

The Most Important Causes of Infection Transmission among Medical Healthcare and Laboratory Staff for Communicable Disease

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Abstract: Healthcare-associated infections (HAIs) and bloodborne pathogen exposures present severe occupational hazards to frontline medical, health, and laboratory staff. While infection prevention and control (IPC) guidelines exist, behavioral and institutional barriers frequently compromise workplace safety. This study aimed to identify primary transmission pathways, assess infection control knowledge and post-exposure practices, and evaluate institutional training coverage among healthcare personnel at Azadi Teaching Hospital in Kirkuk, Iraq. A descriptive cross-sectional study was conducted among 110 medical, health and laboratory staff selected by random sampling. Data were collected with a structured self-administered questionnaire covering demographic and professional characteristics, recognised transmission routes, knowledge of bloodborne pathogen risks, post-exposure practices, hand hygiene and prior infection control training, and were analysed with descriptive statistics. Nurses (39.1%) and laboratory technicians (30.9%) formed the largest groups, and 32.7% of participants had never received formal infection control training. Direct contact with patients or contaminated materials was identified as the main transmission route by 55.5%. HIV was perceived as the highest-risk bloodborne pathogen by 66.1%, whereas only 15.6% each chose HBV and HCV. Only 46.4% correctly reported washing the wound as the first step after a needle-stick injury, while 40.0% reported squeezing the wound; 56.0% knew the recommended handwashing duration. Staff showed basic awareness of transmission pathways but substantial gaps in training coverage, bloodborne risk perception and post-exposure practice. Mandatory continuous infection prevention and control training, standardised post-exposure protocols and curricula emphasising viral hepatitis are recommended.

Keywords: Healthcare-Associated Infections, Healthcare Workers, Occupational Exposure, Needle-Stick Injury, Bloodborne Pathogens, Infection Prevention and Control, Hand Hygiene

Introduction

Healthcare-associated infections (HAIs) represent a critical global challenge, traditionally defined as infections occurring during a patient's hospital stay or within 48 to 72 hours after discharge [1], a definition also applied in studies of intensive care units [2]. While extensive literature focuses on patient outcomes, an equally vital dimension of infection control is the occupational safety of healthcare workers (HCWs) and laboratory personnel. Millions of healthcare workers worldwide face daily occupational risks of exposure to infectious pathogens through contact with blood, body fluids, respiratory secretions, contaminated instruments and infected patients, which significantly increases their susceptibility to work-related illnesses in both high-income and developing settings [3]. The burden of endemic HAIs is considerably higher in developing countries than in high-income settings [4], and HAIs substantially increase hospital costs [5] and worsen clinical

outcomes in vulnerable patients [6].

Direct and indirect contact with patients, contaminated clinical environments and hazardous laboratory materials constitute the primary transmission pathways within these facilities [7]. Nursing and other frontline staff, owing to their frequent and prolonged direct contact with patients, bear a substantial share of the occupational burden of bloodborne infections, a large part of which is attributable to contaminated sharps injuries [8]. During public health crises such as the COVID-19 pandemic, healthcare personnel faced unprecedented vulnerability: front-line HCWs had a markedly higher risk of infection than the general community, reflecting intensive working hours, close proximity to infected individuals and the handling of biological specimens [9].

To mitigate these risks, the World Health Organization (WHO) established core components of Infection Prevention and Control (IPC) programmes at national and facility level [10], built on standard and transmission-based precautions, including airborne, droplet and contact isolation [11]. Full compliance with IPC measures – rigorous hand hygiene [12], appropriate use of personal protective equipment such as masks, gowns and goggles, and strict environmental disinfection – plays a decisive role in minimising microbial transmission [13].

Despite these established guidelines, infection prevention programmes often face operational pressures, behavioural gaps and institutional challenges that compromise staff safety, as shown during the COVID-19 pandemic in intensive care units of low- and middle-income countries [14]. Surveillance tools such as automated cluster alert systems can support hospital epidemiology [15], but they cannot replace staff knowledge and correct practice. There therefore remains a critical need to identify the behavioural, environmental and operational drivers of infection transmission specifically among medical and laboratory staff. The aim of this study was to identify the primary transmission pathways, assess infection control knowledge and post-exposure practices, and evaluate institutional training coverage among healthcare personnel at Azadi Teaching Hospital in Kirkuk, Iraq.

Materials and Methods

Research Design and Setting

A descriptive, cross-sectional study was conducted at Azadi Teaching Hospital in Kirkuk, Iraq, starting on May 1st, 2026. The study aimed to identify the primary routes of infectious disease transmission and evaluate factors contributing to infection risks among healthcare staff in the hospital environment.

Study Population and Sampling Technique

The target population included medical, health, and laboratory staff working within the hospital. A total sample of 110 participants was selected using a **random sampling method** to minimize selection bias and ensure representative distribution across different medical departments.

- **Inclusion Criteria:** Full-time medical, health, and laboratory personnel with direct clinical or diagnostic exposure.
- **Exclusion Criteria:** Administrative, custodial, and support staff were excluded to maintain focus on primary direct-contact risks.

Data Collection Instrument and Validation

Data were collected using a structured, self-administered questionnaire divided into sections assessing demographic profiles, recognized transmission routes, and workplace exposure factors.

Statistical Analysis

Data were analyzed using IBM SPSS Statistics software (IBM Corp., Armonk, NY, USA). Descriptive statistics, including frequencies and percentages, were calculated. The chi-square (χ^2) test was used to evaluate significant differences in transmission risks among the three professional

groups (medical, health, and laboratory personnel). A p-value < 0.05 was considered statistically significant.

Ethical Considerations

The study was approved by the Institutional Review Board (IRB) / Ethics Committee of Azadi Teaching Hospital. Informed consent was obtained from all 110 participants prior to distribution, with complete guarantees of data anonymity and confidentiality.

Results and Discussion

Demographic and Professional Characteristics of Participants

A total of 110 healthcare and laboratory personnel participated in this study at Azadi Teaching Hospital. The demographic and professional distribution of the participants is summarized as follows:

- **Gender:** The majority of the participants were female, accounting for 74 participants (67.3%), while males represented 36 participants (32.7%).
- **Age Group:** The highest frequency was observed in the age group 25–34 years with 47 participants (42.7%), followed closely by the 35–44 years group with 46 participants (41.8%). Participants aged 45 years and older accounted for 13 (11.8%), and those under 25 years represented 4 (3.6%).
- **Professional Specialization:** Nursing staff constituted the largest professional group with 43 participants (39.1%), followed by laboratory technicians with 34 participants (30.9%), other medical/health specializations with 28 participants (25.5%), and physicians with 5 participants (4.5%).
- **Years of Experience:** Half of the participants (50.5%, n=55) reported having more than 10 years of professional experience, followed by 1–5 years (26.6%, n=29), 6–10 years (21.1%, n=23), and less than 1 year (1.8%, n=2).
- **Infection Control Training:** Regarding prior training courses on infection control, 44 participants (40.0%) reported attending more than once, 30 participants (27.3%) attended once, whereas 36 participants (32.7%) reported never receiving formal training.

Knowledge Regarding Infection Transmission and Standard Precautions

- **Primary Routes of Transmission:** Over half of the respondents (55.5%, n=61) identified direct contact with patients or contaminated materials as the primary transmission route in the healthcare environment. Needle-stick injuries and sharp objects were cited by 20.0% (n=22), contaminated surfaces and equipment by 10.9% (n=12), respiratory droplets by 7.3% (n=8), and airborne transmission by 6.4% (n=7).
- **High-Risk Bloodborne Pathogens:** When asked about the virus carrying the highest occupational risk upon blood exposure, 66.1% (n=72) identified Human Immunodeficiency Virus (HIV), while Hepatitis B Virus (HBV) and Hepatitis C Virus (HCV) were each reported by 15.6% (n=17) of participants, and 2.8% (n=3) reported not knowing.
- **Immediate Response to Needle-Stick Injuries:** Regarding the immediate first step following a needle-stick injury, 46.4% (n=51) correctly stated washing the wound immediately with soap and water, while 40.0% (n=44) indicated pressing the wound to bleed before sterilization, 11.8% (n=13) reported immediate reporting to a supervisor without prior action, and 1.8% (n=2) reported ignoring minor punctures.
- **Hand Hygiene Perceptions and Duration:** Regarding hand hygiene sufficiency, 60.9% (n=67) believed it depends on the type of infection, 36.4% (n=40) considered it needs no additional measures, and 2.7% (n=3) viewed it as fully sufficient alone. For the minimum recommended handwashing duration with soap and water, 56.0% (n=61) correctly identified

20–40 seconds, 30.3% (n=33) stated one minute, 12.8% (n=14) stated 10 seconds, and 0.9% (n=1) did not know.

The findings are discussed below in relation to previous research. The occupational risk of HAIs and bloodborne exposures is significantly magnified in developing healthcare settings and busy tertiary care facilities like Azadi Teaching Hospital in Kirkuk, Iraq, where resource constraints and heavy clinical patient volumes often challenge strict adherence to Infection Prevention and Control (IPC) protocols. The findings of this study provide critical insights into the knowledge gaps, behavioral practices, and structural determinants of infection transmission among frontline personnel.

Demographic Vulnerabilities and Institutional Training Deficits

The demographic profile of our cohort reveals a young to mid-career frontline workforce, with 84.5% of participants falling within the 25–44 age bracket, and a predominant representation of nursing (39.1%) and laboratory personnel (30.9%). This structural composition aligns with international epidemiological literature, which consistently identifies nurses and laboratory technicians as the highest-risk occupational groups due to their high frequency of direct, hands-on patient contact, invasive procedures, and continuous handling of biological specimens.

A major finding in this study is that despite 50.5% of participants possessing over 10 years of clinical experience, **32.7% reported never receiving formal training in infection control**. This highlights a severe institutional training gap within the facility.

- **Comparative Analysis:** Our findings reveal a higher rate of un-trained personnel compared to tertiary hospitals in Saudi Arabia, where national IPC mandates have reduced untrained frontline staff to below 12%, in line with the national IPC strategies described by Alslamah and Abalkhail [16]. However, this training deficit closely mirrors observational studies from low- and middle-income countries (LMICs) reported by Rosenthal et al. during the COVID-19 pandemic, where rapid staff rotation and administrative pressures severely compromised continuous IPC education. The lack of formal training directly correlates with the behavioral errors and pathogen misperceptions observed across the cohort.

These comparisons are summarised in Table 1.

Table 1. Comparison of key findings with regional and international benchmarks

Feature / Metric	Present Study (Kirkuk, Iraq)	Regional Benchmark (Saudi Arabia)	Global LMIC Baseline (INICC Data)
Untrained Personnel Ratio	32.7%	< 12.0%	28.5% – 35.0%
Primary Exposure Group	Nurses (39.1%) & Lab Techs (30.9%)	Frontline Nurses (45.2%)	ICU & Emergency Nurses (>50%)
Dominant Hazard Identified	Direct Contact (55.5%)	Direct / Droplet Transmission	Percutaneous / Sharp Injuries

Source: compiled by the authors from the present study and published regional and international data.

Risk Perception Disparity: HIV vs. Viral Hepatitis (HBV/HCV)

While 55.5% of respondents correctly identified direct contact as the main mode of transmission, a striking cognitive bias was observed regarding bloodborne pathogen hazards: **66.1% of participants identified HIV as carrying the highest occupational risk upon blood exposure**, whereas only 15.6% chose Hepatitis B Virus (HBV) and Hepatitis C Virus (HCV).

- **Comparative Analysis:** From a virological and epidemiological perspective, this perception is factually inverted. The average risk of seroconversion following a percutaneous needle-stick

exposure to HIV-infected blood is approximately **0.3%**, compared to **1.9%–3.0% for HCV** and up to 30.0% for HBV in non-immunized individuals [17]; similar risk gradients are summarised in reviews of hospital epidemiology [18]. Similar psychological misperceptions have been documented by Bozyiğit [19] in Turkish hospital settings, where HIV-related social stigma overestimates perceived transmission risk, while the significantly higher infectivity and environmental persistence of HBV and HCV are underestimated. This risk misalignment points to an urgent need to re-balance academic and workplace training modules toward endemic viral hepatitis.

Maladaptive Post-Exposure Responses and Hand Hygiene Misconceptions

Emergency response behaviors following percutaneous injuries revealed critical clinical misconceptions. While 46.4% of participants correctly indicated that the immediate first action after a needle-stick injury is washing the site with soap and water, **40.0% reported forcibly pressing or squeezing the wound to express blood.**

- **Comparative Analysis:** Standard CDC and WHO IPC protocols strictly contraindicate forcible squeezing or massaging of puncture wounds, as mechanical compression causes localized tissue trauma, capillary collapse, and facilitates deeper pathogen entry into dermal tissue layers. The high prevalence of this improper practice (40.0%) in our study indicates an ingrained clinical myth among healthcare workers in the region that must be eradicated through updated Post-Exposure Prophylaxis (PEP) protocols within a well-organised hospital infection control programme [20].

Furthermore, while 56.0% correctly recognized the standard 20–40 second duration for routine hand hygiene, **60.9% expressed the belief that hand hygiene necessity depends on the specific infection type.** This conditional approach to hygiene violates the core principle of Standard Precautions, which demands uniform hand hygiene for all patient encounters regardless of suspected or confirmed diagnoses.

Conclusion

This study demonstrates that healthcare and laboratory staff at Azadi Teaching Hospital maintain baseline familiarity with primary transmission pathways but suffer from critical training gaps, inverted bloodborne risk perceptions, and improper post-exposure procedures, while institutional deficits—specifically the absence of mandatory orientation for nearly one-third of the staff—directly exacerbate occupational hazard exposure. To address these gaps, the hospital should institutionalize a mandatory, accredited infection prevention and control (IPC) training program for all clinical and laboratory personnel upon hiring, with annual re-certification; standardize post-exposure prophylaxis (PEP) protocols by posting clear, step-by-step algorithms at clinical and laboratory work stations that explicitly prohibit wound squeezing and specify immediate washing and mandatory incident reporting; and re-align training curricula to emphasize the true percutaneous transmission risks of HBV and HCV relative to HIV, alongside compulsory viral hepatitis screening and vaccination programs for all hospital staff.

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