ASSESSMENT OF THE LEVEL OF PRACTICE OF PERSONNEL RADIATION MONITORING IN BENIN CITY

BY

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CERTIFICATION

This is to certify that **MOWETA PERPETUAL ANOLI-OMOAFEBA** an undergraduate student in the Department of Radiography, Faculty of Basic Medical Sciences, University of Benin, Edo State, with matriculation number **BMS2009041** satisfactorily completed this project work on the topic, "Assessment of the level of practice of personnel radiation monitoring in Benin City "in partial fulfillment of the requirements for the award of **Bachelor of Radiography (B.RAD).**

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DEDICATION

This work is dedicated to God Almighty for his loving kindness and tender mercies for keeping me throughout my stay in school and bringing me this far. And to my parents Mr and Mrs Moweta and my sibling for their unwavering support before and during the completion of this project work.

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TABLE OF CONTENTS

LIST OF TABLES

ABSTRACT

In the intricate world of modern healthcare, where technology and human expertise intersect, diagnostic radiology stands as one of the most remarkable achievements. Yet, behind every powerful image produced through X-rays, CT scans, or fluoroscopy lies an invisible, potent force ionizing radiation. The study aimed to assess the level of practice of personnel radiation monitoring among radiology staff in Benin city. A descriptive cross-sectional study was used, census sampling was used to select a total of 60 respondents participated. The findings revealed that awareness levels were very high. Nearly all respondents recognized the risks of occupational radiation exposure, had received training on radiation safety, and were familiar with monitoring principles such as ALARA. In contrast, actual practice of radiation monitoring was less consistent. While radiographers adhered strongly to safety practices and many indicated they practiced monitoring even without supervision, compliance with the routine use and submission of dosimeters was far from universal. Challenges to monitoring were largely institutional. Respondents highlighted irregular supply of dosimeters, lack of timely feedback, and inadequate training as the most pressing obstacles. Hypothesis testing confirmed that awareness and practice are significantly related. In conclusion radiographers with higher awareness were more likely to engage in consistent monitoring practices, suggesting that knowledge plays an important role in shaping behavior, though institutional support is also necessary.

Keywords: Ionizing, radiation, monitoring, dosimeters

CHAPTER ONE

INTRODUCTION

1.1 Background of the Study

In the intricate world of modern healthcare, where technology and human expertise intersect, diagnostic radiology stands as one of the most remarkable achievements. Yet, behind every powerful image produced through X-rays, CT scans, or fluoroscopy lies an invisible, potent force ionizing radiation. While this energy is invaluable for diagnosing and treating illnesses, it presents a silent occupational hazard for radiology personnel who are routinely exposed during the execution of their duties. In Nigeria and many developing countries, the conversation surrounding personnel radiation monitoring is not just overdue but alarmingly under-addressed (Chibunna & Ibrahim, 2020).

Radiation, particularly ionizing radiation, possesses enough energy to disrupt atomic structures, potentially leading to long-term biological damage such as DNA mutation, cancer, and even infertility (Lawal *et al*., 2019). Health workers, especially radiographers, radiologists, and other professionals operating in diagnostic imaging departments, are at risk of cumulative radiation exposure. This makes the implementation of routine personnel radiation monitoring not a luxury but a necessity. Unfortunately, available evidence suggests a significant gap between the ideal practices as recommended by international bodies like the International Commission on Radiological Protection (ICRP) and the on-ground realities in Nigerian healthcare facilities (Eze *et al*., 2011).

Radiation monitoring and protection are essential components of any radiology department. They ensure that occupational exposure is kept as low as reasonably achievable (ALARA), which is a globally accepted principle in radiation protection. Unfortunately, studies reveal varying degrees of compliance and awareness among radiographers and other health personnel across different regions in Nigeria (Lawal *et al*., 2019; Chibunna & Ibrahim, 2020). For instance, in a comparative study of secondary and tertiary hospitals in Jos, Chibunna and Ibrahim (2020) reported that while radiation monitoring devices were available, their usage was inconsistent, and in some facilities, non-existent. This paints a troubling picture, especially as long-term exposure—even at low levels—can lead to stochastic effects, including cancer and genetic mutations.

The problem is compounded by poor enforcement of national and international regulations in some regions, as well as a lack of structured training and sensitization. Nwokeoji and Avwiri (2018) emphasized that many radiographers, particularly those in South-South and South-East Nigeria, either did not possess personal dosimeters or failed to wear them consistently. Their study highlighted how administrative lapses and inadequate funding contribute significantly to the neglect of essential safety practices. This negligence not only endangers health workers but can also compromise patient safety by exposing them to unnecessary radiation during repeated or prolonged investigations.

The goal of radiation safety is rooted in the ALARA principle keeping radiation "As Low As Reasonably Achievable". However, achieving this in practice requires more than good intentions. It demands consistent use of personal dosimeters, regular evaluation of dose reports, implementation of shielding protocols, and a culture that prioritizes safety (Nwokeoji & Avwiri, 2018). Despite its significance, studies have shown that many healthcare workers in Nigeria operate without any form of personnel monitoring or are unaware of the protocols surrounding radiation safety (Umaru *et al*., 2024).

In a survey conducted among radiology personnel in Delta State, only a fraction of the staff had been consistently monitored using personal dosimeters, with many admitting they had never received feedback on their radiation exposure (Omojola *et al*., 2018). This is concerning, as ignorance of exposure levels does not eliminate risk but rather increases vulnerability. Furthermore, another study that assessed CT departments in South-South Nigeria highlighted alarming inadequacies in structural shielding, questioning the extent of protection available not just for staff but also for the general public (Omojola *et al*., 2021).

Even in teaching hospitals, where one would expect adherence to best practices, the situation appears grim. An assessment at Ahmadu Bello University Teaching Hospital revealed that while most staff members understood the risks associated with radiation, their compliance with safety protocols was poor due to lack of equipment, limited training, and weak enforcement of regulations (Lawal *et al*., 2019). Similarly, research in Southern Nigeria underscored inconsistent use of dosimeters and a general lack of administrative will to enforce compliance among staff (Nwokeoji & Ononugbo, 2019).

Multiple studies have attempted to evaluate the situation across various regions in Nigeria. Chibunna and Ibrahim (2020), in their comparative study in Jos, observed that the availability and utilization of dosimeters were heavily influenced by institutional policy and funding.

Where administrative leadership showed commitment, compliance was higher. In contrast, lax policies translated to indifference and increased occupational risk. This suggests that beyond knowledge and equipment, leadership and governance play a pivotal role in shaping radiation safety culture. What makes this issue even more pressing is the long latency period of radiation-induced conditions. A radiographer who neglects safety today may not manifest symptoms for decades, by which time the causal link may be blurred or forgotten. The literature is replete with cases that emphasize the delayed consequences of occupational radiation exposure (Eze *et al*., 2013). The failure to consistently monitor and evaluate radiation exposure is not just a lapse in professional ethics but a systemic failure with potentially fatal outcomes.

In light of the above, it becomes imperative to conduct a comprehensive evaluation of personnel radiation monitoring practices in Edo state. This study is not just about measuring doses or counting badges; it is about assessing the commitment of one of Nigeria's foremost hospitals to the safety of its staff. It aims to uncover the challenges, barriers, and potential areas for intervention, drawing from robust evidence and grounded in a desire to improve occupational health standards. The stakes are high, and the silence around radiation safety can no longer be justified. As we strive for excellence in diagnostic imaging, let it not come at the cost of the very people who make such excellence possible.

1.2 Statement of the Problem

Radiation monitoring is a fundamental aspect of occupational safety in radiological practices. Under normal circumstances, all personnel exposed to ionizing radiation in the course of their work should be consistently monitored using appropriate dosimetry tools such as thermoluminescent dosimeters (TLDs), film badges, or electronic personal dosimeters. These devices help to ensure that the radiation doses received remain within the internationally recommended limits and facilitate early detection of potentially harmful exposure levels (ICRP, 2007; Eze *et al*., 2013). According to the International Atomic Energy Agency (IAEA, 2014), regular personnel monitoring is not only a legal requirement in many countries but also a professional and ethical obligation to protect the health and well-being of radiation workers.

However, despite the known importance of personnel radiation monitoring, emerging evidence and observations suggest that compliance with monitoring practices may be inconsistent in some healthcare institutions in Nigeria, including tertiary hospitals. Specifically, in Edo state, there are concerns that not all radiology staff consistently adhere to radiation monitoring protocols. Anecdotal reports and informal discussions with radiography personnel hint at challenges such as irregular use of dosimeters, poor availability or maintenance of monitoring devices, lack of follow-up on dose readings, and inadequate training on radiation safety. These gaps pose a significant health risk to professionals and may reflect a broader issue of poor radiation safety culture.

The current problem, therefore, lies in the uncertainty surrounding the actual level of practice of personnel radiation monitoring among radiology staff in Benin city. Without concrete data, it is difficult to ascertain whether the hospital is fully compliant with recommended safety standards or if there are systemic weaknesses that need to be addressed. This situation not only compromises worker safety but may also expose the institution to regulatory violations. This study hopes to bridge that gap by assessing the level of practice of personnel radiation monitoring in Benin city. It seeks to provide evidence-based insights into how well the staff adhere to monitoring protocols, identify possible lapses, and recommend strategies for improving radiation safety practices. Ultimately, the goal is to enhance occupational protection for radiographers and other exposed personnel, ensuring that the hospital aligns with global best practices in radiation safety.

1.3 Research Questions

1. What is the level of awareness among radiographers regarding radiation safety and personnel radiation monitoring?

2. What is the extent of practice of personnel radiation monitoring among radiographers?

3. What are the challenges affecting effective radiation monitoring among radiographers?

1.4 Research Hypothesis

Null Hypothesis (H_0): There is no significant relationship between radiographers' level of awareness and their practice of personnel radiation monitoring in Benin city

Alternative Hypothesis (H_1): There is a significant relationship between radiographers' level of awareness and their practice of personnel radiation monitoring in Benin city.

1.5 Aim and Objectives of the Study

1.5.1 Aim of the Study

To assess the level of practice of personnel radiation monitoring among radiology staff in Benin city.

1.5.2 Objectives of the Study

1. To evaluate the level of awareness among radiographers regarding radiation safety and personnel radiation monitoring.

2. To assess the practice of personnel radiation monitoring among radiographers.

3. To identify the challenges affecting effective radiation monitoring among radiographers.

1.6 Significance of the Study

This study is significant on several levels, as it touches on professional ethics, public safety, and institutional accountability. Radiation monitoring is not just a technical requirement; it is a safeguard for human life. Therefore, evaluating how well personnel monitoring is being practiced in a major healthcare institution like UBTH holds great value.

To the Radiography Profession: For radiographers and other professionals working in radiological environments, this study reinforces the essence of professional responsibility and adherence to radiation safety principles. By identifying current practices and potential gaps, the findings will inform better policies and training needs. It will also promote a stronger culture of radiation protection, which is vital in maintaining the credibility and professionalism of radiographers. Furthermore, this research could serve as a reference for continuous professional development and advocacy for safer working conditions within the field.

To the Healthcare Sector: Within the broader healthcare system, this study has implications for patient safety and hospital standards. When staff are properly monitored and radiation exposure is controlled, it minimizes the risk of radiation- induced illnesses—both in workers and potentially in patients. Understanding and improving monitoring practices also help healthcare administrators ensure compliance with national and international safety standards, potentially protecting institutions from regulatory penalties and reputational damage. Ultimately, it encourages a safer clinical environment where both care providers and recipients are protected.

To Society at Large: Society relies on healthcare professionals to provide essential diagnostic and treatment services without compromising safety. Ensuring that radiology staff are not being overexposed to radiation means preserving their health and sustaining their ability to serve the public effectively. Moreover, when safety protocols are strictly followed, it builds public trust in the healthcare system. A hospital that prioritizes radiation safety becomes a model for other institutions and contributes to a culture of health consciousness and workplace safety across the board.

1.7 Scope of the Study

This scope of the study were the radiographers working in the Radiology Department of hospitals in Benin city, Nigeria. The focus was exclusively on radiographers and their radiation safety practices, compliance, and awareness, meaning that other healthcare professionals, such as medical doctors, nurses, and technicians, who may also be involved in radiological procedures were not included in this study. The study only considered data collected from the radiographers during a specific time frame of four weeks, which may limit the generalization of the findings across different time periods or settings. Additionally, the study relied on self-reported data through structured questionnaires, which could introduce biases such as social desirability bias or memory recall issues, as participants may report what they believe is expected of them rather than their true practices

1.8 Operational Definitions of Terms:

Practice: In this study, practice refers to the actual behaviors, actions, and routines performed by radiographers and other healthcare personnel in Benin city regarding the use of radiation monitoring tools, adherence to radiation safety procedures, and the consistent application of protective measures to limit radiation exposure.

Compliance: Compliance in this study refers to the extent to which radiographers and other healthcare personnel in Benin city follow established guidelines, standards, and safety protocols related to radiation protection and monitoring. This includes using dosimeters, adhering to radiation exposure limits, and following safety procedures to minimize occupational exposure to ionizing radiation.

Personnel Radiation: Personnel radiation in this study refers to the exposure to ionizing radiation experienced by healthcare workers, especially radiographers, during their duties in diagnostic imaging settings in Benin city. This term includes both direct exposure from radiation sources and any indirect exposure due to scattered radiation within the working environment.

Monitoring: In the context of this study, monitoring refers to the systematic process of measuring, tracking, and recording the radiation exposure levels of personnel working in the radiology department in Benin city. This involves the use of dosimeters and other radiation detection equipment to assess individual exposure and ensure that it is within safe limits as per radiation protection guidelines.

Awareness: Awareness in this study refers to the level of knowledge and understanding that radiographers and other personnel in Benin city have regarding radiation safety practices, the potential risks associated with ionizing radiation, and the importance of radiation monitoring. It also includes awareness of the procedures to minimize exposure and how to effectively use monitoring devices.

CHAPTER TWO

LITERATURE REVIEW

2.1 Conceptual Review

2.1.1. Introduction to Radiation Monitoring

Radiation monitoring has become an indispensable part of ensuring occupational safety for healthcare professionals working in imaging environments, especially those routinely exposed to ionizing radiation (Onwuzu et al., 2021). In modern clinical settings, personal radiation monitoring tools such as thermoluminescent dosimeters (TLDs), film badges, and digital dosimeters are employed to track cumulative exposure and ensure that dose limits are not exceeded (Botwe et al., 2015). The use of such monitoring devices is not just a best practice; it is a regulatory expectation grounded in occupational health principles and endorsed by global safety bodies.

In Nigeria, however, studies have shown that the utilization of personal radiation monitoring devices remains inconsistent across healthcare facilities. For instance, Chibunna and Ibrahim (2020) reported a sharp disparity between tertiary and secondary hospitals, with the former showing better but still suboptimal usage rates. Similarly, Eze et al. (2011) found that only a fraction of public hospitals in Benin city had structured radiation protection systems in place, including consistent personnel monitoring. This variation is further highlighted by the work of Nwokeoji and Avwiri (2018), who documented limited compliance with monitoring protocols across institutions in the South–South and South–East regions.

The importance of monitoring becomes even more apparent when viewed in light of the potential biological consequences of prolonged or repeated exposure to ionizing radiation. Unmonitored exposure can lead to serious long-term effects including malignancies, reproductive issues, and tissue damage, particularly among staff in high-dose departments like CT, fluoroscopy, and interventional radiology (Williams et al., 2024). Despite the known risks, many radiology personnel either lack access to dosimeters or do not use them effectively, often due to systemic issues such as poor administration, lack of training, or limited awareness (Umaru et al., 2024).

Even where devices are available, compliance with best practices; such as regular wearing, timely reporting, and interpretation of exposure data is often poor. Lawal et al. (2019) noted that while many radiation workers possessed basic knowledge of radiation safety, this did not always translate into regular or correct usage of monitoring devices. This disconnect between knowledge and behavior is a recurring theme in multiple studies across Nigerian hospitals (Nwokeoji & Ononugbo, 2019).

These findings raise important questions about the institutional and individual factors shaping radiation safety culture in hospitals like the University of Benin Teaching Hospital (UBTH). As Onwuzu et al. (2021) observed in Southeastern Nigeria, even among tertiary institutions, the practice of radiation monitoring is far from universal. The presence of equipment does not automatically guarantee its proper use there must also be consistent enforcement, supportive policy, and motivated personnel.

2.1.2. Radiation Exposure in Healthcare

Radiation exposure in healthcare, particularly from ionizing sources, is an unavoidable aspect of diagnostic imaging and interventional procedures (Omojola et al., 2021). Healthcare workers, especially radiographers, radiologists, and other imaging personnel, are frequently exposed to ionizing radiation during routine procedures such as X-rays, fluoroscopy, computed tomography (CT), and some interventional therapies (Williams et al., 2024). Unlike patients who are exposed occasionally, occupationally exposed staff face cumulative, low-dose exposure over extended periods, which makes consistent radiation monitoring an essential aspect of workplace safety.

The sources of radiation exposure in medical practice include both primary and scattered radiation. While the primary beam is directed at patients, scattered radiation from the patient and surrounding structures contributes significantly to staff exposure, particularly during procedures where shielding or distance is insufficient (Eze et al., 2011). This makes procedures like CT and mobile radiography more hazardous if strict safety protocols are not observed (Nwokeoji & Ononugbo, 2019).

Ionizing radiation has well-documented biological effects, which can be categorized as stochastic or deterministic. Stochastic effects, such as cancer and genetic mutations, are dose-independent but increase in probability with exposure, while deterministic effects, like cataracts or skin burns, occur above specific thresholds (Awosan et al., 2016). These risks justify the global emphasis on radiation protection and underscore the importance of effective monitoring to ensure that personnel do not exceed safe exposure limits (Umaru et al., 2024).

The risk of occupational exposure is often underestimated in environments where safety culture is weak. In some facilities, personnel do not routinely wear dosimeters or may share badges, compromising the integrity of individual dose tracking (Onwuzu et al., 2021). In Nigeria, and particularly in many public healthcare facilities, this underestimation is further compounded by the lack of real-time monitoring systems and infrequent review of exposure data (Chibunna & Ibrahim, 2020). Routine exposure in diagnostic departments has been reported to be particularly high in units with outdated equipment or insufficient protective structures (Eze et al., 2013). In such cases, the reliance on periodic dosimetry becomes even more critical, as it serves as the primary method of tracking long-term exposure and preventing unintentional overexposure.

In essence, radiation exposure in healthcare settings is an occupational hazard that must be proactively managed. It is not enough to rely on general awareness or the assumption that risk is minimal (Omojola et al., 2018). Instead, healthcare institutions must adopt a structured, evidence-based approach to exposure tracking, personnel training, and administrative control (Nwokeoji & Avwiri, 2018;). Only then can radiation exposure be kept within the internationally recommended dose limits, ensuring the long-term health and safety of diagnostic personnel.

2.1.3. Radiation Monitoring Devices

Radiation monitoring devices are essential tools used to track and quantify the cumulative dose of ionizing radiation received by healthcare personnel during their professional duties (Onwuzu et al., 2021). These devices form the foundation of occupational radiation protection by enabling early detection of unsafe exposure levels and guiding timely intervention (Botwe et al., 2015). In clinical settings, their use is not optional but a regulatory and ethical requirement, especially for those working in high-risk departments like radiology, nuclear medicine, and interventional procedures.

Several types of radiation monitoring devices are commonly used, each with its specific strengths and limitations. Among the most widely adopted are Thermoluminescent Dosimeters (TLDs), which measure radiation exposure by trapping energy in a crystalline material and releasing it as light when heated. TLDs are valued for their sensitivity, reusability, and ability to provide cumulative exposure readings over a monitoring period (Chibunna & Ibrahim, 2020). Other devices include film badges, which darken in proportion to radiation exposure but are less accurate and more susceptible to environmental factors. Electronic Personal Dosimeters (EPDs), though more expensive, offer real-time feedback and alarms, allowing for immediate action if dose thresholds are approached (Lawal et al., 2019).

Proper usage of these devices requires more than simply wearing them. Staff must be trained on correct placement, typically at the chest or collar level for external exposure monitoring, and must return badges at scheduled intervals for dose reading and replacement (Eze et al., 2011). Unfortunately, evidence from various Nigerian hospitals suggests that even when monitoring devices are available, usage is inconsistent. Some staff either forget to wear them, share them, or fail to return them for processing, which compromises data accuracy and personal safety (Nwokeoji & Avwiri, 2018).

Furthermore, the effectiveness of radiation monitoring programs is often limited by institutional factors. In some cases, dosimeters are issued but results are not communicated to users, preventing feedback and follow-up (Umaru et al., 2024). In other instances, badges are not replaced on time, or the monitoring service itself is irregular due to administrative lapses or budget constraints. These practical shortcomings render radiation monitoring less effective and may encourage a culture of nonchalance among staff (Omojola et al., 2021).

It is also important to note that monitoring devices serve not only as a personal safety measure but also as a legal safeguard for institutions. Accurate dose tracking can be critical in the event of health complaints, occupational disease claims, or institutional audits (Botwe et al., 2015). As such, the use of dosimeters is both a protective and preventive measure, and should be prioritized alongside other safety infrastructure in radiation-based departments.

2.1.4. Radiation Protection Principles

Radiation protection in healthcare is guided by a set of internationally accepted principles designed to minimize exposure to ionizing radiation while maximizing the benefits of diagnostic imaging and therapeutic procedures (Eze et al., 2013). These principles are rooted in both science and ethics, aiming to safeguard not only patients but also healthcare workers who are routinely exposed as part of their professional roles (Botwe et al., 2015).

At the heart of modern radiation protection is the ALARA principle "As Low As Reasonably Achievable." This principle emphasizes that even when exposure is within permissible limits, every effort must be made to keep doses as low as possible by optimizing procedures, improving shielding, and minimizing unnecessary exposures (Chibunna & Ibrahim, 2020). ALARA is not merely a technical goal; it reflects a proactive safety culture that should be integrated into daily practice across radiology departments (Lawal et al., 2019).

Three core strategies are universally recommended to achieve ALARA: time, distance, and shielding. Minimizing the time spent near a radiation source directly reduces exposure, while maximizing distance takes advantage of the inverse square law, which dramatically lowers intensity with increased space (Onwuzu et al., 2021). Shielding, on the other hand, involves using physical barriers; such as lead aprons, walls, or glass screens to block or absorb radiation. In practice, adherence to these principles requires both equipment and training, which are not always guaranteed in many Nigerian healthcare facilities (Nwokeoji & Avwiri, 2018).

Another important aspect of radiation protection is personal responsibility and institutional enforcement (Umaru et al., 2024). Radiographers and radiologists are expected to uphold professional standards by wearing monitoring devices, maintaining safe work habits, and following established protocols. However, without institutional support such as functional Radiation Safety Committees, routine supervision, and availability of protective tools these individual efforts are often compromised (Awosan et al., 2016).

Despite the presence of regulatory frameworks from bodies like the Nigerian Nuclear Regulatory Authority (NNRA), studies show that practical implementation of radiation protection guidelines is inconsistent. For instance, Nwokeoji and Ononugbo (2019) noted that although radiation dose thresholds were widely known among staff, enforcement mechanisms were lacking, and many facilities operated without comprehensive radiation safety audits. Similarly, Williams et al. (2024) highlighted that even in advanced CT suites, staff had limited exposure to refresher training on radiation safety, pointing to a systemic issue in knowledge retention and institutional oversight.

Moreover, the integration of radiation protection into clinical workflows often depends on leadership. Facilities with proactive radiation safety officers or heads of department tend to demonstrate better compliance, regular dosimeter use, and routine documentation of safety checks (Omojola et al., 2021). In contrast, departments without strong leadership often neglect even basic safety practices, placing staff at increased risk of cumulative exposure.

2.1.5. Standards and Guidelines for Radiation Monitoring

The implementation of effective radiation monitoring is not just a matter of institutional practice but is also governed by a set of international and national standards that define permissible radiation limits, the use of protective equipment, and protocols for monitoring and reporting exposure (Umaru et al., 2024). These guidelines are established by recognized organizations such as the International Commission on Radiological Protection (ICRP), the International Atomic Energy Agency (IAEA), and national bodies like the Nigerian Nuclear Regulatory Authority (NNRA). These standards are designed to protect both patients and healthcare workers from the detrimental effects of ionizing radiation.

One of the central principles underpinning these guidelines is the concept of dose limits the maximum permissible levels of radiation exposure for occupationally exposed workers. The ICRP recommends annual dose limits for radiation workers of 50 millisieverts (mSv) per year, with a cumulative limit based on age, and additional specific guidelines for areas such as the eyes, skin, and hands (Botwe et al., 2015). These guidelines ensure that staff are not exposed to excessive radiation that could lead to long-term health consequences, such as cancer or genetic mutations.

At the national level, the NNRA provides regulatory oversight of radiation safety practices within Nigeria. Their standards align with ICRP recommendations, but they also account for the unique infrastructural and healthcare challenges within Nigeria. For instance, NNRA mandates the use of personal dosimeters for all radiology staff, with regular reporting of dosimeter readings to ensure that exposure levels remain within acceptable ranges (Nwokeoji & Avwiri, 2018). Despite these regulations, studies suggest that compliance with these guidelines is variable, particularly in public health institutions, where the resources and infrastructure to fully implement these standards are often lacking (Omojola et al., 2018).

Furthermore, guidelines stress the need for regular training and retraining of healthcare workers. According to the IAEA, radiation safety training should be provided at initial employment and periodically thereafter to keep staff up-to-date with the latest safety protocols, regulatory changes, and technological advancements (Umaru et al., 2024). In many Nigerian hospitals, however, the lack of structured training programs means that staff may not be fully aware of the most current safety measures, contributing to non-compliance with monitoring protocols (Eze et al., 2013).

The radiation safety culture within an institution plays a critical role in the effectiveness of these standards. In institutions with a strong safety culture, such as those with designated radiation safety officers and well-established radiation safety committees, compliance rates tend to be higher, and staff are more likely to adhere to monitoring guidelines (Onwuzu et al., 2021). These facilities typically have well-documented monitoring procedures, regular equipment checks, and a focus on continuous improvement. On the other hand, in hospitals where radiation safety is not prioritized, staff are often less vigilant, and radiation monitoring practices may be inconsistent or entirely absent (Chibunna & Ibrahim, 2020).

2.1.6. Factors Affecting Compliance with Monitoring Procedures

Despite the existence of clear guidelines and safety principles, compliance with radiation monitoring procedures among healthcare personnel remains a persistent challenge across many medical institutions in Nigeria. Several studies have consistently highlighted that both individual behaviors and systemic limitations contribute to the gap between policy and practice in radiation safety (Eze et al., 2013; Chibunna & Ibrahim, 2020).

One of the most commonly cited factors affecting compliance is lack of access to personal dosimeters. In some healthcare facilities, especially in the public sector, there is limited availability of functional radiation monitoring devices, which automatically hinders consistent usage among staff (Nwokeoji & Avwiri, 2018). Even when dosimeters are provided, issues such as irregular replacement, badge sharing, or lack of feedback on exposure levels further weaken the effectiveness of the monitoring process (Onwuzu et al., 2021).

Another major factor is insufficient training and orientation. Many healthcare workers are inadequately informed about how radiation monitors work, where and how to wear them, and what their readings mean (Awosan et al., 2016). Without this basic understanding, the motivation to comply is diminished. Lawal et al. (2019) found that although many radiology personnel in a tertiary hospital in Northern Nigeria acknowledged the importance of radiation monitoring, only a fraction reported actually receiving formal safety training. This educational gap often results in incorrect use of devices or, worse, complete non-use.

Administrative enforcement also plays a crucial role. In settings where institutional oversight is weak or non-existent, compliance tends to decline sharply. Omojola et al. (2021)

emphasized that the presence of radiation safety officers and regular auditing contributed positively to monitoring behavior. Conversely, in hospitals without clear enforcement policies, radiation monitoring is often treated as optional. Nwokeoji and Ononugbo (2019) also pointed out that many facilities lacked a routine schedule for monitoring or clear guidelines on how to handle overexposure events.

Perceived barriers and negative attitudes among staff can further impact compliance. Some personnel view monitoring procedures as burdensome or unnecessary, particularly in departments where acute effects of radiation are not immediately visible (Umaru et al., 2024). Others may distrust the accuracy of the monitoring devices or assume that their exposure levels are too low to be of concern. This mindset often leads to complacency, which is dangerous given the cumulative nature of radiation exposure.

Another challenge is the delay in receiving feedback from dosimeter readings. According to Williams et al. (2024), real-time or regular feedback is essential in reinforcing safe behavior and ensuring staff understand the importance of ongoing monitoring. Unfortunately, in many Nigerian settings, feedback is either delayed for months or never given at all, limiting the learning opportunity and weakening the sense of accountability.

Lastly, workload and clinical pressure can interfere with compliance. In busy diagnostic units, especially in tertiary hospitals like UBTH, the focus is often on rapid service delivery. Staff under pressure may prioritize efficiency over safety, forgetting to wear dosimeters or skipping routine protective measures, particularly during emergencies or high-volume days (Chibunna & Ibrahim, 2020).

2.2 Theoretical Review

2.2.1 Health Belief Model (HBM)

The Health Belief Model (HBM) is one of the most influential and widely adopted behavioral theories used to explain and predict health-related behaviors, especially in the context of disease prevention and health risk mitigation. Originally developed in the 1950s by social psychologists Hochbaum, Rosenstock, and Kegels working in the U.S. Public Health Service, the model was designed to understand why individuals fail to adopt preventive health measures. Over time, it has been refined and expanded, gaining relevance in various fields, including occupational health and hospital-based safety protocols.

At its core, the HBM posits that an individual's engagement in health-promoting behavior depends on six primary constructs:

1. Perceived Susceptibility: This refers to an individual's belief about their personal risk of developing a health problem. In the context of radiation exposure, this would relate to whether healthcare workers believe they are at risk of radiation-related illnesses such as cancer, infertility, or genetic damage due to their routine occupational exposure.

2. Perceived Severity: This describes the belief about the seriousness of the consequences associated with a particular health threat. A radiographer who believes that radiation exposure carries life-altering or life-threatening consequences is more likely to adhere to monitoring protocols than one who sees the risk as trivial or negligible.

3. Perceived Benefits: This construct refers to an individual's belief in the effectiveness of a particular health action in reducing the threat of illness or injury. For this study, it means whether staff believe that using personal radiation monitoring devices (like TLD badges) and complying with safety procedures will truly help reduce their risk of harm.

4. Perceived Barriers: These are the perceived obstacles or costs (whether real or imagined) that prevent a person from engaging in a health-promoting behavior. In Benin city, these may include lack of access to dosimeters, unavailability of radiation safety training, lack of feedback on radiation exposure levels, or even institutional apathy toward monitoring compliance.

5. Cues to Action: These are external or internal factors that prompt an individual to take action. They could be in the form of hospital policy enforcement, safety signage, reminders from supervisors, peer behavior, or personal health concerns that trigger action toward radiation monitoring.

6. Self-Efficacy: This refers to the confidence in one's ability to take a health-related action successfully. A staff member who understands how to properly wear and handle radiation badges, read results, and respond appropriately to feedback is more likely to consistently comply with radiation safety protocols.

Application to the Present Study

The Health Belief Model provides a valuable theoretical lens through which this study

"Assessment of the Level of Practice of Personnel Radiation Monitoring in Benin city can be interpreted. Understanding the behaviors of healthcare personnel in relation to radiation monitoring cannot be isolated from the psychological and perceptual frameworks that guide their actions. Many healthcare workers may be aware of radiation hazards but still fail to practice appropriate monitoring due to perceived low susceptibility, lack of tangible severity, or absence of immediate consequences.

In Benin city, perceived susceptibility may be influenced by the type of procedures a worker is exposed to. For instance, staff in high-exposure areas like CT and C-arm might acknowledge more risk than those in conventional X-ray units, thus affecting their behavior. Similarly, if workers perceive radiation exposure as severe and potentially damaging, they are more likely to use monitoring devices regularly.

However, if barriers such as unavailability of dosimeters, poor maintenance culture, or delay in feedback on exposure levels are present, these perceived obstacles can override even high awareness or concern. In the same vein, staff who feel inadequately trained or unsure of how to engage with radiation safety protocols may lack self-efficacy and therefore disengage altogether.

Moreover, the presence (or absence) of institutional cues to action such as routine safety briefings, visible safety posters, or regular audits by radiation safety officers could make the difference between consistent and inconsistent practice. A culture of silence around radiation risks may foster complacency, while visible safety enforcement may encourage proactive behavior.

By applying the HBM to this study, it becomes possible not only to measure compliance and awareness, but to understand the motivational drivers and psychological barriers behind staff behaviors. This insight will help in developing tailored interventions that do more than inform they will motivate, empower, and sustain safe radiation practices within Benin city.

2.3 Empirical Review

Chibunna and Ibrahim (2020) carried out a comparative study to evaluate how often radiation monitoring devices are used among radio-diagnostic staff in both secondary and tertiary hospitals in Jos, Nigeria. Their research revealed that only 34% of workers in secondary hospitals consistently used personal dosimeters, whereas 71% of their counterparts in tertiary hospitals did. The study employed a cross-sectional design using structured questionnaires administered to 80 radiology personnel, with data analyzed through descriptive and inferential statistics. The results also highlighted that access to monitoring reports was irregular in both hospital types, often limiting staff awareness of their own radiation exposure levels. The authors concluded that although device usage was more frequent in tertiary hospitals, the overall frequency remained below the desired standard, underscoring the need for improved monitoring enforcement and availability across facilities.

Similarly, Onwuzu et al. (2021) conducted a descriptive study to reassess the frequency of radiation monitoring practices among radiographers in tertiary hospitals across Southeastern Nigeria. Data were collected through self-administered questionnaires distributed to 102 radiographers. The study showed that only 31% of respondents consistently wore radiation monitoring badges such as thermoluminescent dosimeters (TLDs), while 59% reported irregular or infrequent access to such devices. Moreover, many respondents indicated that feedback on exposure levels was delayed or completely unavailable, further discouraging consistent usage. The study concluded that despite ongoing awareness efforts, the actual frequency of radiation monitoring device use remained low due to poor infrastructure and weak institutional commitment.

Eze et al. (2011) investigated the state of occupational radiation protection and monitoring in both public and private X-ray facilities in Edo State. Their observational study included 18 facilities and used interviews and facility audits to assess the presence and use of monitoring devices. The findings indicated that only 20% of staff in public hospitals used radiation monitoring tools, compared to 62.5% in private institutions. The study also revealed that many government facilities lacked even basic provisions for dosimetry, leaving workers unmonitored and potentially at risk. Eze and colleagues concluded that usage of monitoring devices was worryingly low, especially in the public sector, and called for urgent policy intervention to address the disparity.

Lawal et al. (2019) conducted a study at the Ahmadu Bello University Teaching Hospital (ABUTH) in Zaria, Nigeria, to evaluate the level of knowledge and compliance with radiation protection practices among radiation workers. The researchers used a structured questionnaire in a cross-sectional design, targeting radiographers, radiologists, and other staff routinely exposed to ionizing radiation. Although 78% of the participants demonstrated good theoretical knowledge of radiation safety, only 42% reported adhering strictly to standard monitoring protocols, such as the regular use of personal dosimeters and adherence to safe working distances. The study concluded that while awareness was relatively high, actual compliance with established monitoring standards was suboptimal, likely due to institutional lapses and limited access to monitoring equipment.

Omojola et al. (2018) carried out a four-year retrospective review of radiation dose records using a novel dosimeter in the radiology and dentistry departments of a medical facility in Delta State, South-South Nigeria. The study sought to assess not just the levels of occupational exposure but also the compliance of personnel with radiation monitoring procedures. The results revealed inconsistent dosimeter use and poor documentation in several instances. Despite the availability of monitoring tools, adherence to scheduled badge wearing, routine replacement, and proper logging was irregular. The authors emphasized that compliance was not merely a function of availability but of training, policy enforcement, and institutional accountability.

Umaru et al. (2024) evaluated radiation safety practices, attitudes, and compliance among medical and health staff in two hospitals in Maiduguri, Nigeria. The study utilized a structured questionnaire distributed to 150 healthcare workers, including those in radiology. Their findings showed that only 36.7% of participants reported full compliance with radiation monitoring standards, such as consistent dosimeter usage and adherence to exposure limits. Many staff members cited irregular badge replacement, delayed dose feedback, and weak internal enforcement as major challenges to compliance. The study concluded that poor compliance was not due to ignorance but rather institutional weaknesses in supervision and logistics.

Nwokeoji and Avwiri (2018) conducted a study across selected hospitals in the South–South and South–East regions of Nigeria to evaluate personnel radiation monitoring practices. Using a structured questionnaire and observational audits, the researchers gathered data from radiographers, radiologists, and medical physicists. The study found that while 65% of respondents acknowledged the importance of radiation monitoring tools, only 48% were actively using them. Key factors influencing non-use included non-availability of dosimeters, irregular distribution, lack of feedback on recorded doses, and poor administrative follow-up. The researchers concluded that institutional support and consistent monitoring infrastructure were critical determinants of usage behavior.

In a similar vein, Awosan et al. (2016) examined the knowledge and practices related to radiation safety among health workers in a Northern Nigerian teaching hospital. Their cross-sectional study used structured questionnaires and was conducted among 110 radiology staff. Although the majority were aware of radiation risks, only 27.3% consistently used dosimeters. Factors discouraging usage included skepticism about the reliability of devices, lack of regular training, and a general absence of consequences for non-compliance. The authors emphasized that behavioral, institutional, and logistic factors all interact to influence the decision to use or not use monitoring devices.

Botwe et al. (2015), in their study at the largest tertiary referral hospital in Ghana, explored personal radiation monitoring practices among radiographers. Using a mixed-methods design that combined survey and administrative data review, they identified several influencing factors. While most staff had access to TLD badges, about 8% had none due to supply gaps. Among those with access, 14% admitted to not wearing them consistently. Delays in feedback (with some reports taking over three months), lack of routine reminders, and the perception that monitoring had little impact on personal safety were all cited as barriers. The authors concluded that both systemic inefficiencies and attitudinal dispositions shaped monitoring practices.

Eze et al. (2013) investigated radiation protection knowledge and practices among radiographers across four tertiary hospitals in Lagos, Nigeria. Using a structured questionnaire distributed to over 100 radiographers, the study revealed that while 73% of the respondents demonstrated good theoretical knowledge about radiation hazards, only a small proportion could accurately define safe dose limits or explain how to interpret personal dosimeter readings. The authors noted a significant knowledge-practice gap and concluded that although awareness was high in theory, practical application was weak due to inadequate refresher training and lack of enforcement.

Omojola et al. (2021) conducted a shielding assessment in two CT facilities in South-South Nigeria and incorporated staff interviews as part of the evaluation. The study found that many personnel lacked proper knowledge of radiation protection principles and monitoring protocols. Only a few understood how shielding design impacted their occupational exposure. The authors concluded that poor awareness among staff, especially in technically complex environments like CT, contributed to unsafe work practices and could undermine institutional safety efforts.

Nwokeoji and Ononugbo (2021) examined radiation exposure levels and awareness among radiological unit personnel in teaching hospitals in Southern Nigeria. The study involved radiation dose estimations and structured questionnaires targeting staff. Results indicated that while most personnel recognized the general dangers of radiation, less than half were aware of the recommended dose limits or the correct use of dosimeters. The researchers highlighted that poor communication between safety officers and staff, coupled with infrequent safety briefings, significantly affected awareness levels.

2.4 Summary of the Review

The reviewed literature provides a comprehensive understanding of radiation monitoring practices and safety awareness among healthcare personnel in Nigeria and other similar contexts. Most of the studies employed descriptive cross-sectional designs, utilizing structured questionnaires, observational checklists, and dosimetry audits to evaluate how radiation monitoring devices are used, the level of compliance with safety protocols, factors influencing adherence, and the awareness levels of staff regarding radiation risks and protection.

Across the studies, a consistent pattern emerged; the frequency of radiation monitoring device use was generally low to moderate, especially in public hospitals. While some tertiary institutions showed relatively better usage rates, availability and consistency remained a major challenge. Similarly, compliance with standard monitoring procedures was suboptimal, often hindered by delayed dosimetry feedback, poor institutional supervision, and inadequate documentation practices. Another key theme was the identification of influencing factors, such as lack of dosimeters, poor administrative follow-up, insufficient training, and weak safety culture all of which shaped how staff engaged with radiation monitoring tools.

Notably, although many workers demonstrated theoretical awareness of radiation hazards, there was a significant disconnect between awareness and practical behavior. Staff frequently reported understanding the risks yet failed to follow proper monitoring procedures, largely due to infrastructural limitations and institutional neglect. Only a few studies reported any formal continuing education or structured training interventions for staff.

However, there were gaps observed across the literature. Very few studies provided hospital-specific data for hospitals in Edo state or similar large tertiary hospitals in South-South Nigeria. Additionally, little emphasis was placed on the relationship between awareness and actual monitoring behavior, and few studies engaged in longitudinal tracking or intervention-based evaluation. There was also a lack of standardized national enforcement mechanisms across institutions, further complicating consistency in monitoring practices.

In Benin city it seeks to bridge the gap between theoretical awareness and actual compliance, while also highlighting institutional factors that either promote or hinder proper radiation monitoring among personnel. This will inform not only academic discourse but also policy-level decisions that enhance occupational safety within radiological departments.

CHAPTER THREE

RESEARCH METHODOLOGY

3.1 Research Setting

The study was conducted in Benin City, Edo State, Nigeria, within five selected healthcare institutions that provide radiological imaging services. These institutions represent a mix of tertiary, specialist, and private facilities, giving a broad overview of radiography practice in the city.

University of Benin Teaching Hospital (UBTH): UBTH is a federal tertiary healthcare institution and the largest hospital in Edo State. It serves as a referral center for Edo and neighboring states, providing a wide range of specialized medical and surgical services. The radiology department is well-established, offering advanced diagnostic imaging modalities such as X-ray, CT, ultrasound, and MRI. With its academic mandate, UBTH also serves as a training ground for radiographers and other healthcare professionals.

Lily Hospital (LILY): Lily Hospital is a private multi-specialist hospital in Benin City, recognized for its modern healthcare facilities. The radiology unit provides essential diagnostic imaging services, particularly X-ray and ultrasound, with a focus on patient-centered care. Its smaller scale compared to tertiary hospitals makes it an important representation of radiography practice in private health institutions.

Raytouch Diagnostic Center (RAYTOUCH): Raytouch is a specialized private diagnostic imaging center in Benin City. It offers a range of radiological investigations, including digital

X-ray, ultrasound, CT scan, and MRI, catering to both outpatient and referred cases from hospitals. As a diagnostic-focused facility, Raytouch plays a vital role in supplementing hospital-based radiology services.

Benin Medical Care (BMC): BMC is a modern private hospital that combines clinical care with diagnostic support services. The radiology department is equipped with X-ray and ultrasound facilities, providing essential imaging support for medical and surgical care. The hospital is known for its efficient service delivery and represents mid-sized private hospital settings in Benin City.

Edo Specialist Hospital (ESH): ESH is a state government-owned specialist hospital located in Benin City. It provides secondary and tertiary healthcare services, including advanced radiological investigations. The radiology department supports patient diagnosis and management across different specialties, making it an essential public healthcare facility in Edo State.

3.2 Research Design

The study used a descriptive cross-sectional research design. This design allows for the collection of data from a specific group of participants (radiographers) at one point in time. This approach provided a snapshot of their radiation safety practices, compliance with safety protocols, and awareness of radiation protection measures. Previous studies on radiation safety practices in radiography, such as those by Eze *et al*. (2013) and Chibunna & Ibrahim (2020), have successfully utilized cross-sectional designs to examine these factors among healthcare workers, making it an appropriate choice for this study.

3.3 Target Population

The study population consisted of all radiographers working in the radiology departments of these five selected institutions in Benin City. Radiographers are the primary professionals conducting radiological examinations involving ionizing radiation, and their compliance with safety protocols is critical.

A total of 60 radiographers formed the study population, distributed as follows:

FACILITY	NUMBER OF RADIOGRAPHERS
University of Benin Teaching Hospital (UBTH)	35
Lily Hospital (LILY)	5
Raytouch Diagnostic Center (RAYTOUCH)	7
Benin Medical Care (BMC)	5
Edo Specialist Hospital (ESH)	8
TOTAL	60

3.4 Sample Technique and Sample Size

The study adopted a census sampling technique, selecting all radiographers across the identified institutions. The rationale for choosing this method goes beyond the small population size, it also ensures complete coverage of the study population and eliminates sampling bias which can occur when only a portion of the population is selected. By involving every eligible radiographer the study captures a true representation of radiation safety practices across all major radiology facilities in Benin city. This approach increases the accuracy and generalizability of the findings within the study context.

3.5 Instrument of Data Collection

Data was collected using a structured questionnaire designed to assess the radiation safety practices, compliance, and awareness of radiographers. The questionnaire included closed-ended questions (using Likert scales) to quantify compliance with safety measures to gather more in-depth responses regarding the challenges radiographers face in adhering to radiation protection protocols. The instrument was pre-tested in a different hospital setting to ensure its clarity and appropriateness. Previous studies, such as those by Eze *et al*. (2011) and Nwokeoji & Avwiri (2018), have successfully used similar questionnaires in radiation safety assessments.

3.6 Validity of Instrument

To establish the validity of the instrument, content validation was carried out. A panel of experts in radiography, radiation protection, and my supervisor reviewed the questionnaire. Their feedback ensured that the instrument accurately measures radiation safety practices, compliance, and awareness. This validation process is crucial for ensuring that the questionnaire is relevant and comprehensive in capturing the necessary data. Similar validation techniques have been used by researchers like Chibunna & Ibrahim (2020) in their studies on radiation safety.

3.7 Reliability of Instrument

The reliability of the questionnaire was assessed using Cronbach's alpha, a statistical measure of internal consistency. A pilot test was conducted with a small group of radiographers at a different healthcare facility (Benin Medical Center). The reliability coefficient was calculated to determine whether the items within the questionnaire are consistently measuring the same concept. A Cronbach’s alpha value of 0.70 was considered acceptable. This reliability testing is essential to ensure that the questionnaire provides consistent and trustworthy data, as seen in similar studies (Omojola *et al*., 2021).

3.8 Method of Data Collection

Data was collected exclusively through an online questionnaire over a four-week period. The questionnaire link was shared electronically with the selected radiographers working in the radiology departments. Before completing the form, participants was required to provide informed consent online, confirming that they understand the purpose of the study, their voluntary participation, and their right to withdraw at any stage without penalty. The online format ensures flexibility, as participants can respond at their convenience. All completed questionnaires was automatically stored in a secure, password-protected database and made accessible only to the researcher for subsequent analysis.

3.9 Method of Data Analysis

Data analysis involved both descriptive and inferential statistics. Descriptive statistics, including frequencies, percentages, and mean scores, was used to summarize the responses to the questionnaire. Data was analyzed using SPSS (Statistical Package for the Social Sciences) software v.25 and presented using tables.

3.10 Ethical Considerations

Ethical approval for the study was sought from the Institutional Review Board (IRB) in University of Benin Taching Hospital. Informed consent was obtained from all participants, ensuring that they understand the nature of the study and their role in it. Participants was assured of their right to confidentiality, and no personal identifying information was included in the data. Additionally, participants were reminded that their participation is voluntary and that they can withdraw at any time without any consequences.

CHAPTER FOUR

DATA PRESENTATION AND DISCUSSION OF FINDINGS

4.1 Data Presentation

Table 4.1 presents the socio-demographic distribution of the respondents.

Variable	Category	Frequency (n)	Percentage (%)
Gender	Male	45	75.0
	Female	15	25.0
Age (years)	20–29	34	56.7
	30–39	14	23.3
	40–49	7	11.7
	50 and above	5	8.3
Marital Status	Single	23	38.3
	Married	37	61.7
Qualification	B.Sc	47	78.3
	PGD	9	15.0
	M.Sc	4	6.7
Years of Experience	1–5	28	46.7
	6–10	24	40.0
	11–15	5	8.3
	Above 15	3	5.0
Type of Hospital	Public	12	20.0
	Private	8	13.3
	Teaching	35	58.3
	Diagnostic Centre	5	8.3

The results in Table 4.1 show that the majority of respondents were male (75%), while females made up 25% of the study population. Most respondents fell within the 20–29 years age group (56.7%), followed by those aged 30–39 years (23.3%), while a smaller proportion were 40–49 years (11.7%) and 50 years and above (8.3%). In terms of marital status, the married respondents formed the majority (61.7%), with singles accounting for 38.3%. Regarding academic qualifications, most held a B.Sc degree (78.3%), while 15% had PGD and 6.7% had M.Sc qualifications. For years of professional experience, nearly half of the respondents (46.7%) had between 1–5 years of experience, while 40% had 6–10 years, 8.3% had 11–15 years, and only 5% had more than 15 years of experience. Finally, the distribution by type of hospital revealed that the majority worked in teaching hospitals (58.3%), followed by those in public hospitals (20%), private facilities (13.3%), and diagnostic centres (8.3%). This indicates that the study population was largely drawn from teaching institutions, with a relatively younger workforce holding predominantly bachelor's degrees.

Table 4.2 analyzes objective one to evaluate the level of awareness among radiographers regarding radiation safety and personnel radiation monitoring.

Table 4.2 presents respondents' level of awareness of radiation monitoring.

S/N	Statement	SA	A	N	D	SD	Mean ± SD	Decision
1	I am aware of the risks of occupational exposure to ionizing radiation.	52 (86.7)	8 (13.3)	0 (0.0)	0 (0.0)	0 (0.0)	4.87 ± 0.34	Agree
2	I have received training on radiation safety and monitoring.	52 (86.7)	8 (13.3)	0 (0.0)	0 (0.0)	0 (0.0)	4.87 ± 0.34	Agree
3	Radiation monitoring is essential to occupational health.	52 (86.7)	8 (13.3)	0 (0.0)	0 (0.0)	0 (0.0)	4.87 ± 0.34	Agree
4	I know how to correctly use radiation dosimeters.	45 (75.0)	11 (18.3)	4 (6.7)	0 (0.0)	0 (0.0)	4.68 ± 0.57	Agree
5	I am aware of the ALARA principle.	52 (86.7)	8 (13.3)	0 (0.0)	0 (0.0)	0 (0.0)	4.87 ± 0.34	Agree
6	My hospital provides periodic radiation safety updates or reminders.	15 (25.0)	19 (31.7)	26 (43.3)	0 (0.0)	0 (0.0)	2.82 ± 0.81	Neutral

The findings in Table 4.2 show that respondents had a very high level of awareness of radiation monitoring. Almost all respondents (86.7% strongly agreed and 13.3% agreed) recognized the risks of occupational radiation exposure, had received training on radiation safety, and acknowledged that radiation monitoring is essential. Similarly, awareness of the ALARA principle was universal (mean = 4.87 ± 0.34). Knowledge of how to use dosimeters was also high (mean = 4.68 ± 0.57), though a small proportion (6.7%) were neutral, suggesting limited confidence in practical use among a few staff. Interestingly, awareness dropped when institutional support was considered, as only 56.7% agreed their hospitals provide periodic radiation safety updates, while 43.3% were neutral (mean = 2.82 ± 0.81). With a grand mean of 4.50, respondents' awareness of radiation monitoring was rated high (Agree).

Table 4.3 analyzes the objective two which is to assess the practice of personnel radiation monitoring among radiographers.

Table 4.3 presents respondents' practice of personnel radiation monitoring.

Statement	SA	A	N	D	SD	Mean ± SD	Decision
I wear my radiation monitoring badge/dosimeter during all procedures.	26 (43.3)	7 (11.7)	11 (18.3)	16 (26.7)	0 (0.0)	2.72 ± 1.35	Neutral
I submit my badge for routine dose reading and replacement.	22 (36.7)	11 (18.3)	11 (18.3)	16 (26.7)	0 (0.0)	2.65 ± 1.33	Neutral
I receive feedback or reports on my exposure dose.	11 (18.3)	15 (25.0)	19 (31.7)	15 (25.0)	0 (0.0)	2.37 ± 1.08	Neutral
I adhere strictly to safety practices during radiological procedures.	26 (43.3)	34 (56.7)	0 (0.0)	0 (0.0)	0 (0.0)	4.43 ± 0.50	Agree
I practice radiation monitoring even when supervisors are not watching.	22 (36.7)	22 (36.7)	16 (26.7)	0 (0.0)	0 (0.0)	4.10 ± 0.78	Agree

Table 4.3 indicates that although awareness was high, actual practice of radiation monitoring was inconsistent. Strict adherence to safety practices during radiological procedures was well observed (100% agreement, mean = 4.43 ± 0.50), and most respondents (73.4%) continued monitoring practices even without supervision (mean = 4.10 ± 0.78). However, only about 55% reported always wearing their dosimeters during procedures, while 26.7% admitted not doing so (mean = 2.72 ± 1.35). A similar pattern was observed for badge submission, where 55%

complied but 26.7% failed to submit theirs for routine dose reading (mean = 2.65 ± 1.33). The weakest area was feedback on exposure dose, where only 43.3% agreed to receiving reports, and 25% disagreed outright (mean = 2.37 ± 1.08). This gap shows that monitoring results are not regularly communicated back to staff. The grand mean of 3.25 suggests that respondents' practice of radiation monitoring was average (Neutral), reflecting a gap between knowledge and consistent compliance.

Table 4.4 analyzes objective three which is to identify the challenges affecting effective radiation monitoring among radiographers.

Table 4.4 presents respondents' views on challenges affecting radiation monitoring.

Statement	SA	A	N	D	SD	Mean ± SD	Decision
There is irregular supply or access to dosimeters.	11 (18.3)	30 (50.0)	11 (18.3)	8 (13.3)	0 (0.0)	3.73 ± 0.95	Agree
Lack of feedback discourages consistent use of monitoring tools.	22 (36.7)	15 (25.0)	23 (38.3)	0 (0.0)	0 (0.0)	3.98 ± 0.87	Agree
There is insufficient training on radiation monitoring.	11 (18.3)	22 (36.7)	11 (18.3)	16 (26.7)	0 (0.0)	3.42 ± 1.12	Agree
The hospital management does not enforce compliance with monitoring.	4 (6.7)	11 (18.3)	26 (43.3)	11 (18.3)	8 (13.3)	2.87 ± 1.10	Neutral
I do not always use dosimeters due to workload or urgency of tasks.	8 (13.3)	4 (6.7)	15 (25.0)	19 (31.7)	14 (23.3)	2.55 ± 1.32	Disagree
Monitoring practices are hindered by lack of supervision.	8 (13.3)	22 (36.7)	11 (18.3)	11 (18.3)	8 (13.3)	3.18 ± 1.28	Neutral

As shown in Table 4.4, several institutional and operational challenges affect personnel monitoring. The most significant issues were irregular supply of dosimeters (68.3% agreement, mean = 3.73 ± 0.95) and lack of feedback on dose reports (61.7% agreement, mean = 3.98 ± 0.87). Insufficient training was also a concern for more than half of respondents (55%, mean = 3.42 ± 1.12). In contrast, opinions on management enforcement and supervision were mixed. While 25% agreed that hospital management fails to enforce compliance, 43.3% were neutral, producing a borderline neutral decision (mean = 2.87 ± 1.10). Similarly, lack of supervision recorded a neutral decision (mean = 3.18 ± 1.28). Interestingly, workload and urgency were not strongly endorsed as barriers: only 20% agreed they skip dosimeter use due to workload, while nearly 55% disagreed (mean = 2.55 ± 1.32). With a grand mean of 3.29, respondents agreed that significant challenges exist, mainly revolving around access to dosimeters, inadequate feedback, and insufficient training.

4.2 Test of Hypothesis

The following hypothesis was tested to determine the relationship between awareness and practice of personnel radiation monitoring:

Null Hypothesis (H_0): There is no significant relationship between radiographers' level of awareness and their practice of personnel radiation monitoring in Benin City.
Alternative Hypothesis (H_1): There is a significant relationship between radiographers' level of awareness and their practice of personnel radiation monitoring in Benin City.

Table 4.5: Chi-Square Test of Relationship between Awareness and Practice of Personnel Radiation Monitoring

Variable	χ^2-value	df	p-value	Decision
Awareness × Practice	18.64	4	0.001	Significant

The result of the Chi-Square analysis (Table 4.5) shows that the calculated χ^2-value of 18.64 at 4 degrees of freedom yielded a p-value of 0.001, which is less than the 0.05 level of significance. This indicates that the relationship between radiographers' awareness and their practice of personnel radiation monitoring is statistically significant. Therefore, the null hypothesis (H_0) which states that there is no significant relationship between awareness and practice is rejected, while the alternative hypothesis (H_1) is accepted. This implies that higher awareness of radiation monitoring is positively associated with better monitoring practices among radiographers in Benin City.

4.3 Discussion of Findings

Table 4.2 showed that radiographers in Benin City demonstrated a very strong awareness of radiation safety and monitoring. Almost all respondents acknowledged the risks of radiation exposure, confirmed that they had received some form of radiation safety training, and agreed that personnel monitoring is an essential aspect of occupational health. Knowledge of the ALARA principle was also widespread, with nearly every respondent strongly endorsing it. However, one area that stood out was the issue of institutional reinforcement. While most radiographers knew the theory, only about half reported that their hospitals provided periodic safety updates, while a significant proportion remained neutral on this point. The grand mean of 4.50 therefore paints a clear picture: while individual awareness levels are high, institutional structures that should continually reinforce this awareness are not as strong.

The meaning of this result is twofold. On one hand, it reflects the effectiveness of professional training received during radiography education, which equips practitioners with a solid knowledge base about radiation risks, monitoring principles, and international standards such as ALARA. On the other hand, it exposes a weakness in the workplace environment, where continuous reinforcement through refresher training, seminars, or routine safety briefings may be missing. The fact that nearly half of the respondents were uncertain about whether their hospitals provide regular updates suggests that institutional safety culture may not be consistent across facilities. In practice, this could result in a situation where radiographers begin their careers with strong theoretical knowledge but, without sustained reinforcement, risk becoming complacent or failing to keep up with evolving best practices.

When compared with literature, this finding agrees with Lawal et al. (2019), who observed that although radiation workers at ABUTH possessed strong theoretical knowledge (78%), actual compliance and reinforcement mechanisms were weak. Similarly, Eze et al. (2013) found that while radiographers in Lagos could demonstrate knowledge of radiation hazards, many lacked the ability to interpret personal dose readings, underscoring that knowledge alone is not enough without practical reinforcement. My finding contrasts with Williams et al. (2024), who highlighted low awareness levels among CT staff, with less than 40% attending safety training in recent years. The difference may reflect variations in institutional culture, as CT units often deal with higher radiation doses yet paradoxically appear to have weaker awareness reinforcement compared to general radiography departments.

The implication of this result is that radiographers in Benin City are not lacking in awareness, but hospitals need to build stronger systems of continuous education and institutional support. Regular safety meetings, mandatory refresher courses, and proactive communication of dose reports would help transform this high level of awareness into sustained safe practice. Without such reinforcement, there is a risk that theoretical awareness may not translate into consistently safe day-to-day behavior.

Table 4.3 revealed that while respondents expressed strong awareness of radiation safety, their actual practice of personnel monitoring was inconsistent. A significant proportion admitted that they did not always wear their dosimeters during procedures, with only about 55% reporting consistent use. Submitting badges for dose readings followed a similar pattern: slightly over half complied routinely, while more than a quarter failed to submit theirs as required. The weakest area was feedback on exposure doses, where less than half of respondents confirmed receiving reports, while others either remained neutral or disagreed. Interestingly, despite these lapses, respondents reported strict adherence to general safety procedures, with all of them indicating compliance, and most agreed they continued to practice radiation monitoring even without direct supervision. The grand mean of 3.25 therefore suggests that while radiographers are knowledgeable, their actual monitoring practices fall into a middle ground — not outright poor, but far from optimal.

This result highlights a critical gap between knowledge and application. In practice, radiographers may be aware of the risks of radiation but may fail to consistently use dosimeters due to factors such as convenience, workload pressures, or institutional lapses in badge distribution and monitoring. The fact that general safety practices scored much higher than dosimeter-related practices suggests that radiographers are more inclined to follow visible safety measures (like positioning and shielding) but are less consistent with compliance measures that rely on institutional support, such as badge replacement and exposure reporting. Feedback mechanisms also appear to be a weak link. When workers do not receive timely dose reports, they may feel that monitoring is not beneficial, which can erode motivation to comply strictly.

Comparing with earlier studies, my findings align with Onwuzu et al. (2021), who reported that only 31% of radiographers in Southeastern Nigeria consistently wore badges, while a majority had irregular access to devices and rarely received feedback on their doses. Similarly, Eze et al. (2011) found poor use of monitoring devices in public hospitals in Edo State, blaming weak institutional provisions for dosimetry. These results mirror the challenges seen in my study, where awareness exists but consistent practice lags behind. However, the results contrast somewhat with Chibunna and Ibrahim (2020), who reported higher usage rates (71%) among radiographers in tertiary hospitals in Jos. This difference may reflect variations in institutional capacity and enforcement across regions, with some centers better equipped to provide and track monitoring devices than others.

The implication of this finding is clear: without consistent use of dosimeters, the health risks to radiographers remain significant despite their high awareness levels. Hospitals must address systemic issues such as irregular badge distribution, lack of timely feedback, and inadequate enforcement. For radiographers, improving personal accountability in consistently using and submitting monitoring badges is also crucial. Bridging this knowledge-practice gap will require both stronger institutional support and a renewed commitment by professionals to make monitoring a routine part of their practice, not just an optional safety step.

Table 4.4 showed that radiographers in Benin City face several institutional and operational challenges that limit consistent radiation monitoring. The most prominent barriers identified were the irregular supply of dosimeters (68.3% agreed) and the lack of feedback on recorded doses (61.7% agreed). These two factors suggest that even when radiographers are willing to comply, lapses in institutional support make consistent monitoring difficult. Respondents also highlighted insufficient training as a problem, with more than half acknowledging gaps in refresher education on monitoring procedures.

Meanwhile, opinions on management enforcement and supervision were more divided. About a quarter of respondents agreed that management did not enforce compliance, but the largest proportion (43.3%) chose a neutral position. This neutrality could indicate uncertainty about whether enforcement structures exist or perhaps a reluctance to criticize management directly. A similar pattern was seen for supervision, where responses were spread across agree, neutral, and disagree, leading to an overall neutral decision. Interestingly, workload and urgency were not strongly endorsed as major obstacles — only one in five respondents agreed with this statement, while over half disagreed. This suggests that radiographers do not necessarily view their workload as the main reason for lapses in monitoring, but rather point to systemic weaknesses in supply, training, and feedback. The grand mean of 3.29 indicates that respondents generally agreed that challenges exist, though their nature and intensity vary.

This finding speaks to a deeper issue: compliance with radiation monitoring is not just about personal responsibility but also about how well institutions support safe practice. A radiographer may be fully aware of the risks and willing to comply, but if dosimeters are unavailable, not replaced regularly, or feedback on exposure is never given, compliance becomes difficult to sustain. Training gaps further compound the problem, as many radiographers may not fully understand the implications of irregular monitoring or how to interpret exposure reports when they are available. The neutral responses on management enforcement also suggest that many workers do not feel their institutions actively prioritize monitoring. This can create a culture of complacency, where safety is seen as the worker’s responsibility alone, rather than a shared institutional duty.

When compared with existing literature, this result aligns closely with Nwokeoji and Avwiri (2018), who found that even when radiographers acknowledged the importance of monitoring, non-availability of dosimeters, irregular distribution, lack of feedback, and poor administrative follow-up hindered consistent practice. Similarly, Umaru et al. (2024) reported that irregular badge replacement and delayed dose reports were major barriers to compliance in Maiduguri, concluding that poor institutional supervision, not ignorance, was the root cause of weak monitoring. In contrast, Awosan et al. (2016) emphasized behavioral and attitudinal factors, such as skepticism about device reliability and lack of consequences for non-compliance, as stronger barriers than institutional ones. My findings therefore lean more towards systemic and institutional weaknesses as the dominant challenges, rather than purely individual behavior.

The implication of this result is that any effort to improve monitoring must go beyond raising awareness or instructing radiographers to comply. Hospitals need to guarantee a regular supply of dosimeters, establish clear reporting systems for dose feedback, and provide continuous training on monitoring practices. Management should also play a more visible role in enforcing compliance, as weak enforcement risks normalizing unsafe practices. By addressing these institutional barriers, radiographers would be better positioned to translate their awareness into consistent practice, thereby protecting both themselves and their patients from unnecessary radiation risks.

Table 4.5 presented the result of the Chi-Square test examining whether there is a significant relationship between radiographers' awareness and their practice of personnel radiation monitoring. The test produced a χ^2 value of 18.64 with 4 degrees of freedom and a p-value of 0.001. Since this p-value is below the 0.05 threshold, the result is statistically significant. This means that awareness and practice are not independent of each other; rather, radiographers who demonstrated higher levels of awareness were more likely to engage in better monitoring practices. The null hypothesis, which stated that no significant relationship exists, was therefore rejected, and the alternative hypothesis accepted.

The meaning of this result is clear: while awareness alone does not guarantee perfect compliance, it plays a critical role in shaping radiographers' practices. A radiographer who is fully aware of radiation hazards, understands the ALARA principle, and knows how to use a dosimeter correctly is more inclined to use monitoring devices and adhere to safety protocols than one with poor awareness. However, the earlier results from Table 4.3 also showed that awareness does not always translate into uniform compliance, as gaps were observed in consistent dosimeter usage and feedback. This suggests that awareness is a necessary but not sufficient condition for safe practice institutional support and enforcement remain crucial.

When compared with literature, my finding supports the work of Chibunna and Ibrahim (2020), who found that hospitals where radiographers had higher awareness levels, particularly tertiary centers, also recorded higher frequencies of monitoring device use compared to secondary hospitals. Similarly, Lawal et al. (2019) reported that while knowledge of radiation safety was high among staff at ABUTH, those with stronger knowledge scores tended to report higher levels of compliance. On the contrary, Awosan et al. (2016) emphasized that even with adequate awareness, behavioral factors such as skepticism and lack of enforcement weakened practice, suggesting that awareness alone could not drive compliance. My study therefore shows that while awareness significantly influences practice, it must be combined with institutional reinforcement to produce consistent results.

The implication of this finding is that efforts to improve radiation monitoring should not treat awareness and practice as separate silos. Awareness training programs should be directly linked with practical monitoring systems, such as timely distribution of dosimeters, regular feedback of exposure reports, and visible management enforcement. By strengthening this awareness–practice connection, hospitals in Benin City can create a more effective culture of radiation safety where knowledge naturally leads to consistent protective behaviors.

CHAPTER FIVE

SUMMARY, CONCLUSION, AND SUGGESTION FOR FURTHER STUDIES

5.1 Summary of Findings

This study examined the awareness, practice, and challenges of personnel radiation monitoring among radiographers in Benin City. A total of 60 respondents participated. The findings revealed that;

1. Awareness levels were very high. Nearly all respondents recognized the risks of occupational radiation exposure, had received training on radiation safety, and were familiar with monitoring principles such as ALARA. However, awareness of periodic safety updates provided by institutions was weaker, with a large proportion of respondents remaining neutral.

2. In contrast, actual practice of radiation monitoring was less consistent. While radiographers adhered strongly to safety practices and many indicated they practiced monitoring even without supervision, compliance with the routine use and submission of dosimeters was far from universal. Feedback on exposure reports was also poor, leaving many radiographers without knowledge of their dose history.

3. Challenges to monitoring were largely institutional. Respondents highlighted irregular supply of dosimeters, lack of timely feedback, and inadequate training as the most pressing obstacles. Issues of management enforcement and supervision received mixed responses, while workload and urgency were not widely viewed as significant barriers.

4. Hypothesis testing confirmed that awareness and practice are significantly related.

Radiographers with higher awareness were more likely to engage in consistent monitoring practices, suggesting that knowledge plays an important role in shaping behavior, though institutional support is also necessary.

5.2 Conclusion

The study concludes that radiographers in Benin City are well informed about radiation safety and the importance of monitoring. However, this high awareness does not automatically translate into consistent practice due to systemic and institutional barriers. Gaps in regular badge use, lack of dose feedback, and limited refresher training weaken the effectiveness of monitoring systems. The significant link between awareness and practice underscores the need to bridge the gap by reinforcing awareness with practical, institutional measures. Without addressing these systemic weaknesses, awareness alone will not guarantee the protection of radiographers from occupational risks.

5.3 Recommendations

Based on the findings of this study, the following recommendations are made:

1. Strengthen institutional monitoring systems: Hospitals should ensure the regular supply, replacement, and proper distribution of dosimeters to all radiographers.

2. Provide consistent feedback: Monitoring reports should be delivered promptly to staff so they can track their exposure and adjust their practices accordingly.

3. Enhance training and refresher courses: Continuous professional development on radiation safety and monitoring should be organized periodically.

4. Improve enforcement: Hospital management should enforce compliance with monitoring protocols, making badge use and submission a mandatory requirement.

5. Encourage a culture of safety: Beyond compliance, institutions should foster a culture where monitoring is seen as an integral part of professional responsibility.

5.4 Suggestions for Further Study

1. Future research could expand beyond Benin City to compare findings across multiple states in Nigeria allowing for a broader comparison of radiation safety practices across regions.

2. A longitudinal design could be employed to measure how awareness and practice change over time with interventions such as refresher training.

3. Further studies could also include medical physicists and radiologists to broaden the understanding of radiation safety practices across professions.

5.5 Limitations of the Study

1. Self-reported data: The study relied on self-reported data, which are subject to response and social desirability bias. Some radiographers may have overstimulated their compliance with radiation safety practices to present themselves more favorably. .

2. Cross-sectional design: The cross-sectional design captures practices at a single point in time, limiting the ability to assess changes over time.

3. Availability of institutional records on badge distribution and dose feedback was not verified, which could have provided stronger validation of responses.

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PROTOCOL NUMBER: ADM/E 22/A/VOL.VII/20

PROPOSAL TITLE: "ASSESSMENT OF THE
MONITORING IN BENIN

PRINCIPAL INVESTIGATOR(S): MOWETA I

DEPARTMENT/INSTITUTION: DEPARTME
SCIENCES,

DATE CONSIDERED: AUGUST 20TH, 2025

DECISION OF THE COMMITTEE: APPROVED

THIS APPROVAL DATES 20/8/2025 TO 19/8/2026.
PLEASE INFORM THE HREC SO THAT THE DA

REMARK:

CHAIRMAN: PROF. (MRS) A.N. OFILI

SUPERVISOR (S): AKPOBASAHAN E.A. (DR)

DECLARATION BY INVESTIGATOR(S):
PROTOCOL NUMBER (please quote in all enquiries
Note that no participant accrual or activity related to thi
consent forms used in this study must carry the HREC
In multiyear research, endeavor to submit your annua
approval and avoid disruption of your research. No cha
HREC except in circumstances outlined in the Code.
research site without previous notification

Signature & Date..

ubthresearchethics@gmail.co

QUESTIONNAIRE

Dear respondents

I am a final year student in the department of Radiography, University of Benin, Benin City. I am currently conducting research on "**ASSESSMENT OF THE LEVEL OF PRACTICE OF PERSONNEL RADIATION MONITORING IN BENIN CITY**."This questionnaire aims to collect relevant information for this study. Kindly answer the following questions to the best of your knowledge. Your responses are crucial to this study, so I would appreciate your honest response. All information provided would be treated with confidentiality and would be used solely for research purposes. Thank you for your time and participation

Section A: Socio-Demographic Characteristics

Please tick [✓] as appropriate.

1. Gender: ☐ Male ☑ Female

2. Age: ☑ 20–29 ☐ 30–39 ☐ 40–49 ☐ 50 and above

3. Marital Status: ☐ Single ☑ Married ☐ Divorced ☐ Widowed

4. Qualification: ☑ B.Sc ☐ PGD ☐ M.Sc ☐ Others (Specify): ________

5. Years of Experience: ☑ 1–5 ☐ 6–10 ☐ 11–15 ☐ Above 15

6. Type of Hospital: ☑ Public ☐ Private ☐ Teaching ☐ Diagnostic Centre

From section B to D Kindly select your level of agreement using the scale: SA – Strongly Agree, A – Agree, N – Neutral, D – Disagree, SD – Strongly Disagree

Section B: Awareness of Radiation Monitoring

S/N	Statement	SA	A	N	D	SD
1	I am aware of the risks of occupational exposure to ionizing radiation.	✓				
2	I have received training on radiation safety and monitoring.	✓				
3	Radiation monitoring is essential to occupational health.	✓				
4	I know how to correctly use radiation dosimeters.	✓				
5	I am aware of the ALARA principle.	✓				
6	My hospital provides periodic radiation safety updates or reminders.		✓			

Section C: Practice of Personnel Radiation Monitoring

S/N	Statement	SA	A	N	D	SD
1	I wear my radiation monitoring badge/dosimeter during all procedures.	✓				
2	I submit my badge for routine dose reading and replacement.	✓				
3	I receive feedback or reports on my exposure dose.	✓				
4	I adhere strictly to safety practices during radiological procedures.	✓				
5	I practice radiation monitoring even when supervisors are not watching.	✓				

Section D: Challenges Affecting Radiation Monitoring

S/N	Statement	SA	A	N	D	SD
1	There is irregular supply or access to dosimeters.		✓			
2	Lack of feedback discourages consistent use of monitoring tools.		✓			
3	There is insufficient training on radiation monitoring.				✓	
4	The hospital management does not enforce compliance with monitoring.				✓	
5	I do not always use dosimeters due to workload or urgency of tasks.				✓	
6	Monitoring practices are hindered by lack of supervision.		✓			

INTELLECTUAL PROPERTY & TECHNOLOGY TRANSFER OFFICE (IPTTO)

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CLEARANCE FORM

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