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ASSESSMENT OF KNOWLEDGE AND PRACTICE OF SAFETY PRECAUTIONS AMONG HEALTHCARE WORKERS IN A TERTIARY CARE FACILITY: A CROSS-SECTIONAL STUDY AND IMPLICATIONS FOR TECHNOLOGY-ENABLED INTERVENTIONS

Chatta Rakiyat Joy*[1], Arokyo Adenoke Florence[2], Ayuba Mamud[3], Kayode Tumininu Benjamin[4]

[1,2,3]Department of Environmental Health, Kogi State College of Health Sciences and Technology, Idah, Nigeria.

[4]Department of Computer Science, Kogi State College of Health Sciences and Technology, Idah, Nigeria.

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***Corresponding Author: Chatta Rakiyat Joy**

Department of Environmental Health, Kogi State College of Health Sciences and Technology, Idah, Nigeria.

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ABSTRACT

Background: Adherence to safety precautions among healthcare workers (HCWs) is fundamental to preventing healthcare-associated infections and occupational exposures. A disparity between knowledge and practice remains a critical challenge, as noted in previous studies in similar settings [8, 9]. Objective: To assess the level of knowledge and self-reported practice of standard safety precautions among HCWs and to identify factors associated with compliance, with implications for technology-enabled interventions. Methods: A hospital-based analytical cross-sectional study was conducted among 350 randomly selected HCWs (doctors, nurses, and laboratory technicians) at a tertiary hospital in Nigeria from January to March 2024. Data were collected using a structured, self-administered questionnaire adapted from validated instruments [1, 2]. Knowledge and practice scores were categorized as good (\geq 80\%), moderate (60 - 79\%), and poor (< 60\%). Data were analyzed using SPSS version 26. Chi-square and logistic regression were used to test associations. Results: The response rate was 91.4\% (n = 320). Overall, 78.4\% of HCWs demonstrated good knowledge of safety precautions. However, only 62.5\% reported good practice. Nurses had significantly higher knowledge and practice scores compared to

doctors and laboratory technicians (p< 0.05). The main barriers to compliance reported were heavy workload (65\%), lack of accessible supplies (48\%), and perceived low risk of transmission (22\%). Logistic regression revealed that good knowledge (AOR=3.2, 95\% CI: 1.8-5.7), availability of personal protective equipment (PPE) (AOR=4.1, 95\% CI: 2.3-7.4), and regular training within the past year (AOR=2.8, 95\% CI: 1.6-4.9) were independent predictors of good safety practice. Conclusion: While knowledge of safety precautions is high among HCWs, its translation into consistent practice is suboptimal. This paper proposes that beyond traditional institutional interventions, digital and computer-based solutions—including IoT monitoring systems, AI-powered compliance auditing, gamified training platforms, and secure data management systems—offer innovative approaches to bridge the knowledge-practice gap and enhance occupational safety in modern healthcare environments.

KEYWORDS: Standard Precautions, Infection Prevention and Control, Healthcare-Associated Infections, Needlestick Injuries, Knowledge-Practice Gap, Occupational Health, Digital Health, Health Informatics, Computer Vision, IoT.

1 INTRODUCTION

Healthcare workers (HCWs) are routinely exposed to a variety of occupational hazards, including biological risks from bloodborne pathogens and other infectious agents. Standard Precautions, as advocated by the World Health Organization and CDC, form the cornerstone of infection prevention and control (IPC), designed to protect both HCWs and patients [1, 2].

Despite global guidelines and protocols, adherence to safety precautions remains inconsistent, leading to preventable needle-stick injuries, exposures to bodily fluids, and healthcare-associated infections [3]. Studies from diverse settings consistently reveal a concerning gap: HCWs often possess adequate theoretical knowledge but fail to apply it consistently in clinical practice [4, 5]. This gap is influenced by a complex interplay of individual, environmental, and organizational factors, including staffing levels, availability of resources, safety culture, and perceived risk [6].

Previous research in Nigerian healthcare settings has identified preliminary gaps in specific practice areas, but a comprehensive assessment of both knowledge and practice across all major HCW categories was lacking. This study, therefore, aimed to assess the level of knowledge and self-reported practice of standard safety precautions among HCWs at a tertiary care facility in Nigeria and to identify the factors associated with compliance.

Novel Contribution: This interdisciplinary study extends beyond traditional assessment by integrating computer science perspectives to address the identified gaps. We examine how digital tools and systems could transform safety protocol implementation, monitoring, and reinforcement in resource-limited settings like ours. The inclusion of computer science expertise (author 4) strengthens the technological analysis and recommendations.

2 METHODS

2.1 Study Design and Setting

A hospital-based analytical cross-sectional study was conducted at a 500-bed tertiary teaching hospital in North-Central Nigeria over three months from January to March 2024. The study setting was chosen based on preliminary observations indicating potential knowledge-practice discrepancies in infection control practices.

2.2 Study Participants and Sampling

A sample size of 350 was calculated using the formula for single population proportion with the following parameters: 95\% confidence level, 5\% margin of error, and an expected proportion of good knowledge of 50\% to yield maximum sample size. Participants were selected through stratified random sampling from the three major professional groups: physicians, nurses, and laboratory technicians. HCWs with less than six months of experience were excluded.

2.3 Data Collection Tool and Technique

Data were collected using a pre-tested, structured questionnaire adapted from WHO guidelines [1] and instruments previously validated in similar Nigerian healthcare settings. The questionnaire had three sections: Socio-demographic and Professional characteristics (5 items), Knowledge assessment (20 items on transmission routes, hand hygiene moments, PPE use, sharps handling), and Self-reported practice assessment (15 items on a 5-point Likert scale from 'always' to 'never').

2.4 Operational Definitions

Good Knowledge was defined as score \geq 80\% on knowledge questions. Moderate Knowledge was score 60 - 79\% on knowledge questions. Poor Knowledge was score < 60\% on knowledge questions. Good Practice was defined as self-reported adherence ('always' or 'often') on \geq 80\% of practice items. Moderate Practice was self-reported adherence on 60 -

79\% of practice items. Poor Practice was self-reported adherence on < 60\% of practice items.

2.5 Data Analysis

Data were entered and analyzed using SPSS version 26. Descriptive statistics were presented as frequencies and percentages. The association between categorical variables was assessed using the Chi-square test. Variables with $p < 0.05$ in bivariate analysis were entered into a binary logistic regression model to identify predictors of good practice. A p-value < 0.05 was considered statistically significant.

2.6 Ethical Consideration

Ethical approval was obtained from the Institutional Review Board of the study hospital (Ref: IRB/2024/045). Written informed consent was obtained from each participant. Confidentiality and anonymity were maintained throughout.

3 RESULTS

3.1 Socio-demographic Characteristics

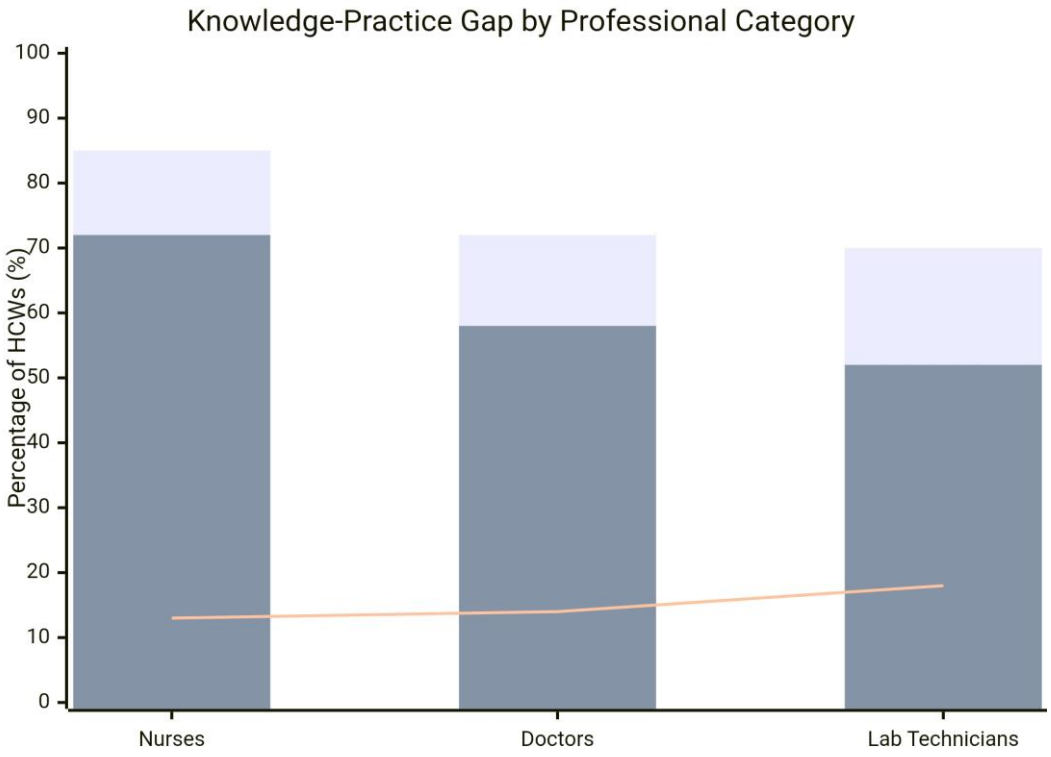
Out of 350 questionnaires distributed, 320 were completed and returned (response rate 91.4\%).

3.2 Knowledge and Practice of Safety Precautions

The overall mean knowledge score was 82.7\% (SD \pm 11.2). The overall mean practice score was 74.1\% (SD \pm 14.5).

3.3 Knowledge-Practice Gap Analysis

The relationship between knowledge and practice levels is presented in the graph below, showing the significant gap between theoretical knowledge and practical application across professional categories.



Mermaid

Xychart-beta

Title "Knowledge-Practice Gap by Professional Category"

X-Axis ["Nurses", "Doctors", "Lab Technicians"]

Y-Axis "Percentage of HCWs (%)" 0 --> 100

Bar [85, 72, 70]

Bar [72, 58, 52]

Line [13, 14, 18]

Note: The gap is calculated as the difference between Knowledge and Practice percentages.

3.4 Predictors of Good Safety Practice

Multivariate logistic regression analysis was conducted to identify independent predictors of good safety practice. The results are presented in the table below.

Predictor Variable	Adjusted Odds Ratio (AOR)	95 Confidence Interval (CI)	p-value	Significance
Good Knowledge	3.2	1.8 – 1.7	<0.001	***
PPE Availability	4.1	2.3 – 7.4	< 0.001	***

Recent Training (≤1 year)	2.8	1.6 – 4.9	< 0.001	**
Professional Category (Nurse vs. Doctor)	1.5	0.8-2.8	0.210	NS
Age (>30 years)	1.1	0.6 – 1.9	0.720	NS
Years of Experience (>5 years)	1.2	0.7-2.1	0.450	NS

Note: AOR = Adjusted Odds Ratio; CI = Confidence Interval; *** = p < 0.001; NS = Not Significant.

4 DISCUSSION

This study confirms the persistent and troubling gap between knowledge and practice of safety precautions among HCWs in a Nigerian tertiary hospital, aligning with findings from other regions [4, 5]. While a commendable 78.4\% possessed good knowledge, this translated into good practice for only 62.5\%.

The superior performance of nurses in both knowledge and practice, compared to physicians, has been noted elsewhere [7] and may be attributed to the central, repetitive emphasis on IPC in nursing curricula and daily workflow. Physicians, often focused on diagnostic and procedural tasks, may perceive IPC as a secondary priority, a dangerous cognitive bias that needs addressing [6].

The identified barriers are systemic and resonant. Heavy workload, leading to rushed procedures and cognitive overload, is a critical, often institutional, failing. The unavailability of PPE is an unacceptable infrastructural deficit that directly undermines safety protocols. The strong association between PPE availability and good practice (AOR=4.1) underscores that providing tools is as important as providing training [8].

The independent predictive power of recent training (AOR=2.8) highlights that IPC education cannot be a one-time event but must be reinforced through regular, interactive, and practical sessions, as demonstrated in similar intervention studies [9]. Simulation-based training on PPE use and sharps handling is recommended, building on successful models from previous research.

5 Computer Science Applications to Bridge the Knowledge-Practice Gap

Based on our findings, we propose several computer science applications that could address the identified challenges. These technological interventions could transform how safety protocols are implemented, monitored, and reinforced in healthcare settings.

5.1 Data Management & Analytics

Our cross-sectional study generated structured data from 320 participants, highlighting the need for robust data management systems for ongoing monitoring. Applications include creating secure, HIPAA/GDPR-compliant databases to store longitudinal compliance data, enabling trend analysis and predictive modeling. Advanced analytics using machine learning algorithms can identify non-obvious predictors of non-compliance.

5.2 Human-Computer Interaction (HCI) & Digital Interventions

The "Practice" gap indicates behavioral challenges that could be addressed through better interface design. Applications include designing context-aware mobile health applications that provide just-in-time safety reminders during high-risk procedures, addressing the "perceived low risk" barrier.

5.3 Internet of Things (IoT) & Automated Monitoring

The study's reliance on self-reported data introduces social desirability bias. IoT systems provide objective compliance data. Applications include deploying IoT sensors (smart hand hygiene dispensers, RFID-enabled PPE) to automatically track adherence, validating self-reported practices.

5.4 Simulation & Serious Games for Training

Recent training was a strong predictor of good practice, suggesting innovative training methods could enhance effectiveness. Applications include developing immersive virtual reality (VR) simulations for high-risk procedures and creating gamified learning platforms with mobile apps.

5.5 Artificial Intelligence & Computer Vision

Direct observation is resource-intensive. AI can provide scalable auditing solutions. Applications include using privacy-preserving computer vision to analyze ward footage for hand hygiene moments and PPE use, providing objective data.

5.6 Cybersecurity & Digital Safety Integration

Modern hospital safety includes both biological and digital protection. Applications include expanding future studies to assess cybersecurity hygiene alongside biological safety practices and implementing secure data storage solutions.

6 Limitations and Future Research Directions

This study has several limitations. First, the use of self-reported practice data is subject to social desirability bias, which may overestimate actual compliance rates. Future research should integrate IoT and computer vision systems to provide objective validation. Second, the single-center design limits the generalizability of the results to other healthcare settings. Third, the cross-sectional nature of the study prevents establishing causal relationships.

Proposed interdisciplinary research titles include: "Design and Pilot Testing of an IoT-Based Real-Time Compliance Monitoring System for Hand Hygiene in a Tertiary Care Facility," "Predictive Modeling of PPE Non-Compliance Among Healthcare Workers Using Machine Learning," and "Developing and Usability-Testing a Gamified Mobile Application to Improve Safety Protocol Adherence."

7 CONCLUSION AND RECOMMENDATIONS

This study reveals a significant knowledge-practice gap in the observance of safety precautions among HCWs in a Nigerian tertiary hospital. Knowledge, while necessary, is insufficient without an enabling environment.

Based on our findings and the proposed technology framework, we recommend:

1. Hospital Administration should conduct regular audits of PPE supply chains using IoT-enabled inventory systems.
2. IPC Committee should implement technology-enhanced training including VR simulations and gamified mobile apps.
3. Safety Culture Promotion should foster a technology-supported, non-punitive reporting system.
4. Technology-Enabled Monitoring should establish automated compliance auditing using computer vision and IoT sensors.
5. Interdisciplinary Collaboration should form partnerships between healthcare institutions and computer science departments.

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Conflict of Interest

The authors declare no conflict of interest.

Data Availability Statement

The de-identified dataset supporting the conclusions of this article will be made available by the corresponding author upon reasonable request, in compliance with ethical regulations and participant confidentiality agreements.

Author Contributions

Chatta Rakiyat Joy: Conceptualization, methodology, formal analysis, funding acquisition, writing original draft, project administration.

Arokoyo Aderonke Florence: Data curation, investigation, validation, writing review and editing, supervision.

Ayuba Mamud: Data collection, survey administration, literature review, writing review and editing.

Benjamin Kayode Tumininu: Technology applications framework, computer science analysis, writing technology section, data visualization.

All authors read and approved the final manuscript.

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