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Evaluation of Infection Prevention and Control Practices among Healthcare Workers in Teaching Hospitals in Ibb City, Yemen

Noman Ahmed Yahya Al Hatemi[1], Adel Mohammed Ali Aljawfi[2], Ghona Abd l-nasser[3], Sarah Abdulwareth Hussein Al-qadasi[4], Abdulqadeer Shayef Ahmed Alnamis[4], Ashraf Ali Abdu Mohammed[4], Naseem Ali Hael Al-samouli[4], Salah Alezzi Mohammed Alsarory[4], Wheeb Ahmed Ali Alshghdri[4]

[1]Department of Community Health Nursing, Faculty of Nursing, Jiblah University for Medical and Health Sciences, Ibb, Yemen; nalhatemi2019@gmail.com

[2]Assistant Professor of Family and Community Health Nursing, Faculty of Medical Sciences, Thamar University.

[3]Professor of Medical-Surgical Nursing, Faculty of Nursing, Sohag University, Egypt.

[4] Undergraduate students, Faculty of Nursing, Jiblah University for Medical and Health Sciences, Ibb, Yemen.

Corresponding author: E-mail: **nalhatemi2019@gmail.com*

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Abstract:

Introduction: Globally, nosocomial infections affect over 100 million patients each year. **Objective**: This study aimed to assess the perceptions, practices, and perceived barriers related to infection prevention and control (IPC) among healthcare workers (HCWs) in teaching hospitals in Ibb City, Yemen. **Methods**: A descriptive cross-sectional study was conducted among HCWs at teaching hospitals in Ibb Governorate, Yemen, from September 2024 to March 2025. Data were collected using a structured questionnaire. The selected hospitals followed infection control guidelines overseen by infection control committees. **Results**: Among the participants, 77% had attended seminars, and 71.3% had participated in IPC training courses. Although 67% were vaccinated against hepatitis B virus (HBV), only 65.7% had completed all three doses, and just 4.3% had received the COVID-19 vaccine. Overall, 74.6% demonstrated moderate perception of IPC, while 65.1% showed good IPC practices. A significant difference in IPC practices was observed between Al-Thawrah Teaching Hospital (77.6% good practice) and Jiblah University Hospital (52%) (p = 0.001). Significant differences were also found in perceived barriers between the two hospitals (p = 0.001). Furthermore, practice level was significantly associated with both knowledge (p = 0.001) and perceived barriers (p = 0.001). **Conclusion**: Despite good IPC knowledge among HCWs, gaps remain in their practical implementation. The strong associations between knowledge, practice, and barriers underscore the need for targeted training programs and sustained institutional support to strengthen IPC compliance in teaching hospitals.

Keywords: *Health Care Workers, Infection, Preventive, Control, Teaching Hospital.*

1. INTRODUCTION

Nosocomial infections (NIs) are common infections that occur among healthcare workers during the provision of health care services, and they are also referred to as healthcare-associated infections (HAIs) [1]. These infections typically develop at least 48 hours after hospital admission with no evidence of infection at the time of admission [2]. HAIs are classified into several types, including catheter-associated urinary tract infections (CAUTIs), central line-associated bloodstream infections (CLABSIs), ventilator-associated pneumonia (VAP), surgical site infections (SSIs), and hospital-acquired *Clostridioides difficile*

infections (HO-CDIs) [3]. In addition, they may include soft tissue infections, upper respiratory tract infections, central nervous system infections, and reproductive tract infections [4].

Globally, nosocomial infections affect more than 100 million patients annually [5]. high-income countries, seven out of every 100 hospitalized patients develop an HAI, whereas in low- and middle-income countries, this number increases to 15 per 100 patients [6].

In the 21st century, nosocomial infections have become increasingly alarming due to several factors, including hospitals serving large numbers of immunocompromised patients, the frequent use of invasive medical procedures, inadequate hygiene practices, and the routine use of antimicrobial agents [7]. HAIs continues to pose a major public health challenge, particularly due to the growing problem of antimicrobial resistance [8].

HCWs-associated infections (HAIs) are a significant global concern, contributing to increased morbidity, mortality, and healthcare costs [9]. Effective infection control practices are essential in preventing HAIs, especially in teaching hospitals, where patient exposure is high and clinical staff, including students, rotate frequently [10]. The perception and adherence of healthcare workers to infection control measures play a crucial role in their effectiveness [11]. However, gaps in infection control practices within teaching hospitals can compromise patient safety, student training, and overall healthcare quality [12].

Yemen is experiencing a rise in infectious diseases, including measles, polio, dengue, pertussis, and diphtheria [13]. Low vaccination coverage and vaccine hesitancy have increased the risk of preventable disease outbreaks [14]. Communicable diseases such as dengue, malaria, and cholera are likely to persist and worsen as climate change contributes to the spread of vectors and waterborne pathogens [15]. This crisis threatens vulnerable populations, leading to higher morbidity and mortality among them [16]. A global systematic review and meta-analysis that included Yemen found rising healthcare-associated infection (HAI) rates. Regional differences in infection rates and microorganisms were noted, alongside significant data gaps, particularly in low- and middle-income countries [17]. Knowledge of infection prevention and control (IPC) is essential for healthcare workers (HCWs) as it plays a critical role in clinical practice [18]. Accordingly, education and awareness regarding IPC measures are pivotal in reducing the risk of infection among HCWs and patients [19].

The onset of the internal conflict in 2015 has resulted in weaknesses in hospital equipment, healthcare workers, and their training. Hospitals in Ibb Governorate have also experienced a significant influx of patients from neighboring governorates. A study conducted in Ibb City in 2021, which included 189 patients, aimed to evaluate the prevalence of Methicillin-resistant Staphylococcus aureus (MRSA) among patients with skin and soft tissue infections. The study revealed that the prevalence of MRSA isolated from nasal swabs among males was 45.2%, compared with 4.8% among females [20]. Furthermore, other studies conducted in health facilities in Yemen revealed a low level of knowledge and poor practices among healthcare workers regarding the prevention and control of nosocomial infections [21,22,23]. These findings prompted the researchers to evaluate infection prevention and control practices among healthcare workers in teaching hospitals in Ibb City, Yemen. This study aimed to evaluate the infection prevention and control practices among healthcare workers in teaching hospitals in Ibb City, Yemen.

2. METHODOLOGY

2.1. Study Design and Settings

A descriptive cross-sectional study using a structured questionnaire was carried out among healthcare workers (HCWs) in teaching hospitals, including Jiblah University Hospital and Al-Thowrah Teaching Hospital, which have infection control guidelines established by separate infection control committees, in Ibb Governorate, Yemen. This study was conducted from September 2024 to March 2025.

2.2. Study Population and Sampling

The study included HCWs (doctors, nurses, laboratory technicians, dentists, pharmacists, and other allied health workers) in the target hospitals who had regular contact with patients during their routine clinical services. The total number of HCWs in the target teaching hospitals during the study period was 836.

2.2.1. Participant Selection Procedure

- Lists of HCWs in each department were reviewed.
- Participants HCWs were approached during their duty hours and invited to participate voluntarily.
- HCWs who were available during the data collection period and consented to participate were involved in the study.

2.2.2. Inclusion and Exclusion Criteria

The inclusion criteria comprised all nurses, laboratory technicians, cleaners, midwives, medical assistants, anesthetists, and radiographers who were directly involved in patient care. The exclusion criteria included all non-clinical staff and those who were absent during the study period, who therefore were not included in this study.

2.2.3. Sample size

The total number of healthcare workers in the targeted teaching hospitals was 836 during the study period. The researchers selected 25% from each professional category as a representative cross-sectional sample of the population. Verbal consent was obtained from all participants, and they were informed that they had the right to withdraw from the study at any time.

2.3. Data Collection Tools

The questionnaire was adapted from other studies conducted in the region [24,25]. The face and content validity of the questionnaire was ensured by infection control specialists at Jiblah University Hospital. To further ensure validity, the questionnaire was reviewed for clarity of language, feasibility, formatting, readability, and consistency of style by two community medicine specialists and infection control specialists from Al-Thowrah Teaching Hospital. A perception, practice, and barriers questionnaire consisted of four sections:

1. **First part:** Demographic information: This part focused on the demographic characteristics of HCWs and included items such as hospital name, age, sex, marital status, occupation, years of experience, qualification level, department of work, and professional role. In addition, this part included general information such as attendance at infection control training courses, receipt of the Hepatitis B vaccine, and COVID-19 vaccination status.
2. **Second part:** Perception: This part consisted of ten questions related to perceptions about hospital-acquired (nosocomial) infections, hand hygiene, antiseptic solutions, the use of clean water, standard precautions, personal protective equipment (PPE), and hospital-acquired infection guidelines. The healthcare workers were asked to select the correct answer for each question (yes/no). Each correct answer was assigned a score of one, and each incorrect answer was assigned a score of zero. The total score for each participant therefore ranged from 0 to 10. Perception levels were classified as follows: poor perception (0–3 correct answers), moderate perception (4–6 correct answers), and good perception (7–10 correct answers).
3. **Third part:** Practice: This part focused on practice-related questions concerning hospital-acquired infection guidelines, hand hygiene practices, standard precautions (SPs), sharp and waste disposal management, and measures for preventing and controlling hospital-acquired infections. A total of nine practice questions were used.

   Scoring System : The total score for each participant ranged from 0 to 9. Practice levels were categorized as follows: poor practice (0–3 correct answers), moderate practice (4–6 correct answers), and good practice (7–9 correct answers).
4. **Fourth part:** Barriers: This part included 12 questions regarding barriers that hinder the implementation of standard precautions (SPs) in infection prevention and control (IPC). The scoring system for barriers was calculated as follows: a score of one was assigned if the participant agreed with the statement, and zero if the participant did not agree.

   Data Collection Process : The official approval to conduct this research was obtained from the administrators of both hospitals after the aims and objectives of the study were clearly explained to them to ensure their cooperation and support. Face-to-face interviews were conducted using a structured questionnaire administered in private rooms to ensure confidentiality and minimize interruptions. All participants were informed that their participation was voluntary and that they had

the right to withdraw at any time during the interview. At the beginning of each interview, the researchers introduced themselves to establish rapport and facilitate communication. The purpose of the study was clearly explained to each participant before completing the questionnaire. Verbal informed consent was obtained from all healthcare workers prior to participation.

2.4. Data Analysis

Data was analyzed using ***SPSS*** version 22. Quantitative data were presented as means and standard deviations, while qualitative data were expressed as frequencies and percentages. The Chi-square test and Fisher's exact test were used where appropriate, and a Z-score was used to compare proportions. The student's t-test was applied to compare differences between two means, while correlation analysis was performed to examine the association between quantitative variables.

2.5. Ethical Considerations

This study received approval from the ethical committee of Jiblah University, as along with authorizations from Jiblah University Hospital and Al-Thwarah Teaching Hospital (No.JUM5-2025-10-3). Additionally, this study was approval from the managers of both hospitals. Before data collection, verbal consent was acquired from each participant after providing detailed information about the nature of the study.

3.RESULTS

3.1. Demographic characteristics of Participants

The table (1) shows that the distribution of HCWs is based on their demographic characteristics. Concerning to gender, out of 209 individuals; 102 (48.8) were males and 107 (51.2%) were females. Regarding the occupational of participants, 85 (40.7%) were nurses, followed by nurse assistant 34 (16.3%), whereas Laboratories formed (11.5%), compared with only 6 (2.9%) of participants were anesthetics. Based on duration of work, 65 (31.1%) of participants have 1-5 years worked and 61 (29.2%) of them have more than 10 years, whereas 50 (23.9%) of them have 6-10 years. Table 1 also showed that around three fifths of participants 123 (58.9%) had a diploma qualified and 57 (27.3%) had a bachelor's degree, whereas 22 (10.5%) had only high school qualified, and 7 (3.3%) of participants had master's degree.

Table 1. Shown Distribution of Health Care Workers Based on their Demographic Characteristics at Teaching Hospitals, Ibb Governorate, Yemen 2024 (N=209)

	Variable	Frequency (n)	Percent (%)
Gender	Males	102	48.8
	Females	107	51.2
Specialty/ occupation	Doctor	20	9.6
	Nurse	85	40.7
	Nurse assistant	34	16.3
	Laboratories	24	11.5
	Cleaner	9	4.3
	Midwifery	13	6.2
	Medical assistant	8	3.8
	Anesthetics	10	4.8
	Radiographer	6	2.9
Work duration	Less than 1 year	33	15.8
	1-5	65	31.1
	6-10	50	23.9
	More than 10	61	29.2
Qualification	Diploma	123	58.9
	Bachelor	57	27.3
	Master	7	3.3
	High school	22	10.5

Table 2. Distribution Health Care Workers Regarding Training on Control of Infection at Teaching Hospitals, Ibb Governorate, Yemen 2024 (N=209)

Variable		Frequency (n)	Percent (%)
Seminar to infection Control	Yes	161	77.0
	No	48	23.0
Training course to infection control	Yes	149	71.3
	No	60	28.7

Table (2) showed that distribution HCWs regarding training on control of infection. More than three quarters 161 (77%) of the participants reported that they had attended seminars on infection control, compared to 48 (23%) did not attend. While 149 (71.3%) of participants participated in the training course on infection control, compared to 60 (28.7) hadn't participate.

Table 3. Distribution of the Health Care Workers Regarding Vaccination to HBV and COVID-19 at Teaching Hospitals, Ibb Governorate, Yemen 2024 (N=209)

Variable		Frequency (n)	Percent (%)
HBV vaccination	Yes	140	67.0
	No	69	33.0
Number of HBV vaccine dose	One	18	12.9
	Two	30	21.4
	Three	92	65.7
COVID-19 vaccination	Yes	9	4.3
	No	200	95.7

Table (3) showed that distribution of the HCWs regarding vaccination to HBV and COVID-19. Only 140 (67%) of participants had vaccinated for Hepatitis B virus (HBV). Out of them 92 (65.7%) had completed three vaccine doses, compared to 18 (12.9%) of them had one dose. Moreover, 69 (33%) of total participants had never received HBV dose. Concerning COVID-19 vaccines; only 9 (4.3%) of participants had received vaccine, compared to 200 (95.7%) hadn't never receive.

Table 4. Distribution of Health Care Workers Regarding Teaching Hospital and Departments at Teaching Hospitals, Ibb Governorate, Yemen 2024 (N=209)

Variable		Frequency (n)	Percent (%)
Hospital	Jiblah	102	48.8
	Althwarah	107	51.2
Departments	Emergency	34	16.3
	ICU	17	8.1
	Operation	21	10.0
	Inpatients	49	23.4
	Outpatients Clinics	38	18.2
	Primary Health care	3	1.4
	Gynecology	19	9.1
	Hemodialysis	14	6.7
	Incubator	14	6.7

Table (4) showed the distribution of HCWs regarding teaching hospital and departments. Concerning distribution participants by hospitals, 107 (51.2%) of them participated from Althwarah Teaching Hospital, compared to 102 (48.8%) were from Jiblah University Hospital. While distribution of the participants according to departments, data showed that 49 (23.4%) of participants were from inpatients ward, followed up by 38 (18.2%) were from the outpatients' clinics, 34 (16.3%) were from emergency department, 21 (10%) were from operation, 19 (9.1%) were from gynecology, whereas 14 (6.7%) of participants were from each one of department hemodialysis, and incubator, and 3 (1.4%) were from primary health care department.

3.2. Perception of Heath Care Workers To Infection preventive and Control

According to Table 5, 207 (99%) of participants referred to hospital-acquired infections can be transmitted through medical equipment. Concerning to potentially infectious diseases; 201 (96.1%) of participants referred to staff and patients. The majority 169 (80.9%) of participants knew that "the standard precautions

are applied to all patients regardless of their medical diagnosis". More than three fifths 131 (62.7%) said that gloves provide complete protection against infection or transmission to and from the patient. Moreover, 186 (89%) of participants reported that pathogenic microorganisms cannot be destroyed by using only clean water.

Regarding hand washing, 153 (73.2%) of participants were knew of the “5 Moments for Hand Hygiene” identified by the World Health Organization, whereas majority of participants 205 (98.1%) said that hand hygiene must be performed before and after direct contact with the patient. When participants were asked that they had no need to wash hands before performing procedures that do not involve any body fluids, only 33 (15.8%) reported incorrect answer "Yes", compared to 176 (84.2%) of them reported correct answer "no". While majority of participants 181 (86.6%) reported correct answer "no", compared to 28 (13.4%) of them reported incorrect answer "Yes" when participants were asked if hands are not visibly dirty, there is no need to wash hands before contacting the patient to perform any procedure. Final, table 5 showed that 130 (62.2%) of participants answered that when using alcohol-based sanitizers, they should continue rubbing my hands until they are dry.

Table 5. Perception of Health Care Workers to Infection Preventive and Control at Teaching Hospitals, Ibb Governorate, Yemen 2024 (N=209)

	Variable		Frequency (n)	Percent (%)
1	Hospital-acquired infections can be transmitted through medical equipment such as syringes, needles, catheters, stethoscopes, thermometers, etc.	Yes	207	99.0
		No	2	1.0
2	Are pathogenic microorganisms destroyed using only clean water?	Yes	23	11.0
		No	186	89.0
3	Standard precautions are applied to all patients regardless of their medical diagnosis.	Yes	169	80.9
		No	40	19.1
4	While working in a hospital, we must consider that staff and patients may be potentially infectious.	Yes	201	96.2
		No	8	3.8
5	Gloves provide complete protection against infection or transmission to and from the patient.	Yes	131	62.7
		No	78	37.3
6	Do you know the “5 Moments for Hand Hygiene” identified by the World Health Organization?	Yes	153	73.2
		No	56	26.8
7	Hand hygiene must be performed before and after direct contact with the patient.	Yes	205	98.1
		No	4	1.9
8	When using alcohol-based sanitizers, I should continue rubbing my hands until they are dry.	Yes	130	62.2
		No	79	37.8
9	There is no need to wash hands before performing procedures that do not involve any body fluids.	Yes	33	15.8
		No	176	84.2
10	If hands are not visibly dirty, there is no need to wash hands before contacting the patient to perform any procedure.	Yes	28	13.4
		No	181	86.6

3.3. Health Care Workers Practices Towards of Infection Control

According to Table (6), data analyses showed that majority of participants 172 (82.3%) reported that infection prevention and control are monitored in their hospital. Only 135 (64.6%) of participants reported that they conducted patients screen for infectious agents even if there is no sign of infection. Hand washing before and after contact with sick people was done by majority of participants183 (87.6%), whereas 207 (99%) of them have washing hands practice after going to the toilet and after contact with blood or body fluids. Majority of participants 199 (95.2%) used a proper manner as waste container to keep injections disposed after used. A majority of 185 participants (88.5%) had adhered to a statement of infection prevention guidelines, whereas 170 (81.3%) of them pointed education of patients, family members and caregivers about infection control are provided by infection prevention and control program. Only 137 (65.6%) of participants had accepted to personal protective equipment always uses.

Table 6. Practice of Health Care Workers Towards Infection Preventive and Control at Teaching Hospitals, Ibb Governorate, Yemen 2024 (N=209)

	Variable		Frequency (n)	Percent (%)
1	Infection prevention and control monitored in the hospital?	Yes	172	82.3
		No	37	17.7
2	Patients screen for infectious agents even if there is no sign of infection?	Yes	135	64.6
		No	74	35.4
3	Always washing hands before and after direct contact with sick people?	Yes	183	87.6
		No	26	12.4
4	Washing hands after going to the toilet?	Yes	207	99.0
		No	2	1.0
5	Washing hands after contact with blood or body fluids?	Yes	207	99.0
		No	2	1.0
6	Injections disposed of in the proper manner (presence of a waste container)?	Yes	199	95.2
		No	10	4.8
7	The infection prevention and control program provide education to patients, family members, and other caregivers about infection control?	Yes	170	81.3
		No	39	18.7
8	Infection prevention guidelines adhered to?	Yes	185	88.5
		No	24	11.5
9	Personal protective equipment (PPE) always uses**?**	Yes	137	65.6
		No	72	34.4

3.4 Barriers of infection control

The table (7) showed the barriers of infection control among health care workers. Only 131 (62.7%) of participants indicated that others health care workers do not follow infection control procedures. While 119 (56.9) of participants reported that gloves cause skin irritation. Regarding hepatitis B vaccine, 91 (43.5%) of participants said that the vaccine is not available, whereas 89 (42.6%) of them indicted that there are not enough gowns, and 69 (33%) of them cleared that the gloves isn't enough. Concerning the standard procedure of infection control; 80 (38.3%) of participants indicated that guidelines are vague, whereas 83 (39.7%) of them reported that standard requirement of standard procedure is expensive and 94 (45%) of them referred to follow up standard procedure is need too long time. Finally, 54 (25.8%) of participants mentioned insufficient hand washing facilities, and 55 (26.3%) of them reported that the PPE items uncomfortable with use. Only 36 (17.2%) of participants said that the following standard procedure of PPE makes work more difficult.

Table 7. Barriers of Infection Preventive and Control Among Health Care Workers at Teaching Hospitals, Ibb Governorate, Yemen 2024 (N=209)

	Variable		**Frequency (n)**	**Percent (%)**
1	There are not enough gloves.	Agree	69	33.0
		Don't agree	140	67.0
2	Others do not follow infection control procedures	Agree	131	62.7
		Don't agree	78	37.3
3	There are not enough gowns.	Agree	89	42.6
		Don't agree	120	57.4
4	Standard procedure guidelines of infection control are vague.	Agree	80	38.3
		Don't agree	129	61.7
5	There are not enough hand washing facilities.	Agree	54	25.8
		Don't agree	155	74.2
6	Standard procedure requirements of infection control are expensive.	Agree	83	39.7
		Don't agree	126	60.3
7	Gloves cause skin irritation	Agree	119	56.9
		Don't agree	90	43.1
8	Hepatitis B vaccine is not available.	Agree	91	43.5
		Don't agree	118	56.5
9	It takes a long time to follow standard procedures.	Agree	94	45.0
		Don't agree	115	55.0
10	PPE Items are uncomfortable with use	Agree	55	26.3
		Don't agree	154	73.7
11	It is unimportant to follow standard procedure guidelines.	Agree	21	10.0
		Don't agree	188	90.0
12	Following standard procedures makes work more difficult.	Agree	36	17.2
		Don't agree	173	82.8

3.5. Association between perception, practice and barriers

Table 8. Level of Perception among Health Care Workers Towards Infection Preventive and Control at Teaching Hospitals, Ibb Governorate, Yemen 2024 (N=209)

Hospitals	Perception Level							*p*- value
	Poor		Moderate		Good		Total	
	No.	%	No.	%	No.	%	No.	
Jiblah University Hospital	16	15.7	73	71.6	13	12.7	102	0.567
Al-Thawrah Teaching Hospital	12	11.2	83	77.6	12	11.2	107	
Total	28	13.4	156	74.6	25	12.0	209	

Table (8) showed that level of perception among HCWs regarding IPC. It was cleared that there was no significant difference between knowledge level of HCWs regarding IPC in teaching hospitals, *p* - value = 0.567.

Table 9. Level of practice among health care workers Towards Infection Preventive and Control at Teaching Hospitals, Ibb Governorate, Yemen 2024 (N=209)

Hospitals	Practice Level							*p*- value
	Poor		Moderate		Good		Total	
	No.	%	No.	%	No.	%	No.	
Jiblah University Hospital	10	9.8	39	38.2	53	52	102	*p* <0.001*
Al-Thawrah Teaching Hospital	2	1.9	22	20.6	83	77.6	107	
Total	12	5.7	61	29.2	136	65.1	209	

Table (9) showed the practice level among HCWs regarding IPC at teaching hospitals. It was noted that there was a statistically significant difference between practice level among HCWs in teaching hospitals regarding IPC, *p* <0.001.

Table 10. Level of Practice's barriers among health care workers Towards Infection Preventive and Control at Teaching Hospitals, Ibb Governorate, Yemen 2024 (N=209)

Hospitals	Barriers of Practice Level							*p*- value
	Low		Moderate		High		Total	
	No.	%	No.	%	No.	%	No.	
Jiblah University Hospital	44	43.1	42	41.2	16	15.7	102	*p* <0.001*
Al-Thawrah Teaching Hospital	92	86	15	14	0	0	107	
Total	136	65.1	57	27.2	16	7.7	209	

Table (10) showed the practice barriers level among HCWs regarding IPC at teaching hospitals. It was noted that there was a statistically significant difference between level of practice's barriers among HCWs in teaching hospitals regarding IPC, *p* <0.001 .

Table 11. Relationship Between Perception Level and Practice Level among Study Participants Regarding Infection Control at Teaching Hospitals, Ibb Governorate, Yemen 2024 (N=209)

		Perception Level							*p*- value
		Poor		Moderate		Good		Total	
		No.	%	No.	%	No.	%	No.	
Practice level	**Poor**	3	25.0	9	75.0	0	0.0	12	< 0.05 *
	Moderate	13	21.3	43	70.5	5	8.2	61	
	Good	12	8.8	104	76.5	20	14.7	136	
	Total	28	13.4	156	74.6	25	12.0	209	

Table (11) showed the relationship between knowledge level and practice level among study participants regarding infection control. It was cleared that there was a high statistically significant association between level of practice and level of knowledge among HCWs at $p < 0.05$.

Table 12. Relationship Between Barriers and Practice Level Among Health Care Workers Regarding Infection Control at Teaching Hospitals, Ibb Governorate, Yemen 2024 (no=209)

		Barriers					*p*- value
		Agree		Don't agree		Total	
		No.	%	No.	%	No.	
Practice	Low	10	83.3	2	16.7	12	
	Moderate	25	41	36	70.2	61	< 0.001
	High	38	27.9	98	72.1	136	
	Total	73	34.9	136	65.1	209	

Table (12) showed the relationship between barriers and practice level of HCWs regarding infection control. 136 (65.1%) of participants reported that barriers do not hinder practice. But there was a statistically significant association between level of practice and level of barrier among HCWs at *p* (0.001).

4.DISCUSSION

Usually, nurses' staff are considered as largest occupational at health care facilities. In current study, slightly more than two fifths of HCWs were from nurse's staff. Previous results are in same line with global healthcare settings where nurses form the backbone of patient care [27]. Many studies have shown that highly qualified HCWs with long-term experience and training can lead to quality infection prevention and control (IPC) in the workplace. [28, 29,30,31]. In our study, more than half of HCWs had diploma-level education, this group of HCW need to more training and evaluation for their knowledge and practice to reach health care services without infection. Only less than third of HCWs had 1–5 years, while more than one quarter of them had more than 10 years experiences. While most of HCWs received seminar or training courses regarding IPC.

The World Health Organization (WHO) stresses the importance of vaccinating HCWs (HCWs) to protect both staff and patients, particularly against diseases like hepatitis B (HBV) and COVID-19 [32,33]. In Yemen, many studies carried out to address vaccine hesitancy among HCWs. A study conducted in Sana'a found that only half of HCWs were willing to receive the COVID-19 vaccine, with hesitancy linked to concerns about side effects, vaccine safety, and reliance on herd immunity. While female HCWs and those in the public sector showed higher hesitancy [34]. A national survey involved 1,581 HCWs found that while only slightly more than three fifths (61.7%) were willing to get vaccinated against COVID-19, only 10.9% had received the vaccine, highlighting challenges in access and distribution [35]. Another study on clinical laboratory staff in Sana'a revealed low HBV vaccination coverage despite high exposure risk, emphasizing the need for better vaccination programs and workplace safety measures [36]. In current study, more than two thirds of HCWs had vaccinated for Hepatitis B virus (HBV). Out of them only less than two thirds had completed three vaccine doses, and around one third of HCWs hadn't never receive HBV dose. While majority of HCWs had never received. Previous findings from this study reveal a substantial gap in the prevention and protection of health workers and patients against infectious diseases, particularly hepatitis B and coronavirus. Yemen faces numerous significant challenges regarding vaccine access and distribution. The country's prolonged conflict has severely disrupted vaccine supply chains, leading to issues with vaccine availability and logistical operations [37]. Additional barriers include political and security-related obstacles [38], inadequate infrastructure [39], economic and funding limitations [40], as well as cultural hesitancy and the spread of misinformation [34]. Furthermore, low coordination with international organizations such as the WHO presents its own set of challenges [41].

The present study reveals that over three-quarters of HCWs were familiar with the World Health Organization's (WHO) "5 Moments for Hand Hygiene," indicating a commendable level of awareness regarding infection prevention protocols. This aligns with findings from Hong and Xu (2024), who reported

that most of HCWs demonstrated comprehensive knowledge of hand hygiene practices in a post-pandemic context [42].

Furthermore, the majority of HCWs in our study recognized the necessity of performing hand hygiene before and after direct patient contact, and reported adherence to handwashing protocols prior to procedures, irrespective of the presence of body fluids or visible soiling. These practices are consistent with the WHO's guidelines, which emphasize the importance of hand hygiene at critical moments to prevent healthcare-associated infections (HAIs) [43].

Despite this adherence, several barriers to optimal hand hygiene compliance were identified. Over one-fifth of HCWs reported insufficient handwashing facilities and discomfort associated with personal protective equipment (PPE) in this study. These challenges are consistent with findings from other studies. For instance, research in Bangladesh reported that more than half of HCWs cited insufficient supplies as a key barrier to hand hygiene compliance [44]. Another study conducted in India identified various factors influencing PPE use among HCWs, highlighting that discomfort can deter consistent hand hygiene practices [45].

Contaminated medical devices and equipment are significant reservoirs for pathogenic organisms responsible for HAIs. For instance, A systematic review focusing on Medical Radiation Science departments found that more than three fifths of healthcare equipment sampled was contaminated with infectious organisms [46]. A surveillance study conducted across 121 hospitals in India reported that majority (95%) of healthcare-associated infections, including bloodstream infections, ventilator-associated pneumonia, and urinary tract infections, were linked to medical devices [47]. The finding of this study shown that majority of HCWs had precepted regarding the transmission of hospital-acquired infections (HAIs) via medical equipment and the potential role of both staff and patients in propagating such infections. This result was in same line with other studies conducted in Ethiopia [48]. Regarding the HCWs' practices, majority of HCWs reported that infection prevention and control were monitored in target hospitals. Previous result was high than other study conducted at 23 hospitals in India, revealed that more than one third of HCWs had monitoring for IPC in their hospitals [49]. Also, this study revealed that over three fifths of HCWs reported routinely screening patients for infectious agents, even in the absence of clinical symptoms, and the majority of HCWs reported adherence to IPC guidelines [50], while slightly more than four-fifths indicated that they routinely educate patients, family members, and caregivers about infection control [51].

A systematic review study screened 3,417 papers identified multiple factors contributing to noncompliance with infection prevention and control (IPC) guidelines. The authors recommend a multifaceted approach to strengthen IPC intervention strategies, with the primary objective of improving healthcare workers' adherence to IPC measures [52]. In this study, the identified barriers to infection prevention and control (IPC) included non-compliance with infection control procedures by other healthcare workers [53], skin irritation caused by gloves [54], insufficient availability of face masks and gloves [55], ambiguous guidelines [65], and the lengthy time required to follow standard procedures [57].

In this study, we found that there was a statistically significant association between HCWs knowledge levels and their perceived barriers to IPC practices ($p < 0.019$). This result aligned with other study conducted in China [58]. Empirical evidence has demonstrated that insufficient knowledge of IPC protocols often contributes to heightened perceptions of barriers, such as lack of time, inadequate resources, or low institutional support [59]. Also, there was a statistically significant association observed between healthcare workers' IPC practice levels and their perceived barriers ($p < 0.05$), the highlights the complex relationship between behavior and contextual factors in clinical environments. This finding aligns with previous study was conducted at Northwest Bank Hospitals [60]. Conversely, limited engagement in IPC practices may reinforce or amplify perceptions of such barriers [56]. Study in Yemen on HCWs of COVID-19 management in isolation center 2020 concluded that COVID-19 IgG antibodies become detectable in HCWs 94.44 % [61]. Finally, there was a significant association between IPC practice and knowledge levels among healthcare workers ($p < 0.001$), reinforces the foundational role of knowledge in shaping professional behavior in clinical settings. This finding is well-supported by other studies [62,63]. Healthcare professionals with a strong understanding of IPC principles are more likely to engage in appropriate preventive behaviors, including hand hygiene, use of personal protective equipment (PPE), and safe waste disposal practices.

This study has limitations, which should be addressed for future research. The study was exclusive to teaching hospitals at Ibb governorate, and it used non-probability sampling method. Therefore, we can't generalizability of the results from this study because it was conducted in two hospitals and one governorate. The selection of participants might be bias from departments. Moreover, most of participants were from nurses and inability to make a note for the research participants in this study.

5. CONCLUSION

The findings highlight critical gaps in infection prevention and control (IPC) practices among healthcare workers, despite a generally high level of knowledge. While most participants understood the importance of standard precautions and hand hygiene, misconceptions about protective measures and barriers such as inadequate PPE and unclear guidelines persist. Significant differences in IPC practices and perceived barriers between hospitals, along with strong associations between knowledge, practice, and barriers, emphasize the need for targeted interventions. Our study recommends : Enhance Ongoing IPC Training , Ensure Adequate Supply of PPE ; Clarify and Standardize IPC Guidelines ; Improve Vaccination Coverage and Follow-Up and Integrate IPC into Quality Monitoring Systems:

Authors Contributions

All authors have read and agreed to the published version of the manuscript.

Conflicts of Interest

All authors declare that they have no conflict of interest.

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