# Assessment of Infection Control Measures Application among Health Workers in Dongola Town Hospitals, Northern State, Sudan 2022 – 2023

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## Abstract

**Background:** Infection control is a clinical and public health specialty based on a practical, evidence-based approach that protects patients, health workers and visitors to health care facilities by preventing avoidable infections**.** It is universally relevant to every health worker and patient, at every health care interaction. The Aim of this study was, Assess the Infection Control Measures, Application among Health Worker in Dongola Town Hospitals Northern State, Sudan. 2022 – 2023. **Materials and Methods:** This is a cross sectional analytical hospital base study conducted in Dongola town hospitals among health workers. A multi stage sample of about 300 health workers were selected as participants by using the simple random method. The data in this study were collected by using two methods, namely the questionnaire and the checklist, and then the data was analyzed by using the Statistical Program for Social Sciences, and the results were presented in the form of tables and figures. **Results:** Hand hygiene facilities were available in 87.5% of hospitals, but only 56.3% of healthcare workers practiced hand washing correctly. 42% of healthcare workers washed their hands only during surgeries. Personal protective equipment was available in all hospitals, but its distribution was not according to the specific needs of different medical procedures, leading to improper use. In terms of medical waste management, 75% of hospitals had unsafe disposal practices, and only 35% of hospitals had safety boxes for syringe disposal. Regarding adherence to infection control standards, only 42% of healthcare workers had good access to and knowledge of infection control procedures. **Conclusion**: The study revealed significant gaps in infection control practices in Dongola hospitals, such as inconsistent hand hygiene, inadequate use of Personal protective equipment, unsafe medical waste disposal, and insufficient adherence to infection control standards. These issues highlight the need for improvements to effectively control infections and protect both healthcare workers and patients.

**Keywords:** ***Infection Control, Hand Hygiene, Personal Protection equipment, Medical Waste Management, Healthcare Workers.***

## Introduction

Hospital-acquired infections (HAIs) continue to be a significant health challenge worldwide, contributing to increased patient morbidity, mortality, and healthcare costs. This is particularly true in low-resource settings such as Dongola Town in Northern Sudan, where healthcare infrastructure struggles to meet the demands of infection prevention and control. HAIs not only worsen patient outcomes but also place additional strain on the healthcare system, increasing the burden on already limited resources. Healthcare workers (HCWs) are the frontline defense against HAIs, yet their adherence to infection control protocols often varies due to a range of factors, including insufficient training, inadequate facilities, and a lack of essential infection control resources. This situation is exacerbated in hospitals in low-income regions like Dongola, where gaps in knowledge, equipment availability, and institutional support hinder the effective implementation of infection control practices.

The World Health Organization (WHO) has emphasized that effective infection control practices—such as hand hygiene, proper use of personal protective equipment (PPE), aseptic techniques, and regular cleaning—are essential for preventing the spread of infections. In Sudan, despite the growing recognition of the importance of infection control, hospitals often lack the necessary resources to implement these measures fully. Healthcare workers may not have adequate training or may face environmental constraints that hinder their ability to comply with infection prevention protocols (WHO, 2017; Sayed et al., 2020). The problem is further exacerbated by the high prevalence of antibiotic resistance, a shortage of PPE, and insufficient awareness of infection control protocols.

Healthcare workers are essential in infection prevention, and their adherence to guidelines plays a critical role in minimizing the transmission of infections. However, numerous factors affect their compliance, including a lack of training, inadequate facilities, and overwhelming patient loads. This results in lapses in infection control practices, particularly in Dongola Town hospitals, where there is limited research and data on the effectiveness of infection control measures. Prolonged hospital stays, higher healthcare costs, and an increased risk of mortality due to HAIs make it crucial to understand the current state of infection control practices in Dongola hospitals.

Numerous studies across different settings have highlighted the global prevalence of HAIs and the critical role of infection control measures in mitigating these infections. For example, a study in Northern Nigeria assessed the knowledge and practice of standard precautions among healthcare workers in hospitals, revealing significant gaps in adherence to infection control measures. While 77.9% of healthcare workers understood the importance of universal precautions, only 70.1% regularly wore gloves, and a mere 3.3% had a proper sharp disposal system (Amoran & Onwube, 2013). These findings emphasize the importance of ensuring access to necessary equipment and consistent training to improve compliance.

Similarly, studies on the economic burden of nosocomial infections highlight the severe consequences of inadequate infection control. A study by Puchter et al. (2019) noted that the implementation of infection control measures, such as those targeting vancomycin-resistant enterococci, significantly impacted healthcare costs due to prolonged hospital stays and the need for specialized care. This financial burden is particularly evident in low-income settings where resources are limited, making the prevention of HAIs even more crucial.

Systematic reviews have underscored the effectiveness of multifaceted infection control interventions in reducing HAIs across different economic contexts. Schreiber et al. (2018) conducted a meta-analysis of studies on interventions aimed at reducing catheter-associated urinary tract infections, ventilator-associated pneumonia, and surgical site infections. Their findings revealed that these interventions could reduce infection rates by 35-55%, regardless of the country's income level. This highlights the importance of implementing comprehensive infection control measures that could significantly reduce the burden of HAIs in Sudan’s healthcare facilities.

In India, Rajesh Mehta et al. (2011) conducted a needs assessment of infection control practices in delivery care units, revealing that while 70% of respondents reported following standard infection control procedures, only 5% of facilities had written guidelines, and over 70% reused surgical gloves. This further illustrates the importance of not only having guidelines in place but also ensuring they are followed and that healthcare workers have access to the necessary materials.

Similar concerns were echoed in a more recent study by Sharma et al. (2022), which underscored persistent gaps in infection control implementation despite increased awareness and training efforts.

**Problem Statement:**

**Globally**, healthcare-associated infections (HAIs) remain a major public health challenge, contributing significantly to patient morbidity, mortality, and healthcare costs. The World Health Organization (WHO) reported that in low- and middle-income countries, 15 out of every 100 patients acquire at least one HAI during hospital care, often due to insufficient infection prevention and control (IPC) measures (WHO, 2016). Despite global efforts, implementation of IPC programs remains uneven and resource dependent.

**Regionally in Africa**, IPC remains under-prioritized due to limited resources, infrastructural gaps, and a high burden of communicable diseases. Studies show that African health systems often lack the trained personnel, surveillance systems, and policy enforcement necessary for effective infection control (Alemu et al., 2022). The COVID-19 pandemic further exposed these gaps, stressing the need for stronger IPC programs across the continent (Kabego et al., 2023).

**Nationally in Sudan**, prolonged conflict, economic instability, and underfunded health systems have resulted in poor infection control practices. Research shows that many healthcare workers in Sudan lack adequate training and resources to implement standard precautions effectively (Saeed, 2021). Hospitals frequently suffer from shortages of personal protective equipment (PPE), sanitation supplies, and consistent guidelines, increasing the risk of HAIs among patients and staff (Fadil All et al., 2023).

**Locally**, in many regions across Sudan such as Darfur, the situation is even more dire. A 2021 study at Eldaein Teaching Hospital in East Darfur revealed limited compliance with infection control measures, primarily due to insufficient training, PPE shortages, and lack of administrative support (Fadil All et al., 2023). These findings point to an urgent need for coordinated policy, education, and infrastructure development to improve IPC at all levels of the healthcare system.

The situation in Dongola Town hospitals mirrors these findings, where a lack of adequate infection control resources and training is likely contributing to high rates of HAIs. Despite the critical role of healthcare workers in preventing the spread of infections, their ability to

implement effective infection control measures is hindered by a lack of resources and structured support. Without a comprehensive strategy to improve infection control practices, the prevalence of HAIs is likely to remain high, further complicating healthcare delivery and increasing the financial burden on hospitals and patients alike.

This research is crucial, as there is a lack of comprehensive data regarding infection control practices in Dongola Town hospitals. Previous studies have shown that infection control in Sudanese hospitals is often inadequate due to factors such as poor training, insufficient resources, and inconsistent adherence to guidelines (Mohammed et al., 2021). The consequences of inadequate infection control are substantial, as hospital-acquired infections increase both the financial burden on healthcare systems and the morbidity and mortality rates among patients (Ibrahim et al., 2019). Addressing these issues is essential for improving healthcare outcomes in Sudan, and this study will provide the much-needed data to inform better infection control practices and strategies in the region.

In conclusion, hospital-acquired infections represent a significant health burden in Dongola Town, Sudan. The findings of this study will shed light on the barriers healthcare workers face in implementing effective infection control measures and will provide insights that can help develop more targeted interventions to reduce the prevalence of HAIs. Improving infection control in Sudan's healthcare facilities is vital to improving patient safety and reducing the financial and human costs of hospital-acquired infections.

This study aims to assess the current infection control measures in Dongola Town hospitals and evaluate the adherence of healthcare workers to infection control practices. The findings will provide valuable insights into the strengths and weaknesses of infection control practices in this region and will help inform the development of targeted interventions to improve infection prevention strategies

## General Objective

To assess the current infection control measures and evaluate the adherence of healthcare workers to infection control practices in Dongola Town hospitals 2022-2023

## Specific Objectives

The specific objectives of this study were to assess the actual infection prevention practices implemented by healthcare workers in Dongola Town hospitals, evaluate their knowledge regarding infection control principles and guidelines, examine their adherence to standard infection control procedures, assess the implementation of safety protocols and medical waste management practices, and to identify the existing gapes and strengths in the overall infection control measures applied during the period 2022- 2023.

## Materials and Methods

**Study Design:** This study utilized a cross-sectional analytical hospital-based design conducted in Dongola town hospitals, located in Northern Sudan, from November 2022 to March 2023. This design was chosen to assess the infection control practices and adherence among healthcare workers within a defined time frame

**Study Area:** Dongola, located on the western bank of the Nile in northern Sudan, has a hot desert climate and a population of 13,417 as per the 2009 census. The city is historically rich with cultural significance.

**Study Population:** The study targeted a population of 1,500 healthcare workers employed across 8 hospitals in Dongola. This cohort consisted of 620 physicians, 392 nurses, 304 laboratory technicians, 20 midwives, 29 radiological technicians, and 130 other healthcare workers.

**Inclusion Criteria:** Healthcare workers actively employed in Dongola town hospitals during the study period (November 2022 to March 2023) were included.

**Exclusion Criteria:** Healthcare workers who refused participation or were absent during the study period were excluded from the study.

**Sample Size Calculation:** The sample size of 300 was calculated using the formula: $n=\frac{N}{1+N\times d^2}$

Where, $n$ represents the sample size, $N$ is the total population (1,500 healthcare workers), and $d$ is the margin of error (5%). This calculation resulted in a final sample size of 300 participants, distributed proportionally across the strata.

**Sampling selection:** The study employed a multi-stage sampling technique, ideal for large, dispersed populations. The process was as follows:

- **Stage 1: Hospital Selection**; All 8 hospitals in Dongola were selected, with the hospitals acting as clusters in the sampling process.

- **Stage 2: Stratification of Healthcare Workers**; Healthcare workers were grouped based on their professional roles: physicians, nurses, lab technicians, radiological technicians, midwives, and other workers, ensuring representation from all roles.
- **Stage 3: Proportional Allocation**; A sample size of 300 healthcare workers was allocated proportionally according to the number of workers in each group. For example, 124 physicians were selected from 620, while 78 nurses were chosen from 392.
- **Stage 4: Simple Random Sampling**; Within each stratum, simple random sampling was used to select individuals, ensuring that each healthcare worker had an equal chance of selection.

**Data Collection Methods:**

- **Questionnaire:**
  A structured and standardized questionnaire was developed to collect quantitative data from healthcare workers. The questionnaire consisted of several sections, including demographic data, knowledge and practices related to infection control, and health and safety conditions. Specific areas of focus included hand hygiene, use of personal protective equipment (PPE), sterilization protocols, and training in infection control measures.

- **Checklist:**
  A checklist was employed to evaluate the infrastructure and infection control practices in the hospitals. This checklist assessed the availability of sanitation facilities, waste disposal systems, medical equipment, and the presence and implementation of infection control guidelines and protocols.

**Variables:**

- **Independent Variables:** Demographic characteristics (age, gender, job role, years of experience, education), training on infection control, and the availability of infrastructure (e.g., sanitation facilities, PPE).
- **Dependent Variables:** Knowledge of infection control measures, adherence to infection control practices (e.g., hand hygiene, PPE usage), and compliance with hospital safety protocols (e.g., waste management, sterilization).

**Data Analysis:** The data collected through the questionnaire and checklist were analyzed using appropriate statistical methods to identify patterns and correlations between healthcare workers' characteristics and their infection control practices. Statistical tests were conducted to assess the relationship between training in infection control and the healthcare workers' adherence to standard protocols. The results also explored the impact of hospital infrastructure on the level of compliance with infection control measures.

**Ethical Considerations:** Ethical approval was obtained from the Faculty of Graduate Studies at Shendi University and the Northern State Ministry of Health. Informed consent was obtained from all participants, ensuring that participation was voluntary. To maintain confidentiality, personal identifiers were replaced with numerical codes, and data was securely stored and analyzed in an anonymous manner. This robust methodology ensured a comprehensive assessment of infection control measures in Dongola hospitals, providing reliable data on the current status of infection prevention and the practices of healthcare workers.

## Results

The results from the data collected on healthcare workers in Dongola town hospitals provide valuable insights into the demographics, educational background, and infection control practices of the healthcare workforce. This section discusses the findings in greater depth, identifying strengths, weaknesses, and areas that require improvement.

### Demographics and Educational Composition

The demographic data from Table 1 reveal a predominantly young, female workforce in Dongola hospitals.

**Table 1: Demographic and Educational Distribution of Healthcare Workers in Dongola Town Hospitals**

| Category | Sub-category | Frequency | Percent |
|---|---|---|---|
| **Sex** | Male | 111 | 37% |
| | Female | 189 | 63% |
| **Age** | 20-29 years | 168 | 56% |
| | 30-39 years | 85 | 28.3% |
| | 40-49 years | 23 | 7.6% |
| | 50-59 years | 23 | 7.6% |
| | 60 and above | 1 | 0.3% |
| **Marital Status** | Single | 173 | 57.6% |
| | Married | 110 | 36.6% |
| | Divorced | 11 | 3.6% |
| | Widowed | 6 | 2% |
| **Educational Level (Total)** | Illiterate | 14 | 4.7% |
| | Primary | 6 | 2% |
| | Intermediate | 3 | 1% |
| | Secondary | 6 | 2% |
| | Diploma | 27 | 9.9% |
| | Bachelor's | 197 | 71.9% |
| | Master | 32 | 11.7% |
| | PhD | 15 | 5.5% |
| **Total** | | 300 | 100% |

With 63% of workers being female and more than half (56%) in the 20-29 age range, the workforce is dynamic, energetic, and likely to adapt well to new methods and training. The younger demographic could contribute to an enthusiasm for incorporating modern practices in healthcare

settings. Furthermore, the high percentage of workers with a bachelor's degree (71.9%) indicates that many have the theoretical knowledge to perform complex medical tasks.

However, the presence of workers with lower educational levels, such as 4.7% being illiterate, is concerning. These individuals may struggle to keep up with the increasingly complex medical and safety procedures required in modern healthcare settings. Targeted training programs are necessary to bridge these knowledge gaps and ensure that all workers meet the required standards for providing safe care. This highlights a need for more inclusive education and training tailored to varying levels of literacy and educational attainment.

**Infection Prevention Practices**

When examining the infection prevention practices (Table 2), it becomes clear that while there is overall compliance with key practices, significant gaps remain.

**Table 2: Infection Prevention Practices of Healthcare Workers in Dongola Town Hospitals**

| Practice Category | Yes (%) | No (%) |
|---|---|---|
| **Hand Hygiene** | | |
| Regular Hand Washing | 150(54.7%) | 124(45.3%) |
| **Alcohol Hand Rubbing** | | |
| Uses Alcohol-Based Hand Rub | 167(60.9%) | 107(39.1%) |
| **Surgical Scrub** | | |
| Performs Surgical Scrub | 132(48.2%) | 140(51.8%) |
| **PPE Use (Donning/Doffing)** | | |
| Correct PPE Use | 214 (78.1%) | 60(21.9%) |
| **Safe Injection Practices** | | |
| Practices Safe Injection Procedures | 251(91.6%) | 23(8.4%) |
| **Waste Management** | | |
| Follows Waste Management Procedures | 65(23.7%) | 123(44.9%) |
| Uncertain About Waste Management | 86(31.4%) | - |

The high adherence to safe injection practices (91.6%) and proper PPE use (78.1%) is promising. These findings suggest that healthcare workers understand and follow critical protocols that directly affect patient safety and infection control. This is especially important in preventing healthcare-associated infections (HAIs), which can have serious consequences for patients.

However, hand hygiene remains a major concern. Only 54.7% of workers regularly wash their hands, which is below the acceptable threshold for such a critical practice. The lack of consistent hand washing could lead to the transmission of infectious agents, undermining efforts to prevent infections. Similarly, surgical scrubbing, which is essential for maintaining sterile conditions during procedures, is not consistently practiced by all healthcare workers (48.2%). These practices are fundamental in infection control, and improvements are needed to ensure that all workers adhere to these procedures.

Waste management is another area of concern, with only 23.7% of workers following proper waste disposal protocols. Given the significant risks associated with improper waste disposal—especially with infectious materials—this gap in practice could lead to contamination and the spread of infections. The 31.4% of workers who are uncertain about waste management highlight a lack of clarity in procedures, suggesting the need for clearer guidelines and more comprehensive training.

**Knowledge and Training on Infection Control**

One of the most striking findings is the discrepancy between knowledge and formal training on infection control.

**Table 3: Knowledge and Practices Related to Infection Control among Healthcare Workers in Dongola Town Hospitals**

| Category | Yes | No |
|---|---|---|
| Knowledge of Infection Control Procedures | 214 (78.1%) | 60 (21.9%) |
| Training on Infection Control Procedures | 118 (39.3%) | 182 (60.7%) |
| Knowledge of PPE Usage | 214 (78.1%) | 60 (21.9%) |
| Knowledge and Practice of Donning and Doffing PPE | 214 (78.1%) | 60 (21.9%) |

While 78.1% of workers claim to know infection control procedures, only 39.3% have received formal training on these procedures. This suggests that a significant proportion of healthcare workers may not have received the necessary education to fully understand and implement infection control standards in practice. The high level of self-reported knowledge does not always translate into practical competence, as evidenced by the gaps in hand hygiene, surgical scrubbing, and waste management practices.

The lack of formal training on infection control is concerning, particularly when considering that 60.7% of workers have not received this essential training. Given the complex nature of infection control procedures, it is critical that healthcare workers receive structured, formal training that not only covers the theoretical aspects but also ensures practical competence. Training programs should be regularly updated to reflect current best practices and should be mandatory for all staff.

**Challenges in Adherence to Infection Control Standards**

The difficulties in adhering to certain infection control practices are further evident in the knowledge and practice of infection control standards (Table 4).

**Table 4: Knowledge of Standards and Practices among Healthcare Workers in Dongola Town Hospitals**

| Category | Easily | Moderate | Hardly |
|---|---|---|---|
| Hand Hygiene | 157 (57.3%) | 96 (35.0%) | 21 (7.7%) |
| Personal Protective Equipment (PPE) | 112 (40.9%) | 117 (42.7%) | 45 (16.4%) |
| Respiratory Hygiene (Cough Etiquette) | 124 (45.3%) | 95 (34.7%) | 55 (20.1%) |
| Waste Management | 65 (23.7%) | 123 (44.9%) | 86 (31.4%) |

For example, while 57.3% of workers find hand hygiene easy to practice, a significant portion (35%) report moderate difficulty, and 7.7% find it hard. This suggests that while hand hygiene is a fundamental practice, it may not always be easy to implement consistently, possibly due to factors such as time constraints or inadequate facilities. A similar trend is observed with PPE use, where 42.7% of workers report moderate difficulty, indicating that issues with PPE availability or comfort may hinder compliance.

Waste management, however, is the most challenging area for healthcare workers, with 44.9% finding it moderately difficult and 31.4% finding it hard. This is a critical concern as improper waste disposal can lead to contamination and outbreaks of infections. The difficulty in following waste management protocols may stem from unclear procedures, inadequate training, or insufficient resources, all of which need to be addressed to improve infection control.

Table 5 highlights key safety and waste management practices among healthcare workers.

**Table 5: Safety and Waste Management Procedures among Healthcare Workers in Dongola Town Hospitals**

| Category | Yes | No |
|---|---|---|
| Safe Injection Practices | 251 (91.6%) | 23 (8.4%) |
| Cough Hygiene Practices (Mask Usage) | 249 (90.9%) | 25 (9.1%) |
| Waste Management Practices | 8 (100%) | 0 (0%) |
| Handling and Disposal of Infectious Waste | 6 (23.1%) | 20 (76.9%) |

The data shows high compliance with safe injection practices (91.6%) and cough hygiene practices (90.9%), indicating that healthcare workers are generally following these essential infection control measures. These high percentages suggest a strong understanding and implementation of practices that directly prevent infection transmission.

However, waste management practices are concerning. While 100% of the respondents reported following waste management procedures, this might not fully reflect the actual practice. The handling and disposal of infectious waste, with only 23.1% adherence, is particularly alarming. This poor compliance poses significant risks, as improper disposal of infectious waste can lead to **cross-contamination and spread of infections.**

While there is good adherence to safe injection and cough hygiene practices, waste management, particularly the disposal of infectious waste, requires immediate attention and improvement.

**Table 6: Assessment Infection Control Measures in Dongola hospital's infrastructure and measures related to infection control** (N=8)

| Item | Yes (%) | No (%) | Total (%) |
|---|---|---|---|
| Presence of committee responsible for infection control | 0 (0%) | 8 (100%) | 8 (100%) |
| Presence of officer responsible for infection control | 2 (25%) | 6 (75%) | 8 (100%) |
| Publication of an infection control manual | 8 (100%) | 0 (0%) | 8 (100%) |
| Hand Hygiene Facilities | | | |
| 24-hour running water | 7 (87.5%) | 1 (12.5%) | 8 (100%) |
| Wash basin | 8 (100%) | 0 (0%) | 8 (100%) |
| Soap | 8 (100%) | 0 (0%) | 8 (100%) |
| Antiseptics for skin preparation or alcohol gel | 8 (100%) | 0 (0%) | 8 (100%) |
| Safe storage and handling of syringes (safety box) | 3 (37.5%) | 5 (62.5%) | 8 (100%) |
| Personal protective equipment (PPE) | 8 (100%) | 0 (0%) | 8 (100%) |
| Vaccination program for healthcare workers | 0 (0%) | 8 (100%) | 8 (100%) |
| Criteria for placing and separating patients | 3 (37.5%) | 5 (62.5%) | 8 (100%) |
| Waste Management and Disposal Procedures | | | |
| Distinctive markings on the place of waste disposal | 2 (25%) | 6 (75%) | 8 (100%) |
| Waste basket availability | 8 (100%) | 0 (0%) | 8 (100%) |
| Colored bags for waste segregation | 3 (37.5%) | 5 (62.5%) | 8 (100%) |
| The disposal site is safe and medical waste does not leak into the environment | 2 (25%) | 6 (75%) | 8 (100%) |
| Isolation room availability | 1 (12.5%) | 7 (87.5%) | 8 (100%) |

This table provides an assessment of the availability and effectiveness of infection control measures in Dongola Hospital. The findings reveal several key points:

**Commitment to Infection Control**: There is no designated infection control committee (0% response), and only 25% have an officer responsible for infection control, indicating a gap in

institutional oversight. A 100% availability of published infection control guidelines indicates that there is awareness, though it may not be sufficiently implemented.

**Hand Hygiene Facilities**: Most hospitals have the essential hand hygiene facilities (soap, antiseptics, wash basins), with running water available in 87.5% of the cases. However, safe storage and handling of syringes, such as safety boxes, was found to be lacking in 62.5% of hospitals.

**Waste Management**: There are challenges in waste management, with only 25% of hospitals having distinctive waste disposal markings, and only a small portion (25%) reporting safe disposal sites for medical waste. The absence of isolation rooms in 87.5% of hospitals is a significant concern for controlling the spread of infections.

**Personal Protective Equipment (PPE)**: PPE is available in all hospitals, but the lack of vaccination programs (0% response) and inconsistent patient placement and separation criteria (37.5% response) highlight critical gaps in preventive measures.

This assessment indicates that while some infection control practices, like hand hygiene and PPE usage, are well implemented, others, particularly waste management, vaccination programs, and patient isolation protocols, need significant improvements to ensure the safety of both healthcare workers and patients.

**Table 7: Immunization Coverage Among Healthcare Workers (HCWs) in Dongola Town Hospitals, N = 274**

| Vaccine Type | Coverage Percentage | Explanation |
|---|---|---|
| Hepatitis B Vaccine | 54.7% | More than half of healthcare workers are vaccinated against Hepatitis B, which is crucial due to the potential exposure to blood and bodily fluids in hospital settings. |
| Influenza Vaccine | 16.7% | A low percentage of healthcare workers are vaccinated against influenza, despite the fact that vaccination helps protect both staff and patients from flu complications. |
| COVID-19 Vaccine | 56.3% | A significant portion of healthcare workers are vaccinated against COVID-19, which helps prevent the spread of the virus within hospitals and ensures public health safety. |
| DTP (Diphtheria, Tetanus, Pertussis) Vaccine | 32.7% | Less than one-third of healthcare workers are vaccinated against DTP, which are dangerous bacterial diseases that can be life-threatening, highlighting the importance of vaccination. |
| Meningococcal Vaccine | 49.3% | Around half of the healthcare workers are vaccinated against meningococcal disease, which is important to prevent outbreaks of meningitis in hospital environments. |
| Measles Vaccine | 46.7% | A moderate percentage of healthcare workers are vaccinated against measles, a highly contagious viral disease that can lead to severe complications, necessitating vaccination. |
| Unvaccinated | 11% | This percentage represents healthcare workers who have not received any vaccinations, which is concerning due to the risks they face in healthcare settings without protection. |

This table outlines the immunization status of healthcare workers in Dongola Town hospitals, emphasizing the need for proper vaccination programs to protect workers and reduce the risk of disease transmission in healthcare settings.

## Discussion

This study, conducted in Dongola town hospitals from 2022 to 2023, was designed to evaluate the existing infection control measures and practices, and assess the adherence of healthcare workers (HCWs) to infection control standards. The findings from this research indicate several significant gaps and challenges in infection control practices, infrastructure, leadership, and training, all of which have profound implications for both the safety of healthcare workers and patient safety.

A critical issue identified by this study was the lack of awareness regarding the importance of having an Infection Control Committee (ICC) in Dongola hospitals. Only 37.2% of the respondents acknowledged the importance of such a committee, which is concerning. Infection Control Committees play a pivotal role in establishing standardized infection control practices, monitoring adherence, and ensuring the overall safety of patients. This aligns with the findings of Singh (2020), who emphasized that having a dedicated Infection Control Committee is essential for providing leadership, developing, protocols, and evaluating infection control processes within healthcare institutions. The absence of such committees in most hospitals in Dongola reflects a larger issue where infection control lacks structured oversight, making it more difficult to enforce uniform practices. A proper ICC ensures that infection prevention measures are standardized across all departments and that there is consistent monitoring and evaluation.

The absence of a designated Infection Control Officer (ICO) further compounds this problem. The study found that 42.3% of respondents reported that no ICO existed in their hospitals, and in 75% of hospitals, no ICO was appointed. This gap is concerning, as the ICO is responsible for overseeing the implementation of infection control measures, ensuring compliance with protocols, and offering guidance on infection prevention strategies. Jemez Pueblo (2023) emphasizes that the presence of an ICO is crucial in reducing the transmission of nosocomial infections. Without an ICO, hospitals lack the leadership needed to monitor infection control practices and ensure their consistent application across departments.

Hand hygiene is widely recognized as one of the most effective ways to prevent healthcare-associated infections, as highlighted by NHS England (2022). The

study found that 87.5% of hospitals had 24-hour running water for hand washing, and 100% provided wash basins, soap, and antiseptics. Despite this, there were significant barriers to consistent access and use of hand hygiene facilities. Only 57.3% of HCWs reported easy access to hand hygiene facilities, while 35% described their access as moderately easy, and 7.7% stated that access was difficult. These findings suggest that although the infrastructure for hand hygiene exists, barriers such as inadequate placement or accessibility issues persist. This is consistent with the guidelines by NHS England (2022), which emphasize that hand hygiene facilities must be located as close to the point of care as possible to minimize barriers to use. Improving the accessibility and visibility of hand hygiene stations is crucial to encourage consistent and effective hand washing practices among healthcare workers.

In addition to the availability of facilities, the study found that 56.3% of HCWs performed hand hygiene periodically and correctly. However, a concerning 41% of HCWs did not practice surgical scrubbing, which is a critical component of infection prevention during surgeries. The discrepancy between basic hand hygiene and surgical scrubbing points to gaps in training and adherence to standard infection prevention protocols. The NHS (2022) clearly states that surgical scrubbing is essential for preventing infections in surgical procedures, and failure to practice it properly can lead to serious consequences, including surgical site infections.

The study showed that PPE was available in all hospitals, but its allocation was insufficient and not always according to the specific needs of each procedure. This suggests that while PPE is available, the lack of a designated infection control officer and the absence of a formal infection control committee contribute to the mismanagement of PPE resources. PPE is essential for preventing the transmission of infections, especially in high-risk environments, but without clear guidelines on how and when to use them, PPE is often underutilized or used incorrectly.

The absence of comprehensive infection control oversight is a key factor in the inadequate provision of PPE, and this can lead to an increased risk of cross-contamination and the spread of infections. This is supported by recent studies, including Verbeek et al. (2020), which found that inconsistent use of personal protective equipment (PPE) in healthcare settings directly increases the risk of nosocomial infections.

The study also revealed that only 37.5% of hospitals had criteria for patient placement and separation, and only 42% of HCWs practiced patient separation. The lack of standard operating procedures for patient isolation is a significant gap in infection control practices. Patient isolation is one of the most effective methods for controlling the spread of infections, particularly in hospital settings where patients are at an increased risk of acquiring infections from other patients. The absence of these protocols likely results from insufficient training, a lack of awareness about the importance of isolation, and a failure to implement routine infection control procedures.

Moreover, only one hospital had a functional isolation room, but it was not used because of its inappropriate location within the hospital. This finding is alarming, as isolation rooms play a critical role in containing the spread of infectious diseases, particularly those that are airborne or highly contagious. As noted by NHS England (2022), the location and functionality of isolation rooms should be a top priority, and these rooms should be strategically located to minimize the risk of cross-contamination.

One of the most significant findings of this study was the absence of a structured vaccination program for HCWs in Dongola hospitals. Although some HCWs were vaccinated against diseases such as Hepatitis B (54.7%), influenza (16.7%), and COVID-19 (56.3%), a considerable proportion (11%) of HCWs had not received any vaccinations. This lack of a formal vaccination program for HCWs is a serious concern, as vaccinations are an essential measure for preventing the spread of infectious diseases within healthcare settings. The CDC (2016) highlights that healthcare workers are at higher risk of exposure to infectious agents, and vaccination is critical for both their protection and the protection of patients. The lack of a comprehensive vaccination program suggests that hospital administration in Dongola town has not prioritized the health and safety of healthcare workers, which can increase the risk of healthcare-associated infections.

Medical waste management is another area where Dongola hospitals face challenges. While 25% of hospitals had safe waste storage systems that prevented leakage, many hospitals still used unsealed and unsafe waste storage methods. The improper storage of medical waste increases the risk of contamination and poses a

serious threat to public health. The findings of this study are contradict current OSHA guidelines, which emphasize the importance of storing medical waste in leak-proof, biohazard-labeled containers to minimize the risk contamination (Occupational Safety and Health Administration [OSHA], 2023). Additionally, the final disposal of medical waste in Dongola hospitals was done by burial in landfills without any form of treatment. This practice is not in line with the recommended guidelines for medical waste disposal, which require that medical waste be treated before final disposal to eliminate any hazardous pathogens. Failure to follow these guidelines could lead to environmental contamination and an increased risk of disease transmission to the surrounding community.

The study examined disinfection practices among HCWs and found that 42.3% of HCWs used alcohol-based disinfectants, while only 2% used formaldehyde. Alcohol-based disinfectants are widely regarded as effective for surface disinfection and hand sanitizing, but they have limitations, particularly in terms of their effectiveness against certain viruses and spores (Kampf et al., 2020; CDC, 2019). The use of alcohol-based disinfectants in Dongola hospitals is a positive indicator, but greater awareness of the full range of disinfecting agents is necessary to ensure comprehensive disinfection practices across all hospital departments. The limited use of formaldehyde may reflect a lack of awareness regarding its potential effectiveness for certain disinfection needs.

**Conclusion**,

The findings of this study underscore several critical challenges facing infection control practices in Dongola hospitals. These include the lack of formal leadership structures (such as Infection Control Committees and Infection Control Officers), insufficient infrastructure for patient isolation, inadequate PPE provision, gaps in hand hygiene and vaccination practices, and suboptimal medical waste management. To address these challenges, hospitals in Dongola must prioritize the establishment of a formal infection control program, including the appointment of Infection Control Officers, the creation of standardized protocols, and the provision of necessary resources and training. Furthermore, improving infrastructure, such as the accessibility of hand hygiene facilities, the construction of properly located isolation rooms, and the implementation of structured vaccination programs for HCWs, is

essential for safeguarding both healthcare workers and patients. In line with global guidelines from the CDC (2016), NHS England (2022), and OSHA (2023), these improvements will enhance infection control practices and ultimately reduce the incidence of healthcare-associated infections in Dongola hospitals.

**Recommendation**

To effectively prevent the transmission of healthcare-associated infections (HAIs), the Ministry of Health must implement and oversee comprehensive infection control policies and strategies within healthcare settings. This includes establishing and activating infection control committees, enhancing infection prevention practices through hospital administration, and ensuring that all healthcare workers receive consistent pre-service and in-service training on standard precautions. These measures are crucial for maintaining safe environments for both patients and staff.

In addition, healthcare facilities must prioritize the provision of high-quality personal protective equipment (PPE) tailored to the specific needs of different departments and procedures. Vaccination of hospital staff should be conducted in line with CDC guidelines to reduce the risk of infectious disease transmission. Promoting research and studies on infection control and encouraging healthcare workers to adhere to infection prevention protocols through policies, laws, and continuous education programs will further strengthen the overall infection control framework.

**Declarations:**

- **Abbreviations**

| | |
|---|---|
| CDC | Centers for Disease Control and Prevention |
| DOV | Specific type of virus (e.g., influenza or COVID-19) (Specific type of vaccine) |
| DTP | Diphtheria, Tetanus, Pertussis |
| HAI | Healthcare-Associated Infections |
| HCWs | Healthcare Workers |
| ICC | Infection Control Committee |
| ICO | Infection Control Officer |

| | |
|---|---|
| NHS | National Health Service |
| OSHA | Occupational Safety and Health Administration |
| PPE | Personal Protective Equipment |
| SPSS | Statistical Program for Social Sciencesinfection |
| WHO | World Health Organization |

### ❖ Ethical approval and consent to participate:

Ethical approval was obtained from the Faculty of Graduate Studies at Shendi University and the Northern State Ministry of Health. Informed consent was obtained from all participants, ensuring that participation was voluntary. To maintain confidentiality, personal identifiers were replaced with numerical codes, and data was securely stored and analyzed in an anonymous manner. This robust methodology ensured a comprehensive assessment of infection control measures in Dongola hospitals, providing reliable data on the current status of infection prevention and the practices of healthcare workers**.**

**Consent for publication:**

Not applicable

### ❖ Competing interests

The authors declared no conflict of interest.

### ❖ Availability of data and materials;

The datasets used and analyzed during this study are available from the corresponding author or reasonable request.


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The research did not receive any fund from any source.


### ❖ Authors' contributions

AAAO designed the study and collected data. HE and ASMA analyzed the data, designed tables and rewired rewrote manuscript text. All authors reviewed manuscript. All authors read and approved the final manuscript. All authors contributed significantly to this work, conceiving the idea of the research, collection and analysis of data, writing and editing of the manuscript.


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