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Knowledge, Attitude, and Practice of Iranian Medical Students Regarding Healthcare-Associated Infection Prevention: A Cross-Sectional Study

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ABSTRACT

Background and Aim: Healthcare-associated infections (HAIs) are infections acquired in healthcare settings that are not present at admission and contribute to morbidity, mortality, and financial burden worldwide. Healthcare workers play a critical role in preventing HAIs, and adequate knowledge, attitude, and practice (KAP) are essential for effective infection control. This study evaluated KAP regarding HAI prevention among medical students.

Materials and Methods: A cross-sectional online survey was conducted with 200 medical students at Ahvaz Jundishapur University of Medical Sciences over 3 months. A validated 34-item questionnaire was used to assess knowledge (12 items), attitude (8 items), and practice (14 items) on a 5-point Likert scale.

Results & Conclusion: One hundred fifty students completed the survey (response rate: 75%). Mean scores were 42.4±4.5 for knowledge, 30.9±3.3 for attitude, and 52.1±5.5 for practice. Notable gaps were observed in hand hygiene (HH) and biomedical waste disposal. No significant association was found between KAP scores and gender, internship duration, or prior HAIs training. Iranian medical students demonstrated moderate KAP regarding HAI prevention, with deficiencies HH and waste management. The low proportion of students with prior HAI training highlights the need for structured educational interventions, including simulation-based HH training and targeted waste-management workshops before clinical rotations to improve infection control and patient safety.

Keywords: Attitude Healthcare-associated Infections, Infection Control, Knowledge, Medical Students, Practice

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1. Introduction

Healthcare-associated infections (HAIs), also called hospital-related infections, represent major concerns for hospitalized patients, particularly those with prolonged stays **(1, 2)**. According to the World Health Organization (WHO), hundreds of millions of patients are affected by HAIs each year worldwide, resulting in prolonged hospital stays, long-term disability, antimicrobial resistance, increased healthcare costs, and avoidable deaths **(1)**. These infections typically occur in 48 hr or more after hospital admission and may also manifest after discharge, often associated with invasive procedures, device use, and exposure to healthcare environments **(1-5)**. Common HAIs include catheter-associated urinary tract infections, central

line-associated bloodstream infections, surgical site infections, and ventilator-associated pneumonia **(3)**.

Globally, HAIs contribute substantially to mortality and morbidity, with incidence rates ranging from 5–15% in high-income countries to 5.7–19% in low- and middle-income countries **(2)**. In Iran, the incidence is estimated at 4.95 per 1,000 patient-days, with crude mortality of 19.85%. This rate is relatively high, with pneumonia, urinary tract infections (UTIs), and surgical site infections (SSIs) representing the most frequently reported HAIs **(4)**.

Preventive measures, including hand hygiene (HH), use of personal protective equipment (PPE), safe injection practices, proper handling of contaminated instruments, and waste management, are essential to reduce HAIs **(1, 5, 6)**.

Several studies have examined HAI-related knowledge, attitude, and practice (KAP) among health care workers including nurses, general physicians and medical residents regarding HAIs **(6, 7)**. Studies have also evaluated this topic among nursing, medical, pharmacy, and dental students **(8-15)**. Most of these studies represent rather weak levels of KAP regarding HAIs and low levels of adherence to recommended guidelines preventing HAIs. Prior studies in Iran and the region indicate suboptimal KAP among healthcare workers and students **(13, 16)**.

Given that the internship period is the starting point for medical students' independent activities in hospital wards and providing services to patients, it is crucial that they receive adequate training on routes of infection transmission and methods of preventing themselves and patients from contracting various types of infections. Thus, they will be able to practice appropriately in their future career and they can also transfer their knowledge to other medical staff Thus, they will be able to practice appropriately in their future careers and transfer their knowledge to other medical staff, potentially reducing the incidence of HAIs. It should be noted that the latest version of clinical training curriculum in Iran does not include independent content on HAIs.

2. Materials and Methods

This cross-sectional study was conducted at Ahvaz Jundishapur University between October and December 2022, following STROBE guidelines **(17)**. Using simple random sampling, 200 medical students were invited to participate. Eligibility criteria included active enrollment and clinical engagement during the study period.

Data were collected using an online questionnaire via a secure Porsline link, which remained open for 3 weeks. Two reminders were sent at one-week intervals to maximize the response rates, and the link was distributed through participants' university emails and WhatsApp. Before participation, students reviewed an online information sheet detailing the study objectives, procedures, risks, and benefits, and provided electronic informed consent by selecting "I agree to participate." Participation was voluntary, and anonymity and confidentiality were maintained using coded responses accessible only to the research team.

The questionnaire used in this study was adapted from an instrument originally developed by Kamunge **(6)** to assess the KAP toward HAIs among nurses. Since the current study targeted medical students rather than nurses, several modifications were made to ensure the relevance of the items. These modifications included adjustments to reflect the educational and clinical context of medical students. The content validity of the adapted questionnaire was established through expert evaluation. A panel of 10 experts including, including infectious disease specialists, community medicine specialists, and hospital infection control nurses reviewed the instrument for relevance, clarity, and appropriateness to the medical student population. Their feedback was incorporated to refine item wording and ensure that each item accurately represented the intended construct. Following the expert review, a pilot test was conducted among 25 medical students to assess the comprehensibility and reliability of the instrument. Internal consistency was evaluated using Cronbach's α. The overall reliability coefficient for the questionnaire was 0.8, indicating good internal consistency. Domain-specific Cronbach's α values were 0.78 for knowledge, 0.82 for attitude, and 0.76 for practice, all of which demonstrated acceptable reliability. The final instrument comprised 34 items across three domains: knowledge **(12)**, attitude **(8)**, and practice **(14)**, rated on a five-point Likert scale (1 = strongly disagree, 5 = strongly agree). For scoring, items within each domain were summed to produce domain-specific scores, with higher scores indicating better knowledge, more positive attitudes, and improved preventive practices toward HAIs. The participants' scores were then ranked into quintiles to categorize their KAP levels as weak (<40%), intermediate (40%-60%), good (60%-80%) and very good (>80%). Demographic data including gender, internship duration, and prior HAIs training were also collected to examine associations with KAP scores.

Descriptive data are presented as mean ± SD. Normality and homogeneity of variances were assessed using Shapiro–Wilk test, Q–Q plots, and Levene's test (P>0.05), supporting parametric

analysis. Although data were normally distributed, median and range were additionally reported to provide a comprehensive description of score dispersion and distribution characteristics. Independent t-tests, one-way ANOVA, and Pearson correlation were applied, with 95% confidence intervals and significance set at P<0.05. All analyses were performed using SPSS v.20 (IBM Corp., Armonk, NY, USA).

3. Results and Discussion

Of the 200 selected students 150 consented and completed the study, yielding a response rate of 75% (150/200×100). Female participants were numbered 82 (54.7%), and males 68 (45.3%). Internship durations were ≤6 months (18%), 6–12 months (23.3%), and >12 months (58.7%). Only 25 students (16.7%) had prior HAIs training.

Table 1, presents the mean, median, and range of KAP scores across domains, together with the corresponding levels determined using quintile categorization. Among the three domains, practice scores were highest, followed by knowledge and attitude. Based on the data, the students' scores in all three aspects were more than average.

Using the Pearson correlation test no significant correlations were observed between knowledge and attitude (r=0.16, *P*=0.06), knowledge and practice (r=0.02, *P*=0.87), or attitude and practice (r=0.2, *P*=0.81).

Table 2, summarizes the item-wise responses for each domain, including the number and percentage of correct and incorrect answers to individual questions. Half of the knowledge questions were answered correctly by at least 70% of medical students. A small number of students knew how the hospital biohazard wastes are segregated and disposed. Most of the students had never been supervised during hand washing activity and only a few of them were aware of the correct way to use biohazard bags and containers. More than 70% of the students did not know following HH tips is necessary before and after using sterile or non-sterile gloves. Out of 8 attitudinal questions only 3 items were answered correctly by at least three quarter of the students. In terms of practice most of the students reported that they follow the recommended guidelines for antiseptics usage before opening vascular access equipment. Almost 75% of the students wash their hands before and after inserting indwelling urinary catheters. However, a small proportion of them follow HH instructions before having contact with patient's intact skin. Most of the students use the computer keyboard with their gloves during a busy patient care episode.

According to independent t-test and One-Way ANOVA, students' level of knowledge, attitude and practice were not related to variables including gender, internship duration, and prior HAIs training (Table 3).

The students were ranked into quintiles based on their scores. Quintile 1 and 2 (<40%) is considered weak while quintile 3 (40%-60%), quintile 4 (60%-80%) and quintile 5 (>80%) represent intermediate, good and very good levels respectively.

Table 1. Students' mean and median grades and level of KAP regarding HAIs prevention and control.

Variable	Median	Mean ± SD	Minimum	Maximum	Level*	Frequency (n)	Percentage (%)
Knowledge (up to 60 points)	43 (12-53)	42.4±4.5	12	53	Weak (< 24)	1	0.7
					Intermediate (24-36)	9	6
					Good (36-48)	135	90
					Very good (48-60)	5	3.3
Attitude (up to 40 points)	31 (22-37)	30.9±3.3	22	37	Weak (< 14)	0	0
					Intermediate (14-24)	5	3.3
					Good (24-32)	94	62.7
					Very good (32-40)	51	34
Practice (up to 70 points)	53 (35-64)	52.1±5.5	35	64	Weak (< 28)	0	0
					Intermediate (28-42)	5	3.3
					Good (42-56)	112	74.7
					Very good (56-70)	33	22

Table 2. Students KAP regarding HAIs prevention and control.

Knowledge questions	Correct (n, %)	Incorrect (n, %)
K1. I am fully aware of hand-washing guidelines	125 (83.3)	25 (16.7)
K2. I have been supervised during hand-washing activity	17 (11.3)	133 (88.7)
K3. Healthcare facility harbors variety of pathogens that could be transmitted by healthcare workers	128 (85.3)	22 (14.7)
K4. I know how to use biohazard bag/container	30 (20)	120 (80)
K5. I know how the hospital biohazard wastes are segregated and disposed	7 (4.7)	143 (95.3)
K6. I know safety precautions for disposal used medical supplies e.g. needles, syringes and catheters	104 (69.3)	46 (30.7)
K7. I know that NIs can be transmitted via fomites e.g. needles, syringes, catheters and thermometers	130 (86.7)	20 (13.3)
K8. I know isolation procedures for neutropenic patient or those with communicable diseases	111 (74)	39 (26)
K9. I know microbes are not eradicated by alcohol-based solutions	102 (68)	48 (32)
K10. I know that hand hygiene tips should be followed before and after using sterile or non-sterile gloves	40 (26.7)	110 (73.3)
K11. I know recommended guidelines for hand hygiene with alcohol-based formulations	106 (70.7)	44 (29.3)
K12. I know that long nails or artificial nails can play role in NI distribution	105 (70)	45 (30)
A1. In my opinion NIs lead to serious outcomes (extended hospital stay days, mortality and increased healthcare costs)	140 (93.3)	10 (6.7)
A2. In my opinion, I can transmit NI if aseptic precautions are not followed	124 (82.7)	26 (17.3)
A3. I believe that when a colleague (doctor or nurse) does not follow the recommended guidelines for NI prevention and control, I should warn him/her.	96 (64)	54 (36)
A4. I am more compliant with the recommended guidelines for reducing the transmission of a nosocomial infection when training a new worker	105 (70)	45 (30)
A5. I serve as a role model in demonstrating adherence to recommended practices for hand hygiene	57 (38)	93 (62)
A6. It is unrealistic to expect healthcare workers to clean their hands after every contact with the patient	38 (25.3)	112 (74.7)
A7. In my opinion, healthcare workers should be sanctioned for non-compliance with protocols for reducing transmission of nosocomial infections (for example, denied promotion).	99 (66)	51 (44)
A8. In my opinion, healthcare workers should be rewarded (for example given plaques or certificate) for compliance with protocols aimed at reducing transmission of nosocomial infections	138 (92)	12 (8)
P1. I follow recommended guidelines for use of alcohol-based solutions or other antiseptics before and after contacting a patient.	76 (50.7)	74 (49.3)
P2. I follow recommended guidelines for use of alcohol-based solutions or other antiseptics before opening vascular access equipment.	120 (80)	30 (20)

Knowledge questions	Correct (n, %)	Incorrect (n, %)
P3. I use alcohol-based solutions or other antiseptics between each patient contact.	102 (68)	48 (32)
P4. I wash my hands or rub with alcohol-based solution or other antiseptics before and after providing a clinical procedure.	96 (64)	54 (36)
P5. I wash my hands or rub with alcohol-based solution or other antiseptics after contact with equipment /objects likely to be contaminated followed by patient care activity e.g. taking vital signs	104 (69.3)	46 (30.7)
P6. I wash my hands before and after drawing and, or manipulating patient's any body fluid sample	108 (72)	42 (28)
P7. I always wash my hands before and after having direct contact with patient's intact skin.	46 (30.7)	104 (69.3)
P8. I always wash my hands before and after inserting indwelling urinary catheters.	111 (74)	39 (26)
P9. I always wash my hands when moving from a contaminated body site to a clean-body site during patient examination.	100 (66.7)	50 (33.3)
P10. I occasionally polish my fingernails or wear artificial nails	101 (67.3)	49 (32.7)
P11. I am less compliant with recommended guidelines for reducing transmission of NI when workload increases or in emergencies.	54 (36)	127 (64)
P12. I wash my hands after touching inanimate surfaces and objects in patient's surroundings.	67 (44.7)	83 (55.3)
P13. During a busy patient care episode, I use the computer keyboard with my gloves on.	11 (7.3)	139 (92.7)
P14. I remove my ring(s), watch or bracelet before beginning hand hygiene.	105 (70)	45 (30)

K1 to K12, A1 to A8 and P1 to P14 represent KAP questions respectively. Knowledge: 4-5 = correct; Attitude/Practice: ≥ 4 = positive. Scores (%) ≥ 80: good, 60-79: moderate, <60: poor.

Table 3. Comparison of KAP scores by participant characteristics.

Gene symbol	Category	n	Knowledge (Mean ± SD)	t/F (df)	P-value	Cohen's d / η2	Interpretation
GAPDH	Male	68	42.4±3.7 95%CI* (41.6-43.2)	t(148) = 0.13	0.89**	0.02	Negligible
	Female	82	42.3±5.3 95%CI (41-43.6)				
			Attitude: 30.9±3.4 95%CI (30.2-31.6) vs. 30.7±3.1 95%CI (30-31.4)	t(148) = 0.36	0.62**	0.06	Negligible
			Practice: 51.9±5.6 95%CI (50.7-53.1) vs. 52.4±5.2 95%CI (51.1-53.7)	t(148) = 0.61	0.56**	- 0.09	Negligible
RNU6-F	Yes	25	43.4±3.1 95%CI (42.2-44.6)	t(148) = 1.7	0.28**	0.35	small
	No	125	42.4±2.5 95%CI (41.9-42.9)				
			Attitude: 31.2±2.8 95%CI (30.3-32.3) vs. 30.3±8.4 95%CI (29.8-31.8)	t(148) = 0.60	0.53**	0.13	Negligible
			Practice: 52.5±4.6 95%CI (50.7-54.3) vs. 50.4±9.5 95%CI (48.8-52)	t(148) = 1.15	0.23**	0.23	small
Internship duration (months)	< 6	27	41.3±7.3 95%CI (38.7-43.9)	F(2,147) = 0.65	0.61***	η2 = 0.009	Small / NS
	6 -12	35	42.6±2.4 95%CI (41.8-43.4)				
	12 -18	88	42.3±7.8 95%CI (40.7-43.9)				
			Attitude: 30.3±6.1 95%CI (28-32.6)/ 31.3±2.2 95%CI (30.6-32) / 30.3±1.4 95%CI (30-30.6)	F(2,147) = 0.84	0.73***	η2 = 0.011	Small / NS
			Practice: 52.4±1.7 95%CI (51.7-53.1) / 53.4±1.4 95%CI (53-53.8) / 51.6±7.1 95%CI (50.1-53.1)	F(2,147) = 1.45	0.48***	η2 = 0.019	Small / NS

Notes: SD = standard deviation; NS = non-significant. Cohen's d: 0.2 small, 0.5 medium, 0.8 large. η^2 (eta square): 0.01 small, 0.06 medium, 0.14 large. P<0.05 considered significant. * Confidence Interval, ** Student t-test, * One-Way ANOVA.**

The present study indicates that Iranian medical students demonstrate a moderate level of KAP regarding HAIs. Although overall scores were categorized as acceptable, item-level deficiencies in HH supervision and biomedical waste management reveal clinically meaningful gaps. These findings are particularly significant because medical students occupy a transitional position between student and independent

practitioner, frequently performing invasive procedures and rotating across departments, thereby influencing transmission dynamics within hospital settings **(2–5)**.

When compared with other healthcare worker groups in Iran, medical students appear to demonstrate less structured adherence to infection-control practices than nursing staff. Evidence from Iranian and international studies shows that nurses achieve improved compliance when continuous education and audit-based supervision systems are implemented **(6, 19)**. Unlike nurses, medical students often lack formal accountability frameworks and routine monitoring, which may explain inconsistencies between knowledge and actual behavior observed in this study. Regionally, similar gaps have been reported among medical students in Saudi Arabia **(10, 13)** and Afghanistan **(16)**, whereas relatively higher compliance among Qatari students has been attributed to longitudinal integration of infection-prevention modules within the undergraduate curriculum **(18)**. These comparisons suggest that curricular structure and institutional culture, rather than baseline awareness alone, are major determinants of infection-control competency.

The observed weakness in HH before and after glove use reflects a persistent misconception in clinical environments, where gloves are frequently perceived as substitutes rather than adjuncts to HH **(19)**. Such cognitive distortion may arise from informal learning patterns and observational modeling in busy wards. Evidence indicates that direct observation combined with structured feedback improves the HH compliance significantly **(19)**. Therefore, the deficits observed in this study likely represent a systems-level supervision gap rather than a purely informational deficiency.

Similarly, limited awareness of biomedical waste segregation suggests that this domain remains underemphasized in undergraduate medical education. Improper segregation increases occupational exposure risk and environmental contamination **(4, 10)**. The discrepancy between moderate theoretical knowledge and poor operational understanding implies that passive instruction is insufficient to ensure competence in this area **(11, 14)**.

Notably, prior participation in HAI-related training did not correlate with higher KAP scores. This finding is consistent with literature indicating that lecture-based education alone may have limited impact on sustained behavioral change, whereas competency-based and simulation-driven approaches may be more effective **(11, 14)**. The absence of significant correlations between knowledge, attitude, and practice further highlights the multifactorial nature of infection-control behavior, which is influenced by environmental constraints, workload, and institutional norms in addition to cognitive understanding **(19)**.

Given the substantial morbidity, mortality, antimicrobial resistance, and economic burden associated with HAIs (**2, 4, 5**), strengthening infection-control competency at the internship stage represents a potentially important patient safety strategy. Embedding infection prevention within formal educational standards and institutional policy frameworks may yield long-term benefits that extend beyond individual trainees. Institutional policies mandating structured supervision, competency-based assessments, and integration of infection-control metrics into student evaluation systems may strengthen accountability and improve compliance.

The strength of this study was the use of a validated instrument and its focus on an underexplored transitional group. The use of simple random sampling and a relatively high response rate (75%) strengthens the representativeness and reliability of the findings. Nevertheless, non-response bias may be present as students who did not participate could differ in key characteristics or perspectives from respondents, potentially affecting the results. The study's cross-sectional design precludes causal inference **(17)**. Self-administered questionnaires may overestimate actual KAP due to social desirability bias. The sample size was slightly below the target, and direct observation of practices was not performed, which may limit generalizability.

4. Conclusion

Medical students achieved moderate KAP scores regarding HAI prevention, with notable gaps in hand hygiene and waste management. Incorporating simulation-based training, structured workshops, and mandatory curriculum modules is recommended to enhance infection prevention practices, align training with institutional policies, and improve patient safety outcomes. Future multicenter longitudinal studies incorporating observational measures are needed.

5. Declarations

5.1 Acknowledgment

Nil.

5.2 Ethical Considerations

All procedures were conducted in accordance with relevant laws and institutional guidelines, following approval from the appropriate institutional committees. Specifically, the research received ethical approval from both the Ethics Committee of SRM Institute of Science and Technology and the Ethics Committee of SRM Medical College Hospital and

Research Centre (Approval No. SRMIEC-ST0624-1310). Informed consent was obtained from all individual participants involved in the study, ensuring their privacy rights were fully observed.

5.3 Authors' Contributions

AP: Methodology, Validation, Formal Analysis, Investigation, Data Curation, Writing - Original Draft; AG: Conceptualization, Methodology, Validation, Writing – Review & Editing, Supervision; MD: Writing -Review & Editing, Visualization; JSS: Writing -Review & Editing, Visualization; ASN: Writing -Review & Editing; LKV: Writing -Review & Editing, Project Administration. All authors have read and approved the final manuscript.

5.4 Conflict of Interests

The authors declare no conflict of interest.

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This research received no specific grant from any funding agency in the public, commercial, or not-forprofit sectors.

5.6 Using Artificial Intelligence Tools (AI Tools)

The authors did not used A.I tools. All content, interpretations, and conclusions are solely the work of the authors.

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