact of level of education on nurses practice was significant, while in Zabul, Iran level of education didn't have a significant impact on practice [13].

In this study, most of the participants stated that they use warning signs to identify patients with MDR infection. The MDR patient's bed or room is often labeled with a sign signaling including MRSA, VRE, ESBL, CRKP and CRAB the contagious status. In fact, labeling the patient's room or bed shows the risk of hand and glove contamination after contact with a MDR (+) patient environment [17]. These symptoms indicate a visible reservoir of MDROs, which can ultimately help reduce the spread of these bacteria.

In 2021, a recent systematic review by Lena et al. [18] indicated that different types of HCW uniforms were found to be contaminated with MRSA and other MDR bacteria, which could potentially play a role in the spread of nosocomial infections. Therefore, work clothes should be washed to prevent the spread of infection and to reduce bacterial load on the hands. In the present study, most participants (68.9%) stated that nurses' uniforms are washed once a week, which can increase the chance of infection transmission in the ICU. This delay in washing nurses' uniforms can be due to reasons such as the lack of changing facilities and lack of washing facilities, the lack of awareness of ICU head nurses about the importance of washing uniforms in controlling the spread of MDR strains, and the failure of the hospital management team to provide enough clothes for personnel. This contradicts the finding of Riley et al. [19], who have recommended washing uniforms separately after every shift and within 24 h of the shift starting.

Based on previous studies [20, 21], daily bathing with 2% chlorhexidine is now one of the most investigated infection control strategies. Because it can significantly reduce HAI incidence and the risks of acquisition of MDROs in intensive care settings. Almost half of the participants (50.8%) said that bathing with chlorhexidine is done once a week for each patient, and 16.4% also declared that it is not done due to the lack of staff.

WHO recommended some IPC measures to prevent the spread of MDR bacteria [11]. Single room isolation policy as an infection control strategy has contributed significantly to the reduction of cross-transmission of resistant pathogens in ICUs. In this study, only 27.9% of the participants said that they always use the single isolation room for infectious patients, while 18% stated that their ICU does not have an isolation room at all. It seems that in several Iranian hospitals, the ICUs are not structurally designed properly, and in some cases, the insurance does not cover the cost of the isolation room for the patient, on the other hand, 26% announced that only according to the order. Doctors transfer infected patients to the isolation room.

Respiratory tract suctioning is an important factor in caring for patients with respiratory obstruction. According to nursing references, suctioning in the upper and lower respiratory tract should be done in a clean and sterile process, respectively. Though suctioning is a normal process, it is critical to prevent HAIs. Therefore, suctioning of the patient's nose or mouth should be done cleanly with a pair of clean protective gloves and a sterile suction catheter to prevent bacterial colonization and secondary infection. While in most ICUs of Iranian hospitals which are endemic MDR bacteria, clean suction technique is not observed and suction is performed with contaminated gloves, which increases the risk of colonization in the patient's mouth or lower and upper airways. Therefore, it is suggested to follow a clean technique or use gauze or sterile gloves. In the present study, almost 50% of the participants stated that gauze or sterile gloves are used during oral suction in their ICUs.

The main limitation of our study was the relatively small sample size selected from one province of central Iran which may limit the generalizability of our findings to the national level, but we are confident that our findings are useful in strengthening the current IPC and AMR measures and developing new ones. Another limitation was that, like most surveys, the use of self-report

questionnaires might lead to false information because some participants may have answered some questions by chance.

Conclusion

Having good KAP of healthcare workers especially nurses regarding infection control programs and AMR is vital to prevent the spread of HAIs among inpatients. The findings of our study indicate that most ICU head nurses had weak knowledge, attitudes and practices toward infection control and AMR. Therefore, arranging training courses for ICU head nurses might be useful in refreshing and improving their knowledge of IPC and AMR. Improving KAP among ICU head nurses is important because they can reduce antibiotic consumption, length of stay, costs, and mortality by properly planning and implementing infection control protocols to prevent the spread of resistant strains among patients admitted to the ICU. Finally, it is recommended that Iran's Ministry of Health and Medical Education and the subsidiary universities make changes in educational curricula, especially in nursing schools to improve awareness and create a favorable attitude among nurses towards the infection control programs and AMR.

Abbreviations

ICU	Intensive care unit
MDR	Multidrug-resistant
KAP	Knowledge, Attitudes and practices
IPC	Infection prevention and control
AMR	Antimicrobial resistance
HAIs	Healthcare-associated infections
CAUTI	Catheter-associated urinary tract infections
CLABSI	Central line-associated bloodstream infections
SSI	Surgical site infections
HAP	Hospital-acquired pneumonia
VAP	Ventilator-associated pneumonia
WHO	World Health Organization
HCW	Healthcare workers

Supplementary Information

The online version contains supplementary material available at https://doi.org/10.1186/s12912-025-02937-w.

Supplementary Material 1

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Author contributions

H.S conceived and designed the survey. P.K, S.S, M.AN, N.K, M.D and MS.A performed the data collection. M.A and H.S analyzed data. H.S, P.K and M.A draft writing, design and manuscript writing. All the authors reviewed the final version of the manuscript and agreed to its publication.

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Data availability

The data that support the findings of this study are available from the corresponding author upon reasonable request.

Declarations

Ethics approval and consent to participate

The study was approved by the Ethical Committee of the Isfahan University of Medical Sciences (IR.MUI.MED.REC.1402.389). This study was conducted in accordance with the ethical principles outlined in the Declaration of Helsinki. All participants provided verbal informed consent after they were informed about the study overview.

Consent for publication

Not applicable.

Competing interests

The authors declare no competing interests.

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