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RESEARCH ARTICLE

EDUCATIONAL GAPS AND COMPLIANCE WITH OCCUPATIONAL HAZARDS OF BLOOD-BORNE PATHOGENS AT WORKPLACE AMONG HEALTHCARE WORKERS

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ABSTRACT

Background: Globally, healthcare personnel play a crucial role in ensuring patient safety, yet their practices and compliance with infection control measures often vary. Limited training and exposure to occupational hazards, such as needle stick injuries, further complicate efforts to maintain a safe healthcare environment. ***Aim:*** The main objective of the current study is to assess the demographic characteristics, training status, and infection control practices among healthcare personnel to identify gaps and recommend improvements. ***Methods:*** A cross-sectional study was conducted among healthcare personnel; data were collected on demographics, job characteristics, training in infection control, occupational hazards, and practice grades. Descriptive statistics, including frequencies and percentages, were analyzed using SPSS. ***Results:*** The study included 112 participants, with 51.8% males and 58.0% Saudi nationals. Most were aged 31–40 years (44.6%). Only 17.0% had received training on infection control, while 62.5% reported experiencing needle stick injuries. Job roles were evenly split between specialized and general duties (50% each). Nurses comprised the largest group (45.5%), and 51.8% held graduate qualifications. Practice grades showed that 54.5% demonstrated "Good" practices, while 45.5% fell into the "Poor" category. ***Conclusion:*** The study highlights critical gaps in infection control training and compliance, particularly in high-risk departments. Addressing these gaps through enhanced education programs, resource allocation, and policy enforcement is essential to improve workplace safety and reduce occupational hazards.

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INTRODUCTION

Bloodborne pathogens (BBPs) are infectious microorganisms p in human blood or other body fluids that can create and cause human diseases (Ballouz*et al.,* 2024). These pathogens are potentially life-threatening infections transmitted when an infected person's blood or certain body fluids directly contact another person's bloodstream (Islam, 2024). The most prevalent and concerning BBPs in healthcare settings are Human Immunodeficiency Virus (HIV), Hepatitis B Virus (HBV), and Hepatitis C Virus (HCV). Their risk of transmission depends on the pathogen, the nature of exposure, and the availability of preventive measures like vaccinations for HBV and post-exposure protocols for HIV and HCV (Ballouz*et al.,* 2024). Healthcare workers (HCWs) are at high risk due to frequent exposure to blood and body fluids in the clinical environment (Ishola & Alsaidi, 2024). All specialties work in emergency and intensive care units; operating rooms, laboratories, ordinary wards, and blood Sampling units are at high risk (Lee & Choi, 2023). In particular, surgeons and operating room staff face higher risks of BBP transmission due to their exposure to blood during surgery and the frequent use of sharp instruments (Karunarathna *et al.,* 2024). On the other hand, nurses and phlebotomists are workers who regularly handle needles and draw blood, placing them at risk of needlestick injuries and exposure to BBPs (Canetti *et al.,* 2024 & Ballouz*et al.,* 2024). Laboratory personnel working with blood samples or handling biological materials are at risk if proper precautions are not followed. Individuals responsible for cleaning healthcare facilities are often exposed to contaminated waste or improperly discarded sharps (Canetti *et al.,* 2024; Ballouz*et al.,* 2024). A lack of thorough adherence to safety protocols during high-pressure situations contributes to this issue (Takougang*et al.,* 2024). Insufficient training regarding infection control practices can result in improper handling of sharps and failure to use personal protective equipment (PPE). Also, the long hours, high patient volumes, and burnout can lead to decreased vigilance in following safety protocols, increasing the risk of

exposure (Aliyo & Gemechu, 2024). In addition, inadequate access to disposal containers for sharps, lack of safety-engineered devices, and poor workplace organization can increase the likelihood of exposure incidents (Aliyo & Gemechu, 2024). Fortunately, these pathogens are preventable through proper safety protocols, PPE use, and post-exposure prophylaxis (PEP) in healthcare environments (Khoe *et al.,* 2024). However, challenges such as inconsistent training, inadequate reporting systems, and uneven resource allocation across facilities hinder compliance and undermine the effectiveness of the prevention policy. In Saudi Arabia, a rapidly growing healthcare sector coupled with a high prevalence of blood-borne diseases among patients necessitates a critical focus on protecting HCWs (Ibrahim *et al*., 2019; Saad & Jasli, 2024). Therefore, the government has implemented national standards that align with OSHA guidelines and WHO recommendations, aiming to reduce BBP exposure. Despite these initiatives, there remains a need for continuous education and strict adherence to safety protocols to reduce further the incidence of needlestick injuries (Almuzaini, 2023, Saad and Jasli, 2024). Therefore, identifying and addressing the gaps in healthcare workers' training courses on infection control, experiencing needle stick/ sharp injuries, and practice grades are highly needed to improve overall safety and reduce BBP exposure risks. In addition, these problems are exacerbated by the lack of robust data on the incidence of exposure, the effectiveness of training programs, and the gaps in preventive practices. This indicates a need for targeted research focused on understanding the depth of these issues and identifying the most effective solutions to bridge the existing gaps.

Goal and Objectives: The goal of the current study was to identify the gaps in healthcare workers' training courses on infection control, experiencing needle stick/ sharp injuries, and practice grade

Research Design and Methods

Research Design: A quantitative cross-sectional study design

Study Area and Population: King Fahad Hospital (Specialized, AL-Madinah AL-Munawara, Saudi Arabia, is a locally and internationally accredited hospital by CBAHI (Central Board for Accreditation of Healthcare Institutions) and Joint Commission International (JCI). It is classified as a tertiary, referral, teaching, and training hospital under the Ministry of Health (MOH). This hospital has a 500-bed capacity that caters to all adult critical, medical, and surgical sub-specialties and deals with emergencies. And Al-Miqat General Hospital in AL-Madinah AL-Munawara, Saudi Arabia. It is a secondary care hospital under the Ministry of Health (MOH) and receives government funding. HCWs' specialties (physicians, nurses, technicians, cleaners) currently working in the two hospitals are eligible for inclusion in the current field test study.

Sample Size: The sample size was calculated, total which was of 112 participants.

Inclusion criteria: All different specialties in the study population currently work in departments (emergency, intensive care unit, operating rooms, laboratory, ordinary wards, and blood sampling unit) in the selected hospital. Both (male and female) and (Saudi and Non-Saudi) and those HCWs who gave informed consent to participate were involved in this study.

Exclusion criteria: All HCWs on vacation and any health professional who works in an office and is not at high risk of blood contact or dealing with it were excluded.

Data Collection Tool and Procedure for Data Collection: Healthcare workers completed a questionnaire to gather data on their infection control training, experiences with needle sticks and sharp injuries, and practice grades. The questionnaire comprised sections on demographic data, including age, sex, nationality, hospital department, job title, qualifications, and years of experience, alongside information regarding training courses, needle stick or sharp injuries, and practice grades. The practices section comprised 20 items that assessed compliance with safety protocols, categorized into four primary categories and 20 subcategories. The categories encompassed hand hygiene, sharp device safety, disposal and handling, and personal protective equipment (PPE). Each domain included items structured as closed-ended questions, utilizing a combination of five multiple-choice options: always, often, sometimes, seldom, and never.

Definitions for scoring: Assessing the practice on practicing, Participants will be given 1 point for each activity they were always practicing and 0 points for other answers. The overall level of practice will be classified as poor (<50% score), moderate (50–79% right answer), and good (80–100% score) (Abalkhail*et al*., 2021).

Data Analysis: The collected data were entered, cleaned, and analyzed using SPSS version 29 statistical software. Descriptive statistics were calculated and correlated, including numbers and percentages in both demographic and test sections .

Validity and Reliability: A pilot study was conducted to test the reliability and validity of the questionnaire to ensure that it is clear, intelligible, and relevant to the research topic. All participants in the pilot study should meet the same inclusion criteria. Furthermore, face validity confirmed the questionnaire's clarity and relevance. Additionally, the researcher will ensure that the participants understand each statement in the questionnaire (Peirce *et al*., 2016).

Ethical Implications: This study adhered to ethical guidelines, ensuring participant confidentiality, voluntary participation, informed consent, and protection of participants' rights. Before data collection began, ethical approval was sought from the relevant institutional review board

RESULTS

The study analyzed the characteristics and practices of personnel working in a healthcare setting.

Response Rate: All the selected candidates 112 were respondents and answered the questionnaire questions, giving a 100% response rate.

Socio-demographic variables: Most participants were aged between 31–40 years (44.6%), followed by 41–50 years (30.4%) and 21–30 years (25.0%). Gender distribution was

Table 1. Descriptive statistics among the studied personnel

Variables		Frequency	Percentage (%)
Age (years)	21-30	28	25.0
	31-40	50	44.6
	41-50	34	30.4
Gender	Male	58	51.8
	Female	54	48.2
Nationality	Saudi	65	58.0
	Non-Saudi	47	42.0
Job description	Specialized	56	50.0
	General	56	50.0
Department	Emergency room	26	23.2
	Operation room	21	18.8
	Lab	22	19.6
	Ward	19	17.0
	ICU	24	21.4
Job category	Physician	17	15.2
	Nurse	51	45.5
	Technician	34	30.4
	Cleaner	10	8.9
Qualification	Undergraduate	39	34.8
	Graduate	58	51.8
	Postgraduate	15	13.4
Length of time worked at the hospital (Years)	1-5	31	27.7
	6-10	23	20.5
	11-15	26	23.2
	16-20	21	18.8
	>20	11	9.8
Training courses on infection control (BBPS)	Yes	19	17.0
	No	93	83.0
Experiencing needle stick/ sharp injuries	Yes	70	62.5
	No	42	37.5
Practice grade	**Poor**	13	11.6%
	Moderate	53	47.3%
	Good	46	41.1%

Nearly even, with males comprising 51.8% and females 48.2%. A majority were Saudi nationals (58.0%), while 42.0% were non-Saudi. Job roles were split evenly between specialized and general (50% each). Departments included Emergency Room (23.2%), ICU (21.4%), Lab (19.6%), Operating Room (18.8%), and Ward (17.0%). Nurses formed the most significant professional group (45.5%), followed by technicians (30.4%), physicians (15.2%), and cleaners (8.9%). More than half of the participants were graduates (51.8%), while 34.8% were undergraduates and 13.4% were postgraduates. Most personnel had worked for 1–5 years (27.7%), with fewer in the 6–10 years (20.5%), 11–15 years (23.2%), 16–20 years (18.8%), and >20 years (9.8%) categories.

The test variables: Only 17.0% of the personnel had received training in infection control, while 83.0% had not. 62.5% of participants reported needle sticks or sharp injuries, indicating a significant occupational risk. 41.1% of participants rated their practice as "Good,",47.3% as "Moderate," and 11.6% as "Poor."

DISCUSSION

Socio-Demographic Variables: The participants' socio-demographic profile provides a comprehensive snapshot of the workforce in the study setting. The age distribution, with the majority (44.6%) between 31–40 years, reflects a predominantly mid-career workforce, often associated with practical experience and familiarity with institutional protocols. However, the significant proportion of younger personnel (25.0% aged 21–30 years) highlights the need for targeted training initiatives to build foundational skills, particularly in infection control, early in their careers. The nearly equal gender distribution (51.8% males, 48.2% females) underscores a balanced workforce, allowing diverse perspectives in addressing occupational challenges. The dominance of Saudi nationals (58.0%) suggests the study's findings represent the local healthcare workforce, though the inclusion of 42.0% non-Saudis highlights the multicultural nature of healthcare settings in the region. The representation of various departments (Emergency Room, ICU, Lab, Operating Room, and Ward) indicates a well-rounded assessment of infection control practices across high-risk areas. Nurses, being the largest group (45.5%), likely account for the bulk of patient-facing roles, which may explain their increased vulnerability to occupational hazards like needle stick injuries. Technicians (30.4%) and physicians (15.2%) contribute to the specialized care spectrum, while cleaners (8.9%) play a critical role in maintaining hygiene, often with limited formal training. The educational qualifications reveal a workforce primarily composed of graduates (51.8%), with fewer undergraduates (34.8%) and postgraduates (13.4%). This distribution suggests potential gaps in advanced infection control knowledge among undergraduates. Furthermore, the distribution of work experience, with 27.7% having 1–5 years and fewer in higher experience brackets, may imply a workforce in transition or turnover, necessitating continuous professional development programs. Education, Occupational Hazards, and Practices: The findings on infection control training are striking, with only 17.0% of participants reporting formal training. This deficiency is concerning, as it likely contributes to suboptimal practices and increased exposure to occupational hazards. The high prevalence of needle sticks or sharp injuries (62.5%) underscores a critical safety gap, potentially exacerbated by inadequate training and non-

compliance with standard precautions. The first report of needlestick and sharps injury of HCWs in a tertiary care center in Saudi Arabia was reported (Memish *et al*., 2002). Later, a significant serious consequence of needle sticks among Healthcare Workers in Najran, Saudi Arabia, was reported (Hashmi *et al*., 2012) and recently by Makeen and his colleagues (2022). These injuries pose severe risks, including transmission of blood-borne pathogens, and highlight the urgent need for comprehensive safety protocols and regular training programs (Alsabaani *et al*., 2022). Despite these challenges, 41.1% of participants demonstrated "Good" infection control practices, which is encouraging. However, the 58.9% rated as "Moderate and Poor" indicates significant room for improvement. This discrepancy may reflect varying levels of awareness, training, and adherence to infection control measures across departments and professional roles. Departments such as the ICU and Emergency Room, which face high patient turnover and critical cases, may particularly benefit from targeted interventions.

Implications for Practice: The demographic and occupational data reveal key areas for intervention. Younger, less experienced personnel and those without formal training should be prioritized for infection control education. Additionally, targeted workshops for non-clinical staff, such as cleaners, are essential to uphold safety standards across all roles. Addressing the high rate of needle stick injuries through enhanced safety protocols, such as the adoption of safety-engineered devices and post-exposure prophylaxis policies, is critical. The findings also highlight the need for organizational policies to standardize infection control training as a mandatory onboarding and continuous education component. Tailored programs for high-risk departments, like the ICU and Emergency Room, could bridge the practice gap and improve compliance.

CONCLUSION

This study underscores critical gaps in training and safety practices among healthcare personnel, with significant implications for infection control and workplace safety. By addressing these gaps through structured training, resource allocation, and enforcement of safety policies, healthcare institutions can foster a safer environment for both patients and staff. These findings serve as a call to action for stakeholders to invest in long-term solutions for sustainable improvements in infection control practices.

RECOMMENDATION

Regular, mandatory infection control training should be implemented for all personnel, focusing on high-risk departments. Training sessions should emphasize proper handling of sharps and strategies to prevent needle stick injuries. Establish robust systems to monitor adherence to infection control practices and provide feedback to staff. Conduct periodic assessments of infection control knowledge and skills to ensure continued improvement. Develop and enforce comprehensive infection control policies across all departments. Allocate sufficient resources, including personal protective equipment (PPE) and safety devices, to minimize occupational risks. Promote a workplace culture that prioritizes safety through leadership involvement and regular communication. Encourage reporting of needle stick injuries and near-miss events to learn from incidents and improve prevention strategies. Conduct follow-up studies to evaluate the impact of training and policy changes on compliance and practice outcomes.

Delimitations and Limitations: The study was conducted in a specific healthcare setting (within Saudi Arabia), limiting the focus to this region and potentially excluding diverse healthcare environments, such as rural. The relatively small sample size of 112 participants limits the ability to generalize the findings to all healthcare personnel, particularly those outside the study's setting or population demographics. Reliance on self-reported information for training, experiences, and practices may introduce bias, such as recall bias or social desirability bias, potentially affecting the accuracy of the findings. The study did not account for differences in the quality, duration, or content of infection control training received, which could have influenced practice grades among participants.

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APPENDIX

Questionnaire

Healthcare workers practice: practice compliance to blood-borne pathogen prevention (select only one option for each statement).

NO	Statements	Always	often	Sometimes	seldom	never
1	Performing hand hygiene with each an aseptic task.	☐	☐	☐	☐	☐
2	Hands washed before and after using gloves.	☐	☐	☐	☐	☐
3	Hands should be washed after contact with blood and body fluid	☐	☐	☐	☐	☐
4	Wash hands immediately after contacting any blood, body fluid, secretion, excretion, or dirty substances.	☐	☐	☐	☐	☐
5	Opportunities for Hand Hygiene with soap or alcohol hand rub gel	☐	☐	☐	☐	☐
6	If a safe needle device isn't available the recap a needle, I used a one-handed scoop recapping technique.	☐	☐	☐	☐	☐
7	Always keep the sharps pointed away from you and others	☐	☐	☐	☐	☐
8	When procedures and activities are likely to generate splashes or sprays of blood or body fluids, Needles should not be bent before disposal.	☐	☐	☐	☐	☐
9	Activate any sharp device safety feature as soon as possible after using it, following the manufacturer's guidelines.	☐	☐	☐	☐	☐
10	Never reach into a sharps container or push other sharps into a container if they stick out.	☐	☐	☐	☐	☐
11	Don't hand a sharp to another person or place it in a location for disposal by another person.	☐	☐	☐	☐	☐
12	Place all sharps into a sharp container in the area where you used them immediately after use.	☐	☐	☐	☐	☐

Continue ….

13	Don't separate contaminated needles from syringes or tubing before discarding them.	☐	☐	☐	☐	☐
14	A surgical mask should be worn to protect the nose and mouth during contact with blood and body fluids.	☐	☐	☐	☐	☐
15	Wearing gloves when handling patient fluids or during contact with any blood and body fluids.	☐	☐	☐	☐	☐
16	Wearing gloves when performing parenteral injections or contact with any blood and body fluids.	☐	☐	☐	☐	☐
17	Wearing gloves when they come in contact with blood medical waste disposal	☐	☐	☐	☐	☐
18	Wearing a mask when performing procedures that might induce the spraying of blood, body fluid, secretions, or excretions	☐	☐	☐	☐	☐
19	Wearing a protective eye patch or goggles when performing procedures that might induce the spraying of blood, body fluids, secretions, or excretions	☐	☐	☐	☐	☐
20	I wear protective suits or gowns when carrying out tasks that might cause blood, bodily fluids, secretions, or excretions to spray.	☐	☐	☐	☐	☐

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