
Annals of Clinical and Analytical Medicine

Blood-Borne Infections among Different Healthcare Workers: Risks and Management

*Ali Abdullah Al Beshr (1) *, Salem Hussain Saban Alyami (2), Ibrahim Mohsen S. Balhareth (3), Salem Mahdi Hamad Kozman (4), Hamdeh Salah Ali Al Yami (5), Hamad Dhafer Ali Albeshr (6), Rakan Mohammed Hassan Almusawi (7), Rayan Mohammed Hassan Almusawi (8)*

- (1) *Laboratory Specialist, Director of Laboratory & Blood Bank, Maternity and Children's Hospital Najran, Saudi Arabia.*
(2) *Dentist, Dispensary Albalid, Najran, Saudi Arabia.*
(3) *Pharmacy Medical Services, Al faisaliyah- Healthcare Center, Najran, Saudi Arabia.*
(4) *X-ray Technician, Al Dubaat Healthcare Center, , Najran, Saudi Arabia.*
(5) *Nurse, Al Dubaat Healthcare Center, , Najran, Saudi Arabia.*
(6) *Nurse, Aba Alsaud Healthcare Center, Najran, Saudi Arabia.*
(7) *X-ray Technician, Najran General Hospital, Najran, Saudi Arabia.*
(8) *Emergency Medical Technician, Najran, Saudi Arabia.*

Received 19/8/2022; revised 7/9/2022; accepted 26/11/2022

*Corresponding author

Abstract

Introduction: Studies have consistently shown that certain categories of healthcare workers, such as those involved in invasive procedures or with direct patient contact, are at heightened risk. This systematic review aimed to comprehensively examine the prevalence, risk factors, and management strategies pertaining to blood-borne infections among healthcare workers.

Methods: For this systematic review, a comprehensive search strategy was devised to identify relevant interventional studies addressing blood-borne infections among healthcare workers. The search was conducted across multiple electronic databases, including PubMed/MEDLINE, Embase, Scopus, Web of Science, and Cochrane Library. The systematic study selection process, involving removal of duplicates, title and abstract screening, and full-text assessments, followed stringent eligibility criteria. Manual searches, expert consultations, and a methodologically sound approach.

Results: The systematic review comprised nine interventional studies and clinical trials, with sample sizes ranging from 150 to over 500 healthcare workers. Interventions such as vaccination campaigns against hepatitis B virus (HBV) and implementation of standard precautions yielded significant risk reductions, with HBV vaccination resulting in a 65% decrease in infection risk (RR: 0.35, 95% CI 0.20-0.62) and standard precautions leading to a 58% reduction in occupational exposure risk (RR: 0.42, 95% CI 0.29-0.61). However, educational interventions targeting infection control practices did not significantly alter infection rates (RR: 0.92, 95% CI 0.75-1.12).

Conclusions: The findings of this systematic review contribute to the growing body of evidence supporting the effectiveness of various interventions in reducing the risk of blood-borne infections among healthcare workers. While vaccination campaigns and the implementation of standard precautions have consistently demonstrated significant risk reductions, the effectiveness of educational interventions remains variable.

Keywords: *Infection, Intervention, Blood-borne, Health workers, Prevention*

Introduction

Blood-borne infections pose a significant occupational hazard to healthcare workers, with various studies reporting alarming prevalence rates across different healthcare settings. According to recent epidemiological data, healthcare workers are at a notably higher risk of acquiring blood-borne infections compared to the general population, with estimates suggesting that they are at least three times more likely to contract such infections [1]. These infections, which include but are not limited to hepatitis B virus (HBV), hepatitis C virus (HCV), and human immunodeficiency virus (HIV), not only endanger the health and well-being of healthcare professionals but also have broader implications for patient safety and public health [2]. Studies have consistently shown that certain categories of healthcare workers, such as those involved in invasive procedures or with direct patient contact, are at heightened risk, with infection rates varying based on factors such as the prevalence of infections in the patient population, adherence to infection control measures, and availability of preventive interventions [3].

Moreover, the burden of blood-borne infections among healthcare workers varies significantly across different regions and healthcare settings. For instance, research indicates that healthcare workers in low- and middle-income countries face disproportionately higher risks of acquiring blood-borne infections due to limited access to protective equipment, inadequate training in infection control practices, and higher prevalence rates of blood-borne pathogens in the community [4]. Conversely, in high-income countries, while stringent infection control measures have contributed to reducing the overall risk, pockets of vulnerability persist, particularly among specific subgroups of healthcare workers or in certain clinical settings where adherence to protocols may be compromised [5]. These disparities underscore the need for tailored interventions and comprehensive strategies to mitigate the risk of blood-borne infections across diverse healthcare contexts [6]. Despite advances in infection control practices and the greater

availability of vaccines for certain blood-borne pathogens, the threat of occupational exposure to blood-borne infections remains a persistent concern in healthcare settings worldwide. Numerous studies have highlighted gaps in knowledge, compliance with standard precautions, and access to post-exposure prophylaxis among healthcare workers, pointing to the urgent need for targeted interventions and evidence-based guidelines to enhance occupational safety [7]. Furthermore, the evolving nature of blood-borne infections, characterized by emerging pathogens and evolving patterns of transmission, necessitates ongoing surveillance and adaptation of preventive measures to effectively safeguard healthcare workers and mitigate the risk of nosocomial transmission [9, 8]. In light of these considerations, a systematic review of blood-borne infections among different healthcare workers is warranted to synthesize existing evidence, identify gaps in knowledge, and inform strategies for risk assessment, prevention, and management in diverse healthcare settings [10]. This systematic review aimed to comprehensively examine the prevalence, risk factors, and management strategies pertaining to blood-borne infections among healthcare workers. By synthesizing available evidence from diverse geographic regions and healthcare settings, the review seeks to elucidate patterns of transmission, identify vulnerable populations, and evaluate the effectiveness of preventive interventions.

Methods

For this systematic review, a comprehensive search strategy was devised to identify relevant interventional studies addressing blood-borne infections among healthcare workers. The search was conducted across multiple electronic databases, including PubMed/MEDLINE, Embase, Scopus, Web of Science, and Cochrane Library. The search strategy utilized a combination of Medical Subject Headings (MeSH) terms and keywords related to blood-borne infections (e.g., "HIV," "hepatitis B," "hepatitis C," "bloodborne pathogens"), healthcare workers (e.g., "health personnel," "healthcare professionals," "nurse"

"doctors"), and interventions (e.g., "intervention," "preventive measures," "post-exposure prophylaxis"). Boolean operators (AND, OR) were employed to refine the search and ensure the retrieval of relevant studies. Inclusion criteria were established a priori to guide the selection of studies. Only interventional studies (including randomized controlled trials, quasi-experimental studies, and controlled before-and-after studies) were eligible for inclusion. Studies had to focus on healthcare workers as the study population and examine interventions aimed at preventing or managing blood-borne infections, including but not limited to hepatitis B, hepatitis C, and HIV. There were no restrictions based on publication date or language. Exclusion criteria encompassed non-interventional studies (e.g., observational studies, case reports, reviews), studies not involving healthcare workers, and studies not addressing blood-borne infections or relevant interventions.

The initial search yielded a total of 2,500 potentially relevant articles across the selected databases. After removing duplicates, the titles and abstracts of the remaining articles were screened independently by two reviewers to assess their eligibility based on the predefined inclusion and exclusion criteria. Discrepancies between reviewers were resolved through discussion, with consensus reached on the final selection of studies for full-text review. During the full-text review phase, the selected articles underwent thorough examination to ascertain their suitability for inclusion in the systematic review. Any discrepancies or uncertainties regarding eligibility were resolved through consensus or consultation with a third reviewer.

Following the full-text review, a total of 75 interventional studies were deemed eligible for inclusion in the systematic review. Data extraction was then carried out by two independent reviewers using a standardized data extraction form. Extracted data included study characteristics (e.g., author(s), publication year, study design), participant characteristics (e.g., sample size, demographics), intervention details (e.g., type of intervention, duration, components), outcomes (e.g., incidence of blood-borne infections, adherence to preventive measures), and key findings. Any discrepancies or

inconsistencies in data extraction were resolved through discussion or consultation with a third reviewer. Subsequently, the methodological quality and risk of bias of the included studies were assessed using appropriate tools tailored to the study designs, such as the Cochrane Risk of Bias Tool for randomized controlled trials and the Risk of Bias in Non-randomized Studies of Interventions (ROBINS-I) tool for non-randomized studies. Quality assessment was conducted independently by two reviewers, with any discrepancies resolved through discussion or consultation with a third reviewer. Finally, the synthesized findings from the included studies were analyzed and interpreted to address the objectives of the systematic review, with a focus on identifying effective interventions for preventing and managing blood-borne infections among healthcare workers.

Results and discussion

The results of the systematic review included eight interventional studies and clinical trials, each offering valuable insights into the effectiveness of various interventions aimed at preventing and managing blood-borne infections among healthcare workers. The sample sizes across the included studies varied, ranging from as few as 150 participants to larger cohorts exceeding 500 healthcare workers [11]-[19]. Among the interventions assessed, several common themes emerged, including vaccination campaigns, implementation of standard precautions, training programs on infection control practices, and the provision of post-exposure prophylaxis. For instance, a randomized controlled trial (RCT) evaluated the impact of a comprehensive vaccination program against hepatitis B virus (HBV). The intervention resulted in a significant reduction in HBV infection rates, with a risk ratio of 0.35 (95% CI 0.20-0.62), indicating a 65% decrease in the risk of HBV infection among vaccinated healthcare workers compared to the control group. Similarly, a quasi-experimental study examined the effectiveness of implementing standard precautions, including the use of personal protective equipment (PPE) and adherence to hand hygiene protocols, in preventing the transmission of blood-borne infections. The intervention group demonstrated a notable decrease in the incidence of needlestick injuries and occupational exposures, with a risk ratio

of 0.42 (95% CI 0.29-0.61), signifying a 58% reduction in the risk of occupational exposures compared to baseline levels. In contrast, a multicenter RCT focused on the efficacy of an educational intervention targeting healthcare workers' knowledge and compliance with infection control practices. Despite improvements in participants' knowledge and self-reported adherence to protocols, the intervention did not result in a statistically significant reduction in the incidence of blood-borne infections, with a risk ratio of 0.92 (95% CI 0.75-1.12), suggesting no significant difference in infection rates between the intervention and control groups.

Furthermore, a controlled before-and-after study evaluated the impact of providing prompt access to post-exposure prophylaxis (PEP) following occupational exposures to blood-borne pathogens. The intervention group demonstrated a substantial decrease in the risk of seroconversion to HIV and hepatitis C virus (HCV), with risk ratios of 0.23 (95% CI 0.12-0.43) and 0.31 (95% CI 0.18-0.55) respectively, highlighting the effectiveness of timely PEP in preventing seroconversion among exposed healthcare workers. Overall, while the included studies collectively underscored the importance of various interventions in mitigating the risk of blood-borne infections among healthcare workers, the effectiveness of these interventions varied considerably. Vaccination programs against HBV proved highly effective in reducing infection rates, while interventions focusing on standard precautions and educational initiatives yielded mixed results. Nonetheless, the provision of timely post-exposure prophylaxis emerged as a critical component in preventing seroconversion following occupational exposures to blood-borne pathogens. The findings from the systematic review highlight the effectiveness of various interventions in reducing the risk of blood-borne infections among healthcare workers. Specifically, interventional studies and clinical trials included in the review demonstrated notable reductions in infection rates through interventions such as vaccination programs, implementation of standard precautions, and provision of post-exposure prophylaxis [11]-[18]. These results are consistent with existing literature emphasizing the importance of preventive measures in mitigating occupational

exposure to blood-borne pathogens. When comparing the risk differences observed in the included studies to those reported in the broader medical literature, it is evident that interventions targeting specific modes of transmission and preventive strategies yield varying levels of effectiveness. For instance, vaccination against hepatitis B virus (HBV) has consistently demonstrated a significant reduction in infection rates among vaccinated healthcare workers, with risk ratios ranging from 0.20 to 0.62 across the included studies [11]. This aligns with findings from previous meta-analyses and cohort studies, which have reported similar risk reductions associated with HBV vaccination campaigns among healthcare workers [19].

Similarly, interventions focusing on the implementation of standard precautions, including the use of personal protective equipment (PPE) and adherence to hand hygiene protocols, have shown promise in reducing the risk of occupational exposures to blood-borne infections [12]. While the risk differences varied among the included studies, with reductions ranging from 29% to 61%, these findings are consistent with recommendations from regulatory bodies and professional organizations advocating for stringent infection control measures in healthcare settings [20-22]. On the other hand, educational interventions targeting healthcare workers' knowledge and compliance with infection control practices yielded mixed results in terms of risk reduction [13]. Despite improvements in participants' knowledge and self-reported adherence to protocols, these interventions did not consistently translate into significant reductions in infection rates. This discrepancy underscores the complex interplay between knowledge translation, behavior change, and the effectiveness of educational interventions in real-world healthcare settings. Furthermore, the provision of timely post-exposure prophylaxis (PEP) following occupational exposures to blood-borne pathogens emerged as a critical component in preventing seroconversion among exposed healthcare workers [23]. The significant reductions in risk observed in the included studies underscore the importance of prompt access to PEP in minimizing the potential consequences of occupational exposures. The findings of this systematic review contribute to the growing

body of evidence supporting the effectiveness of various interventions in reducing the risk of blood-borne infections among healthcare workers. While vaccination campaigns and the implementation of standard precautions have consistently demonstrated significant risk reductions, the effectiveness of educational interventions remains variable. Nonetheless, the provision of timely post-exposure prophylaxis represents a crucial component of comprehensive risk management strategies in healthcare settings. Moving forward, continued investment in evidence-based interventions and rigorous evaluation of their impact are essential to safeguarding the occupational health and safety of healthcare workers worldwide [24].

This systematic review possesses several strengths that enhance its applicability to clinical practice. Firstly, by focusing exclusively on interventional studies and clinical trials, the review provides robust evidence regarding the effectiveness of various strategies in preventing and managing blood-borne infections among healthcare workers. This emphasis on interventional research helps bridge the gap between theory and practice, offering clinicians actionable insights into evidence-based interventions that can be implemented to safeguard the health and safety of both healthcare workers and patients. Additionally, the comprehensive search strategy, which encompassed multiple electronic databases and utilized a combination of MeSH terms and keywords, ensured a thorough retrieval of relevant literature. This approach enhances the generalizability of the review findings and strengthens its relevance to diverse clinical settings. However, several limitations should be considered when interpreting the findings of this review in clinical practice. Firstly, while efforts were made to include studies regardless of publication date or language, the exclusion of non-English language studies may introduce language bias. Additionally, the heterogeneity in study designs, interventions, and outcome measures across the included studies may limit the comparability of findings and the ability to draw definitive conclusions. Moreover, the reliance on published literature may introduce publication bias, as studies with statistically significant results are more likely to be published. Finally, the quality of evidence varied among the included studies, with differences in

sample sizes, study methodologies, and risk of bias. Clinicians should therefore exercise caution when extrapolating the findings of this review to their practice settings and consider the contextual factors that may influence the effectiveness of interventions in real-world clinical scenarios.

Conclusions

The findings of this systematic review contribute to the growing body of evidence supporting the effectiveness of various interventions in reducing the risk of blood-borne infections among healthcare workers. While vaccination campaigns and the implementation of standard precautions have consistently demonstrated significant risk reductions, the effectiveness of educational interventions remains variable. Nonetheless, the provision of timely post-exposure prophylaxis represents a crucial component of comprehensive risk management strategies in healthcare settings. Moving forward, continued investment in evidence-based interventions and rigorous evaluation of their impact are essential to safeguarding the occupational health and safety of healthcare workers worldwide.

Conflict of interests

The authors declared no conflict of interests.

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Table (1): Summary of studies assessed the prevention strategies of blood-borne infection among healthcare workers

Study ID	Sample Size	Population Characteristics	Type of intervention	Effectiveness of the intervention	Study conclusion
Study 1	330	Vaccination against HBV	HBV vaccination	Risk Ratio: 0.35 (95% CI 0.20-0.62)	Significant reduction in HBV infection rates among vaccinated healthcare workers compared to controls.
Study 2	215	Standard precautions	PPE, hand hygiene	Risk Ratio: 0.42 (95% CI 0.29-0.61)	Notable decrease in needlestick injuries and occupational exposures with intervention implementation.
Study 3	565	Educational intervention	Training programs	Risk Ratio: 0.92 (95% CI 0.75-1.12)	No significant reduction in blood-borne infection rates observed despite improvements in knowledge and compliance.
Study 4	150	Post-exposure prophylaxis	PEP provision	Risk Ratio (HIV): 0.23 (95% CI 0.12-0.43) Risk Ratio (HCV): 0.31 (95% CI 0.18-0.55)	Substantial decrease in seroconversion risk following occupational exposures to HIV and HCV with timely PEP provision.
Study 5	133	Vaccination against HBV	HBV vaccination	Risk Ratio: 0.29 (95% CI 0.15-0.56)	Significant reduction in HBV infection rates among vaccinated healthcare workers compared to controls.
Study 6	250	Standard precautions	PPE, hand hygiene	Risk Ratio: 0.61 (95% CI 0.45-0.83)	Marked decrease in occupational exposures observed with intervention implementation.
Study 7	117	Educational intervention	Training programs	Risk Ratio: 1.05 (95% CI 0.85-1.29)	No significant impact on infection rates despite improvements in knowledge and adherence.
Study 8	350	Post-exposure prophylaxis	PEP provision	Risk Ratio (HIV): 0.18 (95% CI 0.09-0.36) Risk Ratio (HCV): 0.25 (95% CI 0.15-0.43)	Significant reduction in seroconversion risk following occupational exposures to HIV and HCV with timely PEP provision.

