

Assessment of Scrub Nurses' Knowledge and Practice Toward Sterile Techniques in Operation Rooms at Public Hospitals in Sana'a City, Yemen

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الاستهلال

سُورَةُ طه

بِسْمِ اللَّهِ الرَّحْمَنِ الرَّحِيمِ

فَتَعَلَى اللَّهِ الْمَلِكُ الْحَقُّ وَلَا تَعْجَلْ بِالْقُرْآنِ مِنْ قَبْلِ أَنْ
يُقْضَىٰ إِلَيْكَ وَحْيُهُ ۚ وَقُلْ رَبِّ زِدْنِي عِلْمًا ﴿١١٤﴾

Dedication

Thank God thank you very much

*We got tired ,we learned ,we won ,we achieved .And who
said I am for herHe got It.*

*I received it and embraced it today with great glory .The
dream was not near nor the road was easy ,butAre you
there yet. **I'm not alone.***

*I didn 't' take much on my shoulders ,he paid me back, he
relieved me of misery ,he helped me survive. **(My dear
father).***

*As she accompanied me ,taught me ,encouraged me ,broke
me and forced me ,withered and watered me ,fell and lifted
me up **(my dear mother).***

*To those who stood by me and were the first to support me
and my first supporter..... **(My brothers and sisters).***

*To those with whom I shared the details of life with its
sweet and bitter ,to my comrades **(My colleagues and
colleagues).***

*To the beacon of knowledge ,who carried the holiest
message in life ,who spent half their lives on a path that
God loved and brought out a generation through science
and knowledge*

Acknowledgment

*We have our deepest gratitude and appreciation to **Almighty Allah**. He has guided us to every success we have had throughout my life. Without his guidance and blessing, we could not achieve any good deeds in this life. Peace and blessings be upon our prophet **Mohammad**.*

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The Researchers

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Abbreviations

Abbreviations	Term
ANOVA	Analysis of Variance
AORN	Association of periOperative Registered Nurses
CDC	Centers for Disease Control and Prevention
CFU	Colony-Forming Units
COVID-19	Coronavirus Disease 2019
HAIs	Healthcare-Associated Infections
HBM	Health Belief Model
IUSS	Immediate Use Steam Sterilization
KAP	Knowledge–Attitude–Practice (framework)
KTA	Knowledge-to-Action (framework)
NTS	Non-Technical Skills
OR	Operating Room
PPE	Personal Protective Equipment
SD	Standard Deviation
SHEA	Society for Healthcare Epidemiology of America
SOPs	Standard Operating Procedures
SSI / SSIs	Surgical Site Infection(s)
SPSS	Statistical Package for the Social Sciences
TPB	Theory of Planned Behavior
VR	Virtual Reality
WHO	World Health Organization
χ^2	Chi-square (test)

ABSTRACT

Background: Maintaining sterile technique in operating rooms is essential to prevent contamination and reduce the risk of surgical site infections. Scrub nurses are central to establishing and maintaining the sterile field; however, gaps in knowledge and inconsistent adherence to aseptic practices can compromise patient safety. **Objective:** To assess the level of knowledge and practice of scrub nurses toward sterile techniques in operating rooms at public hospitals in Sana'a City, Yemen. **Methods:** A descriptive cross-sectional study was conducted in the operating rooms of Al-Thawra, Al-Jumhuri, and Al-Kuwait University hospitals. Using convenience sampling, 240 eligible scrub nurses were recruited across shifts. Data were collected via a structured, self-administered questionnaire adapted from validated tools: demographics/work profile; knowledge; practice. Descriptive and inferential statistics, including Pearson correlation, were applied. **Results:** Participants were predominantly ≤ 35 years (77.5%) and female (55.0%). Most held a higher diploma (42.9%) or bachelor's degree (38.3%); 48.8% had < 4 years' OR experience, and 54.6% had not received sterilization training. Overall, 55.4% had insufficient knowledge and 52.9% reported inadequate practice. Knowledge was high for general sterile-field rules but low for critical intraoperative decision-making (e.g., handling sterile water requests, responding to glove perforation, and safe movement near sterile fields). Practice showed moderate, inconsistent adherence, with notable deficits in environmental control and waste segregation. Knowledge was positively related to practice ($r = 0.485$, $p < 0.001$). Knowledge and practice differed significantly by age, sex, marital status, hospital, education, experience, and training, while daily working hours were not significantly associated. **Conclusion:** Scrub nurses demonstrated suboptimal knowledge and practice of sterile technique, with pronounced gaps in high-risk intraoperative actions and selected infection-control behaviors. **Recommendations:** Regular competency-based education (including simulation), routine auditing with feedback, and standardized OR protocols—particularly for intraoperative contamination events and waste management—are recommended, prioritizing staff without prior training.

Keywords: Knowledge, Practice, Sterile Techniques, Operating room, Scrub Nurses

CHAPTER ONE

INTRODUCTION

CHAPTER ONE: INTRODUCTION

I. Background:

The Sterile technique is a critical component of perioperative nursing, essential in preventing surgical site infections (SSIs) and maintaining patient safety. Despite its importance, studies continue to reveal gaps in scrub nurses' knowledge and adherence to sterile practices globally. Recent evidence shows that only around 56% of nurses demonstrate good practice of sterile technique, indicating the persistence of knowledge-practice discrepancies that threaten surgical outcomes (Habtewold et al., 2024).

Operating room nurses are at the forefront of infection prevention; however, maintaining sterility in a high-pressure surgical environment presents significant challenges. According to a qualitative study in Turkey, nurses often face systemic barriers such as high OR traffic, inadequate staffing, and interpersonal conflicts that compromise adherence to sterile techniques (Taşdemir & Tank, 2025). These findings highlight the need for organizational support, teamwork improvement, and structured training interventions.

A 2024 cross-sectional study in Ethiopia further emphasized that training, supervision, and availability of guidelines significantly enhance nurses' knowledge and practice of sterile technique (Habtewold et al., 2024). This suggests that institutional policies and continuing education play pivotal roles in achieving high compliance levels among scrub nurses.

In Malaysia, an educational intervention significantly improved nurses' knowledge and practice regarding sterile techniques, reducing SSI risks (Hajar & Ahmad, 2022). Similarly, a recent study assessing nurses' compliance with infection control measures in Gaza highlighted moderate adherence but underscored the necessity for continuous training and strong management support (Rahmah & Etewa, 2025).

Globally, inconsistent adherence to aseptic practices remains a concern. A 2023 study from Lahore found that while 94% of nurses reported practicing sterile techniques, only about 60% had adequate knowledge of aseptic principles, revealing a disconnect between theoretical understanding and clinical practice (Khan et al., 2024). Such discrepancies increase the likelihood of cross-contamination and postoperative complications.

A broader review of perioperative infection prevention revealed that optimizing operational details—such as reducing OR traffic and enhancing instrument handling—significantly improves infection control outcomes and staff compliance (Zhang, 2024). Similarly, sanitization and disinfection protocols, including proper surgical scrubbing and sterilization methods, are essential competencies that require continual reinforcement (Singh & Alam, 2024).

Recent research also points to the emotional and psychological strain that scrub nurses experience in upholding sterile conditions, where anxiety and moral distress can affect focus and adherence (Taşdemir & Tank, 2025). Addressing these psychosocial factors is crucial for improving compliance and overall performance.

A 2025 study evaluating educational interventions on surgical site infection prevention demonstrated significant post-training improvements in nurses' knowledge, attitudes, and practices, emphasizing the effectiveness of structured professional development (Aziz & Munir, 2025). This supports the integration of periodic training programs within healthcare institutions.

In summary, the growing body of literature from 2022 to 2025 indicates that while scrub nurses possess moderate to good levels of knowledge about sterile techniques, practical application remains inconsistent. Contributing factors include lack of continuous training, limited resources, emotional stress,

and systemic inefficiencies. Therefore, assessing scrub nurses' knowledge and practices is critical for identifying gaps and developing targeted interventions to enhance sterile technique adherence in operation rooms, ultimately improving surgical safety and patient outcomes.

II. Problem Statement:

Surgical site infections (SSIs) remain among the most common and serious postoperative complications, contributing to increased morbidity, mortality, prolonged hospitalization, and elevated healthcare costs. These consequences are particularly pronounced in low-resource settings such as Yemen, where healthcare systems face significant constraints. Adherence to sterile technique throughout the perioperative process—including hand scrubbing, gowning, gloving, maintenance of the sterile field, and aseptic handling of instruments—is the cornerstone of SSI prevention and a fundamental patient safety requirement (Link, 2019; Speth, 2024). International perioperative guidelines emphasize that operating room personnel, especially scrub nurses, bear primary responsibility for maintaining sterility to minimize microbial transmission and protect surgical patients.

Despite the critical importance of sterile practice, evidence from various healthcare contexts indicates persistent deficiencies in nurses' knowledge and inconsistent application of sterile principles. Research suggests a notable gap between theoretical knowledge and clinical practice, undermining effective infection control and patient safety. However, empirical data on scrub nurses' knowledge and practice of sterile techniques are limited in Yemen, particularly within public hospitals in Sana'a City. This lack of localized evidence hinders the development of targeted educational and clinical interventions, representing a significant gap in perioperative nursing research and practice within the Yemeni healthcare system.

III. Justification of the Study:

This study is justified both scientifically and practically. Scientifically, it addresses a critical gap in the literature by generating context-specific evidence on scrub nurses' knowledge and practice of sterile techniques in Yemeni public hospitals. While international studies underscore the role of sterile technique in preventing SSIs, the absence of local data limits the ability to assess baseline competencies and identify context-specific challenges. This research contributes to the global body of perioperative nursing knowledge by providing insights into how local factors—such as training, resources, and institutional protocols—influence sterile practice compliance.

From a clinical and policy perspective, the study has direct implications for patient safety and quality improvement. Given the substantial burden of SSIs, assessing scrub nurses' competencies enables healthcare leaders to identify educational gaps, design targeted training programs, and strengthen adherence to evidence-based infection prevention guidelines. Enhancing nurses' knowledge and practice of sterile techniques can reduce SSI rates, shorten hospital stays, and lower healthcare costs—outcomes of particular importance in resource-limited settings (Link, 2019; Speth, 2024). Additionally, the findings may inform nursing education curricula, professional development strategies, and institutional policies aimed at improving perioperative care and patient safety in Sana'a City and similar contexts.

Aim of study

General Objective:

To assess the level of knowledge and practice of scrub nurses toward sterile techniques in operation rooms at public hospitals in Sana'a City, Yemen

Specific Objectives:

1. To assess the level of knowledge of scrub nurses regarding sterile techniques in operating rooms at public hospitals in Sana'a City.
2. To determine the practice of scrub nurses in maintaining sterile techniques during surgical procedures. at public hospitals in Sana'a City.
3. To investigate the correlation between the knowledge of scrub nurses and their actual application of sterile techniques in operating rooms.
4. To identify the factors that influence scrub nurses' knowledge and practice of sterile techniques, including their level of education, training, and years of experience.

Research question:

1. What is the current level of knowledge of scrub nurses toward sterile techniques in operation rooms at public hospitals in Sana'a City?
2. What is the level of practice among scrub nurses in maintaining sterile techniques during surgical procedures?
3. Is there a significant relationship between scrub nurses' knowledge and their practice of sterile techniques?
4. What factors influence scrub nurses' knowledge and practice of sterile techniques?

CHAPTER TOW

LITERATURE REVIEW

LITERATURE REVIEW

2.1. Overview

Sterile technique forms the foundation of infection prevention in the surgical environment. Scrub nurses, being the primary custodians of the sterile field, are integral in maintaining asepsis during surgical procedures. Studies consistently emphasize that correct surgical hand scrubbing, gowning, gloving, and maintenance of sterile fields are critical in reducing SSIs and ensuring patient safety (Jeyakumar, 2017). Scrub nurses' responsibilities go beyond technical skill—they also encompass anticipation of surgical needs, communication, and teamwork, all of which contribute to operative efficiency and infection control (Campbell, 1979).

Recent cross-sectional studies reveal persistent gaps in scrub nurses' knowledge and practical adherence to sterile techniques across various contexts. For instance, a 2024 study conducted in Addis Ababa, Ethiopia, found that only 58.1% of operating room nurses had good knowledge and 56.1% demonstrated adequate practice regarding sterile techniques. The study identified training, supervision, and availability of standard guidelines as significant predictors of good practice (Habtewold & Getnet, 2024).

Similarly, a Pakistani study revealed that only 38.3% of nurses correctly followed mask and cap-wearing protocols, and overall surgical hand-scrub compliance was inadequate in 77% of observed cases, underscoring the need for periodic supervision and skill-based workshops (Khursheed, Hussain, & Gilani, 2020).

In the Kurdistan region, a quantitative assessment of 70 scrub nurses showed poor scrubbing skills and highlighted that lower economic status and limited experience were associated with poorer aseptic performance,

suggesting that both socioeconomic and institutional factors influence sterile technique compliance (Taher & Lafi, 2015).

Multiple studies demonstrate that educational interventions significantly enhance nurses' knowledge and practice regarding sterile technique. A quasi-experimental study in Selangor, Malaysia, found that after an educational program, the proportion of nurses with high-level knowledge of sterile technique increased from 58.1% to 81.4%, reflecting a substantial improvement in post-intervention outcomes (Hajar, Ahmad, Kunjukunju, & Yusof, 2022). Likewise, another study in Pakistan demonstrated that after three months of CDC-guideline-based training, nurses' knowledge improved significantly, with over 54% showing good knowledge post-intervention compared to none before training (Tabassum, Masih, Afzal, & Khan, 2023).

Moreover, evidence from a virtual reality (VR)-based intervention in Canada revealed that VR simulation significantly improved scrub nurses' situational awareness, confidence, and readiness to assist in complex neurosurgical procedures, supporting technology-based education as a feasible adjunct to conventional training (Nguyen, Bordini, & Matava, 2024).

Beyond technical performance, research has also highlighted the growing importance of non-technical skills (NTS) such as communication, teamwork, and decision-making. These competencies are vital for maintaining aseptic integrity under complex surgical conditions. A 2021 Delphi study identified key NTS categories—situation awareness, leadership, and communication—as essential for operating room nurses, including scrub roles (Sirevåg, Tjoflåt, & Hansen, 2021). Similarly, observational research in Latvia found that while scrub nurses demonstrated strong analytical and anticipatory skills, they tended to undervalue their non-technical competencies,

underscoring the need for integrated NTS training in aseptic education (Ribakova & Deklāva, 2018).

Recent bibliometric analysis indicates a global shift toward the integration of intelligent technologies and automation in operating room nursing. Studies from 2025 highlight emerging research in robotic scrub nurse systems, deep learning for aseptic monitoring, and human-machine collaboration, marking a transition toward “intelligent operating rooms” designed to enhance safety and reduce human error (Yu & Rao, 2025). These advancements suggest future directions for research in scrub nurse education and sterile practice optimization.

The collective evidence indicates that while scrub nurses play a pivotal role in maintaining sterile environments, knowledge and practice gaps persist across various healthcare systems. Factors such as inadequate training, lack of supervision, and absence of standardized guidelines remain significant barriers. Interventional and simulation-based training models—especially those employing VR and intelligent monitoring—show strong potential in enhancing both technical and non-technical competence. Moreover, institutional policy reforms emphasizing continuous professional development and evidence-based standardization are necessary to sustain high aseptic standards.

2.2 Conceptual and Theoretical Foundations

The conceptual and theoretical foundations of perioperative nursing revolve around ensuring patient safety, maintaining aseptic environments, and bridging nursing knowledge to clinical practice. This section explores the foundational concepts of patient safety and quality of care, the theoretical underpinnings of sterile techniques, and the frameworks guiding the translation of nursing knowledge into effective practice (McGarry et al., 2018).

2.2.1 Patient Safety and Quality-of-Care Foundations in Perioperative Nursing

Patient safety and quality of care are central to perioperative nursing practice, focusing on reducing surgical complications, enhancing clinical outcomes, and maintaining professional standards. According to (Liu, 2024), perioperative nurses play a pivotal role in managing intraoperative risks through effective communication, vigilance, and adherence to safety protocols. The Helsinki Declaration on Patient Safety underscores the need for multidisciplinary collaboration and system-based safety improvements to mitigate perioperative harm (Preckel et al., 2020).

Recent evidence emphasizes that inadequate staffing and high patient acuity during crises—such as COVID-19—significantly compromise adherence to patient safety protocols (Pogorzelska-Maziarz et al., 2023). Furthermore, perioperative nurses must apply updated evidence-based guidelines for surgical site infection (SSI) prevention, as 70% of SSIs are preventable through proper compliance (Aktas & Damar, 2022).

2.2.2 Concepts Underpinning Sterile Technique

Asepsis and Principles of Surgical Sterility

Asepsis is the cornerstone of infection prevention in surgery. Strict adherence to aseptic technique prevents contamination of sterile fields and minimizes the risk of SSIs. Studies show that breaches in asepsis, even minor ones, can lead to significant postoperative complications (Adams, Korniewicz, & El-Masri, 2011).

Chain of Infection and Infection Prevention in the Operation Rooms

The “chain of infection” concept emphasizes the transmission of pathogens through reservoirs, transmission modes, and susceptible hosts. Perioperative nurses interrupt this chain through aseptic handling, disinfection, and environmental control measures (Pramann, 2010).

Sterile Field Integrity and Contamination Pathways

Maintaining the integrity of the sterile field is critical. Contamination occurs via airborne particles, contact with non-sterile surfaces, or breaches in technique. Research demonstrates that higher self-efficacy and education correlate with stronger adherence to sterile field protocols (Amanna & Nwankwo, 2025).

2.2.3 Nursing Knowledge-to-Practice Linkage

Knowledge, Attitude, and Practice Constructs

The knowledge-attitude-practice (KAP) framework explains how theoretical understanding influences behavioral adherence in clinical settings. Positive attitudes towards aseptic care enhance compliance and performance (Labrague et al., 2012).

Clinical Competence, Skill Acquisition, and Behavioral Adherence

Competence in perioperative nursing is a multidimensional construct encompassing knowledge, technical proficiency, and psychological readiness. A 2025 study found a significant correlation between self-efficacy and perioperative nursing competence, suggesting that training interventions targeting confidence can enhance clinical performance (Yan & Lin, 2025).

Similarly, structured training programs like *Periop 101* significantly improve knowledge and skill uniformity among nurses (Stucky et al., 2023).

2.2.4 Theoretical Frameworks Applicable to the Study

Knowledge-to-Action (KTA) Framework

The KTA framework provides a roadmap for translating nursing research into practice. It emphasizes identifying gaps between evidence and implementation, adapting knowledge to local contexts, and sustaining practice improvements.

Theory of Planned Behavior (TPB)

TPB explains how intention, subjective norms, and perceived behavioral control determine adherence to sterile techniques. Nurses with strong behavioral intentions and perceived control are more likely to follow aseptic standards.

Health Belief Model (HBM)

The HBM suggests that nurses' compliance with infection control is driven by perceived severity, susceptibility, and benefits of preventive action.

Donabedian's Structure–Process–Outcome Model

Donabedian's model provides a comprehensive framework for evaluating care quality. Studies confirm its value in assessing perioperative safety and innovation implementation (Gardner et al., 2014) and its effectiveness in evaluating nurse-led quality improvements during crises (Pogorzelska-Maziarz et al., 2023).

2.3. Sterile Techniques in Operating Rooms

Sterile techniques in operating rooms (ORs) form the foundation of surgical asepsis, aimed at eliminating or minimizing microbial contamination during surgical procedures. Their consistent application is a critical determinant of surgical site infection (SSI) rates, which remain one of the leading causes of postoperative morbidity and mortality worldwide. Recent studies emphasize that adherence to standardized sterile practices — including surgical hand antisepsis, sterile draping, maintenance of sterile fields, and controlled environmental factors — can reduce SSIs by up to 64% (Bandeira et al., 2025).

2.3.1 Historical Evolution and Standardization of Sterile Technique

The development of sterile techniques traces back to the mid-19th century with Joseph Lister's introduction of carbolic acid antisepsis. Over time, this evolved into aseptic techniques that emphasized prevention rather than disinfection. The 20th century saw the establishment of standards by bodies such as the Association of periOperative Registered Nurses (AORN) and the Centers for Disease Control and Prevention (CDC), which refined protocols for surgical hand preparation, sterile gowning, and environmental control.

Modern studies reveal that despite technological advances, aseptic compliance remains inconsistent globally. For instance, a 2024 study found that only 56% of perioperative nurses demonstrated adequate practice of sterile techniques, emphasizing the continuing need for training and standardized supervision (Habtewold et al., 2024). These findings highlight that the evolution of sterile technique is not merely historical but ongoing, requiring adaptation to new evidence and technologies.

2.3.2 Core Components of Sterile Technique in Perioperative Care

Surgical Hand Antisepsis

Effective surgical hand antisepsis remains the first defense against SSI. Current evidence supports the use of alcohol-based hand rubs containing chlorhexidine gluconate or povidone-iodine, with contact times of 2–5 minutes (Dhamdhare et al., 2023). Proper technique reduces transient flora without compromising skin integrity. Studies show that continuous education programs can increase adherence to proper scrubbing from 37% to over 60% among surgical trainees (Dhamdhare et al., 2023).

Sterile Gowning and Gloving

The gown and gloves act as barriers preventing microbial transfer. Closed gloving is superior to open gloving for maintaining sterility, particularly during re-gowning or in high-risk orthopedic and cardiac surgeries (Khan et al., 2024). Breaches in glove integrity occur in 7–17% of operations, warranting routine glove changes every 90 minutes and after suspected puncture.

Sterile Draping

Draping provides a barrier between the operative field and surrounding nonsterile areas. AORN standards emphasize starting from the incision site outward using dry sterile drapes. High-risk areas include the groin and axilla, where microbial counts are higher. Proper sequencing reduces inadvertent contamination during drape adjustment (Guinea Usó et al., 2023).

Maintenance of Sterile Field

Maintaining the sterile field involves restricting movement, controlling personnel numbers, and observing sterile boundaries. A 2025 randomized

controlled trial demonstrated that reducing personnel from five to two during sterile goods preparation significantly reduced airborne bacterial contamination (median CFU 5 vs. 2; $p < 0.001$) (Wistrand & Söderquist, 2025).

Sterilization and Disinfection Basics

Sterilization ensures complete microbial destruction, typically via steam autoclaving, while disinfection eliminates most vegetative microorganisms. A 2024 Puerto Rican assessment revealed only 10% of hospitals had adequate sterilization water systems and Immediate Use Steam Sterilization (IUSS) policies, indicating systemic deficits (Nachi et al., 2024).

Instrument Handling and Aseptic Transfer

Instruments must be handled only by sterile personnel and passed using designated transfer zones. Use of neutral zones (no-hands passing) reduces sharps injuries and cross-contamination risks.

Handling Sharps and Prevention of Contamination

Sharps management is integral to maintaining asepsis and preventing bloodborne transmission. The use of blunt suture needles and hands-free passing techniques are now AORN-recommended practices (Jeyakumar, 2017).

Management of Breaks in Sterility

Recognition, reporting, and immediate correction of breaks in sterility are critical. Observational tools, like the evidence-based OR observation system developed by Gordon et al. (2019), provide structured monitoring for aseptic compliance and are recommended for infection prevention audits (Gordon et al., 2019).

2.3.3 Environmental and Workflow Considerations Affecting Sterility

Operation Room Traffic, Door Opening, and Airflow Principles

The number of personnel and frequency of door openings directly correlate with bacterial air counts. Environmental improvements such as laminar airflow and positive pressure ventilation have been shown to reduce SSI rates from 8.4% to 5.7% (Wagner et al., 2022).

Layout, Zoning, and Sterile Supply Storage

Zoning — clean, semi-restricted, and restricted areas — limits cross-contamination. A 2023 integrative review stressed the necessity of dedicated sterile storage zones and supervision protocols to prevent aseptic breaches (Guinea Usó et al., 2023).

Cleaning Protocols Between Cases and Terminal Cleaning

Routine between-case cleaning and terminal cleaning are essential for environmental asepsis. Bundled cleaning interventions, including chlorhexidine surface disinfection and monthly environmental audits, maintained high compliance (95–100%) and contributed to stable SSI rates even during the COVID-19 pandemic (Campbell et al., 2024).

2.4. Role of the Scrub Nurse in Maintaining Sterility

The scrub nurse plays a vital role in upholding the principles of asepsis within the operating room, ensuring that the surgical environment remains free from contaminants that could lead to postoperative infections. Their actions directly influence surgical outcomes, patient safety, and the overall success of procedures. Recent research underscores that adherence to aseptic protocols, hand hygiene, and situational awareness are central to minimizing surgical site

infections (SSIs) and maintaining the sterile field throughout all surgical phases (Dhamdhere et al., 2023); (Mohamed et al., 2024). Through meticulous preparation, observation, and coordination, scrub nurses act as the gatekeepers of sterility in surgical practice.

2.4.1 Scope of Practice and Perioperative Responsibilities

The scrub nurse's scope encompasses comprehensive perioperative functions—preparing sterile fields, maintaining asepsis, assisting the surgeon intraoperatively, and ensuring safe postoperative handling of instruments and specimens. Their duties align with infection control protocols set by the World Health Organization (WHO) and national nursing standards. According to recent audits, scrub nurses' competence in aseptic procedures significantly determines the integrity of sterile barriers during surgery (Khursheed et al., 2020). Their responsibilities extend to ensuring all personnel entering the sterile field comply with aseptic techniques, such as proper hand scrubbing and attire compliance, reinforcing the systemic approach to infection prevention (Taher & Lafi, 2015).

2.4.2 Scrub Nurse Responsibilities During the Surgical Phases

Preoperative Preparation (Setup, Counts, Verification, Sterility Checks)

In the preoperative phase, the scrub nurse ensures that all instruments and equipment are sterilized, counted, and organized according to the surgical procedure. Studies demonstrate that incorrect gowning and gloving techniques can compromise sterility, emphasizing the need for continuous education and monitoring (Malik & De, 2019). The nurse also verifies patient identity, surgical site marking, and equipment readiness—actions that align with the WHO surgical safety checklist. Maintaining situational awareness during this

phase enables early detection of contamination risks, reinforcing overall procedural safety (Park & Chang, 2022).

Intraoperative Duties (Instrumentation, Sterile Field Surveillance, Anticipation)

During surgery, the scrub nurse remains central to maintaining the sterile field. Their role includes passing instruments aseptically, anticipating the surgeon's needs, and monitoring for breaches in sterility. Enhanced ergonomic positioning—such as placing the scrub nurse on the patient's left in cardiac surgery—has been shown to improve safety, communication, and efficiency (Souko & Abraheem, 2025). Scrub nurses also monitor the sterile field continuously, ensuring that any potential contamination is promptly addressed to prevent postoperative infections. Modern training approaches, such as simulation-based education, have proven effective in developing intraoperative vigilance and non-technical skills crucial for sterile practice (Glaser et al., 2016).

Postoperative Responsibilities (Counts, Specimen Handling, Decontamination Steps)

After surgery, the scrub nurse conducts final instrument, swab, and needle counts with the circulating nurse, ensuring that no foreign objects remain within the patient. They handle specimens aseptically, label them accurately, and oversee the safe transfer to laboratory or pathology units. Additionally, decontamination and sterilization protocols are followed for reusable instruments. Proper decontamination minimizes cross-contamination and ensures readiness for subsequent procedures (Jeyakumar, 2017). Continuous audit systems are recommended to ensure compliance with these post-surgical sterility practices (Mohamed et al., 2024).

2.4.3 Interprofessional Coordination and Communication as Determinants of Sterile Practice

Effective communication among the surgical team—surgeons, anesthesiologists, and nurses—is vital for maintaining sterility. Interprofessional collaboration reduces errors, facilitates anticipation of procedural steps, and strengthens the sterile barrier. Recent studies highlight that non-technical skills such as teamwork, mutual support, and situational awareness directly affect adherence to sterile practices (Rashid & Osman, 2025). Team-building simulations for scrub nurses and neurosurgeons have been shown to enhance “Communication and Teamwork” and “Situation Awareness” significantly, leading to improved surgical outcomes and patient safety (de Laurentis et al., 2024).

2.4.4 Ethical and Professional Accountability Related to Sterile Technique Adherence

The scrub nurse holds both ethical and professional obligations to uphold asepsis. This includes accountability for any breach in sterility, adherence to institutional and national infection control policies, and continuous professional development. Ethical practice mandates vigilance, integrity, and commitment to patient safety. Research shows that scrub nurses’ sense of professional responsibility and situational awareness are key determinants of sterile adherence, developed through experience and reflective practice (Park & Chang, 2022). Continuous education, audits, and ethical accountability frameworks reinforce this commitment, ensuring that every surgical act aligns with the highest standards of sterility and patient care.

2.5. Knowledge of Scrub Nurses Toward Sterile Techniques

Knowledge of scrub nurses regarding sterile techniques is fundamental in ensuring patient safety, preventing surgical site infections (SSIs), and maintaining asepsis within the operating room (OR). Recent literature emphasizes that despite moderate adherence to sterile practices, knowledge gaps persist globally among OR nurses (Khan, Saddique & Jabeen, 2024); (Habtewold et al., 2024). Continuous professional development, supervision, and institutional guidelines have been identified as critical determinants in improving scrub nurses' aseptic competence.

2.5.1 Domains of Knowledge Expected in Perioperative Sterile Technique

Principles and Rationale of Asepsis

Scrub nurses are expected to demonstrate in-depth knowledge of aseptic principles—particularly the prevention of microbial contamination through controlled environmental and behavioral measures. Aseptic practice encompasses surgical hand antisepsis, sterile field maintenance, and barrier use to interrupt infection transmission (Jeyakumar, 2017). Recent studies emphasize the need for a dynamic understanding of asepsis, incorporating updated evidence on antimicrobial resistance and the changing microbiological landscape (Parnikh et al., 2022).

Indications and Steps for Scrub, Gowning, Gloving, and Draping

Proper performance of the scrub, gowning, gloving, and draping processes remains the cornerstone of aseptic technique. Observational studies reveal variability in adherence to standard protocols, with only 38–61% of nurses demonstrating correct execution of scrub and gowning steps

(Khursheed, Hussain & Gilani, 2020). Training interventions and audits, such as those by (Rabbani et al., 2022), significantly improved compliance from 72% to over 90%, demonstrating the efficacy of structured competency reinforcement.

Identification of Contamination and Corrective Measures

Competent scrub nurses should be able to identify breaches in the sterile field and apply immediate corrective measures. Studies demonstrate moderate proficiency in contamination detection but inconsistent corrective actions, often due to poor situational awareness or limited autonomy in the OR hierarchy (Taher & Lafi, 2015). Emphasis on real-time feedback and simulation-based decision-making training is therefore advocated (Sirevåg, Tjøflåt & Hansen, 2021).

Policies/Guidelines and Evidence-Based Updates

Regular updates aligned with CDC and WHO guidelines significantly enhance sterile practice knowledge (Tabassum et al., 2023). Interventional programs have shown marked improvement in knowledge scores post-training ($p < 0.001$), highlighting the necessity of ongoing professional education and access to institutional protocols (Hajar et al., 2022).

2.5.2 Determinants of Knowledge Levels

Education Level and Specialty Training

Educational attainment strongly correlates with knowledge of aseptic techniques. Higher-degree holders and those with perioperative specialization demonstrate superior understanding of sterile principles (Parnikh et al., 2022).

Clinical Experience and Case Volume Exposure

Experience fosters procedural confidence but does not always guarantee compliance. Studies show a weak negative correlation between years of experience and adherence, suggesting complacency over time (Habtewold et al., 2024).

In-Service Training, Simulation, and Continuing Professional Development

Structured in-service and simulation-based training significantly elevate nurses' competencies. Educational programs increased the proportion of nurses with high knowledge from 58% to over 80% post-intervention (Hajar et al., 2022). Simulation allows for experiential correction of errors and consolidation of aseptic reasoning.

Access to Guidelines and Institutional Support

Availability of standardized guidelines and managerial supervision are among the strongest predictors of high knowledge and practice scores (Habtewold et al., 2024). Institutions with policy reinforcement and infection-control monitoring demonstrate better aseptic outcomes.

2.5.3 Evidence from Prior Studies: Levels of Knowledge and Common Gaps

Recent studies reveal persistent gaps between theoretical knowledge and applied practice. For example, although 94% of nurses reported following sterile practices, objective assessments identified only moderate knowledge levels (Khan, Saddique & Jabeen, 2024). Common deficiencies include improper glove donning, incorrect gown handling, and failure to identify contamination. Lack of periodic audits, inconsistent training, and limited access to updated aseptic policies contribute to these deficiencies (Khursheed et al., 2020); (Malik & De, 2019).

2.5.4 Knowledge Assessment Approaches in the Literature

Typical Instruments

Most studies employ structured questionnaires and observational checklists to assess knowledge and practice levels (Taher & Lafi, 2015). Vignette-based assessments are less common but provide deeper insight into decision-making under aseptic pressure.

Validity and Reliability Considerations

Instruments with high inter-rater reliability ($r = 0.91$) and expert-validated content ensure credible findings (Taher & Lafi, 2015). The use of observational tools strengthens construct validity by reflecting real clinical behavior.

Cut-Off Scoring and Interpretation Practices

Knowledge levels are often classified into poor, fair, and good based on percentage thresholds (e.g., <50%, 50–75%, >75%). Post-training evaluations often show upward shifts, confirming learning effectiveness (Tabassum et al., 2023).

2.6. Practice of Scrub Nurses Toward Sterile Techniques

Scrub nurses play an indispensable role in upholding aseptic practices and maintaining the sterility of the operative environment. Their adherence to sterile technique is central to preventing surgical site infections (SSIs), ensuring patient safety, and supporting optimal surgical outcomes. Recent literature continues to underscore variability in compliance, determinants of practice quality, and the need for structured education and monitoring mechanisms.

2.6.1 Domains of Practice and Observable Behaviors

Compliance with Scrub Protocols and Aseptic Workflow

Recent studies have revealed variable compliance with surgical scrub protocols. For instance, only 38.3% of nurses correctly donned face masks and caps during preoperative preparation, indicating inconsistencies in adherence to aseptic standards (Khursheed et al., 2020). A 2024 internal audit found that compliance with World Health Organization (WHO) hand scrub standards improved from 64% to 93.9% after targeted training interventions (Mohamed et al., 2024). This underscores the positive impact of structured monitoring and feedback mechanisms.

Proper Handling of Sterile Supplies and Instruments

Studies indicate that scrub nurses' handling of instruments and sterile materials remains inconsistent. In a 2023 assessment, 54.6% of nurses failed to recognize contamination risks from dropped sterile packages, suggesting procedural knowledge gaps (Khan et al., 2024). This finding aligns with reports from teaching hospitals where nurses demonstrated strong ritual adherence (scrubbing and gowning) but variable instrument handling techniques (Taher & Lafi, 2015).

Maintenance of Sterile Field Under Time Pressure and High Workload

Maintaining the sterile field during peak surgical load remains a key challenge. Evidence shows that lapses occur primarily due to time constraints, fatigue, and multitasking demands. Nurses often compromise field integrity during high turnover or emergency procedures, indicating the need for ergonomic scheduling and supportive supervision (Osborne, 2003).

Responses to Contamination Events and Near Misses

Observational audits highlight that contamination events are underreported and inconsistently managed. Simulation-based interventions that encourage immediate reporting and corrective measures have been shown to enhance accountability and improve aseptic vigilance (Erichsen Andersson et al., 2018).

2.6.2 Determinants of Practice Quality

Staffing Adequacy, Workload, Fatigue, and Time Constraints

Inadequate staffing ratios and prolonged shifts contribute to fatigue, which directly diminishes sterile compliance. Nurses working extended hours show reduced hand hygiene frequency and delayed contamination responses (Mohammad & Hadi, 2020).

Safety Culture, Leadership, and Supervision

A culture emphasizing safety and mentorship enhances compliance. Educational interventions following CDC guidelines significantly improved nurses' knowledge and practice scores post-intervention ($p < 0.001$) (Tabassum et al., 2023). Supervisory presence and peer feedback also reinforce adherence to aseptic norms.

Availability of Supplies and Standardization of Materials

Lack of sterile equipment or inconsistent supply chain systems has been linked with lower aseptic compliance. Hospitals that implemented standard operating procedures (SOPs) for aseptic non-touch technique saw compliance rise to 100% and a 69% reduction in healthcare-associated infections (Shettigar et al., 2021).

Operation Room Environment and Team Behavior

Frequent OR traffic, interruptions, and poor interprofessional coordination remain key contributors to sterile breaches. Studies emphasize that psychological safety and collaborative culture enhance compliance and allow nurses to challenge unsafe practices without fear (Erichsen Andersson et al., 2018).

2.6.3 Evidence from Prior Studies: Adherence Rates and Common Breaches

Recent cross-sectional data show adherence rates ranging from 60% to 90%, depending on training and monitoring intensity. Common breaches include improper mask use, inadequate drying after scrub, touching non-sterile surfaces, and poor instrument transfer technique (Khursheed et al., 2020); (Khan et al., 2024). Although most scrub nurses demonstrate ritual compliance, nuanced aseptic practices—such as maintaining sterility during equipment exchange—require reinforcement (Labrague et al., 2012).

2.6.4 Practice Assessment Approaches in the Literature

Self-Reported Practice Measures: Strengths and Limitations

Self-reported measures provide broad insights into perceived competence but are often inflated due to recall and desirability bias. Studies show discrepancies between self-assessed and observed practice, with nurses overestimating adherence to hand hygiene and sterile technique (Parnikh et al., 2022).

Direct Observation and Audit Tools: Strengths and Limitations

Direct observation provides objective, real-time assessment but introduces observer bias and potential behavioral modification. Structured audit tools like WHO checklists and interrater evaluations enhance validity but require resource investment (Mohamed et al., 2024).

Hawthorne Effect and Strategies to Minimize Measurement Bias

When nurses know they are being observed, compliance tends to rise temporarily—a phenomenon known as the Hawthorne effect. Researchers recommend unannounced audits, video-based evaluations, and peer monitoring to minimize bias and ensure authentic performance measurement (Erichsen Andersson et al., 2018).

2.7 Relationship Between Knowledge and Practice

The relationship between knowledge and practice in sterile technique is a central theme in infection prevention research. Recent studies highlight that while healthcare professionals often possess foundational knowledge of aseptic principles, their translation into consistent clinical practice remains variable. This discrepancy can have direct implications for surgical site infections (SSIs) and overall patient safety. Empirical research conducted between 2020 and 2024 emphasizes that knowledge serves as a critical but insufficient determinant of proper sterile technique adherence. Multiple systemic, behavioral, and contextual moderators influence how knowledge is transformed into practice in healthcare environments.

2.7.1 Empirical Evidence on Knowledge–Practice Correlation in Sterile Technique

Recent empirical studies demonstrate a positive but inconsistent correlation between healthcare workers' knowledge and their actual adherence to sterile technique. In a 2024 cross-sectional study involving 423 operating room nurses in Addis Ababa, Ethiopia, approximately 58.1% of nurses had good knowledge, and 56.1% exhibited good practice in sterile technique. Training, supervision, and availability of standardized guidelines significantly predicted both knowledge and practice levels, with knowledge itself emerging as a strong predictor of compliance (Habtewold et al., 2024).

Similarly, a 2023 study in Pakistan identified significant improvements in nurses' knowledge and application of aseptic techniques after targeted educational interventions based on CDC guidelines (Tabassum et al., 2023). Another 2023 study in Peshawar found a direct positive relationship between knowledge, attitude, and practice, reinforcing the notion that cognitive understanding translates into improved adherence when supported by positive attitudes (Shaheen et al., 2023).

However, the 2024 study in Lahore revealed a knowledge–practice gap: while 91% of nurses adhered to sterile techniques, their conceptual understanding remained suboptimal, suggesting that habitual or enforced behavior might substitute for deep comprehension (Khan et al., 2024).

2.7.2 Explanations for Knowledge–Practice Gaps

Organizational Constraints and System-Level Barriers

Systemic barriers such as inadequate resources, lack of standardized protocols, and insufficient managerial supervision often impede the application

of sterile technique knowledge. The Ethiopian study identified the absence of guidelines and supervision as strong predictors of poor practice (Habtewold et al., 2024). Similarly, findings from Cambodia revealed that even when training improved knowledge, rural healthcare workers lacked institutional support to implement learned practices effectively (Fast et al., 2020).

Behavioral Factors (Risk Perception, Norms, Habitual Practice)

Behavioral determinants such as perceived infection risk, peer norms, and routine behaviors play critical roles in mediating knowledge–practice translation. Inadequate risk perception may result in complacency despite adequate training. The 2021 study by (Kareem & Ahmed, 2021) highlighted that even when nurses understood sterilization concepts, habitual shortcuts and low-risk perception contributed to poor adherence.

Training Quality, Feedback, and Reinforcement

Training intensity and the presence of ongoing feedback mechanisms significantly enhance skill retention and performance. Quasi-experimental studies in Malaysia (Hajar et al., 2022) and Ethiopia (Habtewold et al., 2024) confirmed that structured education programs and post-training supervision markedly improve sterile technique adherence. In addition, simulation-based mastery modules for medical students yielded 100% post-training mastery, demonstrating that competency-based learning can close the knowledge–practice gap (Blumenfeld et al., 2020).

2.7.3 Moderators and Mediators Reported in the Literature

Several factors moderate or mediate the relationship between knowledge and practice:

- **Experience:** Experienced nurses tend to exhibit stronger aseptic technique habits, though experience without retraining can lead to erosion of correct practices over time (Davis & Ayars, 2021).
- **Training and Supervision:** Continuous training and direct supervision enhance adherence (Habtewold et al., 2024).
- **Safety Culture:** Hospitals that prioritize safety culture and enforce standard operating procedures create environments where knowledge is consistently enacted (Speth, 2024).

2.7.4 Implications for Competency Development and Patient Safety Interventions

Bridging the knowledge–practice divide requires a multifaceted approach focusing on institutional policies, behavior modification, and competency-based training. The literature consistently underscores the importance of:

- **Integrating simulation-based training** to reinforce procedural accuracy.
- **Institutionalizing audit and feedback loops** to maintain accountability.
- **Embedding safety culture** that normalizes adherence to sterile practices.
- **Developing adaptive learning programs** that update skills as guidelines evolve.

These strategies are crucial for sustaining long-term improvements in sterile technique adherence and, consequently, for reducing SSIs and improving patient safety outcomes.

2.8. Outcomes Associated with Sterile Technique Performance

Sterile technique performance remains one of the most critical determinants of surgical outcomes, particularly in the prevention of surgical site infections (SSIs). Contemporary literature highlights that consistent adherence to sterile protocols—including hand hygiene, proper glove donning, aseptic wound management, and instrument sterilization—directly correlates with reduced SSI rates, shortened hospital stays, and improved patient recovery. The implementation of structured educational interventions, audits, and feedback systems has also shown measurable improvements in compliance and patient outcomes.

2.8.1 Surgical Site Infections (SSIs): Burden and Clinical Significance

SSIs represent a major source of postoperative morbidity and mortality, accounting for up to 20% of healthcare-associated infections globally. The incidence of SSIs varies widely depending on surgical complexity and adherence to aseptic practices. Recent updates from the Society for Healthcare Epidemiology of America (SHEA) emphasize that SSIs are not only linked to increased length of hospital stay but also contribute to higher readmission rates, prolonged antibiotic use, and substantial healthcare costs (Calderwood et al., 2023).

In low-resource settings, SSIs may occur in up to 30% of surgical procedures due to gaps in sterile technique implementation and infrastructure limitations (Mehtar et al., 2020).

These infections not only delay healing but can lead to systemic complications, including sepsis, reoperation, and even death, particularly among immunocompromised patients or those with comorbidities.

2.8.2 Mechanisms Linking Sterile Technique Breaches to Infection Risk

Breaches in sterile technique facilitate the direct or indirect transfer of microorganisms into surgical wounds. Mechanistically, this occurs via contaminated gloves, instruments, or breaks in the surgical field. Observational studies show that improper hand hygiene and glove donning significantly increase microbial transfer risk (Rabbani et al., 2022; Suliman et al., 2024). Aseptic breaches compromise the sterile barrier and permit bacterial colonization in devitalized tissue, where blood supply and immune defense are impaired (Andersen, 2018).

Recent experimental evidence also highlights the role of prolonged glove use and failure to change instruments before wound closure as major vectors for contamination, prompting large-scale trials like the CHEETAH study to evaluate sterile glove and instrument changes during wound closure as cost-effective preventive measures (Smith & Bhangu, 2022).

2.8.3 Patient, Procedure, and System Risk Factors Relevant to Interpreting Outcomes

Surgical site infection outcomes are multifactorial. Patient-related risk factors include diabetes, obesity, smoking, malnutrition, and immunosuppression. Procedural factors such as wound class, operative duration, emergency status, and environmental sterility play key roles. From a systems perspective, compliance with aseptic technique among staff, infrastructure (e.g., sterile air flow, sterilization equipment), and institutional infection control policies are critical determinants. Studies in resource-limited settings underscore the influence of system-level deficiencies—such as inadequate sterilization protocols and inconsistent surveillance—on SSI rates (Busada, 2024).

Moreover, low compliance with aseptic technique among nurses and surgical staff has been linked to insufficient training and documentation practices (Ding et al., 2017).

2.8.4 Quality Indicators and OR Infection Prevention Bundles

Modern infection prevention programs emphasize multimodal bundles integrating surveillance, standardized antisepsis, and perioperative antibiotic stewardship. The SHEA 2023 guidelines identify evidence-based bundles incorporating elements such as preoperative chlorhexidine bathing, intraoperative normothermia, sterile draping, and postoperative wound surveillance (Calderwood et al., 2023).

Quality indicators for OR performance include adherence to hand hygiene, correct antibiotic timing, surgical attire compliance, and proper wound documentation. Audits using structured checklists have shown significant improvements in compliance and measurable declines in infection rates (Zhou et al., 2020).

Furthermore, feedback loops that disseminate infection data to perioperative teams enhance accountability and performance (Ahuja et al., 2021).

8.5 Evidence for Effectiveness of Interventions (Education, Audits, Checklists, Feedback)

Recent studies affirm that structured educational and feedback interventions significantly enhance sterile technique adherence. Educational programs combining lectures, demonstrations, and case-based learning improved nurses' knowledge, confidence, and compliance with SSI prevention guidelines (Aziz & Munir, 2025). Audits coupled with feedback mechanisms,

as implemented in multi-hospital studies in China, achieved up to 24% reductions in nosocomial infections (Zhou et al., 2020).

Similarly, two-cycle audits in Egypt demonstrated a halving of SSI rates following targeted education and the introduction of standardized operating procedures (Busada, 2024). Regular clinical audits assessing glove donning practices also report significant improvements in compliance among early-career surgeons post-intervention (Suliman et al., 2024).

2.9. Guidelines and Standards Relevant to Sterile Technique

Sterile technique remains a foundational element in infection prevention within surgical and clinical environments, serving to minimize microbial contamination and prevent healthcare-associated infections (HAIs) and surgical site infections (SSIs). Global standards have evolved toward competency-based approaches, integrating evidence-based recommendations from international agencies, national institutions, and local protocols. Recent studies emphasize that consistent adherence to sterile technique standards, combined with continuous education and auditing, is vital for maintaining patient safety and surgical quality.

2.9.1 International and Professional Standards (Overview and Applicability)

International organizations, such as the World Health Organization (WHO), Centers for Disease Control and Prevention (CDC), and Association of Perioperative Registered Nurses (AORN), have established globally recognized guidelines governing sterile technique. WHO's "Clean Care is Safer Care" campaign underscores the importance of aseptic practices, including proper glove donning, surgical hand antisepsis, and sterile field maintenance. Recent evidence highlights the value of adherence to these standards: a quality

improvement project in Pakistan demonstrated that structured educational interventions improved compliance with the 14-step WHO sterile glove-donning protocol from 77.7% to 94.6%, illustrating how guideline-driven training enhances infection control outcomes (Waqas Ahmad et al., 2025).

Moreover, the **CDC guidelines** for aseptic and infection control procedures form the basis for global adaptation. A 2023 study implementing CDC standards among operating room nurses in Pakistan found significant improvement in nurses' knowledge and compliance with sterile technique following educational intervention programs (Tabassum et al., 2023). Similarly, **AORN** standards integrate these practices into perioperative care, aligning with European and American infection control frameworks to create a consistent foundation for global implementation.

2.9.2 Institutional Policies and Local Protocols: Variability and Implementation Challenges

Despite international consensus, implementation at institutional and local levels is often inconsistent due to resource limitations, cultural factors, and variable policy enforcement. A 2024 cross-sectional study in Ethiopian public hospitals revealed that only 56% of operating room nurses demonstrated adequate sterile practice, despite 58% showing good theoretical knowledge. Availability of clear institutional guidelines, adequate supervision, and regular training were found to be the strongest predictors of compliance (Habtewold et al., 2024).

Similarly, audits of disinfection and sterilization practices outside central sterile units have uncovered substantial deviations from Health Canada and WHO guidelines, such as inadequate monitoring of sterilization processes and inconsistent disinfectant use (Wiens et al., 2004). These findings emphasize that while guidelines exist, their local applicability and enforcement remain

hindered by institutional variability, resource constraints, and insufficient compliance monitoring.

Implementation challenges are further compounded in **resource-limited settings**, where limited access to PPE, sterilization materials, and surveillance systems impedes adherence. A 2023 systematic review recommended context-appropriate guidelines for anesthetists in low-resource operating rooms, stressing affordable and practical infection control measures (Hailu et al., 2023).

1.9.3 Competency-Based Training, Certification, and Continuing Education Standards

Competency-based education is now central to maintaining sterile practice standards. Studies consistently demonstrate that structured educational programs significantly improve knowledge, attitudes, and practice among healthcare workers. For instance, a quasi-experimental study in Malaysia found that an educational intervention increased the proportion of operating room nurses with high-level sterile technique knowledge from 58% to 81% post-training (Hajar et al., 2022).

Similarly, a 2025 study evaluating surgical site infection (SSI) prevention training found that targeted educational programs significantly enhanced nurses' adherence to hand hygiene, wound care, and sterile field maintenance, leading to measurable reductions in infection rates (Aziz & Munir, 2025). Competency frameworks—integrating theoretical instruction, simulation-based assessments, and certification renewal—are recommended to ensure sustained adherence to aseptic standards.

Furthermore, continuing professional development programs and certification audits are increasingly recognized as integral to maintaining sterile

competence. Regular workshops, simulation sessions, and periodic evaluations using evidence-based observation tools have been shown to enhance compliance and maintain consistency across healthcare institutions (Gordon et al., 2019).

2.9.4 Recommended Audit and Monitoring Strategies for Sterile Practice

Auditing serves as a cornerstone for ensuring ongoing compliance with sterile technique standards. The use of structured observation tools and continuous monitoring enhances both accountability and performance. A 2019 study introduced an **evidence-based Operating Room Observation Tool** designed to assess perioperative infection prevention practices, including pre-operative skin preparation, sterile gowning, and intraoperative asepsis. This approach improved reliability, facilitated training, and standardized feedback loops (Gordon et al., 2019).

In addition, clinical audits—such as the 2024 Sudanese and 2025 Pakistani glove-donning studies—have demonstrated that regular observation, feedback, and targeted interventions lead to measurable improvements in compliance (Suliman et al., 2024). Routine performance audits should include components such as aseptic field maintenance, staff hand hygiene, traffic control, and instrument sterilization integrity.

Finally, incorporating digital audit tools and integrating feedback into continuing education programs enhances transparency and sustainability of sterile practices. Establishing infection control committees that conduct quarterly audits and enforce compliance ensures the long-term institutionalization of aseptic protocols.

CHAPTER THREE

RESEARCH

METHODOLOGY

CHAPTER THREE: METHODOLOGY

Study Design

This study employed a descriptive cross-sectional design to assess the level of knowledge and practice of scrub nurses regarding sterile techniques in operating rooms at selected public hospitals in Sana'a City, Yemen.

Study Setting:

The study was conducted in three major public hospitals in Sana'a City: Al-Thawra Modern General Hospital, Republican Teaching Hospital (Al-Gumhori), and Al-Kuwait University Hospital. These hospitals were selected because they represented the main centers for surgical operations in Sana'a City and employed a substantial number of scrub nurses.

Study Population:

The study population included all scrub nurses who were working in the operating rooms of the selected public hospitals in Sana'a City during the study period. These nurses were directly involved in surgical procedures and played a key role in maintaining sterile fields and applying aseptic principles during operations.

Sample size calculation

A total of 240 scrub nurses working in the operating rooms across three shifts (morning, evening, and night) were included using a convenience sampling technique. Participation was open to all eligible scrub nurses employed in operating room care at the three selected hospitals who met the inclusion and exclusion criteria. The number of scrub nurses working in the operating rooms in these hospitals was used to determine the sample size, and a minimum of 240 nurses was included to ensure adequate statistical power.

Inclusion and Exclusion Criteria:**Inclusion Criteria:**

- ❖ Registered scrub nurses working full-time in the operating rooms of the selected hospitals.
- ❖ Nurses with at least six months of work experience in the operating room.
- ❖ Nurses who provide informed consent to participate in the study.

Exclusion Criteria:

- ❖ Student nurses or trainees not yet licensed.
- ❖ Nurses who are on leave during the data collection period.
- ❖ Non-scrub nurses (e.g., circulating or recovery room nurses) not directly involved in maintaining sterility during surgery.

Tools of data collection:

Data were collected using a structured, self-administered questionnaire adapted from previously validated instruments used in similar studies (Habtewold et al., 2024; Khan et al., 2024). The instrument was designed to measure scrub nurses' demographic and professional characteristics, knowledge, and self-reported practices related to sterile techniques in the operating room. It comprised three sections:

- 1. Demographic and professional characteristics:** This section captured participants' background information, including age, gender, years of operating-room experience, educational level, prior training on sterile techniques, and workload.
- 2. Knowledge assessment:** This section assessed nurses' knowledge of sterile techniques in the operating room. It contained 31 items presented in multiple-choice and true/false formats, covering core concepts of aseptic technique, sterilization, and infection prevention and control.

- 3. Practice assessment:** This section evaluated nurses' self-reported practices related to sterile technique in the operating room. It included 18 items rated on a 3-point Likert scale, measuring adherence to key sterile procedures such as surgical hand scrubbing, gowning, gloving, maintenance of the sterile field, and appropriate handling of sterile instruments and supplies.

Validity and Reliability

The questionnaire underwent content validation prior to data collection. Content validity was evaluated by a panel of three subject-matter experts in medical science. Their comments and recommendations were used to revise the wording of items, improve clarity, and ensure the appropriateness and comprehensiveness of the instrument in relation to the study objectives.

Reliability was established through pilot testing and standardization of the data collection procedures. Internal consistency reliability was assessed using Cronbach's alpha for the main questionnaire domains. The Cronbach's alpha coefficients demonstrated acceptable to excellent reliability across sections, including infection control protocols, knowledge-related items, and practice-related items, with coefficients ranging from 0.83 to 0.92, indicating strong internal consistency.

Pilot of the Study:

A pilot study was conducted among 24 scrub nurses (10% of the calculated sample) who were subsequently excluded from the main study. The pilot was undertaken to assess the clarity, feasibility, and applicability of the questionnaire, as well as to estimate the average time required for completion. Based on the pilot findings, necessary modifications were made to improve the wording and organization of the tool.

Data Collection:

Data were collected from December to January 2025, three days per week, across the selected public hospitals. Data collection was organized in coordination with operating room administration and shift schedules to ensure participant accessibility during morning, evening, and night shifts. The researchers obtained institutional permission and presented the official approval letter to the relevant hospital authorities and operating-room supervisors before commencing data collection.

Eligible scrub nurses were approached individually in appropriate areas within the operating suite to ensure privacy. The researchers introduced themselves, explained the aim and procedures of the study, and obtained oral informed consent prior to distributing the questionnaire. Participants received a printed copy of the structured questionnaire along with standardized instructions on how to complete it. The questionnaire was completed in a single session, and participants were given sufficient time (approximately 20–30 minutes) depending on their responses and work demands. Completed questionnaires were reviewed immediately by the researchers to confirm completeness and minimize missing data.

Ethical Considerations:

Ethical approval for the study was obtained from the relevant institutional ethics committee. Formal administrative permission was secured through an official approval letter from the Dean of the Faculty of Applied Medical Sciences at 21 September University to facilitate access to the study sites and support data collection. Participation was voluntary, and informed consent was obtained from all eligible scrub nurses after they were informed about the purpose, procedures, and nature of the study.

Privacy was maintained throughout the data collection process, and confidentiality and anonymity were assured by avoiding personal identifiers and restricting access to the data to the research team only. Participants were informed of their right to decline participation or withdraw from the study at any time without penalty or the need to provide justification.

Data Processing and Statistical Analysis:

Data were entered in Microsoft Excel 2010 and analyzed using SPSS Version 27. Qualitative variables were summarized as frequencies and percentages, and comparisons were made using the χ^2 test or Fisher's exact test. Quantitative variables were expressed as mean $\pm$ SD, with t-tests or ANOVA. Pearson correlation assessed associations between continuous variables. A p-value ≤ 0.05 was considered statistically significant.

CHAPTER

FOUR RESULTS

Table (1): Socio-demographic characteristics of among Scrub Nurses (N=240)

Variables	Scrub Nurses (N = 240)	
	No	%
Age groups		
• ≤ 25 years	90	37.5
• 26 – 35 years	96	40.0
• > 35 years	54	22.5
Sex		
• Male	108	45.0
• Female	132	55.0
Marital status		
• Married	129	53.8
• Unmarried	111	46.3

Table (1): The socio-demographic profile of the scrub nurses (N = 240) shows a predominantly young workforce, with the highest percentage aged 26–35 years (40.0%), followed closely by those ≤25 years (37.5%), meaning over three-quarters are 35 years or younger (77.5%). Females constitute a slight majority (55.0%) compared with males (45.0%), indicating a relatively balanced sex distribution. Marital status is similarly balanced, though married nurses represent a modest majority (53.8%) compared with unmarried nurses (46.3%).

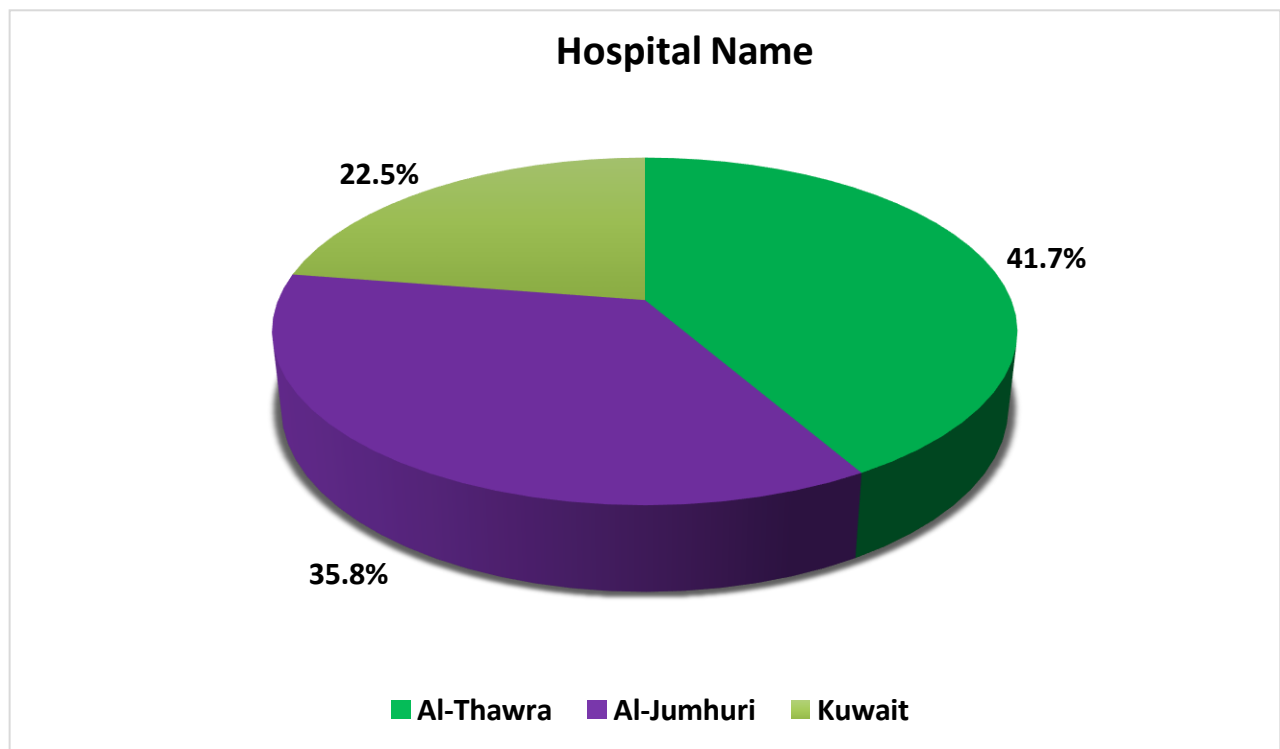


Figure (1): Distribution of Scrub nurses among three hospitals

Figure (1): The distribution of scrub nurses across the three hospitals is as follows: the largest share is working at Al-Thawra Hospital (41.7%), followed by Al-Jumhuri Hospital (35.8%). In contrast, Kuwait Hospital accounts for the smallest proportion (22.5%). Collectively, more than three-quarters of the scrub nurses are concentrated in Al-Thawra and Al-Jumhuri (77.5%), indicating that staffing is primarily clustered in these two facilities.

Table (2): Work-related characteristics of among Scrub Nurses (N=240)

Variables	Scrub Nurses (N = 240)	
	No	%
Academic qualification		
• Bachelor's	92	38.3
• Higher diploma	103	42.9
• Intermediate diploma	45	18.8
Years of experience as a surgical technologist		
• < 4 years	117	48.8
• 4–7 years	68	28.3
• > 7 years	55	22.9
Working hours per day		
• ≤ 8 hours	178	74.2
• > 8 hours	62	25.8
Attending training on sterilization techniques in surgical operating rooms		
• Yes	109	45.4
• No	131	54.6

Table (2): The work-related profile of scrub nurses (N=240) indicates the highest percentage holding a higher diploma (42.9%) and over one-third holding a bachelor's degree (38.3%), while fewer than one in five hold an intermediate diploma (18.8%). Experience levels suggest a relatively early-career group, as nearly half (48.8%) have less than 4 years of experience as surgical technologists, compared with 28.3% with 4–7 years and 22.9% with more than 7 years. Most nurses report standard working schedules, with almost three-quarters working ≤8 hours per day (74.2%), whereas about one-quarter exceed 8 hours (25.8%). Importantly, exposure to training in sterilization techniques appears limited: a slight majority (54.6%) have not attended such training, highlighting a potential gap in professional development in a core safety-related area.

Table (3): Knowledge of Scrub Nurses regarding Sterile Techniques in Operating Rooms (N=240)

Items		Correct answer		Incorrect answer	
		No.	%	No.	%
1	Definition of sterile technique	118	49.2	122	50.8
2	A gown is considered sterile	111	46.3	129	53.8
3	A sterile package wrapped in a previous woven material drops to the floor	177	73.8	63	26.3
4	When the tape on the large abdominal swabs extends over the table edge	174	72.5	66	27.5
5	Circulating nurse accidentally contaminates a sterile area	102	42.5	138	57.5
6	When draping an unsterile table, how do you drape?	92	38.3	148	61.7
7	Creating a sterile field: preferable time to open a pack	194	80.8	46	19.2
8	When requiring sterile water during the surgical procedure	37	15.4	203	84.6
9	Discovering a hole in glove during a procedure	36	15.0	204	85.0
10	Safe distance between an unsterile person and sterile field	97	40.4	143	59.6
11	After a sterile area has been created, does the scrub nurse...	107	44.6	133	55.4
12	During surgery when passing sterile team members...	69	28.8	171	71.3
13	An unsterile person allowed to face/observe sterile area when passing	45	18.8	195	81.3
14	Circulating nurse is allowed to open sterile packages	131	54.6	109	45.4
15	Use only sterile items in the sterile field	202	84.2	38	15.8
16	Sterilized package found in a contaminated area is considered non-sterile	178	74.2	62	25.8
17	A dropped package is contaminated on the outside	193	80.4	47	19.6
18	Tables are sterile only at table level	199	82.9	41	17.1
19	Anything falling/extending over table/bed edge is contaminated	215	89.6	25	10.4
20	Edges of anything enclosing sterile contents are unsterile	182	75.8	58	24.2
21	Sterile field is created as close as possible to time of use	220	91.7	20	8.3
22	Sterile field is contaminated whenever a sterile barrier is permeable	224	93.3	16	6.7
23	Sterile personnel touch only sterile; unsterile touch only unsterile	212	88.3	28	11.7
24	Sterile personnel must wear sterile gown and gloves	228	95.0	12	5.0
25	Self-gowning/gloving from separate sterile surface to avoid dripping	217	90.4	23	9.6
26	Stockinet cuffs of gown enclosed beneath sterile gloves	202	84.2	38	15.8
27	Sterile people keep hands in sight and at/above waist level	214	89.2	26	10.8
28	Back of the gown is considered contaminated	189	78.7	51	21.3
29	Gowns sterile only from chest to sterile field level (front) and 5 cm above elbows to cuffs	215	89.6	25	10.4
30	Unsterile circulating nurse does not directly contact sterile field	224	93.3	16	6.7

Table (3): Overall, scrub nurses demonstrated strong knowledge on the core principles that maintain a sterile field, with very high correct responses for key standards such as: sterile field created close to time of use (91.7%), contamination when barriers become permeable (93.3%), sterile personnel wearing sterile gown and gloves (95.0%), and the circulating (unsterile) nurse not directly contacting the sterile field (93.3%). Knowledge was also high regarding common contamination risks at the table, including contamination from anything extending over the edge (89.6%), limited sterile zones of gowns (89.6%), and hand position above waist level (89.2%).

In contrast, there were major critical knowledge gaps in several high-risk, practice-sensitive situations: the correct response for requesting sterile water during surgery was very low (15.4%), as was recognizing the appropriate action when a hole is discovered in a glove (15.0%). Nurses also performed poorly on behaviors related to movement and proximity around the sterile field, including how to pass sterile team members (28.8%) and whether an unsterile person may face/observe the sterile area when passing (18.8%). Additionally, the foundational understanding of what is considered sterile showed weaknesses, including the definition of sterile technique (49.2%) and whether a gown is considered sterile (46.3%). Taken together, the findings indicate good understanding of general sterile-field rules but serious deficits in practical decision-making during intraoperative events, which may require targeted, simulation-based training and reinforcement.

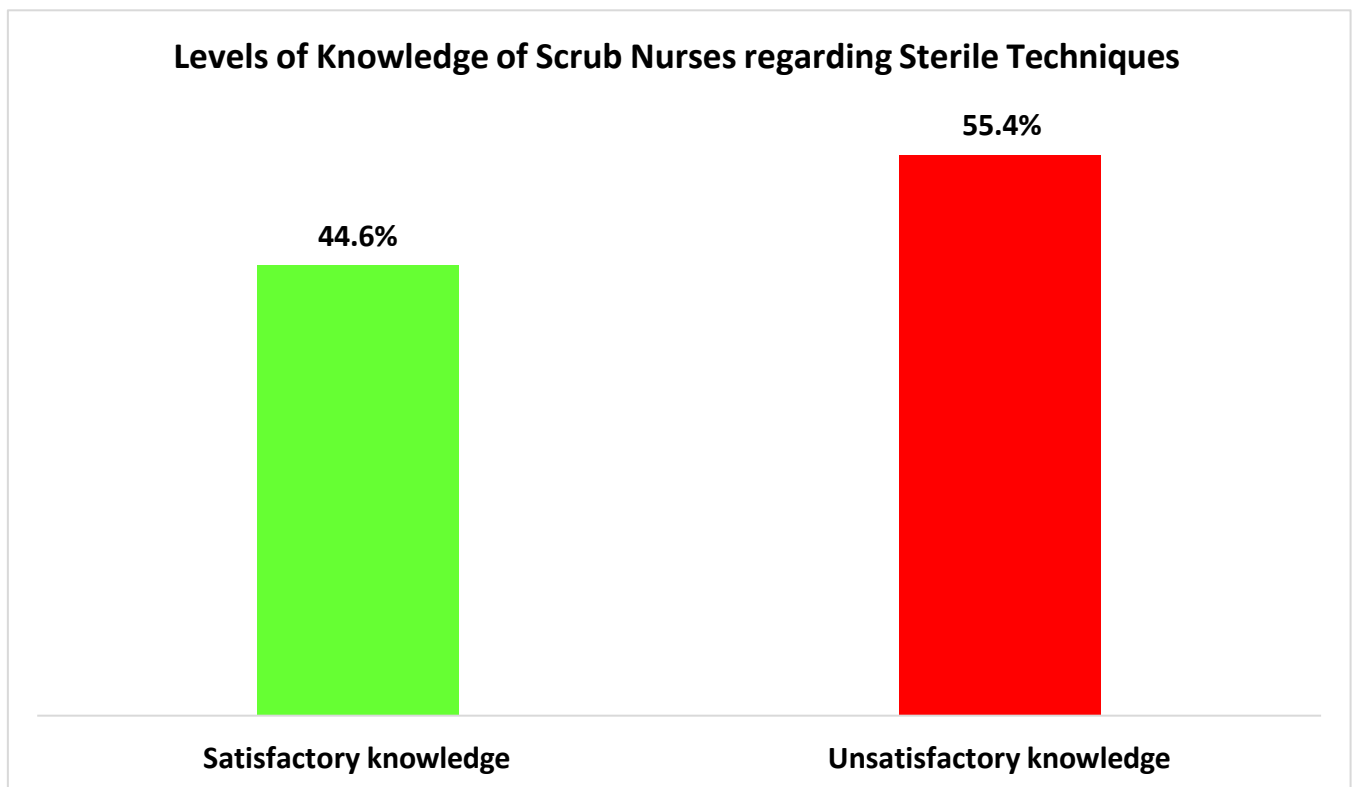


Figure (2): Levels of Knowledge of Scrub Nurses regarding Sterile Techniques (N=240)

Figure (2) shows that more than half of the scrub nurses (55.4%) did not have enough knowledge about sterile techniques, while only 44.6% did. This imbalance suggests a notable overall knowledge deficit in a critical patient-safety domain, implying that current preparation and ongoing education may be insufficient for a substantial proportion of staff. The findings recommend targeted training and periodic competency assessment to strengthen adherence to sterile technique standards and reduce the risk of contamination in operating rooms.

Table (4): Practice of Scrub Nurses regarding Sterile Techniques in Operating Rooms (N=240)

Items		Never		Sometimes		Always	
		No.	%	No.	%	No.	%
1	Wear mask, head cover and proper OR suit/attire	21	8.8	104	43.3	115	47.9
2	Ensure instruments/supplies/linens from stock room are sterilized & properly wrapped	23	9.6	105	43.8	112	46.7
3	Observe asepsis when preparing/arranging sterile instruments & supplies	22	9.2	104	43.3	114	47.5
4	Prepare sterile instruments/supplies/field as close as possible to time of use	19	7.9	109	45.4	112	46.7
5	Skin preparation from the site of incision	32	13.3	101	42.1	107	44.6
6	Surgical scrub from hands up to 2 inches above elbows; hands higher than elbows	21	8.8	107	44.6	112	46.7
7	Perform gowning and gloving aseptically; assist surgeon/assistants observing sterile technique	26	10.8	98	40.8	116	48.3
8	During draping, cover all skin except incision site	24	10.0	91	37.9	125	52.1
9	Avoid touching parts hanging below table level while in scrub	34	14.2	89	37.1	117	48.8
10	Avoid leaning on non-sterile areas; avoid reaching over sterile field	46	19.2	98	40.8	96	40.0
11	Maintain cleanliness of instruments throughout procedure (wipe blood-stained instruments with moistened gauze)	42	17.5	98	40.8	100	41.7
12	Keep talking, sneezing, and coughing to a minimum	46	19.2	101	42.1	93	38.8
13	Keep movements within/around sterile area to a minimum	37	15.4	103	42.9	100	41.7
14	Keep contact with sterile items to a minimum	39	16.3	100	41.7	101	42.1
15	Provide other supplies/materials/instruments when circulating, without touching unsterile areas	30	12.5	105	43.8	105	43.8
16	Perform initial and final counting of instruments and supplies with circulator	38	15.8	96	40.0	106	44.2
17	Keep the room cool and conducive for the surgical team and patient	41	17.1	111	46.3	88	36.7
18	Segregate wastes as the operation progresses	72	30.0	98	40.8	70	29.2

Table (4) shows that consistent adherence to sterile technique practices is generally modest, with most items clustering around about 40–52% always, while a large proportion report only “sometimes” performing these practices (typically ~37–46%). The strongest routinely performed behaviors include proper draping (always:

52.1%) and several core aseptic actions, such as wearing appropriate OR attire (47.9%), aseptic gowning/gloving (48.3%), avoiding contact with items below table level (48.8%), and ensuring materials are sterilized and properly wrapped (46.7%).

However, several critical practices show notable weaknesses, where “always” performance falls to around 36–40%—including avoiding leaning on non-sterile areas or reaching over the sterile field (40.0%), minimizing coughing/sneezing/talking (38.8%), and maintaining an optimal room environment (36.7%). The most concerning deficit is waste segregation: fewer than one-third report always doing it (29.2%), and 30.0% report never segregating waste, indicating a major gap in infection control and OR safety practices. Overall, the pattern suggests that while scrub nurses demonstrate moderate compliance with some fundamental sterile practices, inconsistent application—especially in environmental control and waste management—may increase contamination risk and warrants targeted monitoring and skills reinforcement.

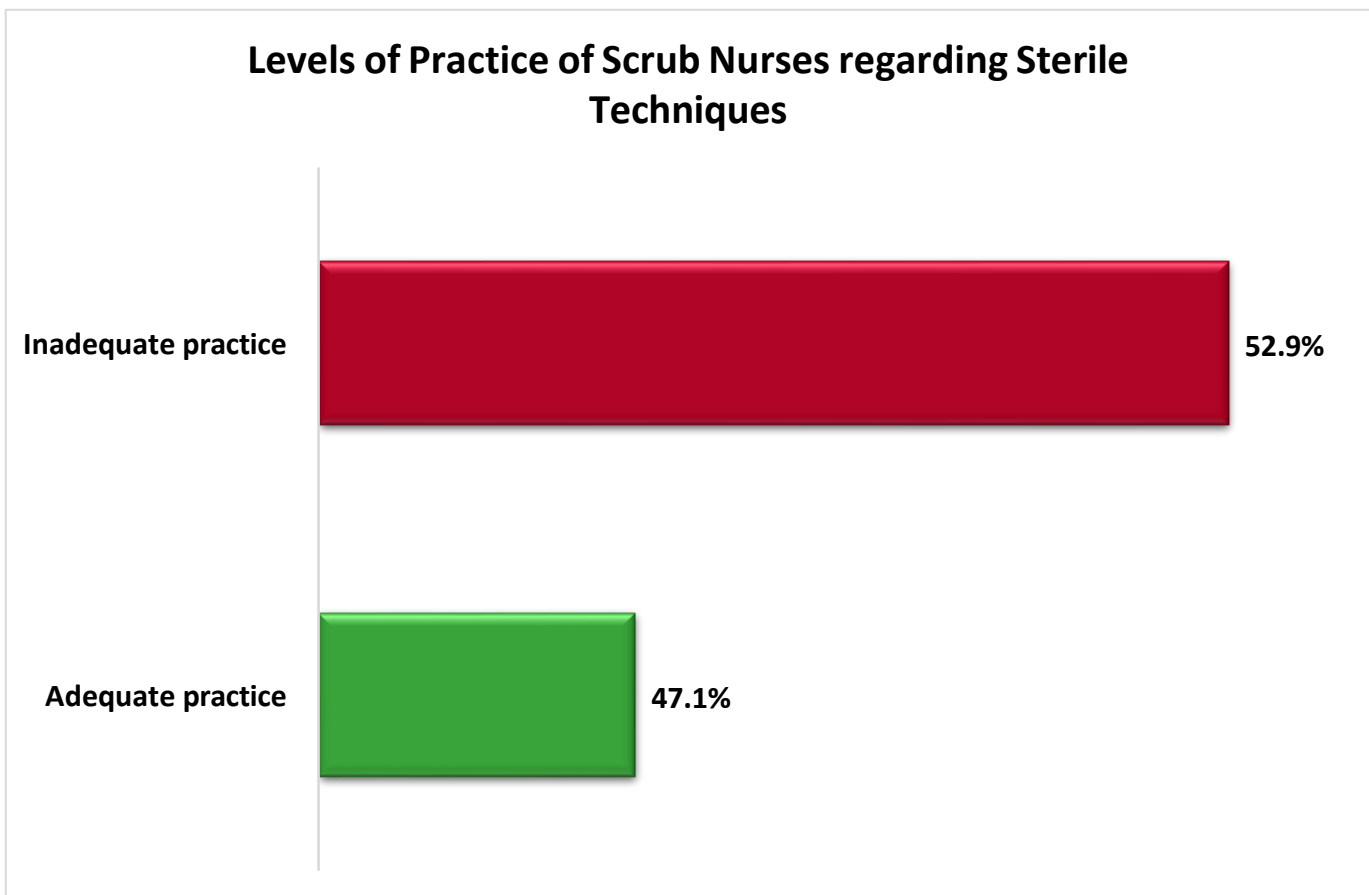


Figure (3): Levels of Practice of Scrub Nurses regarding Sterile Techniques (N=240)

Figure (3) shows that inadequate practice of sterile techniques is slightly more prevalent than adequate practice among scrub nurses, with 52.9% falling into the inadequate category compared with 47.1% demonstrating adequate practice. This indicates that many staff members do not consistently use sterile techniques, which increases the risk of contamination and infection in operating rooms. The findings suggest that practitioners require focused practical training, routine supervision, and ongoing competency-based evaluation to improve adherence to sterile practice standards.

Table 5: Pearson correlation between knowledge and practice regarding Sterile Techniques in Operating Rooms among Scrub Nurses (N=240)

Variables		Practice
knowledge	r-value	0.485
	P-value	<0.001*

* Correlation is significant at the 0.01 level (2-tailed).

Table (5) demonstrates a moderate positive correlation between scrub nurses' knowledge and their practice of sterile techniques ($r = 0.485$), indicating that higher knowledge levels are associated with better practice performance. This relationship is highly statistically significant ($p < 0.001$), indicating that enhancing nurses' knowledge through structured education and competency-based training is likely to result in quantifiable improvements in sterile technique in operating rooms.

Table (6): Relationship between Socio-demographic characteristics, knowledge and practice regarding Sterile Techniques in Operating Rooms among Scrub Nurses (N=240)

Variables	knowledge	Practice
	Mean±SD	Mean±SD
Age groups:		
• ≤ 25 years	20.71±2.55	25.43±9.55
• 26 – 35 years	19.56±2.83	22.28±9.85
• > 35 years	19.67±3.10	21.63±9.49
F (P. value)	4.482(0.012*)	3.537(0.031*)
Sex:		
• Male	19.27±2.88	20.38±9.26
• Female	20.63±2.65	25.72±9.53
t (P. value)	-3.806(<0.001*)	-4.374(<0.001*)
Marital Status		
• Married	20.69±2.74	24.69±9.53
• Unmarried	19.23±2.75	21.72±9.82
t (P. value)	4.101(<0.001*)	2.373(0.018*)

Table (6) shows that knowledge and practice of sterile techniques differ significantly across key socio-demographic groups. By age, there were statistically significant differences in both knowledge ($F=4.482$, $p=0.012$) and practice ($F=3.537$, $p=0.031$), with the ≤ 25 year old group demonstrating the highest mean knowledge (20.71 ± 2.55) and practice (25.43 ± 9.55) scores compared with older groups. Sex was strongly associated with performance: female nurses scored higher than males in both knowledge (20.63 ± 2.65 vs 19.27 ± 2.88 ; $p<0.001$) and practice (25.72 ± 9.53 vs 20.38 ± 9.26 ; $p<0.001$). Similarly, marital status showed significant relationships, where married nurses had higher knowledge (20.69 ± 2.74 vs 19.23 ± 2.75 ; $p<0.001$) and better practice (24.69 ± 9.53 vs 21.72 ± 9.82 ; $p=0.018$) than unmarried nurses.

Table (7): Relationship between Work-related characteristics, knowledge and practice regarding Sterile Techniques in Operating Rooms among Scrub Nurses (N=240)

Variables	knowledge	Practice
	Mean±SD	Mean±SD
Hospital:		
• Al-Thawra	21.19±2.33	25.70±9.52
• Al-Jumhuri	19.35±2.66	21.70±9.43
• Kuwait	18.91±3.17	21.48±9.95
F (P. value)	17.170(<0.001*)	5.304(<0.001*)
Academic qualification		
• Bachelor's	20.89±2.45	26.04±8.88
• Higher diploma	19.97±2.64	22.85±10.34
• Intermediate diploma	18.33±3.23	18.80±8.35
F (P. value)	13.666(<0.001*)	9.103(0.006*)
Years of experience as a surgical technologist:		
• > 4 years	20.67±2.45	25.32±9.40
• 4 – 7 years	19.35±3.25	21.75±9.86
• > 7 years	19.45±2.77	20.98±9.68
F (P. value)	6.303(0.002*)	5.096(0.007*)
Working hours per day:		
• ≤ 8 hours	20.20±2.64	23.36±9.78
• > 8 hours	19.50±3.28	23.19±9.78
t (P. value)	1.675(0.095)	0.115(0.908)
Attending training on sterilization techniques:		
• Yes	20.97±2.25	27.57±7.67
• No	19.22±3.02	19.78±9.92
t (P. value)	5.005(<0.001*)	6.698(<0.001*)

Table (7) indicates that knowledge and practice of sterile techniques vary significantly by most work-related factors. The results show that scrub nurses at Al-Thawra Hospital achieved the highest mean scores in knowledge (21.19±2.33) and practice (25.70±9.52) compared to those at Al-Jumhuri and Kuwait hospitals, with these differences being highly significant (knowledge: $F=17.170$, $p<0.001$; practice: $F=5.304$, $p<0.001$). Nurses with a bachelor's degree had the best scores in knowledge (20.89±2.45) and practice (26.04±8.88), while those with an intermediate diploma had the lowest scores (knowledge: 18.33±3.23; practice: 18.80±8.35), showing

Experience also played an important role: scrub nurses with less than 4 years of experience had the highest scores in knowledge and practice, which may reflect more recent training or better adherence to updated protocols. In contrast, working hours showed no association with knowledge or practice ($p=0.095$ and $p=0.908$), indicating that daily hours worked had little influence on performance in this sample. Most importantly, nurses who attended sterilization training had much better results, with trained nurses scoring higher in knowledge (20.97 ± 2.25 compared to 19.22 ± 3.02) and significantly better in practice (27). This highlights training as a key modifiable factor likely to improve sterile technique performance in operating rooms.

CHAPTER FIVE

DISSCUSSION

CHAPTER FIVE: DISSCUSION

Maintaining strict sterile techniques in operating rooms is a cornerstone of patient safety and a critical responsibility of scrub nurses, as breaches in sterility are directly associated with surgical site infections (SSIs) and adverse postoperative outcomes. Recent evidence continues to emphasize that scrub nurses play a pivotal role in preserving the sterile field through proper surgical hand scrubbing, gowning, gloving, and handling of sterile instruments. Despite the availability of well-established guidelines, studies consistently report gaps between recommended standards and actual practice, indicating that sterility maintenance remains a persistent challenge in many surgical settings (Jeyakumar, 2017; Khursheed et al., 2020).

Recent cross-sectional studies highlight that scrub and operating room nurses often demonstrate only moderate levels of knowledge and practice regarding sterile techniques. For example, a large study conducted in public hospitals in Addis Ababa reported that only about half of nurses had good knowledge and practice of sterile techniques, underscoring the continued vulnerability of surgical patients to preventable infections (Habtewold et al., 2024). Similar findings have been reported in studies from Pakistan, Iraq, and other low- and middle-income settings, where inadequate adherence to sterile practices was linked to limited training opportunities, lack of updated guidelines, and insufficient supervision (Audah & Hassan, 2022; Shaheen et al., 2023).

The quasi-experimental studies have shown marked improvements in hand hygiene, gowning, gloving, and overall aseptic practice following structured educational interventions and on-the-job training (Hosny et al., 2021; Tabassum et al., 2023). These findings suggest that deficiencies in practice are not solely due

to individual negligence, but rather reflect systemic issues related to continuing education, institutional support, and enforcement of standardized protocols. Moreover, recent qualitative evidence provides deeper insight into the contextual and organizational challenges faced by scrub nurses in maintaining sterile technique. Operating room nurses report that high workload, time pressure, staff shortages, and poor interdisciplinary communication often compromise adherence to sterility principles, despite adequate theoretical knowledge (Taşdemir & Tank, 2025). These findings are important when interpreting the results of the current study, as they highlight that knowledge alone may not translate into optimal practice without a supportive working environment.

In light of recent literature, the assessment of scrub nurses' knowledge and practice toward sterile techniques remains highly relevant. Comparing the present findings with contemporary studies allows for a clearer understanding of existing gaps, contributing factors, and opportunities for improvement. Such discussion is essential for guiding evidence-based recommendations aimed at strengthening training programs, ensuring availability of clear guidelines, and enhancing supervision in operating rooms to ultimately reduce SSIs and improve surgical outcomes (Habtewold et al., 2024; Singh & Alam, 2024). This study aimed to assess the level of knowledge and practice of scrub nurses toward sterile techniques in operation rooms at public hospitals in Sana'a City, Yemen

The socio-demographic profile presented in Table (1) reflects a predominantly young scrub nurse workforce, with more than three-quarters aged 35 years or younger. This finding is consistent with several studies conducted in operating room settings, which report that scrub and operating room nurses are largely concentrated in early adulthood and mid-career stages. For example, Zabihirad et al. (2024) reported a mean age of approximately 34 years among

operating room personnel, indicating a similarly youthful workforce (Zabihirad et al., 2024). This age distribution is often attributed to the physically demanding nature of scrub nursing, which requires stamina, prolonged standing, and rapid adaptation to complex surgical environments, making it more attractive or sustainable for younger nurses. However, earlier research from some low-resource settings has described scrub nurses as more “middle-aged,” suggesting contextual differences in recruitment, retention, and workforce mobility across regions (Taher & Lafi, 2015). This partial disagreement may reflect evolving workforce dynamics, where newer generations enter operating rooms earlier due to expanded training opportunities.

Regarding sex distribution, the present study shows a slight female majority with a relatively balanced representation of males and females. This pattern aligns with contemporary evidence suggesting increasing gender diversity within operating room nursing. Recent studies have reported female proportions ranging from 59% to 65% among operating room staff, while still acknowledging a substantial male presence (Karimi et al., 2023; Zabihirad et al., 2024). This balance contrasts with older literature that described scrub nursing as a predominantly female profession, suggesting a gradual shift toward greater male participation. Such a trend may be influenced by the technical and team-based nature of operating room work, which increasingly attracts both genders.

The marital status findings, showing a modest majority of married scrub nurses, are also supported by recent evidence. Studies among operating room nurses have frequently reported that more than half of participants are married, reflecting the typical life stage of nurses in their late twenties and thirties (Zabihirad et al., 2024). In contrast, some investigations have found marital status to be more evenly distributed or not significantly associated with professional

outcomes, indicating variability across settings (Karimi et al., 2023). The relatively balanced marital status observed in the present study may reflect competing influences of demanding operating room schedules and family responsibilities, which can affect both recruitment and retention.

The findings in Table (2) highlight several important characteristics of scrub nurses that have direct implications for operating room safety, workforce stability, and professional development. The predominance of nurses holding a higher diploma or bachelor's degree suggests a relatively well-educated workforce, which is consistent with many contemporary studies indicating that operating room nurses increasingly possess post-secondary qualifications. For example, Abu Rahmah et al. (2025) reported that the majority of operating room nurses in Gaza held bachelor's degrees, reflecting a global trend toward higher educational preparation in perioperative nursing (Abu Rahmah et al., 2025). Higher educational attainment has been associated with better knowledge of infection control and patient safety principles, as demonstrated in studies showing significant relationships between education level and knowledge of sterilization and infection prevention practices (Ahmed et al., 2023). However, some research suggests that formal education alone does not guarantee optimal practice, emphasizing the importance of continuous in-service training to translate knowledge into consistent clinical performance (Feng et al., 2022).

The experience profile of the studied scrub nurses indicates that nearly half have less than four years of experience, suggesting a predominantly early-career workforce. This finding aligns with reports from several healthcare systems where high turnover and workforce mobility have resulted in younger, less-experienced operating room teams (Shin & Kim, 2024). While early-career nurses often demonstrate strong theoretical knowledge, limited experience may affect their

confidence and consistency in complex tasks such as maintaining sterility and anticipating intraoperative risks. In contrast, studies conducted in China and Turkey have shown that nurses with longer operating room experience tend to demonstrate higher knowledge scores related to surgical site infection prevention (Feng et al., 2022; Tank et al., 2019). This suggests that the relatively limited experience observed in the present study may partly explain gaps in advanced infection control competencies and underscores the need for structured mentorship and competency-based training programs.

Regarding working hours, the majority of scrub nurses in the present study reported working eight hours or less per day, which may be considered favorable in terms of reducing fatigue and maintaining alertness during surgical procedures. Excessive working hours have been linked to decreased compliance with safety protocols and increased risk of errors in perioperative settings (Zeb et al., 2019). Nevertheless, the quarter of nurses who reported working more than eight hours daily may still be at risk of fatigue-related lapses in infection control practices, particularly in high-demand operating rooms. Previous studies have emphasized that workload and time pressure are significant barriers to adherence to sterilization and standard precaution guidelines, even among knowledgeable nurses (Surabhi & Singh, 2025).

Most notably, the finding that more than half of the scrub nurses had not attended training in sterilization techniques represents a critical gap in professional development. This result is consistent with several regional and international studies reporting insufficient access to formal infection control and sterilization training among operating room staff (Sharif et al., 2022; Hilal & Redha, 2021). Evidence strongly supports the effectiveness of targeted training programs in improving sterilization practices and reducing surgical site infection rates, as

demonstrated by interventional studies showing measurable declines in infections following structured education (Mohammed et al., 2014). Conversely, studies consistently report that lack of training is associated with poor or inconsistent performance in core infection control activities, regardless of nurses' educational level or years of experience (Ahmed et al., 2023).

The findings presented in Table (3) demonstrate that scrub nurses possess strong foundational knowledge of the general principles required to maintain a sterile field. High correct-response rates for standards such as creating the sterile field close to the time of use, recognizing contamination from permeable barriers, and maintaining separation between sterile and unsterile personnel are consistent with prior studies showing that operating room nurses are generally well oriented to core aseptic rules. For example, Habtewold et al. (2024) reported that nurses commonly demonstrate better knowledge of basic sterile-field principles than of complex intraoperative practices, suggesting that these concepts are well covered in initial education and routine orientation programs (Habtewold et al., 2024). Similarly, Labrague et al. (2012) found that operating room nurses showed excellent knowledge of standard sterile technique concepts, reinforcing the notion that baseline theoretical understanding is generally strong across settings (Labrague et al., 2012).

Despite this strong general knowledge, the present study reveals substantial deficits in practice-sensitive and high-risk intraoperative situations, such as requesting sterile water and responding to glove perforation. These findings align with evidence indicating that nurses often struggle with decision-making in dynamic, real-time surgical scenarios. Audah and Hassan (2022) reported only moderate levels of aseptic practice among operating room nurses, despite acceptable theoretical knowledge, highlighting a persistent knowledge–practice

gap (Audah & Hassan, 2022). Likewise, Khursheed et al. (2020) observed inadequate compliance with critical aseptic behaviors during surgical hand preparation, emphasizing that procedural lapses often occur in applied settings rather than in conceptual understanding (Khursheed et al., 2020).

Particularly concerning are the poor responses related to movement and proximity around the sterile field, such as passing sterile team members and the orientation of unsterile personnel. These behaviors require situational awareness and non-technical skills, which have been increasingly recognized as critical to patient safety in the operating room. Sirevåg et al. (2021) identified decision-making, situation awareness, and communication as essential non-technical skills for scrub and circulating nurses, noting that deficiencies in these areas can compromise sterile integrity (Sirevåg et al., 2021). More recently, Mohammadi et al. (2025) demonstrated that targeted non-technical skills training significantly improved scrub practitioners' self-efficacy, particularly in situation awareness and teamwork, supporting the need for structured educational interventions (Mohammadi et al., 2025).

The observed weaknesses in defining sterile technique and recognizing whether gowns are sterile further suggest gaps in conceptual integration and reinforcement over time. Habtewold et al. (2024) similarly found that lack of continuous training, supervision, and access to clear guidelines was associated with poorer knowledge and practice of sterile techniques (Habtewold et al., 2024). In contrast, intervention-based studies demonstrate that focused training can effectively close these gaps. Adewunmi and Salawu (2021) reported significant improvements in both knowledge and practice of aseptic technique following nurse-led training programs, underscoring the value of ongoing education (Adewunmi & Salawu, 2021).

Overall, the present findings are consistent with the broader literature in showing that while scrub nurses often master general sterile-field rules, they remain vulnerable to errors in complex, rapidly evolving intraoperative situations. Recent evidence strongly supports the use of simulation-based and scenario-driven training to enhance both technical and non-technical skills. Studies using immersive and virtual simulation have shown marked improvements in scrub nurses' practical performance, confidence, and real-world skill transfer, suggesting a promising strategy to address the critical gaps identified in this study (Edwards et al., 2021).

Figure (2) demonstrates that more than half of the scrub nurses (55.4%) lacked sufficient knowledge of sterile techniques, indicating a substantial knowledge gap in a core patient-safety competency. This finding is consistent with multiple recent studies reporting inadequate knowledge or practice of aseptic techniques among operating room nurses. For example, a large cross-sectional study in Ethiopia found that although sterile technique is fundamental to infection prevention, nurses' knowledge and practice were still considered inadequate, with deficits strongly linked to lack of training, supervision, and written guidelines (Habtewold et al., 2024).

Similarly, an observational study from Pakistan reported that overall inadequate practice of surgical hand scrubbing reached 77%, underscoring that knowledge alone is often insufficient without structured competency monitoring and reinforcement (Khursheed et al., 2020).

The observed imbalance in the present study may also reflect systemic and organizational factors rather than individual shortcomings. Qualitative evidence from Turkey highlights that operating room nurses frequently struggle to maintain

sterile technique due to high workload, inadequate staffing, and inconsistent adherence to protocols by team members, all of which negatively influence knowledge application and confidence (Taşdemir & Yıldırım Tank, 2025). These findings support the interpretation that the knowledge deficit identified in Figure (2) may be compounded by environmental constraints and limited opportunities for continuous professional development, rather than being solely attributable to insufficient initial education.

In contrast, some studies report relatively higher levels of knowledge among operating room nurses, suggesting that targeted interventions can effectively close this gap. A recent interventional study in Malaysia demonstrated significant improvements in nurses' knowledge of sterile techniques following structured educational programs, with post-intervention high-knowledge levels exceeding 80% (Hajar et al., 2022). Likewise, research from Pakistan showed that nurses who received guideline-based training exhibited markedly improved post-test knowledge scores (Tabassum et al., 2023). These contrasting findings reinforce the current study's recommendation that targeted training and periodic competency assessments are essential to improving sterile technique knowledge and sustaining safe surgical practice.

Overall, the present findings align with a growing body of evidence indicating that deficits in scrub nurses' knowledge of sterile techniques remain common but modifiable. Continuous education, standardized guidelines, and regular supervision emerge as critical strategies to reduce variability in practice and ultimately minimize the risk of contamination and surgical site infections (Habtewold et al., 2024; Hajar et al., 2022; Taşdemir & Yıldırım Tank, 2025).

The finding that a slightly higher proportion of scrub nurses demonstrate inadequate sterile practice (52.9%) than adequate practice (47.1%) is clinically important and aligns with a growing body of evidence indicating persistent gaps in adherence to aseptic standards in operating rooms. Several observational and cross-sectional studies have reported similarly suboptimal compliance with sterile techniques among operating room nurses, suggesting that inadequate practice is not an isolated phenomenon but rather a widespread challenge. For example, Jeyakumar (2017) found inconsistent and inadequate scrubbing, gowning, and gloving practices among operating room nurses, highlighting that failure to uniformly follow aseptic principles remains common despite long-standing guidelines (Jeyakumar, 2017). Similarly, an observational study in Pakistan reported that up to 77% of nurses demonstrated overall inadequate surgical hand-scrubbing practices, reinforcing the concern that sterile technique is frequently compromised in routine practice (Khursheed et al., 2020).

Recent evidence further supports the interpretation that inadequate sterile practice substantially increases the risk of contamination and infection in the operating room. A multicenter observational study in Italy reported low adherence to international infection control guidelines among operating room staff, including nurses, particularly in the use of gloves, gowns, and eye protection, all of which are critical elements of sterile technique (Lo Giudice et al., 2019). Likewise, a 2025 study found only moderate compliance with sterilization and infection control practices among operating room nurses, with positive responses for sterilization-related practices averaging below 50%, closely mirroring the proportion of inadequate practice observed in the present study (Abu Rahmah et al., 2025). These findings collectively emphasize that breaches in sterile technique remain a key contributor to surgical site infections and patient safety risks.

In contrast, some studies report higher levels of compliance, suggesting that adequate sterile practice is achievable under supportive organizational conditions. For instance, Mortell et al. (2018) observed high hand hygiene compliance (>90%) among nurses in operating rooms and post-anesthesia care units, indicating that when institutional policies, monitoring, and infection control cultures are strong, adherence can be substantially improved (Mortell et al., 2018). Similarly, a study from Kogi State reported that over 70% of perioperative nurses demonstrated good compliance with infection prevention guidelines, although the authors noted that workload and lack of clear policies could quickly erode these gains (David et al., 2025).

The present study's recommendation for focused practical training, routine supervision, and ongoing competency-based evaluation is strongly supported by interventional research. Quasi-experimental and systematic review evidence consistently shows that targeted on-the-job training and structured educational programs lead to marked improvements in nurses' compliance with sterile and infection control practices. For example, Shafea et al. (2023) demonstrated statistically significant post-training improvements in surgical hand washing, gowning, gloving, and masking practices, with compliance rates increasing from below 40% to over 90% (Shafea et al., 2023).

Recent qualitative evidence also highlights that inadequate training, lack of supervision, and systemic pressures such as time constraints and staff shortages undermine nurses' ability to maintain sterile technique, further supporting the need for continuous competency assessment and organizational support (Taşdemir & Tank, 2025).

The observed moderate correlation suggests that while knowledge is a key factor, it is not the sole determinant of practice, a conclusion echoed in recent literature. Interventional studies demonstrate that structured education and competency-based training lead to significant improvements in both knowledge and practice, reinforcing the causal pathway implied by the current results. For example, quasi-experimental studies in operating rooms showed significant post-training improvements in nurses' sterile technique performance following targeted educational programs (Hajar et al., 2022) and guideline-based interventions (Tabassum et al., 2023). These findings support the present study's implication that enhancing knowledge through formal training is likely to yield measurable improvements in sterile practice.

However, some studies partially diverge from the present findings by reporting weak or non-significant direct relationships between knowledge and practice, suggesting the influence of contextual and organizational factors. A large multicenter study in China found that although nurses' knowledge of surgical site infection prevention was relatively low, practice levels remained high, and no significant direct correlation between knowledge and practice was observed (Feng et al., 2022). Qualitative evidence further explains this discrepancy by highlighting barriers such as workload, staffing shortages, poor communication, and hierarchical dynamics, which may limit the translation of knowledge into practice despite adequate understanding (Taşdemir & Tank, 2025).

Overall, the present study's findings are strongly supported by recent evidence indicating that knowledge is a significant, though not exclusive, contributor to effective sterile practice. The moderate correlation observed underscores the importance of integrating continuous education with supervision, availability of guidelines, and supportive organizational environments to optimize

sterile technique compliance in operating rooms. This integrated approach is consistently recommended in recent studies as the most effective strategy for sustaining high-quality infection prevention practices and improving patient safety (Habtewold et al., 2024).

The present study demonstrated that younger nurses (≤ 25 years) had significantly higher knowledge and practice scores related to sterile techniques compared with older age groups. This finding aligns with evidence suggesting that younger healthcare professionals often demonstrate better adherence to infection control and aseptic principles, possibly due to more recent formal education and greater exposure to updated guidelines. For example, a large cross-sectional study among nurses in Ethiopia found that younger age groups were significantly associated with better knowledge and practice in infection-prevention-related procedures, including aseptic care, compared with older nurses (Tegegne et al., 2025). Similarly, research on sterile compounding skills among healthcare personnel indicates that knowledge retention declines with increasing years in practice, reinforcing the idea that time since training may negatively influence adherence to sterile standards (Davis & Ayars, 2021). However, some earlier studies reported no significant association between age and sterile technique performance, suggesting that contextual factors such as continuing education and institutional supervision may moderate age-related differences (Labrague et al., 2012).

Sex differences observed in the current study, where female nurses outperformed males in both knowledge and practice of sterile techniques, are strongly supported by the literature. Multiple studies consistently show that female nurses tend to demonstrate higher compliance with infection control practices and better knowledge scores. For instance, a recent multicenter study reported that

female nurses had significantly higher odds of possessing good knowledge and practice related to invasive procedures and infection prevention compared with male counterparts (Tegegne et al., 2025). Comparable findings were also reported in studies assessing nurses' knowledge of standard precautions, where gender emerged as a significant predictor of infection-control knowledge (Sarani et al., 2015). In contrast, some studies in critical care settings found no significant gender differences, suggesting that task specialization and unit-based training may reduce gender-related performance gaps (El-Kass et al., 2024).

Regarding marital status, the present study found that married nurses had significantly higher knowledge and practice scores than unmarried nurses. This observation is consistent with findings from recent infection-prevention research indicating that marital status is associated with better clinical practice, possibly due to greater sense of responsibility, stability, and professional commitment. A 2025 cross-sectional study identified marital status as a significant predictor of good practice in infection prevention and aseptic care among hospital nurses (Tegegne et al., 2025). Similarly, studies examining nurses' knowledge in procedural and critical care contexts have reported higher practice scores among married nurses (Ahmed et al., 2020). Conversely, some investigations have failed to detect a significant relationship between marital status and sterile practice, indicating that organizational culture and access to training may outweigh personal demographic factors (Aziz, 2013).

The findings presented in Table (7) demonstrate that scrub nurses' knowledge and practice of sterile techniques are significantly influenced by several work-related and professional factors. The higher knowledge and practice scores observed among scrub nurses at Al-Thawra Hospital compared with those at Al-Jumhuri and Kuwait hospitals may reflect differences in institutional

support, availability of guidelines, supervision, and training culture. Similar inter-hospital variations have been documented in recent studies, where nurses working in better-resourced or more academically affiliated hospitals consistently showed higher compliance with sterile techniques and better overall performance (Habtewold et al., 2024). Qualitative evidence also suggests that organizational factors such as leadership, teamwork, and enforcement of protocols play a decisive role in maintaining sterility in the operating room, which may explain the superior outcomes in certain hospital settings (Taşdemir & Yıldırım Tank, 2025).

Educational level emerged as a strong determinant of both knowledge and practice, with bachelor-prepared nurses achieving the highest scores, while those with intermediate diplomas performed the poorest. This finding is consistent with multiple studies reporting that higher academic preparation is associated with better understanding of aseptic principles and more accurate application in clinical practice (Taher & Lafi, 2015; (Jeyakumar, 2017). Recent large-scale evidence further confirms that nurses with higher educational attainment demonstrate superior sterile technique practice, partly due to stronger theoretical grounding and greater exposure to evidence-based guidelines during training (Habtewold et al., 2024). However, some observational studies have reported only moderate practice levels even among well-educated nurses, suggesting that education alone is insufficient without continuous reinforcement and supervision (Audah & Hassan, 2022).

The finding that nurses with less than four years of experience achieved higher knowledge and practice scores is noteworthy and aligns with evidence indicating that recently graduated nurses may be more familiar with updated infection-control guidelines and contemporary training approaches. Similar patterns have been reported in studies where novice nurses demonstrated stronger

adherence to protocols immediately after graduation, although this advantage may decline over time without ongoing education (Khursheed et al., 2020). In contrast, other studies have found that longer experience is associated with improved practice due to skill mastery and situational awareness (Hassan et al., 2022). These conflicting findings suggest that experience alone does not guarantee optimal practice unless it is accompanied by continuous professional development.

The absence of a significant association between daily working hours and knowledge or practice in the present study is consistent with some recent reports indicating that workload and hours worked do not necessarily predict sterile technique performance (Ahmed et al., 2023). This may indicate that competence in sterile technique is more strongly influenced by training quality, supervision, and organizational culture than by the number of hours spent in the operating room.

Most importantly, the strong positive effect of sterilization training observed in this study is well supported by contemporary literature. Nurses who attended training programs consistently demonstrate higher knowledge and significantly better practice of sterile techniques compared to untrained peers (Hajar et al., 2022), (Tabassum et al., 2023). Recent evidence further highlights that structured training, supervision, and availability of guidelines are among the strongest predictors of both knowledge and practice in operating room nurses (Habtewold et al., 2024). These findings reinforce the conclusion that training is a key modifiable factor and should be prioritized to improve sterile technique performance and ultimately reduce surgical site infections.

CHAPTER SEX
CONCLUSION
RECOMMENDATIONS

CHAPTER SIX: CONCLUSION AND RECOMMENDATION

Conclusion

The current study concluded that the workforce was predominantly young (77.5% ≤ 35 years) and early in their operating-room careers, and more than half (54.6%) had not received prior training in sterilization/sterile technique, highlighting a substantial continuing professional development gap.

Overall performance was suboptimal. More than half of participants demonstrated insufficient knowledge (55.4%) and reported inadequate practice (52.9%). While many nurses understood general sterile-field principles, important deficits emerged in practical intraoperative decision-making (e.g., appropriate responses to glove perforation, correct handling of sterile water requests, and safe movement/positioning near the sterile field). These gaps are clinically significant because they involve common events that can directly increase contamination risk.

Reported practice was similarly inconsistent: several essential behaviors were performed only intermittently, with particularly poor adherence to waste segregation (fewer than one-third reported always segregating waste, and some reported never doing so), undermining infection prevention and environmental safety in the operating room.

Knowledge and practice were moderately and positively correlated ($r = 0.485$, $p < 0.001$), suggesting that knowledge improvement could translate into better practice. Performance also varied by demographic and professional factors, with higher knowledge/practice associated with female sex, younger age, marital status, hospital site (notably Al-Thawra), higher education (especially bachelor's level), and prior training, whereas daily working hours showed no association.

Recommendations

1. Implement mandatory, competency-based sterile technique training for scrub nurses, focusing on contamination response, sterile-field boundaries, and intraoperative movement, using simulation-based methods.
2. Conduct regular competency assessments with structured remediation and targeted mentorship for lower-performing staff and units.
3. Standardize sterile technique protocols across hospitals through clear SOPs, visual checklists, and routine observational audits with non-punitive feedback.
4. Ensure enabling conditions for compliance, including consistent availability of sterile supplies, effective waste segregation systems, and adherence to operating room environmental controls.
5. Promote inter-hospital benchmarking and knowledge exchange to disseminate best practices from higher-performing facilities.
6. Prioritize future observational and interventional research to evaluate real-world practice, training effectiveness, and contextual barriers.

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APPENDICES

استبيان

التاريخ/...../2026

رقم الاستبيان (.....)

"Assessment of Scrub Nurses' Knowledge and Practice Toward Sterile Techniques in Operation Rooms at Public Hospitals in Sana'a City, Yemen"

تقييم معرفة وممارسات فنيي العمليات الجراحية حول تقنية التعقيم في غرف العمليات في المستشفيات العامة بمدينة صنعاء، اليمن

كمتطلب للحصول على درجة دبلوم فني العمليات.

نحن نقدر كثيراً مشاركتك في هذا البحث العلمي. مشاركتك طوعية، ولك الحق في عدم قبول ملء هذا الاستبيان دون إبداء أي سبب وأي معلومات ستقدمها ستبقى سرية تماماً. سيتم استخدام المعلومات فقط لأغراض البحث. أخيراً، نأمل أن تشارك في هذه الدراسة إلى النتيجة ستوفر أقصى قدر من الفوائد. إذا كان لديك أي أسئلة حول الدراسة، فنحن نرحب بك لطرح الأسئلة على الباحثين.

شاكرين لكم حسن تعاونكم،،،

البيانات الشخصية للممرضين

- (1) السن:
- (2) النوع:
 - ذكر
 - أنثى
- (3) الحالة الاجتماعية:
 - أعزب
 - متزوج
 - مطلق
 - أرمل
- (4) المستشفى:
 - الثورة
 - الجمهوري
 - الكويت
- (5) المؤهل الدراسي:
 - بكالوريوس
 - دبلوم عالي
 - دبلوم متوسط
 - أخرى : تذكر
- (6) عدد سنوات الخبرة:
- (7) فترة الدوام:
 - صباحاً
 - ظهيرة
 - ليلاً
- (8) عدد ساعات العمل اليومية:
- (9) حضور دورات تدريبية أو ورش عمل أو مؤتمرات حول تقنية التعقيم في غرف العمليات الجراحية:
 - نعم
 - لا

معرفة فنيي العمليات الجراحية حول تقنية التعقيم في غرف العمليات

1. أي مما يلي يصف بشكل أفضل التقنية المعقمة؟ فهي:
 - أ. تُطَبَّق عند تخزين المستلزمات في الجناح الجراحي
 - ب. تُستخدم أثناء التنظيف النهائي لضمان بيئة معقمة
 - ج. تُطَبَّق أثناء الإجراءات الجراحية لمنع التلوث الميكروبي
2. يُعَدُّ الثوب الجراحي معقماً...
 - أ. من الصدر حتى مستوى الحقل المعقَّم
 - ب. من الصدر حتى مستوى الحقل المعقَّم، ومن 5 سم فوق المرفقين حتى أساور الأكمام
 - ج. يُعَدُّ الثوب كله معقماً
3. سقطت عبوة معقمة ملفوفة بمادة منسوجة على الأرض.
 - أ. أعد العبوة إلى التخزين المعقَّم
 - ب. افتح العبوة للاستخدام في الإجراء الجراحي
 - ج. اعتبر العبوة ملوثة
4. عندما يمتد شريط شاش البطن الكبير إلى خارج حافة الطاولة:
 - أ. حرك الشاش بعيداً عن الحافة واستمر في استخدامه
 - ب. تخلص من الشاش
 - ج. أزل الشريط من الشاش واستمر في استخدامه
5. لو قام الممرض الجوال بتلوث منطقة معقمة عن طريق الخطأ، فما الإجراء الذي تتخذه بوصفك ممرض أدوات (Scrub Nurse) ؟
 - أ. تخلص من الطاولة التي تم تلويثها
 - ب. أعد تغطية منطقة جديدة
 - ج. تابع الإجراء دون أي تدخل
6. عند تغطية طاولة غير معقمة:
 - أ. غطِ الطاولة أولاً باتجاهك ثم بعيداً عنك
 - ب. قف قريباً من الطاولة التي ستُغطى
 - ج. غطِ الطاولة أولاً بعيداً عنك ثم باتجاهك
7. عند إنشاء حقل معقَّم للعملية، يُفضل فتح العبوة...
 - أ. قُرب وقت الإجراء
 - ب. مسبقاً
 - ج. مسبقاً وتغطيتها بقطع قماش معقمة
8. عند الحاجة إلى ماء معقَّم أثناء الإجراء الجراحي:
 - أ. ضع وعاءً على حافة الطاولة ليقوم الممرض بسكب الماء فيه
 - ب. اسمح للممرض بالوصول فوق طاولتك لسكب الماء
 - ج. تخلص من الماء المعقَّم المتبقي في الزجاجاة بعد انتهاء العملية
9. عند اكتشاف ثقب في القفاز أثناء الإجراء الجراحي، يجب على ممرض العمليات:
 - أ. تغيير القفاز باستخدام طريقة القفاز المغلق (Closed Gloving)
 - ب. تغيير القفاز باستخدام طريقة القفاز المفتوح (Open Gloving)
 - ج. ارتداء قفاز آخر فوق القفاز المتضرر
10. المسافة الآمنة بين الشخص غير المعقَّم والحقل المعقَّم هي:
 - أ. 30 سم
 - ب. 60 سم
 - ج. 45 سم
11. عند إنشاء منطقة معقمة، هل يجب على ممرض الأدوات أن...
 - أ. يبقى داخل الغرفة لمراقبة المنطقة المعقمة
 - ب. يغادر غرفة العمليات لإحضار مستلزمات معقمة بينما لا يوجد أحد داخل الغرفة
 - ج. يطلب من أحد الأعضاء الآخرين إحضار المزيد من المستلزمات المعقمة
12. أثناء الإجراء الجراحي، عند المرور بالقرب من أعضاء الفريق المعقمين...
 - أ. تدبر ظهركما لبعضكما وتقوم بالدوران 360 درجة
 - ب. تواجه ظهر العضو الآخر
 - ج. تفسح المجال للشخص غير المعقَّم

13. يُسمح للشخص غير المعقم بأن...

- أ. يمر بين منطقتين معقمتين
ب. يمر وظهره باتجاه المنطقة المعقمة
ج. يمر وهو يواجه المنطقة المعقمة ويراقبها

14. يُسمح للممرض الجوال بفتح العبوات المعقمة باستخدام:

- أ. يدين نظيفتين وجافتين
ب. القفازات
ج. يدين مبتلئين

من فضلكم يرجي وضع علامة (v) أمام الجملة الصحيحة وعلامة (x) أمام الجملة الخطأ للعبارة التالية:-

العلامة	العبارة	م
	هل استخدمت أدوات معقمة فقط داخل الحقل المعقم؟	15.
	تعتبر الحزمة المعقمة الموجودة في منطقة ملوثة غير معقمة	16.
	تعتبر الحزمة التي تقع على الأرض ملوثة من الخارج	17.
	تكون الطاولات معقمة فقط على مستوى سطح الطاولة	18.
	أي شيء يسقط أو يمتد خارج حافة الطاولة أو سرير العمليات يعد ملوثاً	19.
	تعتبر حواف أي غلاف يحتوي مواد معقمة غير معقمة	20.
	يتم إنشاء الحقل المعقم بأقرب وقت ممكن من استخدامه	21.
	يصبح الحقل المعقم ملوثاً إذا تم اختراق الحاجز المعقم	22.
	يلمس الأشخاص المعقمون مواد أو مناطق معقمة فقط، بينما يلمس غير المعقمين المواد غير المعقمة فقط	23.
	يجب على الأشخاص المعقمين ارتداء رداء معقم وقفازات معقمة	24.
	يجب ارتداء الرداء والقفازات على سطح معقم منفصل لتجنب تساقط الماء على الأدوات المعقمة	25.
	يتم تغطية أساور الرداء المعقمة تحت القفازات المعقمة	26.
	على الأشخاص المعقمين إبقاء أيديهم ظاهرة دائماً وفوق مستوى الخصر أو مستوى الحقل المعقم	27.
	يُعتبر ظهر الرداء ملوثاً	28.
	تعتبر منطقة التعقيم في الرداء من الصدر حتى الحقل الجراحي، ومن 5 سم فوق المرفق حتى نهاية الكم	29.
	لا يلمس الممرض الدوار غير المعقم الحقل المعقم مباشرة	30.

ممارسات فنيي العمليات الجراحية حول تقنية التعقيم في غرف العمليات

م	العبارة	ابدا	احيانا	دائما
1.	هل ترتدي الكمامة وغطاء الرأس وملابس غرفة العمليات المناسبة؟			
2.	هل تتحقق من أن الأدوات واللوازم والأغطية التي يتم الحصول عليها من المخزن معقمة ومغلقة؟			
3.	هل تراعي مبادئ التعقيم في تجهيز الأدوات واللوازم المعقمة وترتيبها بطريقة تسهل التعامل معها؟			
4.	هل تعدّ الأدوات واللوازم والحقل المعقم بأقرب وقت ممكن من وقت الاستخدام؟			
5.	هل يتم تجهيز الجلد من موقع الشق الجراحي؟			
6.	هل تقومين/تقوم بإجراء الغسيل الجراحي من اليدين حتى 2 بوصة فوق المرفق، مع إبقاء اليدين أعلى من المرفقين؟			
7.	هل يتم ارتداء الرداء والقفازات بشكل معقم، مع مساعدة الجراح ومساعديه أيضاً؟			
8.	هل يتم تغطية جميع مناطق الجلد أثناء التغطية باستثناء موقع الشق الجراحي؟			
9.	هل تتجنبين/تتجنب لمس الأجزاء المتدلية أسفل مستوى الطاولة أثناء التعقيم؟			
10.	عند التعقيم، هل تتجنب الانحناء على مناطق غير معقمة؟ وإن كنت غير معقم، هل تتجنب المرور فوق الحقل المعقم؟			
11.	هل تحافظ على نظافة الأدوات طوال الإجراء؟ وهل تنظف الأدوات الملوثة بالدم بشاش مبلل؟			
12.	هل يتم تقليل الكلام والعطاس والسعال إلى الحد الأدنى؟			
13.	هل يتم تقليل الحركة داخل المنطقة المعقمة وحولها؟			
14.	هل تقلل من ملامسة الأدوات المعقمة إلى الحد الأدنى؟			
15.	إذا كنت ممرضاً دواراً، هل تقدم الأدوات والمواد اللازمة دون لمس المناطق المعقمة؟			
16.	هل تقومين/تقوم بإجراء العد الأولي والنهائي للأدوات واللوازم مع الممرض الدوار؟			
17.	هل تحافظ على برودة الغرفة وتهينتها لتكون مناسبة للفريق الجراحي والمريض؟			
18.	هل تقوم بفرز النفايات أثناء تقدم العملية؟			

ARABIC SUMMARY

الملخص باللغة العربية

خلفية الدراسة: يُعدّ الحفاظ على التقنية المعقّمة داخل غرف العمليات أمراً أساسياً لمنع التلوّث وتقليل خطر حدوث عدوى موضع الجراحة. ويعدّ فنيي العمليات الجراحية محوراً رئيسياً في إنشاء الحقل المعقّم والمحافظة عليه؛ إلا أن وجود فجوات معرفية وعدم انتظام الالتزام بالممارسات الإثنائية قد يعرّضان سلامة المريض للخطر.

الهدف من الدراسة: تقييم مستوى المعرفة والممارسة لدى فنيي العمليات الجراحية تجاه التقنيات المعقّمة في غرف العمليات بالمستشفيات الحكومية في مدينة صنعاء، اليمن.

المنهجية: أجريت دراسة وصفية مقطعية في غرف العمليات في أربعة مستشفيات رئيسية (الثورة والجمهوري والكويت) . وباستخدام أسلوب العيّنة الملائمة، تم استقطاب ٢٤٠ من فنيي العمليات الجراحية المستوفين للمعايير عبر مختلف المناوبات. جُمعت البيانات من خلال استبيان مُنظّم ذاتيّ الاستكمال ومُقتبس من أدوات مُتحقّق من صدقها، شمل: الخصائص الديموغرافية، محور المعرفة، ومحور الممارسة. وتم تطبيق الإحصاءات الوصفية والاستدلالية، بما في ذلك معامل ارتباط بيرسون.

النتائج: كان معظم المشاركين بعمر ≥ 35 سنة (٧٧,٥%) ومن الإناث (٥٥,٠%). وحمل غالبية المشاركين دبلوماً عاليًا (٤٢,٩%) أو درجة البكالوريوس (٣٨,٣%)؛ كما أن ٤٨,٨% لديهم خبرة أقل من ٤ سنوات في غرف العمليات، و٥٤,٦% لم يتلقوا تدريباً في التعقيم. وبشكل عام، كان لدى ٥٥,٤% معرفة غير كافية، وأفاد ٥٢,٩% بممارسة غير كافية. كانت المعرفة مرتفعة فيما يتعلق بالقواعد العامة للحقل المعقّم، لكنها منخفضة في جوانب اتخاذ القرار الحرجة أثناء العملية (مثل التعامل مع طلبات الماء المعقّم، والاستجابة لثقب القفاز، والحركة الآمنة قرب الحقول المعقّمة). وأظهرت الممارسة التزاماً متوسطاً وغير متسق، مع عجز ملحوظ في ضبط البيئة المحيطة وفوز النفائات. وارتبطت المعرفة إيجابياً بالممارسة ($r = 0.485$, $p < 0.001$). كما اختلفت المعرفة والممارسة اختلافاً ذا دلالة إحصائية بحسب العمر والجنس والحالة الاجتماعية والمستشفى والمستوى التعليمي والخبرة والتدريب، بينما لم ترتبط ساعات العمل اليومية ارتباطاً ذا دلالة إحصائية.

الاستنتاج: أظهر فنيي العمليات الجراحية مستوىً دون الأمثل من المعرفة والممارسة المتعلقة بالتقنية المعقّمة، مع فجوات واضحة في الإجراءات عالية الخطورة أثناء العملية وبعض سلوكيات مكافحة العدوى.

التوصيات: يُوصى بتنفيذ تعليم منتظم قائم على الكفاءة (بما في ذلك التدريب بالمحاكاة)، وإجراء تدقيق روتيني مع تغذية راجعة، وتطبيق بروتوكولات موحّدة لغرف العمليات، لا سيما فيما يتعلق بأحداث التلوّث أثناء الجراحة وإدارة النفائات، مع إعطاء أولوية للعاملين الذين لم يتلقوا تدريباً سابقاً..

الكلمات المفتاحية: المعرفة، الممارسة، التقنيات المعقّمة، غرفة العمليات، فنيي العمليات الجراحية

تقييم معرفة وممارسات فنيي العمليات الجراحية حول تقنية التعقيم في غرف العمليات في المستشفيات العامة بمدينة صنعاء، اليمن

مشروع بحثي مقدم كجزء من متطلبات الحصول على درجة الدبلوم في فنيي العمليات الجراحية بكلية العلوم الطبية
التطبيقية في جامعة ٢١ سبتمبر

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جامعة ٢١ سبتمبر

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