THE DEVELOPMENT OF AN ENVIRONMENTAL HYGIENE MANAGEMENT AUDIT TOOL FOR OPERATING ROOMS

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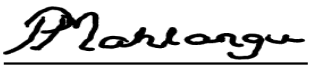
DECLARATION

I, Patience Mahlangu, declare that this Dissertation is solely my own work, I was not assisted by anyone. It is being submitted for the degree of Master of Science in Nursing at the University of the Witwatersrand, Johannesburg. This has not been submitted previously for any degree or examination at any other University.



Signed at Johannesburg

On the 04th day of October 2024

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DEDICATION

I dedicate this work to Almighty God for giving me strength to hold on even when I had lost hope. My two beautiful daughters Nonjabulo Thando Mthembu and Silindile Nelisiwe Mahlangu for their support, love and prayers. To my husband Morris Mahlangu for his patience and tolerance.

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ABSTRACT

Background: The operating theatre environment is as complex as surgical and anaesthetic practices combined. The intra-operative environment may be one of the most contaminated areas in a hospital. Effective operating room environmental management is an important measure to prevent the spread of Surgical Site Infections (SSIs). Environmental cleaning teams require clear instructions and training, and simple methods of assessing cleanliness, which cannot be done by visual assessment. Despite the abovementioned recommendations, incorrect cleaning practices continue to occur for multiple reasons.

Aim: The aim of this study is to contribute to a safe operating room environmental cleaning practices and management through the development of an environmental hygiene audit tool that could enhance the quality care of all patients in the operating room.

Methods: An exploratory three- phase sequential mixed-methods design was conducted to meet the research objectives. 1) In Phase 1, a scoping review of literature was conducted guided by a framework proposed by Johanna Briggs Institute. Five data bases were searched for primary studies published in English between 2010 and 2020. 2) In-depth interviews were conducted with four purposively selected experts in the field of Infection Prevention and Control in the operating theatre, to gather multiple viewpoints on the intraoperative environmental cleaning practices and management in phase 2. 3) In Phase 3, an audit tool of an an environmental hygiene management was developed, based on the findings of phase 1 and 2. The development was guided by the Donabedian framework.

Data analysis: Data were analysed following the thematic analysis in Phase 1 and Phase 2. Following data analysis, 5 major themes emerged in phase 1 and 4 themes in phase 2 of the study. Data from the 2 phases informed the development of the environmental hygiene management audit tool in phase 3.

Summary of findings: The findings of this study indicated that the environmental hygiene in the operating room should be managed through specific cleaning practices, specific cleaning methods and cleaning intervals. It is also indicated that there are different types of chemicals/products with different strength that should be used for surfaces, equipment and floors. The equipment such as mops and cloths should also be cared for and handled in a

certain manner. This was backed up by the participants during the in-depth interviews and they even added on the aspect of cleaner safety, risks, training and responsibility.

Conclusion: Operating theatre environment is a secondary reservoir for organisms with the potential for infecting patients undergoing surgery. This study recommends that thorough and frequent disinfection of surfaces with higher frequency of hand contact be done after each patient procedure.

Keywords: Operating theatre, cleaning, environmental cleaning, environmental decontamination, air quality, surface cleaning, and equipment cleaning.

ACRONYM

SSI	Surgical Site Infection
HAI	Health Associated Infection
C. diff	Clostridioides Difficile
VRE	Vancomycin-Resistant Enterococci
MRSA	Methicillin-Resistant Staphylococcus Aureus
MERS- CoV	Middle East Respiratory Syndrome- Coronavirus
OR	Operating Room
WHO	World Health Organization
HEPA	High efficiency particulate air
CSSD	Central Sterile Supply Department
AORN	Association of Perioperative Registered Nursing
CDC	Centers for Disease Control and Prevention
QA	Quality Assurance
ATP	Adenosine Triphosphate Bioluminescence
NSDA	Negotiated Service Delivery Agreement
IPP	Infection Prevention Practitioner
PCC	Participants, Concept and Context
PRISMA-ScR	Preferred Reporting Items for Systematic reviews and Meta-Analyses extension for Scoping Reviews
JBI	Johanna Briggs Institute for Scoping Review
ISID	International Society of Infectious Diseases
AFPP	Association of Perioperative Practice
PPE	Personnel Protective Equipment
EPA	Environmental Protection Agency

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CHAPTER 1 : OVERVIEW OF THE STUDY

1.1 Introduction and background

This chapter outlines the significance of the study, identification of the research problem, the objectives, research question and the background of the study. This is followed by a brief overview of the research methodology used in the study.

The operating theatre environment is as complex as surgical and anaesthetic practices combined. An operating room environment refers to the dynamic combination of air, surface, and specialized equipment management. According to Link *et al*. (2016) the intra-operative environment may be one of the most contaminated areas in a hospital. Effective operating room environmental management is an important measure to prevent the spread of Surgical Site Infections (SSIs). SSIs have now become a substantial factor that increases the expenditure in the health-care settings and leads to poor surgical outcomes, which can lead to increased patient morbidity and mortality (Dallolio, Raggi, Sanna *et al.,* 2017). SSIs represent the third most common source of nosocomial infections in France with an estimated prevalence of 0.83% (0.71 – 0.95) just after urinary tract and lower respiratory infections (Piednoir *et al.,* 2021). The Italian Ministry of Health estimates that, yearly, infections occurring in hospitalized patients range from 450,000 to 700,000 (a healthcare-associated infection (HAIs) occurs in around 4–7% of hospitalizations). In Europe, each year, HAIs cause 16 million additional delays of hospitalization, 37,000 attributable deaths and 110,000 deaths for which infection is a contributing factor. The direct costs are estimated at approximately 7 billion euros (Treglia *et al.,* (2022)

The survival of the nosocomial pathogen on a surface heightens the risk of transmission and therefore putting the patient's life in danger. Most gram-positive microscopic organisms, for example, *Enterococcus* including *Vancomycin-Resistant Enterococci (VRE), Staphylococcus aureus* including *Methicillin-Resistant Staphylococcus Aureus (MRSA)*, or *Streptococcus* pyogenes have the ability to survive on dry surfaces (Dancer, 2014). According to a study conducted by Doll, Stevens and Bearman (2018) it is suggested that numerous gram-negative species, for example, *Acinetobacter baumanii, Escherichia coli, Klebsiella pneumonia, Pseudomonas aeruginosa, and Shigella* can survive on lifeless surfaces for a considerable length of time (Singh-Moodley, Ismail and Perovic, 2018).

Mycobacteria – including *Mycobacterium tuberculosis* and spore-shaping microscopic organisms, including *Clostridioides difficile (C. diff)* survives for a long time on surfaces (Kramer, Schwebke, and Kampf, 2006).

Studies show that majority of nosocomial pathogens can survive for months on dry surfaces; however, it has also been recognized that other factors such as temperature and humidity can influence the survival of nosocomial pathogens. Low temperatures, such as 4°C or 6°C, are linked to longer survival for most bacteria, fungi, and viruses. High humidity environments higher than 70%, are also linked to longer survival for most bacteria, fungi, and viruses (Kramer *et al.*, 2006).

With the outbreak of the COVID-19 disease, the lack of clearly defined intra-operative environmental guidelines in public hospitals in Gauteng caused a lot of panic and distress, as environmental management guidelines were not available. MERS-CoV, commonly known as the beta coronavirus that causes Middle East Respiratory Syndrome, identified as one of the few human coronaviruses, can remain infectious on lifeless objects at room temperature for up to 9 days, however, the duration is shorter at a temperature of 30°C or more (Kampf *et al*., 2020).

Surgical procedures are carried out using robotics, for example da Vinci robotics. The da Vinci robotic system is composed of three components namely: the surgeon console, the patient trolley, which holds the articulated arms and the imaging system which challenges the environmental cleaning due to its complexity and delicacy of the cords and screens (Pugin et al., 2011).

A study conducted by Dancer in 2009 concluded that cleaning has never previously been regarded as an evidence-based science and, consequently, received little attention from the scientific community. Attempts to manage the transfer of COVID-19 changed perceptions of environmental cleaning practices to a major evidence-based procedure. To reduce the accumulation of dirt and micro-organisms, the hospital environment must always be kept clean and dry. Environmental cleaning teams require clear instructions and training, and simple methods of assessing cleanliness, which cannot be done by visual assessment (Guidelines for the Prevention and Containment of Antimicrobial Resistance in South African Hospitals, 2020).

National Health Act of South Africa indicates that all health establishments must maintain a healthy environment that can help minimize the risk of infection to patients, health care professionals, and visitors. It also emphasizes that there should be systems in place to minimize the transmission of healthcare-associated infections, irrespective of their methods of transmission (National Health Act, No 61 of 2003). The importance of environmental disinfection is highly recognized, and it proves to be effective in the control or reduction in the transmission of the nosocomial pathogens (National Department of Health, 2011).

It has been established that a combination of cleaning and disinfection protocols, staff education, environmental checklists, and audit tools are required to manage environmental challenges in the operating room (Link *et al.,* 2016). The researcher in this study aims to develop an audit tool to assess environmental management practices of the operating room, using the data that was collected from the scoping review.

1.2 Problem statement

The operating room environment is one of the most high-risk environments in any hospital. This is due to its continuous environmental contamination with, and exposure to, body fluids and microorganisms of numerous patients and healthcare personnel daily. Any patient in the operating room environment is at his or her most vulnerable and compromised state due to the invasiveness of surgery and anaesthetic practices. This dual-risk factor is ideal for opportunistic microorganisms to infect patients and to cause hospital-acquired infections. The staff in the operating room is also at risk. There is currently no comprehensive evidence-based intra-operative cleaning audit instrument published for public hospitals in South Africa. This has led to the adoption of different auditing practices in public hospitals which brought about a compromise in the quality of patient care.The development of an environmental hygiene management audit tool could contribute to the quality of all the patients in the operating rooms.

1.3 Aim of the study

The study aims to contribute to a safe operating room environmental cleaning practices and management through the development of an environmental hygiene management audit tool that could contribute to the quality care of all patients in the operating room.

1.4 Research question

The research question for each phase is**:**

1. What evidence - based literature is currently available that describes environmental hygiene cleaning practices in the operating room ?
2. What elements should be included in an Environmental Hygiene Management Audit Tool, according to the outcome of the scoping review through the in-depth interview?
3. How can an environmental hygiene management audit tool for operating rooms be developed?

1.5 Objectives

The study objectives are:

1. To determine the current evidence-based literature published on environmental hygiene cleaning practices, by conducting a scoping review (Phase 1).
2. To explore the views of experts regarding the elements to be included in an environmental hygiene management audit tool, through In-depth interviews (Phase 2) and
3. To develop an environmental hygiene management audit tool for operating rooms (Phase 3), based on the outcome of the previous two phases of this study.

1.6 Significance of the study

The results of the study will influence the development of a standardized environmental hygiene management audit tool on cleaning practices that may be utilized universally among all the public sectors in Gauteng to effectively manage environmental risk factors in the operative environment, to enhance quality intra-operative patient care. This study is adding to body of knowledge on infection control and perioperative fields. Other researchers in the infection control and perioperative fields can draw from the study findings and research further.

1.7 Theoretical Framework

The framework that the researcher used to develop the environmental hygiene management audit tool was Donabedian's framework (1988), which is the three-part

approach of structure, process, and outcome. The venues in which care is provided are indicated by the structure. This covers the characteristics of organizational structure (medical staff organization, peer review procedures, and reimbursement procedures), human resources (number and qualifications of professionals), and material resources (facilities, equipment, and money). Process refers to the actual actions taken when providing and receiving care. It encompasses the patient's actions in seeking and receiving care and the practitioner's actions in diagnosing a condition and suggesting or carrying out a course of action. The term "outcome" refers to how treatment affects patients' and populations' health. A broad definition of health includes beneficial changes in the patient's behavior as well as improvements in their understanding.

According to Donabedian's framework (1988), it is stated that the three-part approach to quality assessment is possible only because good structure increases the likelihood of good process, and good process increases the likelihood of a good outcome.

1.8 Definition of Terms

The following are terms used throughout the study:

1.8.1. The **operating room** is a place where surgical procedures are conducted. It has three levels of restrictions known as unrestricted, semi-restricted, and restricted. The restricted and semi-restricted area is usually separated by the 'red-line' (a red border/ stripe applied on the operating room floor) when entering the operating room and is universally acknowledged and understood by all operating room staff. The semi-restricted area includes the recovery room area, storerooms, and corridors. The restricted area includes the operating rooms, procedure rooms, and Central Sterile Services Department (Phillips, 2017).

1.8.2. **Intra-operative area** it is where the procedure will be performed. It is regarded as the cleanest area in the operating room due to airflow and air quality indicators, humidity management, and temperature regulation (Phillips, 2017).

1.8.3. Environmental hygiene cleaning activities directed at removing and/or killing potentially harmful pathogens capable of being transmitted directly from surfaces or indirectly to susceptible individuals or other surfaces (Carling, 2016).

1.8.4. Audit Tool refers to a generic term for any instrument that has been developed to assess the performance of a task or group of tasks. The performance of an area is scored against the maximum possible level that can be obtained. Problematic practices will then be identified (Segen's Medical Dictionary, 2011).

1.9 Overview of the Research Methodology

This section presents an overview of the research methodology. Detailed information will be discussed in chapter three. The study employed an exploratory three- phase sequential mixed-methods design as a means of integrating data to gain a comprehensive understanding of the research problem. A scoping review was conducted in phase one of this study. The objectives of the study were to determine the current evidence-based literature published on intra-operative environmental management. Scoping review was conducted based on The Johanna Briggs Institute (JBI) framework. In – depth interviews were conducted in phase 2 to gather multiple viewpoints on the intraoperative environmental cleaning practices and management. Data was analysed using thematic analysis in phase 1 and 2 (Braun and Clarke, 2021). In phase 3, an environmental hygiene management audit tool was developed based on the findings from phase 1 and phase 2.

Before commencement of the study, ethical clearance was obtained from the Human Research Ethics Committee of University of Witwatersrand. After permission had been obtained from the department of nursing education to use the small tutorial room in the department of nursing education (Area 261) to conduct interviews (See Appendix H). Consent was obtained from the participants who agreed to participate in the study. Participation in the study was voluntary and participants were free to withdraw at any time. Throughout the study participant's autonomy and confidentiality was maintained. Theresearcher attempted to ensure credibility, dependability, confirmability, and transferability.

1.10 Outline of the Study

The study will be presented in six (6) chapters as depicted in the table below.

Table 1: Chapter outline

CHAPTERS	DESCRIPTION
Chapter 1	Overview of the study
Chapter 2	Literature review
Chapter 3	Research Methodology
Chapter 4	Presentation and discussion of the findings
Chapter 5	Development of an audit tool
Chapter 6	Limitations, Recommendations and Conclusion

1.11 Conclusion

Chapter 1 provided an overview of the study, identification of the research problem, the objectives, research question, the background and the brief overview of the research methodology of the study. Chapter 2 provides a literature review of concepts relevant to peri- operative environment cleaning and decontamination practices.

CHAPTER 2 : LITERATURE REVIEW

2.1 Introduction

This chapter focused on reviewing evidence-based literature on ways to improve environmental hygiene in the operating theatre. The study aimed to contribute to a safe operating room environment and come up with evidence-based environmental management practices through the development of an environmental audit tool that could contribute to the quality of care of all patients in the operating room. The chapter's focus was on exploring the OR as a high risk environment compared to the rest of the hospital, the legislative framework relevant to the environment, the impact of a compromised environment on patients, the role that environmental contamination poses to the rate or amount of Healthcare Associated Infections (HAI), Factors leading to non-compliance to environmental disinfection and how compliance should be monitored, and Quality through auditing.

2.2 Operating Room as a high-risk environment compared to the rest of the hospital

2.2.1 Peri-operative environment

The operating room (OR) is a specially equipped room where many types of surgical procedures are performed. It is considered the restricted part of the operating theatre (Phillips, 2017). OR is designed in such a way that, to prevent surgical site infections (SSI), there is little to no cross-traffic of personnel and supplies from the decontaminated or soiled sections to the sterile or clean areas (Fuller and Claussen, 2018). The operation room should have the cleanest possible environment, complete with a central location for handling sterile supplies and a waiting area for patients. In order to prevent contamination of the sterile space and supplies, healthcare staff should move about and remove spent materials (Fuller and Claussen, 2018). In order to provide a safe environment for the patients, the operating room (OR) needs to maintain a sterile atmosphere; nevertheless, inanimate objects and equipment with surfaces that are prone to accumulation to reduce potential risks of HAIs (Centers for Disease Control and Prevention, 2021).

In recent years OR specialists have experienced an overwhelming amount of modern equipment and technology, resulting in a crowded space surrounding the patient and the operating room bed (Wahr and Abernathy, 2013). ISO 14644 class 8 states that further regulatory standards and regulations based on industry and application must be taken into consideration when constructing a cleanroom. For an ISO 8 cleanroom, there are a few standard specifications and environmental factors to consider. HEPA filtration, air changes per hour (ACH), air pressure, temperature and humidity, the number of people occupying the room, static control, lighting, and noise are among these needs...Although operating rooms (ORs) are meant to be safe spaces for patients, they often contain inanimate objects and equipment whose surfaces might collect bodily fluids such as blood during surgery and anaesthetic care.

2.2.2 Operating theatre zones

Unlike in the wards where traffic movement is not restricted as per specific area, the OR is divided into zones or areas namely: Unrestricted zone or clean area where street clothes are permitted, semi-restricted zone or sub sterile area where traffic is limited to properly attired, authorized personnel, and the restricted zone or sterile area where a mask is required over and above the OR attire where there are open sterile supplies and scrubbed personnel (Fredrick and Kumaran, 2018). Personnel entering the OR must be dressed in proper theatre attire. Dressing rooms should be located in the unrestricted area adjacent to the semi-restricted area of the OR. Only clean and freshly laundered attire is donned each time on arrival in the OR It is well known that germs that may lead to cross-contamination are primarily found on the skin and are a potential source of the disease. By correctly donning and wearing the right theatre attire and head cover to prevent the shedding of hair, squamous cells, and/or dandruff onto the scrub suit, the surgical team members are responsible for preventing surgical site infections (SSIs). Bacteria are present in about 10% of lost skin cells (Spruce and Wood, 2019). Theatre clothes serve as a barrier to keep the outside environment free of theatre contaminants and to shield patients from microorganisms that are released into the air by the skin and hair of theatre employees (Branch and Amiri, 2020). As a result, cleaning the environmental surfaces is essential (AfPP, 2011).

2.2.3 Decontamination and Reprocessing area

The other factor that needs to be considered is the instrument reprocessing area, commonly known as the Central Sterile Supply Department (CSSD). Instruments should be reprocessed in the designated area to control quality and ensure safety, as instrument reprocessing can contaminate the area in which it is performed. This environmental contamination may lead to patient and/or personnel infections (Bringhurst, 2019). The reprocessing area should be segregated accordingly, there should be a receiving area, cleaning and decontamination area, compiling and inspection area, sterilization, and storage area. Storage of reprocessed instruments must be in a manner that prevents recontamination, for example, there should be no sunshine or open windows, and the area to have drying racks, not metal surface shelves. The decontamination area is to have a double sink and an instrument washer, and the use of hospital-approved disinfectant and enzymatic cleaner is to be advocated for. Centers for Disease Control and Prevention, facility policies, infection prevention and control guidelines, and professional organizations' guidelines should always be consulted for cleaning instructions with any instrument and instrument washers and consult the manufacturer's instructions (Bringhurst, 2019).

It is important to note that where possible, medical devices should be disposable and single use. If this is not possible, appropriate decontamination protocols should be in place for all re-usable items. The central sterile supply department (CSSD) plays a key role in providing the items required to deliver quality patient care and to support infection control within the institution. Patients who are being operated on in the operating rooms depend on the availability of supplies, instruments, and equipment supplied by the CSSD. These devices need to be available at the point of care, thoroughly cleaned, disinfected, and/or sterilized, and quality checked to guarantee optimal functioning. These devices could become contaminated and jeopardize the standard of patient treatment if they are not handled, processed, and stored properly (Kartikasari and Wardhani, 2020). Because all medical equipment should be decontaminated by specially trained personnel (Department of Health, England, 2013; BSG Report, 2014; ASG and SHEA 2011), training CSSD professionals is

essential. Although fiber optic endoscopes are a well-known example of an instrument that may be used for both invasive and non-invasive treatments, sterilizing them is difficult because they can only be chemically disinfected and cannot survive the heat of an autoclave. This approach has produced endoscope-associated infections (Department of Health, England, 2013; BSG Report, 2014; ASG & SHEA 2011). Kovaleva *et al*. (2013), reported on transmission of infections via endoscopy and found that, of the 98 outbreaks assessed, 1,113 patients were contaminated, and 249 patients were infected.

2.2.4 Patient's predisposing factors

Patients that are coming to the operating room have some patient factors commonly known as endogenous infection that may place them at an increased risk of SSIs, in certain kinds of operations. Other factors are known as exogenous infection, which are process/procedural related, for example, age and gender. Other factors such as nutritional status, tobacco use, correct use of antibiotics, and the intraoperative technique, however, can be improved to increase the positive surgical outcome (WHO Guidelines, 2018). However, some guidelines have recommendations on how SSIs can be prevented from occurring. Link *et al*. (2019) made the following recommendations that can be used to prevent SSIs and protect the environment from contamination:

- The importance of taking a bath with water and soap before coming to the OR, is that soap can either be microbial or non-microbial.
- For elderly patients booked for all elective colorectal surgery, a combination of mechanical bowel preparation and oral antibiotic preparation is recommended.
- Surgical team to perform an aseptic surgical hand scrub before donning a sterile gown and gloves, with an approved antimicrobial.
- Alcohol-based skin antiseptic preparations should be used unless contraindicated.

Unlike in the wards or other areas in the hospital where terminal cleaning of the room is done after each patient is discharged, it has been found that the high rate of intraoperative transmission events was linked to a high turnover of patients which predisposes the patients to bacterial reservoirs that persisted from one procedure to the next procedure and patient in the same room, which can be attributed to the inadequate cleaning of environmental surfaces in the OR, including the anaesthesia work station (Branch and Amiri, 2020).

2.2.5 High technical environment

There are two possible routes in which airborne micro-organisms can enter surgical wounds: The number of persons in the operating room is the primary cause of these falls, which can occur directly into the wound or on exposed surfaces like surgical swabs, tools, and surgeons' hands before being transported into the wound (Pasquarella, 2020). The OR requires specialized ventilation which will ensure a controlled supply of filtered air under positive pressure delivering around 25 air changes per hour, however, in Orthopaedic theatres, there's an added advantage of ultraclean laminar flow ventilation, which rapidly recirculates the air through high-efficiency particulate air (HEPA) filters, (Phillips, Phiillips, 2017). In a study conducted by (Khalefa *et al.,* 2020) they concluded that environmental infection may be limited through the usage of negative pressure ventilation within the operating room when there's a presence of SARS-Cov-2 virus which is generated through droplet or aerosol elements. The standard of the operating room has a big impact on the frequency of surgical wound infections. During surgical procedures, the operating room's air is contaminated with dust, lint, skin scales, and respiratory aerosols carrying live germs. These particles are released into the air by the surgical team and their surroundings. Surgical site infection (SSI) can be caused by bacteria that land on surgical instruments or enter the surgical site directly. Controlling the risk of surgical infections requires maintaining a high standard of air quality in the operating room (Spagnolo *et al.,* 2013).

It is recommended that sliding doors should be used exclusively in the OR main corridor, to eliminate the air currents caused by swinging doors. Opening and closing of the doors should be limited at the time of the skin incision because microbial count is usually at its peak, following the disturbance of air from gowning and draping of the patient. Closed doors decrease the mixing of air within the OR with that in the corridors, which may contain higher microbial counts (Phillips, Phiillips, 2017). Ensure that the movement of personnel is minimized by ensuring that all required equipment is in the OR at the beginning of the procedure (Wahr and Abernathy, 2013). SARS-Cov-2 virus has an impact on the environment and puts the air at risk of contamination, therefore infection should be minimized by ensuring that the doors are locked during surgery with one possible route for entry and exit. It is also advisable that theatre vents should be covered if possible and

nothing should be placed close to the vents outside the theatres as the air coming out of the vents is contaminated (Khalefa *et al.,* 2020).

The transportation of patients from the wards to the OR may cause the intra-hospital transmission of bacterial pathogens. There is a likelihood that the air in the ward/s or patient's beddings may have been contaminated already during the patient's movement within the hospital, which may contaminate the OR environment (Matthew et al., 2020). According to Matthew et al. (2020) not only does the wound get infected by the droplet and nuclei contaminated with Staphylococcus but also the ground, shelves, and lamps of the OR.

2.3 The impact of a compromised environment on patients

Microbes are found on us, within us, and are living with us. They are inhabitants of every environment on earth and many of the microbes are harmless to us, others on the other hand are extremely harmless to their hosts (Balloux and Van Dorp, 2017). Environments are targeted by facultative which are environmental bacteria and fungi that can occasionally cause infection. They are found among the most problematic hospital-acquired bacteria, and they are responsible for causing antimicrobial resistance. Once pathogens gain entry to the host, they cause illness. They can cause damage to tissues or cells during replication, mostly through the production of toxins, which allows the pathogen to reach new tissues or exit the cells inside which it replicated (Balloux and Van Dorp, 2017).

One of the hospital's most contaminated regions might be the intra-operative environment, according to (Link et al., 2016). It is therefore very possible that the environment will be degraded, which will have a detrimental effect on the patients. HAI infections are common in patients. As to the World Health Organization (WHO), healthcare-associated infections (HAIs) are infections that are not present at the time of admission but are acquired in a hospital or other healthcare facility. HAIs cause patients and their families a great deal of additional suffering and expense. Long-term hospital admissions, permanent impairment, an increase in antibiotic resistance, a significant financial load on health systems, exorbitant costs for patients and their families, and avoidable deaths are all consequences of infections, World Health Organization (WHO).

Because each year millions of patients are impacted. Both high- and low-resource healthcare environments can see or find these illnesses; however, the rates in low-resource

environments are roughly twice as high (15 out of every 100 patients versus 7 out of every 100 patients). According to Best Practices for Environmental Cleaning in Healthcare Facilities in Resource-Limited Settings, a patient may become infected from contaminated environmental surfaces and noncritical equipment, for example, if a vulnerable patient comes into direct contact with the contaminated surfaces (e.g., touches them) or if a healthcare professional, caregiver, or visitor comes into contact with the contaminated surfaces and then transfers the microorganisms to the vulnerable patient. Healthcare workers, caregivers, and guests who have contaminated hands or gloves may also contaminate environmental surfaces in this way. It is possible to stop the spread of germs to patients who are vulnerable, caregivers, visitors, and healthcare workers by practicing good hand hygiene and environmental cleaning. Effective environmental cleaning techniques lower the likelihood of transmission, according to growing, albeit incomplete, evidence (Best Practices for Environmental Cleaning in Healthcare Facilities in Resource-Limited Settings). Patients are not only susceptible to HAIs but also Surgical Site Infections (SSIs), especially patients who are exposed to a compromised environment in the operating room. SSIs have now become a substantial factor that increases the expenditure in healthcare settings and leads to poor surgical outcomes, which can lead to increased patient morbidity and mortality (Dallolio, Raggi, Sanna *et al.,* 2017). The cost of Surgical Site Infections that are mostly HAI is escalating every year (Centres for Disease Control and Prevention, 2019).

The perioperative staff may transfer pathogens from surfaces that harbour the blood, secretions, or other body fluids of the previous patients and that plays a huge role in contaminating noncritical equipment such as blood pressure cuffs, pulse oximeters, OR bed anaesthesia machines, drip stands and mayo tables, which will or may at any point gain entry into the patient's wound, causing SSI’s (Branch and Amiri, 2020). According to Branch and Amiri (2020), hospital surfaces act as a microbial reservoir and increase the risk of transmitting pathogens and the development of HAIs, if adequate environmental hygiene is not present.

In some studies, it has been noted that many pathogens can survive for a certain period in inanimate and dry surfaces and be the contributory factors for the outbreak of HAIs. Many gram-positive bacteria, including Enterococcus spp. (including VRE), Staphylococcus aureus (including MRSA), and Streptococcus pyogenes, may persist for months on dry

surfaces, according to a study done by Kampf et al. (2020). The study also highlights that many gram-negative species, such as Acinetobacter spp., Escherichia coli, Klebsiella spp., Pseudomonas aeruginosa, Serratia marcescens, or Shigella spp. can survive on inanimate surfaces even for months (Kampf *et al.*, 2020). Those that persist only for a few days are among others: Bordetella pertussis, Haemophilus influenzae, Proteus vulgaris, or Vibrio cholera, whereas Mycobacteria, including Mycobacterium tuberculosis and spore-forming bacteria, including Clostridium difficile, can also survive for many months on surfaces (Kampf *et al.,* 2020). These pathogens can be harmful to patients because of their ability to compromise the environment.

2.4 The role that environmental contamination poses to the rate of HAIs

The Healthcare-Associated Infections continue to be a major source of patient morbidity and mortality. The patient's endogenous flora is thought to be the primary source of nosocomial pathogens, according to Weber et al. (2010). Nevertheless, 20% to 40% of nosocomial infections have been linked to healthcare personnel' hands coming into contact with the environment. A study by Yezli et al. (2014) found sufficient evidence that contaminated surfaces play a role in the spread of hospital diseases, based on modeling of transmission and epidemic data. It has also been stated that there’s strong evidence that contaminated surfaces contribute to the risks of transmission and that can be mitigated by improved environmental and surface decontamination. According to Strassle et al. (2012) the longer the contamination stays on surfaces the more pathogens are easily transmitted and a reduction in contamination was only seen after terminal cleaning was done. According to (Yezli et al., 2014) it is clear that the inanimate environment of the operating room, including medical equipment is highly likely to be contaminated with pathogens that can cause SSIs despite adherence to standard environmental practices. It has been found that Escherichia coli, Pseudomonas aeruginosa, and Staphylococcus aureus were the most frequently reported microorganisms contaminating the operating theatres in Iraq (Maysoon and Jamal, 2019). Many studies have shown that approximately 30% to 60% of surfaces where patients are colonized or infected with C. diff, VRE, or MRSA are likely to be contaminated with these organisms (Carling, 2013). In a study conducted by Dancer *et al. (*2012) in two different disciplines, it was noted that patients develop postoperative infections which are commonly known as SSIs. Patients in an orthopaedic theatre who have come for a clean joint

replacement or patients who have come for invasive eye surgery have ended up with SSIs, radiating from the autoclave's general area, which was evidently dusty upon inspection, the workers' clothing, lack of gloves or protective gear, and the absence of a hand basin, all suggested that the workers were handling the surroundings and the instruments with contaminated hands. Six of the 15 orthopedic patients who needed rapid debridement or washout surgery also received intravenous antibiotics. One patient had a girdlestone operation since they were unsuited for another prosthetic insertion, while another patient passed away from an underlying cancer (Dancer et al., 2012). Five individuals in the field of ophthalmology developed endophthalmitis; they all needed an emergency vitrectomy along with many antibiotics. A notable visual impairment was experienced by one patient (Dancer et al., 2012). Wahr and Abernathy (2013) report that mediastinitis following sternotomy occurs globally after sternotomy in cardiac surgery and it ranges between 0.5% and 3.2%. These types of infections double or triple the cost of the surgery, increase hospital stay several folds, and increase acute and long-term mortality rates.

Centers for Disease Control and Prevention identifies that nearly 1.7 million hospitalized patients annually acquire HAIs while being treated for other health issues and that more than 98,000 of these patients (one in 17) die due to HAIs. In a study conducted by Haque et al. (2018), the researcher alluded that HAIs in the USA are seen to be among the top 10 leading causes of death and are the most common complications of hospital care, this is according to the report by the Agency for Health care Research and Quality. In 183 hospitals in the US, a survey was conducted, there was a total number of 11,282 patients and at least 4% of those patients reported having HAI. The typical microbes are Clostridium difficile, Pneumonia, gastrointestinal infections, and surgical site infections (SSIs) accounted for most infections. In one Saudi Arabian hospital, a study on orthopedic patients found that the incidence of surgical site infections (SSIs) was 2.55% (79 out of 3,096 patients). The most common pathogens found in these patients were Staphylococcus species, including MRSA (29.11%), Acinetobacter species (21.5%), Pseudomonas species (18.9%), and Enterococcus species (17.7%). (Haque *et al.,* 2018).

2.5 Legislative framework relevant to the environment

Patients receiving care in the Operating Room are protected by the Constitution of the Republic of South Africa [No. 108 of 1996]. Chapter 2 (Section 24a) which talks to the Bill of

Rights, states that everyone has a right to an environment that is not harmful to their health or well-being. That environment needs to be ensured through cleaning of

the environment and the surfaces. According to the Association of Perioperative Registered Nursing (AORN) guidelines for cleaning practices (Allen, 2014) it is stipulated that there should be a team and collaborative approach to cleaning the OR. The institution is to provide the cleaning schedule and procedures in writing that fully describe the different types of cleaning in the OR namely: routine cleaning, enhanced environmental cleaning, and terminal cleaning. Constitution of the Republic of South Africa [No. 108 of 1996] Chapter 2 (Section 12, sub-section 2c) states that patients are not to be subjected to medical or scientific experiments without informed consent.

National Core Standards for Health Establishments in South Africa, 2011 has an objective to provide the best quality care to patients and users of health services, to meet their expectations and needs, and to improve service delivery. Special consideration must be given to patients under general anaesthesia, as the patients are unable to take care of their own safety needs or voice any concerns. The patient's ability to move has been taken away as well and healthcare workers should be aware that if a patient is unable to move then they are susceptible to infections due to insufficient or inadequate blood circulation, therefore healthcare workers should provide the best quality care to patients as alluded in the National Core Standards for Health Establishments in South Africa, 2011. The standards have been designed in such a way that they are dependent on each other. Seven domains have been set out and our focus is in domains 1 and 2. Domain 1 talks about Patient Rights and sets out what a hospital or clinic must do to make sure that patients are respected and their rights upheld, including getting access to needed care and respectful, informed, and dignified attention in an acceptable and hygienic environment, seen from the point of view of the patient, following Batho Pele principles and the Patient Rights Charter. Domain 2 talks about Patient Safety, Clinical Governance, and Clinical Care to outline how quality nursing clinical care and ethical practice should be ensured; reduce unintended harm to healthcare users or patients in identified cases of greater clinical risk; prevent or manage problems or adverse events, including healthcare-associated infections; and support any affected patients or staff. The perioperative nursing personnel should ensure that the aseptic technique, which is surgical hand scrub, patient skin preparation, setting up of the trollies,

and patient draping is adhered to, this is done as measures to prevent SSIs and promote patient safety as stipulated by the National Core Standards for Health Establishments in South Africa, 2011. In addition to this, the Ideal Hospital Realisation and Maintenance Framework manual, 2018) one of its five-year strategic goals is to prevent disease reduce its burden and promote health. A Numerous set of audit tools and checklists were developed to ensure the implementation of a critical strategy and intervention to facilitate improved health service delivery and strengthen health system effectiveness by capacitating hospitals to identify and address key issues. Section 7 of the document under domain 6 of the National Core Standards and sub-component 18, addresses the cleaning schedules.

The National Health Act no 61 of 2003, Chapter 5 under Health Promotion and Disease Prevention, states that the health establishment must implement systems to promote health and prevent disease. The National Health Act no 61 of 2003 further states that all health establishments must have appropriate systems and procedures for protecting users, health personnel, and the public from environmental hazards following applicable environmental legislation. Standard operating procedures, guidelines, and policies addressing infection prevention and control should be in place and be visible to all staff members.

National Infection Prevention and Control Strategic Framework, 2020 aims to provide uniform correct cleaning methods for the cleaning personnel, whether they are in-house or out-sourced contractors, so that environmental cleaning can be effective, carried out by trained cleaners according to a scheduled routine, ensuring the monitoring of appropriate use of cleaning agents and equipment.

The Minister of Health in South Africa signed a Negotiated Service Delivery Agreement (NSDA) in September 2010 giving supporting and encouraging quality assurance that spells out the plans and interventions required to improve the health outcomes. It has been highlighted that there is a great need to strengthen the effectiveness of the health system, through the establishment of an independent regulator of compliance that will prescribe norms and standards. The National Department of Health together with the Office of Standards Compliance has developed the National Core Standards for Health Establishments, which gives a guide on how to quality assure patient care in health establishments (National Department of Health Office of Standards Compliance: Department of Health, 2012).

2.6 Factors leading to non-compliance to environmental disinfection

The operating room setting is a highly specialized area. The multi-disciplinary team that comprises surgeons, anaesthetists, perioperative nurses, and other staff members in the operating room, have independent responsibilities to fulfil, yet work together to achieve high standards of comprehensive surgical patient care. Although the task of cleaning is usually outsourced in the OR, there could be factors leading to non – compliance which are stipulated in the following sub-headings:

2.6.1 Staff competencies

The use of multiple staff to clean the OR environment which may lead to high-touch areas, such as electrical surgical units, door handles, computer keyboards, anaesthesia machine and phones to be missed when decontaminating the environment (Link *et al.*, 2016). In a study conducted by Ogunsula and Mehtar (2020) mentioned that in many countries cleaning is considered a lower job category thus it is assigned to people with poorer educational levels who are usually untrained in cleaning protocols and practices, resulting in poor outcomes and an increased risk of contamination.

2.6.2 Lack of leadership

Ogunsola and Mehtar (2020) indicated that the leading factor to non-compliance is often that there is no clear job description for healthcare workers and thus lack of accountability. Although according to the Scope of Practice of a professional nurse (R2127) the professional nurse takes responsibility and accountability in advocating for the profession and facilitating the establishment and maintenance of an environment in which health care can be provided safely and optimally. Cleaners are often supervised by a nurse or cleaning supervisor who are usually not trained nor specialised in the cleaning field (Ogunsola and Mehtar, 2020).

2.6.3 Lack of resources

In a study conducted by Birlie *et al.* (2021) nurses sited that supplies needed for cleaning non-critical medical equipment that are compliant with other infection prevention methods for example PPE, are not available.

2.6.4 Lack of clear policies and procedures

Efficient processes, procedures, and protocols can only be implemented with a strong organizational structure, adequate supplies, qualified staff, and accountability (Ogunsola and Mehtar, 2020). However, the cleaning processes are not always organised, and written protocols and checklists are not available (Ogunsola and Mehtar, 2020). The Centers for Disease Control and Prevention's (CDC's) advice hospitals to implement a program that will enhance the current policies and procedures related to environmental disinfection cleaning. There should be a development of cleaning procedures and schedules that are available in writing, including a full description of routine cleaning, enhanced environmental cleaning and terminal cleaning. In a study conducted by Zoutman *et al.* (2014), it was indicated that a substantial minority of environmental services departments did not have written policies for ongoing review of cleaning and disinfection procedures.

2.6.5 Poor auditing standards

According to Allen (2014) regular audits and communication with the Infection Prevention and Control department, in a way of feedback should be conducted. However, according to Zoutman *et al.* (2014) it was said that in Canadian hospitals, there was a general lack of cleaning practice reviews and audits. They further mentioned that the review of cleaning tasks was not done on a regular basis by one third of hospitals.

2.6.6 Lack of training

Gaps in cleaning which may be caused by improper cleaning which emanates from the hospitals often trying to cut environmental hygiene maintenance costs as much as possible in training and continued education of their workforce (Peters *et al*., 2018). There are few opportunities for learning as mentioned by Ogunsola and Mehtar (2020), therefore healthcare workers continue to lack access to basic, practical education, information and effective training in Infection Prevention and Control best practices especially for

environmental hygiene, cleanliness and decontamination. Dancer and Kramer (2019) agree with the others that as much as it is important to maintain a safe environment for everyone, special education, repeated training, and supervision for hospital cleaners is infrequent or non-existent. Institutions should take into consideration adequate training and regular retraining of all staff responsible for cleaning (Dancer, 2014). According to Allen *et al. (*2018) a multi- modal bundle strategy should be used in the management of environmental hygiene. The bundles include a targeted training for environmental hygiene, which reflects the cleaning roles and responsibilities.

2.7 The value of an audit tool and how it contributes to quality patient care

Clinical audit tools are used to determine the alignment of clinical practice to the standards of practice. The utilization of an environmental hygiene audit tool is a way of assessing if the environment is receiving a recognized standard (Godeny, 2012). The use of clinical audits will ensure the measurement of clinical practice against clinical guidelines, protocols and other professional standards, and may have the ability to effect or influence changes to ensure that all patients receive care according to principles of the best practice. This helps health care providers know if the service rendered is doing well and also identify gaps in the service rendered with the aim to achieve quality improvement and improve the outcome for patients (Godeny, 2012). Clinical audits forms basis of quality assurance (QA), which is defined as all activities that contribute to defining, designing, assessing, monitoring, and improving the quality of healthcare. These activities can be performed as part of the accreditation of facilities, supervision of health workers, or other efforts to improve the performance of health workers and the quality of health services. World Health Organization (2006) has alluded that even where health systems are well developed and resourced, it is still evident that quality remains a serious concern, with expected outcomes not being achieved and with wide variations in standards of health-care delivery within and between health-care systems (World Health Organization, 2006). Quality of care: a process for making strategic choices in health systems. Through audit tools, quality assurance and performance of the health-care system can be improved. Clinical audits are the most appropriate tools to use when the intention is to assess the degree to which the clinical services rendered comply with the expected standards. It is however noted that other

processes may have the utility to other aspects of healthcare which don't address the problem at hand (Burgess and Moorhead, 2011).

The effectiveness of cleaning and disinfection practices in healthcare is measured through the undertaking of audits. Auditing forms an integral part of the decontamination process (Otter and Galletly, 2018). Auditing is used to assess, evaluate and improve patient care in a systemic way. Environmental auditing is conducted in different methods: i.e. a) visual assessments e.g. observation, b) microbiological cultures, and c) Process evaluation tools for example: Fluorescent markers and adenosine triphosphate (ATP) bioluminescence. These tools are referred to as quality improvement tools. Types of audit tools include checklists, bundles or pack of toolkits. In study conducted by Assadin (2021), it is stated that universally there are currently no European or global guidelines or practical recommendations for routine surface cleaning and disinfection in hospitals that have been agreed upon. The researcher concurs with Assadin (2021) because currently no comprehensive evidence-based intra-operative cleaning audit instrument published for public hospitals in South Africa. Therefore, it is imperative that standard principles for cleaning and disinfection are defined, and compliance should be ensured by measures such as standard operating procedures, adequate training, and suitable audit and monitoring systems (Assadin, 2021).

2.8 Conclusion

In this chapter literature relevant to the research topic was reviewed where OR as a high-risk environment compared to the rest of the hospital, the role that environmental contamination poses to the rate of HAIs, legislative framework relevant to the environment, factors leading to non-compliance to environmental disinfection were discussed. The next chapter provides the research methodology of the study.

CHAPTER 3 : RESEARCH METHODOLOGY

3.1 Introduction

This chapter provides a detailed description of the research methodology used in the study. A methodology is a science of studying how research is conducted systematically. In this field, the researcher explains himself with the different steps generally taken to study a research problem (Mishra and Alok, 2022). According to Denzin and Lincoln (2018) and Creswell (2018) methodology is a strategy of inquiry that guides a set of procedures. An exploratory three- phase sequential mixed-methods study was used to meet the research objectives.This chapter discusses the research design, setting, population, sample, sampling method, data collection, and data analysis. This chapter also describes ethical considerations, and measures to ensure trustworthiness in detail.

3.2 The aim and objectives of the study

The study aimed to contribute to a safe operating room environmental cleaning practices and management through the development of an environmental hygiene management audit tool that could contribute to the quality care of all patients in the operating room. The objectives of the study were:

1. To determine the current evidence-based literature published on an environmental hygiene cleaning practices, by conducting a scoping review (Phase 1).

2. To explore the views of experts regarding the elements to be included in an an environmental hygiene management audit tool, through In-depth interviews (Phase 2) and
3. To develop an environmental hygiene management audit tool (Phase 3), based on the outcome of the previous two phases of this study.

3.3 Research design

The researcher employed an exploratory three- phase sequential mixed-methods design. The researcher selected this approach because it considers multiple viewpoints, perspectives, positions, and standpoints and integrates the most appropriate techniques from a series of qualitative, quantitative, and mixed strategies to extensively investigate an incidence of interest (Teddlie and Tashakkori, 2012). The researcher extensively investigated existing literature on intraoperative cleaning practices and management followed by the contextual exploration of the views of experts. The findings from the two phases were compared and an audit tool was developed. The aspects of this design are explained in detail in the sub-sections below.

The current study used a pragmatic paradigm, mixed methods, as a guide to developing the research methods.A mixed-methods design assumes that “the research question drives everything” (Teddlie, 2009). In a mixed-methods study, the relationship between qualitative and quantitative phases could be triangulation, exploratory, explanatory or embedded designs (Creswell, 2018).

The researcher utilized the data populated from the scoping review (phase 1) to formulate questions for the in-depth interviews. In-depth interviews (phase 2) were conducted, and the findings of the two phases were compared and integrated (Also known as triangulation). An audit tool was developed in phase 3 based on the findings of the two phases. A mixed-methods design offered a logical ground, methodological flexibility, and an in-depth understanding of smaller cases (Maxwell, 2016). Wisdom *et al*. (2012) also adds that mixed methods help researchers to nurture ideas for future research. In a study by McKim (2013), It was argued that a mixed method allows the researcher to use results from one method to inform another method, thus the researcher concluded that mixed methods are the most appropriate methodology for this study.

This method has enabled the researcher to develop a tool to monitor intraoperative environmental cleaning practices using the findings from the two phases. The researcher used mixed methods research because the method considers multiple viewpoints, perspectives, positions, and standpoints. To answer the research questions, the researcher first conducted a scoping review to determine the current evidence-based literature published on intra-operative environmental management. The data from the scoping review was used to develop the interview guide for the next phase (in-depth interviews). The researcher conducted in-depth interviews to gather multiple viewpoints on the intraoperative environmental cleaning practices from the experts and utilized the data collected to develop an environmental hygiene audit tool.

3.4 Sequential aspect of the design

The study employed an exploratory sequential design whereby the researcher collected and analyzed data in the first phase to inform the second and third phases. In the sequential mixed designs, the processes and questions from the later strand arise from, depend upon, and build upon those from the earlier strand in these designs. It has been argued by Creswell and Plano Clark (2018) that the integration in this design takes place in two ways, firstly by connecting the findings from the scoping review to the in-depth interview discussions. The results were connected to gain a better understanding of the findings from both phases (Dawadi *et al*., 2021). The results from both phases helped the researcher come up with questions included in the development of the environmental hygiene audit tool, done in phase three. The researcher grouped the findings in themes that were similar to all the participants according to the codes that were generated, and categories were formed.

3.5 Exploratory aspect of the design

An exploratory aspect can help understand the problem's general nature, identify possible alternatives to the solution, and relevant variables that need to be considered. One example of exploratory research design is the exploratory sequential design, which involves first collecting and analyzing qualitative data, then collecting and analyzing quantitative data to test or confirm the qualitative findings. In this study, this aspect of the

design was to explore the current evidence-based literature published on intra-operative environmental management.

3.6 Research Setting

The research setting is a place where data is collected. The study was conducted in the operating theatres where postgraduate students in operating theatres are placed during their practical's. An operating theatre is a place where surgical procedures are conducted. It has three levels of restrictions: unrestricted, semi-restricted, and restricted. The restricted and semi-restricted area is usually separated by the ‘red line’ (a red border/ stripe applied on the operating room floor) when entering the operating room and is universally acknowledged and understood by all operating room staff. The semi-restricted area includes the recovery room area, storerooms, and corridors. The restricted area includes the operating rooms, procedure rooms, and Central Sterile Services Department (Phiillips, 2017).

The staff profile from the nursing perspective in each operating room consist of a scrub sister (Registered nurse), an anaesthetic nurse, and a circulating nurse. Then there’s a surgeon, an assistant surgeon, anaesthetist and the anaesthetic consultant.

3.7 Research Methods

Research methods are the techniques used by researchers to structure the study and to gather and analyze information relevant to the research question (Polit and Beck, 2021). The research methods will be discussed under each phase of the study. The study setting, population, sample and sampling, data collection and analysis will be discussed.

3.8 Phases of the study

3.8.1 Phase one: Scoping Review

In phase 1 of this study, a mapping of literature through the scoping review was conducted to determine the current evidence-based knowledge regarding intra-operative environmental cleaning practices and the management thereof. According to Colquhoun *et al.* (2014), the

knowledge that addresses an exploratory research question will be synthesized to map key concepts, types of evidence, and research gaps related to a defined area or field.

3.8.1.1 Mapping process

Due to the topic's nature, the researcher did a scoping review to identify and map the available evidence. The researcher wanted to determine the scope or coverage of a body of literature on the given topic which is to determine the current evidence-based knowledge regarding intra-operative environmental cleaning practices and give clear indication of the number of literature and studies available. Scoping reviews is useful for examining emerging evidence when it is still unclear. They provide a broader scope with expansive inclusion criteria (Munn *et al.,* 2018). The researcher conducted a scoping review to identify certain characteristics and concepts during the mapping and reporting. The influential and used to conduct scoping review was the Johanna Briggs Institute (JBI) framework (Peters et al., 2020). researcher had to come up with a clear objective, and a research question. Then proceeded to develop a protocol, even before the searches were conducted. The protocol included an introduction, a search strategy, and the criteria that the researcher intended to use to include and exclude sources of evidence and to identify what data is relevant, and how the data will be extracted and presented. The researcher used the JBI framework to conduct an extensive literature search to determine the current publications on the intra-operative environmental cleaning practices which was the primary focus to outline the breadth and depth of the review and in addition it included the elements of concept, context and inclusion criteria.

A- Priori protocol was developed before the scoping review was conducted. The Johanna Briggs Institute (JBI) framework was used to guide the development of phase 1 of the study which proposes the use of the following outlined steps below, which are enhancements proposed by Peters et al. (2015, 2017, 2020) however the application of the steps in this review is explained in detailed in the following paragraphs (see from 3.5.2 below).

- Defining and aligning the objective/s and question/s
- Developing and aligning the inclusion criteria with the objective/s and question/s

- Describing the planned approach to evidence searching, selection, data extraction, and presentation of the evidence.
- Searching for the evidence
- Selecting the evidence
- Extracting the evidence
- Analysis of the evidence
- Presentation of the results
- Summarizing the evidence in relation to the purpose of the review, making conclusions and noting any implications of the findings

3.8.1.2 Developing and aligning the inclusion criteria with the objective and review question

The researcher identified the research question, identified relevant studies, selected studies, charted the data, and collated, summarized, and reported the results.

The objective of the review was to determine the current evidence-based literature published on intra-operative environmental management. The following research question guided the scoping review: ***What evidence-based literature is currently available that describes environmental cleaning practices in intra-operative room environments?***

Publications that responded to the research question in English, not older than 10 years, published in peer reviewed journals, guidelines and grey literature were included. Any type of study method (qualitative, quantitative, systematic review, prospective, retrospective, cohort, or quasi-experimental) were included. The inclusion criteria were congruent between the title, objectives, and the research question. The criteria followed the PCC framework, which is the Participants, Concept and Context.

Participants

All the publications relevant to intra-operative environmental cleaning practices and management, in PubMed, ScienceDirect, ClinicalKey, CINAHL, and MEDLINE were reviewed as well as subject-specific publications.

Concept

The concept of the study is the intra-operative environmental cleaning practices and the management.

Context

The context of the publications included in the scoping review was that on the intra-operative environmental cleaning practices. Publications referring to all types and levels of ORs globally.

3.8.1.3 Search strategy

Studies were identified through a search focus, terms, and data basis that included grey literature to ensure a comprehensive representation of data. The researcher used a three-step search approach that the JBI guideline suggested for scoping reviews (Peters et al., 2017). Using google scholar, the researcher performed a preliminary, constrained search to become acquainted with the terminology before narrowing down the search terms. Searches were limited to English language.

3.8.1.4 Search focus and search terms

The selection of studies obtained from the literature search was conducted based on the general selection criteria for inclusion. The general selection criteria used in this review included the following: title of articles screening, removal of duplicates abstracts and full text reading for article inclusion. The studies found were exported to the Mendeley reference manager software to identify duplicates and gather all the publications. In the first stage of selection, one reviewer (PM) designed and conducted the search strategy supported by the second reviewer (LE). The two reviewers independently screened titles, abstracts, and full-text articles. Reviewers read through article abstracts to eliminate duplicates and exclude ineligible articles. The Preferred Reporting Items for Systematic reviews and Meta-Analyses extension (PRISMA ScR) for scoping reviews flow diagram was used to report and map the searching process.

The search terms used included: Operating theatre, cleaning, environmental cleaning, environmental decontamination, air quality, surface cleaning and cleaning practices. An

advanced search was done for example: ((((environmental hygiene) AND (surface cleaning)) AND (disinfection)) AND (cleaning practices)) AND (operating theatre) and this only yielded 1 article. The researcher then refined the search adding more search terms on the list: (((((environmental cleaning) AND (surface cleaning)) AND (cleaning practices)) AND (cleaning guidelines)) AND (operating room)) OR (operating theatre), and through SmartText searching that was generated automatically 15, 088 articles were found which were screened for eligibility and inclusion (see Annexure 4.3)

3.8.1.5 Databases

Identification of relevant studies to this review was done by searching the electronic databases of the published literature and this included the following: PubMed, ScienceDirect, ClinicalKey, CINAHL, and MEDLINE. Due to the specialized area being researched, targeted intraoperative evidence-based literature, including guidelines and audit instruments published by the CDC, WHO, International Society of Infectious Diseases (ISID), Association of Perioperative Registered Nursing (AORN), the Journal of Perioperative Practice published by The Association of Perioperative Practice (AFPP), as well as the International Society of Infectious Diseases (ISID), will be included. Hand searches and grey literature were included as well to identify additional relevant studies.

3.8.1.6 Extraction and analysis of the results

In the scoping review extraction of results is also known as charting of results. The data from the study selection was charted on an instrument (Excel spreadsheet) designed by the researcher. This instrument supported the relevance of each study and its specific contribution to the research question. To reach the objective and answer the research question, the following data was extracted from each publication and entered onto a self-developed data extraction document which included the author, year of publication, country of origin, methodology, and data collecting tools, results, limitations and conclusions. A subject expert (supervisor) assisted with the validation of the data.

Preferred Reporting Items for Systematic reviews and Meta-Analyses extension for Scoping Reviews (PRISMA-ScR) Checklist was followed to screen the publications. The points of

highlights were the year of publication of the article, place/country of origin, methodology, collection tools, results, limitations and conclusions. As stated by (Munn *et al*., 2018) scoping review is ideal to be utilized by authors who do not always wish to ask such single or precise questions and may be more interested in the identification of certain characteristics/concepts in papers or studies, and in the mapping, reporting or discussion of these characteristics/concepts. The researcher is not aiming at producing critically appraised and synthesized results to the research question but to provide an overview or map of the evidence.

Scoping reviews are infrequently exclusively conducted to simply identify and analyze gaps present in each knowledge base, as examination and presentation of what hasn't been investigated or reported, however it requires extensive examination of what is available (Munn *et al*., 2018). At the end of the data collection, findings were synthesized and reported on tables. The scoping review was planned according to the JBI framework. The results were reported on the frequency and number of articles published in a publication year.

The PRISMA-ScR extension for Scoping Reviews flow diagram was used to select articles that are utilized in the study. The diagram allowed for a systematic evaluation of each literature and assisted the researcher in reporting the reviews. The PRISMA-ScR extension was designed to help readers, including researchers, publishers, commissioners, policymakers, healthcare providers, guideline developers, and patients/consumers develop a greater understanding of relevant terminology, core concepts and key items to report for scoping reviews (Tricco *et al.,* 2018). It is further alluded that the PRISMA extension provides guidelines for reporting the scoping review. It is therefore imperative to use the PRISMA ScR extension in line with the JBI guidance for scoping review to improve the reporting of scoping reviews and ensure the increase in their relevance for decision making (Tricco *et al.,* 2018).

Data was analysed through thematic analysis where codes, themes and sub-themes were analysed and compiled according to categories, as well as the compilation of the data on an excel spreadsheet The researcher reported on the number of publications found on each

database searched, number of publications included, number of publications excluded and reasons for exclusion. Data was not synthesized, as it is not the purpose of the scoping review. First, the data was presented via tables and charts representing the geographical distribution of the studies by the year of publication, countries of origin, methodology used, results of each study, limitations, and conclusions. Then a narrative followed the charting of results that described how results relate to the review objective and question. This allowed the researcher to identify specific interventions, and contradicting interventions, and identify research gaps in the evidence, further on this has informed what had to be included in the development of an (environmental hygiene management audit tool in phase 3.

3.8.2 Phase 2: In-depth interviews

3.8.2.1 Introduction

During phase 1 of the study, the researcher conducted a scoping review to determine the current evidence-based literature published on intra-operative environmental management. The results thereof informed the in-depth interview (IDI) questions, whereby questions for IDI were developed. In this chapter, In- depth interviews are discussed. The objectives during this phase were to obtain the participants' perceptions of a focused topic and to gather multiple viewpoints on the intraoperative environmental cleaning practices from the experts.

3.8.2.2 Design

An exploratory descriptive design was used in this phase. The views of the experts regarding the elements to be included in an environmental hygiene audit tool were explored through in-depth interviews.

3.8.2.3 Motivation for conducting in-depth interviews with experts

The purpose of this In-depth interview is to determine what should be included in an intra-operative environmental management audit tool. Participants were purposefully selected based on their expertise. In-depth interviews were conducted with the experts from different backgrounds of infection prevention and control in the operating rooms. The Infection

Prevention Practitioner (IPP) regional manager, national hygiene consultant, national health laboratory services practitioner and a Perioperative Nursing educator were interviewed. The researcher chose the in-depth interview because of the diversity and the skills mix of the participants. According to Roller (2020) it is stated that although the number of required interviews tend to move in direct step with the level of diversity and complexity in the research design, there is little guidance in sample size for the researcher at the planning stage. McIntosh and Morse (2015) states that "semi-structured interviews are designed to ascertain subjective responses from persons regarding a particular situation or phenomenon they have experienced".

3.8.2.4 Population and sampling

Gray, Grove, and Sutherlands (2017) defined the population as "a particular group of people, such as people who have had a common experience, or type of element that is the focus of the research". Gray, Grove, and Sutherlands (2017) defined sampling as "the process that involves selecting a group of people, events, behaviors, or other elements with which to conduct a study".

A purposeful sampling was used to select the in-depth interview participants. The researcher selected the participants purposefully because they are experts in the field of Infection Prevention and Control in the operating theatre. Purposeful sampling is a non-probability sampling used when the focus is on insight, description, and understanding of a phenomenon, cultural event, situation, or process with specially selected study participants who are representative of the area of the study (Creswell and Poth, 2018).

3.8.2.5 Selection of participants and recruitment strategy

Participants were purposefully selected based on their expertise and knowledge in the field of Infection Prevention and Control. The inclusion criteria were experts with 10 years or more experience in Infection Prevention and Control and the operating theater cleaning practices. Experts from both the public and private sectors. Experts from different backgrounds, who are dealing with Infection Prevention and Control matters one way or the other.

We excluded the perioperative nursing practitioners and managers because we wanted an objective and honest viewpoint on the cleaning practices and management.

Participants were contacted via emails which the research supervisor assisted in getting the email addresses via Google search. The researcher requested their participation and indicated the purpose of the study. Once the participants indicated their potential interest in taking part in the interviews, then they were provided with the participant's information document (Appendix A), consent form for participation in the study (Appendix B) as well as for audio recording (Appendix C). A date was set up for an interview at the time and place convenient for the participant.

3.8.2.4 Preparation for conducting in-depth interviews

According to Brounéus (2014) in- depth interviews are conducted to gather individual perspectives of one or a few narrowly defined themes. In phase 1, a scoping review was conducted where literature was searched to determine the current evidence-based literature regarding intra-operative environmental cleaning practices and management. The results were presented and upon presentation of results categories were formed and they were as follows:

Category 1: Cleaning equipment/handling and care

Category 2: Cleaning methods,

Category 3: Chemicals/products,

Category 4: Intervals/sequence and

Category 5: Human resources.

Questions for the in-depth interviews were guided by the results from the scoping review. The researcher further wanted to explore and to ascertain the credibility of the results and to gather perspectives about the phenomena from the experts, therefore developed questions that would explore the cleaning practices in the operating rooms, chemicals that are used for cleaning, the intervals that are employed, cleaning methods, cleaning equipment, responsible person for cleaning and cleaner safety.

The interview guide was developed in pursuit of gathering important information from the participants to ensure consistency across interviews (see Appendix D). Questions were semi- structured which allowed the researcher to have follow-up questions or even probe to get more clarity to the questions. Brounéus **(**2014) cited that each in-depth interview might take different twists and turns and follow its own winding path – an important component being is to have the freedom to follow up on related themes raised by the interviewees themselves. Questions that were asked were open-ended, allowing the interviewees to decide whether they were in a short or long statement. According to Roller (2020) the most typical and effective approach in constructing an interview or discussion guide is to begin broadly and progressively narrow the topic area to the subject matter of greatest importance to the research objectives. The researcher's focus was to find out what elements should be included in an environmental hygiene audit tool, according to the outcome of the in-depth interview?

3.8.2.5 Conducting the interviews

Data collection commenced after obtaining ethical clearance (Appendix A) from the Human Research and Ethics Committee of the University of Witwatersrand and institutional permissions from the study settings. The interviews were conducted from the 21 July 2023 till 1 September 2023. Three (3) out of four (4) participants opted for an online interview and Microsoft Teams was used, whereas one (1) interview was conducted face-to-face. Interviews took between 25-55 minutes, depending on the participant's engagement and information. The interview followed a funnel approach. At the beginning of the interview the interviewer introduced themselves, explained the purpose of the study, and put the interviewee at ease. The participants were asked to complete the forms i.e. consent forms for participation and audio recording, as well as the demographic data sheet. Voluntary participation was confirmed after a study information document as well as an informed consent document had been signed by the participants.

During the interview process, the interviewer employed active listening skills, asking follow-up and probing questions whilst taking field notes from all the interviews. Whilst interviewing, the researcher was also assessing the participant's behavior and attitude towards the questions as the camera was enabled on the laptop. Each participant had their own view

and responded to the questions uniquely. According to Roller (2020) taking notes during the interview is critical as it assists the interviewer to focus attention on the participant's point of view and lived experience relevant to the research questions. This in turn helped the interviewer to internalize what was being said and enabled them with the ability to make follow-up on unclear answers. Whilst taking notes the interviewer was able to assess the interviewee's attitude and also identify important quotes.

3.8.2.6 Recording and transcription

Three (3) interviews were recorded and transcribed on Microsoft Teams, accessed via the researcher's laptop which is password protected. One (1) interview was recorded on the Olympus digital voice recorder and was transcribed via Pro Otter. Data was analyzed using thematic analysis (Braun and Clarke, 2021). The MAXQDA software program was used to analyze transcripts. The software program assisted with the analysis of interview transcripts and generated codes and themes automatically. The document was uploaded, and codes were generated.

Data was analyzed using the thematic analysis steps by Braun and Clarke (2021). Thematic analysis is a qualitative research method that researchers use to organize and analyze complex data sets systematically. This is looking for topics that can capture the narratives that are available in the data sets. According to Braun and Clarke (2021) this involves identifying themes through careful reading and re-reading of transcribed data. A rigorous thematic analytical approach can produce insightful and reliable results (Nowell, Norris, White and Moules, 2017). Thematic analysis is theoretically flexible for identifying, describing, and interpreting patterns (themes) within a data set in great detail (Braun and Clarke, 2021). This is the approach that the researcher used as the study seeks to explore complex research issues. The following steps were used:

Step 1: Familiarization with the Data

The researcher began by familiarizing themselves with the data and this process assisted the researcher in figuring out the type and the number of themes that might emerge from each question. The researcher went through the transcripts numerous times to have an understanding of the information and also to highlight the most interesting information that

comes out repeatedly (Braun and Clarke, 2021). The researcher made notes and jotted down what captured the attention or made an impression.

Step 2: Generating Initial Codes (MAXQDA)

According to Braun and Clarke (2021) this is referred to as a systematic coding of interesting characteristics of the data of the entire dataset, collecting information related to each code. The researcher went through the transcription and listened to the recording for them to pick up any characteristics that could represent a specific idea. The transcripts were imported to the MAXQDA system and codes were generated. Refer to 4.8 above for a detailed explanation of the process. Frequency and percentages were also generated, and summaries were compiled through the generated data, through which the researcher was able to formulate sub – themes. Data that was generated was as follows: The frequency depicts the number of times that each category was mentioned during the interviews across all participants.

Step 3: Searching for themes across the data

Assembling the code into possible themes and collecting data related to all possible themes (Braun and Clarke, 2021). According to Braun and Clarke (2021), there are no hard and loose rules of what depicts a theme. It is stated that a theme is characterized by its importance. The data that was populated by MAXQDA were read and each color code was grouped and categorized into identifiable themes. During this step, it was found that there was an overlap in themes as other themes kept on surfacing under different codes. The codes were analyzed and grouped into four (4) central themes and nine (9) sub-themes. If we take a closer look at the segments and the codes as presented in the data spreadsheet (See Annexure 4.4) a realization is made that there is an overlap in some areas such as cleaning intervals and cleaning practices were described similarly, as well as cleaning intervals and methods were also described similarly, hence it made sense that the cleaning intervals/sequence are classified as a sub-theme under the cleaning method theme.

Step 4: Reviewing themes

The researcher went back to the themes identified and allocated them accordingly. During this step some themes had to be moved to the sub – themes as they were more relevant on that side. The data information from the Excel spreadsheet that was populated by the MAXQDA system was then utilized. The color-coding system was utilized to associate each theme. Deliberations had to be made as to whether the data that was generated supported the themes. The researcher also had to rule out if the overlapping of the themes are separate themes or can be compressed into one theme. For an example where a question required cleaning practices, the same answer came up under cleaning methods and cleaning intervals.

Step 5: Define themes

According to Willig and Rogers (2017) theme development first involves examining codes and associated data, and joining, grouping, or even minimizing codes together into bigger or more meaningful patterns. At this point the researcher placed the themes together with the fitting sub-themes.

Step 6: Producing the report/Write- up

This step is usually taken at the endpoint, in which a report is compiled and produced.

3.8.3 Phase 3: The development of an environmental hygiene management audit tool

An environmental hygiene management audit tool was developed based on the findings of phase 1 and 2.The researcher used an iterative inductive process to compare and integrate the findings of the scoping review as well as the views of the experts. The tool was developed guided by the framework of Donabedian (1988). The draft audit tool was revised based on the supervisor's input and feedback. The framework uses the three crucial elements namely 1) structure, 2) process and 3) outcomes.

3.9 The academic rigor of the study

3.9.1 Trustworthiness

According to Lincoln and Guba (1986) credibility, dependability, confirmability, transferability, and authenticity are all required as criteria to develop the framework of the trustworthiness of a qualitative inquiry. In the study, trustworthiness was established through the sequence that the study followed. Phases of the study are dependent on each other, for example, the results from phase 1 informed the discussions in phase 2, and phase 1 and 2 findings informed the development of an audit tool in Phase 3.

3.9.2 Credibility

Credibility refers to confidence in the truth of the data and interpretations of them (Polit and Beck, 2021). According to Jonsen and Jehn (2009), triangulation is a strategy that uses multiple sources to explore and validate a single research question. In qualitative research, triangulation adds depth to the data that is collected. This rich, in-depth data supports a direct link between triangulation and data saturation (Fusch and Ness, 2015). In this study, the researcher utilized various methodological approaches to ensure triangulation, and these included (1) Scoping review (2) a PRISMA-ScR chart, (3) in-depth individual interviews, and (4) the MAXQDA. PRISMA-ScR chart was used to ensure credibility and also to assist in the identification of articles for inclusion and exclusion. The scoping review data was charted on the Excel spreadsheet developed by the researcher. This data triangulated the authors of the articles reviewed, their year of publication, place or context of study, limitations, and recommendations.

In terms of the authority of the researcher, the researcher is an operating theatre specialist with 32 years of nursing experience. The researcher possesses vast knowledge in the operating theatre that is from being a circulating nurse to an anaesthetic nurse and a scrub sister. In all the roles that the researcher has played in the field of nursing, principles on the management of environmental hygiene are primary and important. The researcher has the added advantage of being a lecturer for the postgraduate diploma in operating theatre. The experience in the field assisted the researcher in the formulation of the appropriate and relevant interview questions.

In addition to triangulation, reflexivity was applied by the researcher to ensure that consensus between her and another researcher who is regarded as an expert in terms of

operating theatre and qualitative research regarding the findings that emerged from both the scoping review and the in-depth individual interviews.

In terms of structural coherence, the researcher worked within the categories of the Donabedian systems framework for the healthcare disciplines. Structural coherences refer in terms of (1) inputs, (2) processes, and (3) outputs or outcomes. Consultation as the last stage of phase one was included. The researcher assessed and checked how well categories and themes covered data to exclude irrelevant data, similarities, and differences

3.9.3 Dependability

Polit and Beck (2021) define dependability as the stability of data over time and conditions. Dependability was achieved through a detailed description of the data collection phase used in this study. During this phase, data was charted on a form that was developed by the researcher including characteristics such as author's name/s, publication year, etc. in a tabular form as depicted in Chapter 3. The process was followed by a compilation of the data on an Excel spreadsheet which was validated by the subject expert to exclude a risk of inconsistency.

3.9.4 Confirmability

Polit and Beck (2021) allude that confirmability refers to objectivity, that is, the potential for congruence between two or more independent people about the data's accuracy, relevance, or meaning. Confirmability was ensured by the researcher through the findings of the data which was collected from the scoping review. Data was verified against labeling and sorting by the researcher, and it was ensured that all researchers agree with the findings, that is the researcher and the study supervisor.

3.9.5 Transferability

According to Polit and Beck (2021), transferability refers to the extent to which findings can be transferred to or are applicable in other settings or groups. The background of this study is clearly described. Comparisons to similar situations were possible. Transferability was ensured by the use of thematic analysis where codes, themes, and sub-themes were analyzed and compiled according to categories, as well as the compilation of the data on an Excel spreadsheet. Data collected from the scoping review was assessed to ascertain

whether it could be used to develop questions for the in-depth interviews and then transferred to develop an audit tool.

3.10 Ethical considerations

The proposal was peer-reviewed by the Department of Nursing Education. The protocol was approved by the Postgraduate Assessors from the School of Therapeutic (See Appendix H). Ethics clearance was obtained from the University's Human Research Ethics Committee (Medical) with reference number (**M210310**) (see Appendix G).

3.10.1 Autonomy

According to Grove and Gray (2018) respect for persons can be violated by withholding information and misinforming the participants about the purpose of the study. Participants were given all the information about the study to ensure that the participation was voluntary, and they could give consent willingly (see Appendix A, B, and C) to ensure autonomy.

3.10.2 Confidentiality

Confidentiality was ensured and participants were not named in the study, they were assigned codes/numbers that will be used to identify them. All the data was collected through electronic devices (i.e. a laptop with the protected password that is known to the researcher and the digital voice recorder with no previous data).

3.11 Conclusion

This chapter has illustrated the description of how the study was conducted to reach the research objectives and to respond to the research questions. The research design for this study is an exploratory sequential three-phase mixed-methods study, comprising of scoping review in phase 1, in-depth interviews in phase 2, and the development of an audit tool in phase 3. In the following chapter, the findings of the scoping review and the in-depth interviews are presented and discussed.

CHAPTER 4 : PRESENTATION AND DISCUSSION OF FINDINGS

4.1 Introduction

This chapter describes the presentation and discussion of the study findings. This data is presented in two sections: the scoping review and in-depth interview findings. First, the data was presented via tables and charts representing the geographical distribution of the studies by the year of publication, countries of origin, methodology used, results of each study, limitations, and conclusions. After all the results were in, the number of articles per cleaning practice were identified, the frequency and the percentages on cleaning practices were pointed out. Then a narrative followed the

charting of results that described how results relate to the review objective and question. This allowed the researcher to identify specific interventions, and contradicting interventions, and identify research gaps in the evidence, further on this has informed what had to be included in the development of an (environmental hygiene management audit tool in phase 3).

Data from the in-depth interviews (phase 2) were analyzed using thematic analysis. The MAXQDA software was used. Codes, themes and sub-themes were generated. In this chapter, the discussion, integration and referencing of the existing literature are done in line with the themes and sub-themes identified in this study to support the research findings.

4.2 Phase One: Scoping review findings

4.2.1 Summary of literature search

This review aimed at gathering research evidence on the cleaning practices and management of environmental hygiene in the operating theatre. Using google scholar, the researcher performed a preliminary, constrained search in order to become acquainted with the terminology before narrowing down the search terms. Searches were limited to English language. The researcher included publications from 2010 with the first entry done on the 03.02.2022 and the last entry on the 29.04.2022, which turned out not to be addressing the research objectives and questions. The researcher then did a second round of search still including publications from 2010 with the first entry done on the 04.08.2022 and the last entry 13.09.2022.

The five databases searched included PubMed, ScienceDirect, ClinicalKey, CINAHL, and MEDLINE. **Table 4.1** summarizes this information. Due to the specialized area being researched, targeted intraoperative evidence-based literature, including guidelines and audit instruments published by the CDC, WHO, International Society of Infectious Diseases (ISID), Association of Perioperative Registered Nursing (AORN), the Journal of Perioperative Practice published by The Association of Perioperative Practice (AFPP), as well as the International Society of Infectious Diseases (ISID), will

be included. Hand searches and grey literature were included as well to identify additional relevant studies.

Table 4. 1: Summary of literature search

Database	Search Words	Results yielded
PubMed	(environmental hygiene) AND (surface cleaning)) AND (disinfection)) AND (cleaning practices)) AND (operating theatre)	1
ScienceDirect	(environmental cleaning) AND (surface cleaning)) AND (cleaning practices)) AND (cleaning guidelines)) AND (operating room)) OR (operating theatre)	292
ClinicalKey	(environmental cleaning) AND (surface cleaning)) AND (cleaning practices)) AND (cleaning guidelines)) AND (operating room)) OR (operating theatre)	1,973
CINAHL	(environmental cleaning) AND (surface cleaning)) AND (cleaning practices)) AND (cleaning guidelines)) AND (operating room)) OR (operating theatre)	3,032
MEDLINE	(environmental cleaning) AND (surface cleaning)) AND (cleaning practices)) AND (cleaning guidelines)) AND (operating room)) OR (operating theatre)	9,790
Total articles		**15,088**

4.2.2 Search outcome: Selection and screening of studies

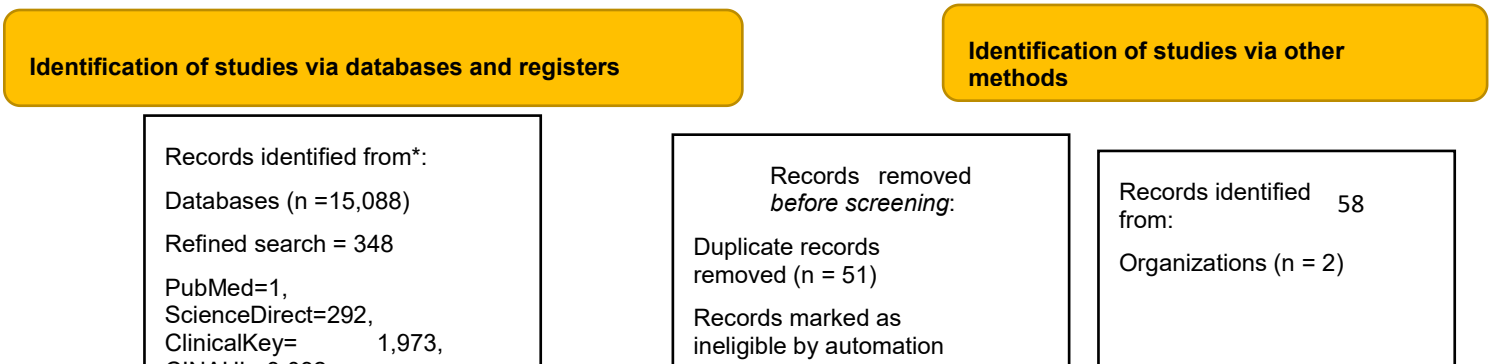
The researcher conducted many literature searches related to the cleaning practices and management of environmental hygiene in the operating theatre. A huge amount of literature

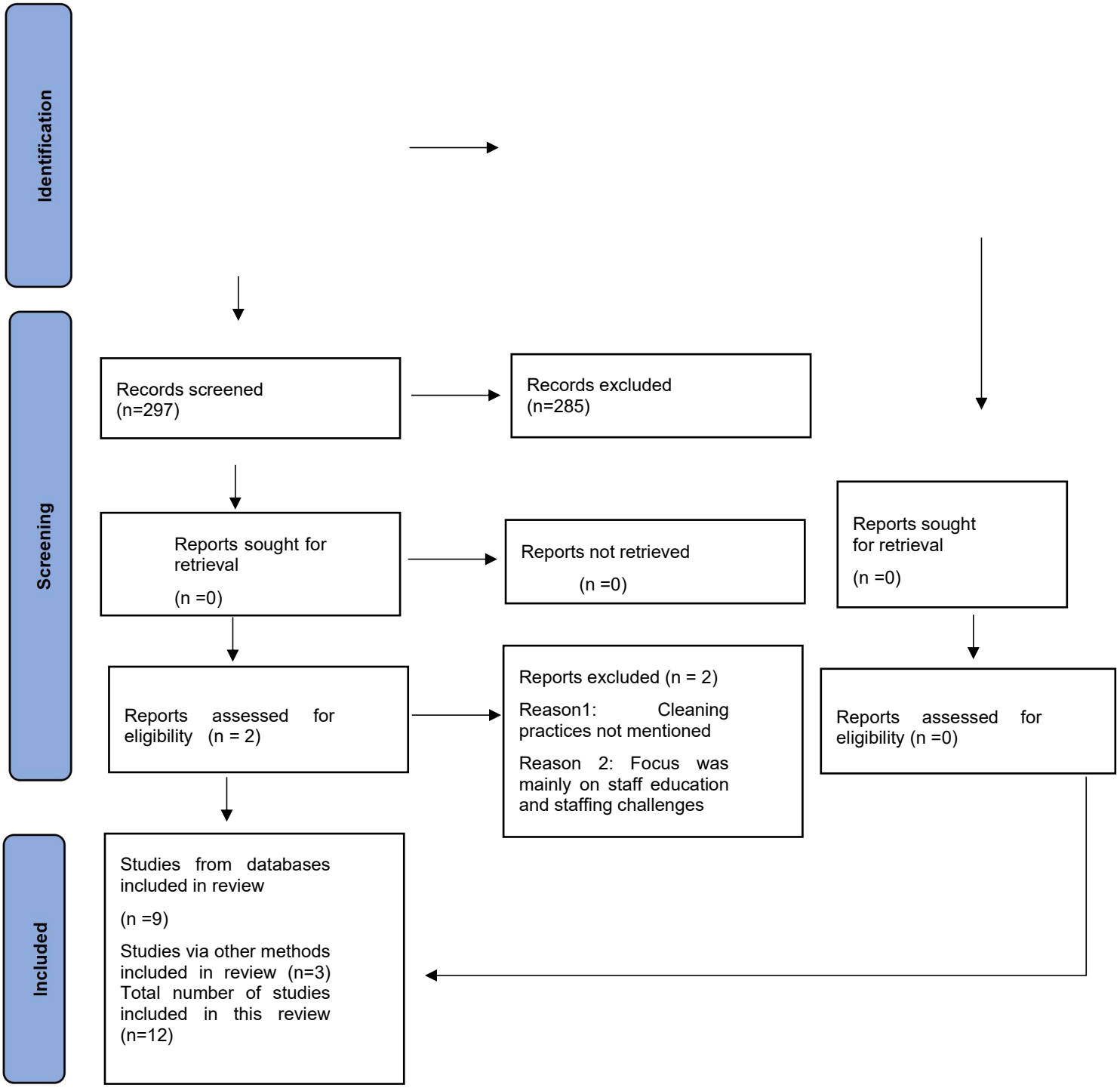
was identified. A three-step search strategy was used in this review. An initial literature search was undertaken from each database using search string followed by analysis of text words contained in the title and abstracts of the identified articles. Secondly, the complement literature search using hand search was done to identify relevant articles that may have been missed during a database search and thirdly, the reference lists of all identified articles as well as grey literature were searched for additional studies.

The selection of studies obtained from the literature search was conducted based on the general selection criteria for inclusion. The general selection criteria used in this review included the following: title of articles screening, removal of duplicates abstracts and full text reading for article inclusion. The studies found were exported to the Mendeley reference manager software in order to identify duplicates and gather all the publications. In the first stage of selection, one reviewer (PM) designed and conducted the search strategy supported by the second reviewer (LE). The two reviewers independently screened titles, abstracts, and full-text articles. Reviewers read through article abstracts to eliminate duplicates and exclude ineligible articles.

A total of 15,088 articles were retrieved, followed by 14,740 records marked as ineligible by automation tools leaving 348 articles. Fifty-one (51) duplicates were removed, leaving 297 articles which were screened. A total of 285 articles were excluded as they did not address the research question, leaving 12 articles that were screened for legibility according to the inclusion criteria set. Two articles were identified from organizations and 2 articles were excluded for two reasons: the first focused mainly on staff education and staffing challenges and the second did not include cleaning practices. A total of 12 articles were included in this review. The PRISMA ScR for scoping reviews flow diagram was used to report and map the searching process (**Figure 4.1)**.

Figure 1: The PRISMA-ScR for Scoping Reviews flow diagram





4.2.3 Presentation of the scoping review findings

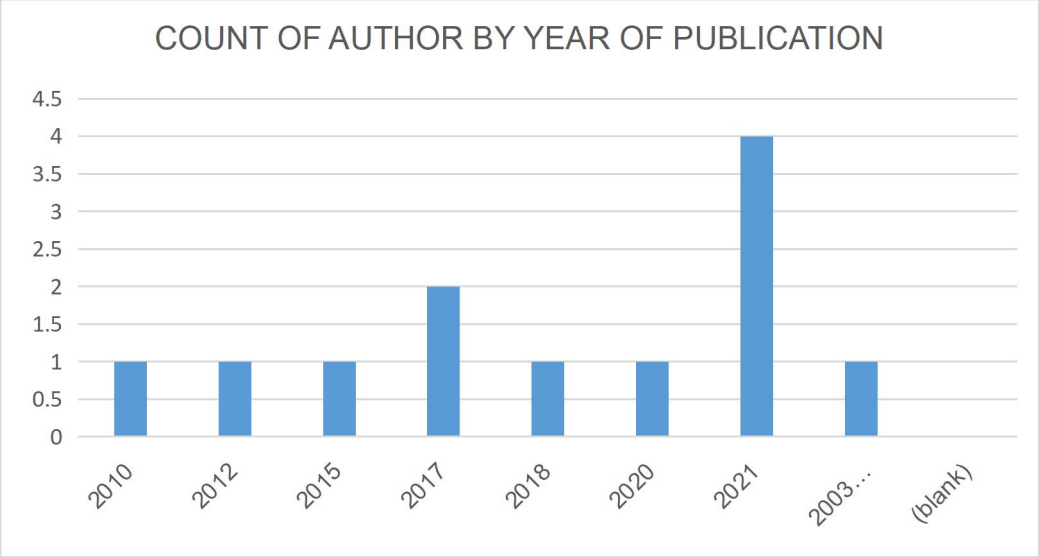
Data from the 12 publications were grouped according to continents. It was found that in Denver there were 2 publications, India 2 publications, Atlanta, Bologna, Winnipeg, South Australia, and Germany was 1 publication from each country, however it should be noted that the one publication had multiple countries of origin, for an example: From one

publication it was authors from 5 countries i.e. Austria, Switzerland, Netherlands, Germany and Spain. 12 countries from 9 presented publications. The map below shows the continents where publications originate from. **Figure 4.2** summarizes this information.

Figure 2: Continents where publications originate from

The graph below indicates the number of publications published between 2003–2021. In the years 2003, 2010, 2012, 2015, 2018, and 2020, there was 1 publication. The researcher used the publication that was published in 2003 and was later updated in 2017 because of the information that the researcher saw as worthy to be acknowledged. Then we saw an increase in 2017, where at least 2 publications were and a rise in publications in 2021, where 4 articles were published.

Figure 3: Year of publication frequency



The table below depicts the frequency, which is the number of times the cleaning practices were mentioned per publication and further illustrated in percentages. The cleaning practices found were further broken down into categories presented in **Table 4.2.**

The numbering of publications is also done on a separate table where publications are numbered according to how they were placed on the Excel spreadsheet that presented the data collected from the scoping review (see Scoping review reference as per data chart **Table 4.3**).

Table 4. 2: Presentation of results

Cleaning practices	**Article**	**Frequency (*f*)**	**Percentage (%)**
Application of pressure	1	1	11.1%
Chemical disinfectant wipes or cloths	1,3	2	22.2%
Hospital grade EPA registered low- level chemical disinfectants	1,3,4	3	33%
Sodium hypochlorite,	1,3	2	22.2%
10% sodium hypochlorite	5	1	11.1%
A blend of hydrogen peroxide	1	1	11.1%
Accelerated liquid hydrogen peroxide	12	1	11.1%
Surfactants	1	1	11.1%
Wetting and chelatting agents,	1	1	11.1%
Phelolics	1	1	11.1%
Quaternary ammonium	1,12	2	22.2%

compounds			
Active chlorine 1080ppm	5	1	11.1%
Alcohol	1	1	11.1%
Intermediate-level germicide	3	1	11.1%
Low-level disinfectant	6	1	11.1%
Chlorine releasing solution	11	1	11.1%
Phenol	8	1	11.1%
High-level disinfectant	12	1	11.1%
Peracetic acid	12	1	11.1%
Cloth dampened with 70% alcohol or disinfectant for the microscope	10	1	11.1%
Sodium dichloroisocyanurate granules or solution	11	1	11.1%
Enough wetness to achieve the contact time.	1	1	11.1%
Cleaning of the theatres occurs when preparing a new operating theatre	10	1	11.1%
Before the first case of the day	4,6,10;12	4	44.4%
Cleaning and disinfection are to be performed after each surgical procedure.	1,9	2	22.2%
Between each operation and at the end of the daily operating session.	5,10	1	11.1%
In between cases, use a cloth dampened in hospital-approved disinfectant solution to clean and disinfect surfaces that have come in contact with a patient or body fluids, including tops of surgical lights, blood pressure cuffs, tourniquets, and leads	8	1	11.1%

4.2.4 Explanation of the categories as per the scoping review

According to the data presented on the Excel spreadsheet from the scoping review, it was noted that cleaning practices were discussed comprehensively incorporating the cleaning methods, cleaning intervals, equipment, disinfectants and the persons responsible for cleaning. The researcher then generated categories that would place each practice where it belongs, therefore, 5 categories were formed which are cleaning equipment/ handling and care, cleaning methods, intervals/sequence, chemicals/products, and human resources. Then sub-categories as per publication were sought from the results that enabled the researcher to identify how many times each sub-category was mentioned in publications

from when the first entry was done on the 04.08.2022 and the last entry 13.09.2022. (see **Table 4.3**)

Table 4. 3: Number of mentions per publication in the Scoping review

CATEGORY	Sub-category as per publication	Frequency
Cleaning Equipment/Handling and care	Mop	7
	Cloths pre-moistened with detergent	2
	Lint-free cloths	4
	Microfiber cloths	1
	Chemical disinfectant wipes or cloths	1
	Disinfectant wipes	1
	Wet vacuum	4
	Buckets	2
	Personal Protective Equipment (PPE)	1
Cleaning Methods	Application of pressure	1
	Enough wetness to achieve the contact time	1
	Start cleaning from the least soiled to the most soiled areas	2
	Cleaning starts from the cleanest area to the dirtiest	2
	Start cleaning from higher to lower	4
	Follow the sequence of in to out	1
	Prioritize cleaning of hand-touch sites	1
	Wiping systematically without going over the same area twice	1
	Follow the principle of one wipe, one site, and one direction	1
	Wet dusting horizontal surfaces daily with cleaning cloths	3
	Clean all horizontal surfaces by wet wiping with an HLD	1
	Clean noncritical medical equipment surfaces with a detergent/disinfectant and do not use alcohol to disinfect large environmental surfaces	1
	Change the mop head at the beginning of the day or after cleaning up large spills of blood or other body substances.	1
	Mop heads and cloths should be cleaned after	1

	each use and allowed to dry before use	
	Wet vacuum or mop operating room floors after the last surgical procedure of the day or night	1
	Decontaminate or change reusable cloths or mops if being used for cleaning to prevent surface contamination	1
	Cleaning cloths or mops should not be returned to the bucket once used in other words avoid double-dipping	2
	The operating or procedure room should be damp dusted with a clean, lint-free cloth moistened with an EPA-registered hospital detergent/disinfectant	1
	Any subsequent equipment should be wiped down before it is transported into the operating or procedure room	3
	The floor should be mopped following each case	1
	Cleaning follows a sequence i.e. removal of waste from designated containers, removal, and disinfection of biological materials with 10% sodium hypochlorite from visibly contaminated surfaces	1
	All surfaces that have come into contact with the patient's blood or bloody fluids and high-hand touch surfaces are treated with a detergent and disinfectant of active chlorine for an action time of 5 minutes	2
	Start at higher surfaces and work down in a clockwise manner	1
	Before cleaning, remove all trash, linen, and recycling from the room including soiled anesthesia equipment and supplies	1
	Environmental cleaning of the OR Theatre will begin after the patient has left the area	1
	Wipe touched objects and areas after each procedure (i.e. control panel, switches, knobs, work area, handles, computer keyboards, and components)	1
	Clean floors within 1.5 meters of the operative area, extend the area if visibly soiled, including floor area under the OR bed	2
	The floor should be cleaned with a vacuum cleaner or wet mops	4
	Brooms are not recommended	2
	Floor cleaning should progress from the cleanest area to the dirtiest, from the perimeter of the room to the center	1

	Clean and disinfect the floor with a mop after each surgical or invasive procedure when visibly soiled or potentially soiled by blood or body fluids	1
	Clean methodically using a clockwise or counterclockwise approach	1
	In case of spillage of blood/ bloody fluids decontamination with bleaching powder/chlorine solution should be done.	1
	Clean and disinfect any furniture or equipment that came in contact with the patient or may have become soiled or damp, including the operating table, surgical lights, blood pressure cuffs, and tourniquets	1
	Discard waste in prescribed plastic bags	1
	At the end of the day Cleaning of all the table tops sinks, and door handles with detergent / low level of disinfectant	1
	Clean the frequently touched areas of the item	1
	Do not begin the environmental cleaning including trash and contaminated laundry removal, until the patient has left the OR	1
	Spot clean and disinfect the walls after each surgical or invasive procedure when visibly soiled	1
	All areas must be cleaned: unrestricted, semi-restricted, and restricted areas	1
	Start in the operating theatre before moving to the scrub areas, anesthetic and recovery rooms, and then the sterilizing area	1
	Once the operating theatre is cleaned and disinfected, keep the door closed for 10 – 15 minutes with ventilation equipment turned on	2
	Collect and remove waste from the kick bucket and remove all other waste, replace all bin liners	1
	Remove waste from equipment such as suction machines and clean, disinfect, or sterilize them appropriately	1
	Surface contaminated with blood or potentially infectious agents be cleaned and decontaminated	1
	Ensure colour-coded waste collection bags are placed in the waste bins	1
	Wash the scrub basin and tap with soap and water	1
	Cleaning solutions should be prepared daily	2

	Use approved cleaning products and follow the manufacturer's instructions	6
Chemicals/ Products	Chemical disinfectant wipes or cloths	1
	Hospital grade EPA registered low- level chemical disinfectants	3
	Sodium hypochlorite	2
	10% sodium hypochlorite	1
	A blend of hydrogen peroxide	1
	Accelerated liquid hydrogen peroxide	1
	Surfactants	1
	Wetting and chelating agents	1
	Phelolics	1
	Alcohol	1
	Intermediate-level germicide	1
	Quaternary ammonium compounds	2
	Active chlorine 1080 ppm	1
	A chlorine-releasing solution of 1000ppm	1
	Low-level disinfectant	1
	Chlorine-based solution	1
	Phenol	1
	High-level disinfectant	1
	Peracetic acid	1
	Cloth dampened with 70% alcohol or disinfectant for the microscope	1
	Sodium dichloroisocyanurate granules or solution	1
Intervals/sequence	Prior first case	4
	After each operation for the next one	1
	Between each operation and at the end of the daily operating session.	2
	In between cases	2
	Cleaning and disinfection are to be performed after each surgical procedure.	2
	Cleaning of the theatres occurs when preparing a new operating theatre	1

	After the last surgical procedure of the day or night	2
	Deeper cleans are carried out once a week and/or once a month. All areas must be cleaned: unrestricted, semi-restricted, and restricted areas	1
	Start in the operating theatre before moving to the scrub areas, anesthetic and recovery rooms, and then the sterilizing area	1
	At the end of the day Cleaning of all the table tops sinks, and door handles with detergent / low level of disinfectant	1
	The toilet should be cleaned last	1
	In the morning use warm, soapy water to clean, then wipe with a cloth soaked in clean water to move any soap (or detergent) residue	1
	Finally, wipe with the disinfectant solution	1
	Terminal cleaning and disinfection procedures should be performed when scheduled procedures are completed for the day and every 24 hours during the regular workweek	2
	Terminally clean operating and procedure rooms each day the rooms are used	1
	Walls should be washed with water and disinfectant weekly	1
	The floors will be done last	1
	A detailed washdown should be done at least once a week for OTs that are used daily	1
	A detailed washdown should be done at least once a month for OTs that are used less frequently	1
Human resources	Carried out by trained and competent personnel	1
	It is a team approach	1
	Done by theatre personnel	1
	Perioperative nurse	1
	Interdisciplinary team	1

References of the publications selected and used to collect the above data are in Table 4.4. The publication number states the order of appearance on the spreadsheet used to chart data.

Table 4. 4: Scoping review reference as per data chart

Reference	Publication number
Branch, R., & Amiri, A. (2020). Environmental surface hygiene in the OR: Strategies for reducing the transmission of healthcare-associated infections. *AORN Journal*, *112*(4), 327–342	**1**
Assadian, O., Harbarth, S., Vos, M., Knobloch, J. K., Asensio, A., & Widmer, A. F. (2021a). Practical recommendations for routine cleaning and disinfection procedures in healthcare institutions: A narrative review. *Journal of Hospital Infection*, *113*, 104–114.	**2**
Chinn, R. Y., & Schuster, L. (2003). *Guidelines for environmental infection control in health-care facilities: Recommendations of CDC and Healthcare Infection Control Practices Advisory Committee (HICPAC)*. Updated 2017	**3**
Seavey, R., (2010). *Environmental Cleaning and Disinfection*.	**4**
Dallolio, L., Raggi, A., Sanna, T., Mazzetti, M., Orsi, A., Zanni, A., Farruggia, P., & Leoni, E. (2018). Surveillance of environmental and procedural infection control measures in the operating theatre setting. *International Journal of Environmental Research and Public Health*, *15*(1), 46.	**5**
Alblas, D., Bartel, A., & Beaudry, J. (2022). *Guidelines for Routine Environmental Cleaning of the Operating Room. Winnipeg Regional Health Authority (WRHA)*.	**6**
Cleaning Standards for Healthcare Facilities accessed at the Department for Health and Wellbeing Internet site *www.sahealth.sa.gov.au/infectionprevention*	**7**
Gupta, C., Vanathi, M., & Tandon, R. (2015). Current concepts in operative room sterilization. *DJO*, *25*, 190–194.	**8**
Link, T. (2021). Guidelines in practice: Environmental cleaning. *AORN Journal*, *113*(5), 487–499.	**9**
Mathenge, C., & Ganesh, Y. (2021). Cleaning the operating theatre. *COMMUNITY EYE HEALTH JOURNAL*, *34*(112), S19.	**10**
Al-Benna, S. (2012). Infection control in operating theatres. *Journal of Perioperative Practice*, *22*(10), 318–323.	**11**

Dighe, R., Memon, I., Shaikh, T., Khan, I., & Samanta, S. (2020). *The role of disinfection in the prevention and control of healthcare-associated infections in operating theatre*.	**12**

4.2.5 Summarizing the evidence about the purpose of the review, making conclusions, and noting any implications of the findings.

The results of the scoping review were discussed and summarized. Conclusions were drawn about the research objective and question. Limitations and recommendations were noted.

Three studies reported that chemical disinfectant wipes or cloths should be used when cleaning the OR (Branch and Amiri, 2020; Chinn and Schuster, 2017; Alblas, Bartel, and Beaudry, 2017). The use of hospital grade EPA registered low- level chemical disinfectants which is sodium hypochlorite has been noted in four publications (Branch and Amiri, 2020; Chinn and Schuster, 2017; Dallolio *et al.,* 2017; Dighe *et al*., 2018). Five studies alluded that cleaning and disinfection should be performed after each surgical procedure (Branch and Amiri, 2020; Alblas, Bartel, and Beaudry, 2017; Gupta *et al,* 2015; Link, 2021; Mathenge, 2021).

The review findings revealed that cleaning should start from the least soiled to the most soiled and from higher to lower, wiping systematically without going over the same area twice. This information was highlighted in four studies (Assadin, 2021; Dallolio *et al.,* 2017; Alblas, Bartel, and Beaudry, 2017; Government of South Australia, 2021). It was further stated that all surfaces that have come into contact with the patient's blood or bloody fluids should be treated with a detergent and disinfectant of active chlorine 1080ppm for an action time of 5 minutes. The use of approved cleaning products is advocated for, and it should follow the manufacturer's instructions.

The findings of this review further emphasized the wet dusting that should be done horizontally on surfaces, using freshly prepared solutions of detergents or disinfectants that are EPA registered (Chinn and Schuster, 2017; Seavey, 2010; Alblas, Bartel, and Beaudry, 2017; Dighe *et al*., 2018).

Three studies emphasized the importance of removing all trash, linen, and recycling from the room including soiled anesthesia equipment and supplies before cleaning (Alblas, Bartel, and Beaudry, 2017; Chinn and Schuster, 2017; Dighe *et al*., 2018).

Two publications (Alblas, Bartel, and Beaudry, 2017; Link, 2021) reported that operating rooms are to be terminally cleaned at minimum once every 24 hours during a regular work week regardless of whether the theatre was used or not. Then clean walls if soiled or potentially soiled. Al-Benna (2012); and Chinn and Schuster (2017) further stated that wet vacuum or mop operating room floors after the last surgical procedure of the day or night.

In three studies by Dallolio *et al. (*2017); Alblas, Bartel, and Beaudry (2017) and Link (2021), we were made aware that it is the responsibility of the perioperative nurse to ensure that the operating rooms are cleaned/disinfected as required after each surgical procedure.

In five individual studies (Branch and Amiri, 2020; Dallolio *et al.,* 2017; Gupta *et al,* 2015; Al-Benna, 2012; Dighe *et al*., 2018) a range of disinfectants were noted as means of ensuring surface environmental cleanliness, namely: A blend of hydrogen peroxide, surfactants, wetting and chelating agents, phelolics, active chlorine, phenol, a chlorine releasing solution 1000ppm, sodium dichloroisocyanurate granules hypochlorite, quaternary ammonium compounds. It was also emphasized that enough wetness to be maintained to achieve the contact time.

The operating theatre environment is a secondary reservoir for organisms with the potential to infect patients undergoing surgery Gupta *et al,* 2015; Link, 2021; Al-Benna, 2012). Three studies (Government of South Australia, 2021; Dallolio *et al.,* 2017; Seavey, 2010) further alluded that cleaning standards guide the cleaning practices from the selection of the detergent, cleaning equipment, cleaning techniques, cleaning schedule, and management of special cases. The importance of cleaning and disinfecting the environmental surfaces and patient care items minimizes the patients' and healthcare workers' exposure to potentially infectious microorganisms. This information was emphasized in four studies included in this review (Branch and Amiri, 2020; Assadin, 2021; Seavey, 2010; Mathenge, 2021).

Limitations noted during the scoping review were that there were limited publications that addressed cleaning practices, and most of the publications used in this study were guidelines and standards.

4.3 Phase Two: In-depth interviews findings

This section presents qualitative findings from the in-depth interviews with the experts at the selected study settings. The in-depth interviews with four (4) participants that were purposefully selected due to their expertise, were conducted based on the findings of the scoping review. The experts were from different backgrounds in infection prevention and control in the operating rooms. Interviews were conducted with the Infection Prevention Practitioner (IPP) regional manager, national hygiene consultant, national health laboratory services practitioner, and a Perioperative Nursing educator.

The interviews were transcribed verbatim on the same day. Data analysis was undertaken using Braun and Clarke's six-phase framework for thematic analysis. The interviews were transcribed verbatim on the same day. Data analysis was undertaken using Braun and Clarke's six-phase framework for thematic analysis (Braun and Clarke, 2021).

Table 4.5 displays the information related to the demographic data of participants which comprises five items. The items included are gender, age, nationality, professional qualification, years of experience and current designation. Judging from their profession, it is noted that they are from different backgrounds with the commonality in Infection Prevention and Control. Looking at the years of experience, it is noted that these are professionals with vast knowledge in their field of work ranging from 25 and 35 years of experience. Participants were also from both sectors public and private, which enabled the researcher to have an outlook of how the environmental hygiene of the ORs is managed in both worlds and spheres, and that is what the researcher was looking for to generate rich information and have a broader understanding of the phenomena.

Table 4. 5: Participant's Demographic Information

Demographic data	Participant 1	Participant 2	Participant 3	Participant 4
Professional qualification	Registered Nurse	Nurse educator	Registered Nurse	Hospital hygiene consultant
Years of experience	32 yrs.	35 yrs.	28 yrs.	25 yrs.
Age	50 yrs.	60 yrs.	50 yrs.	61 yrs.
Nationality	South African	South African	South African	South African
Gender	Female	Female	Female	Male
Current Designation	National Health Laboratory Services practitioner	Perioperative Nursing educator	IPP regional manager	National hygiene consultant
Public or Private sector	Semi-private and public	Public sector	Private	Private

4.4 Presentation of the findings of In-depth interviews

Participant 1, a National Health Laboratory Services practitioner, emphasized a lot on microbiology and how microorganisms can be spread during cleaning. The participant mentioned the principles of cleaning, the first principle being the "elbow grease", which none of the other participants mentioned.

Participant 2, a Perioperative Nursing educator with a vast experience in theatre practices described the operating theatre as exceedingly particular with restricted areas. The environment requires three distinct environmental cleaning intervals throughout the day. The participant went into detail describing the cleaning practices and even went to the extent of giving practical examples.

Participant 3, an Infection Prevention Practitioner regional manager responded to the questions relevantly and precisely to the point. The participant's responses showed that she

possesses a lot of knowledge in infection prevention and control. The monitoring that is done for environmental hygiene was mentioned and even included the water

Participant 4, a national hygiene consultant, understood the questions and responded accordingly. The cleaning practices were said to be generally split into two, that is, between lists which is a “quick go through” between patient cases. And then there's an end-of-list cleaning that should be happening, which is a “complete push out” of the theatres.

During data analysis, the researcher went through the transcription and listened to the recording in order for them to pick up any characteristics that could represent a specific idea. The transcripts were imported to the MAXQDA system and codes were generated. Frequency and percentages were also generated, and summaries were compiled through the generated data, through which the researcher was able to formulate sub – themes. Data that was generated was as follows: The frequency depicts the number of times that each category was mentioned during the interviews across all participants. **Table 4.5** presents this information.

Table 4. 6: Presentation of data

Category	Frequency	Percentage
Cleaning equipment	18	11.46
Cleaning intervals	16	10.19
Cleaning practices	42	26.75
Methods	7	4.46
Monitoring	16	10.19
Products or chemicals	12	7.64
Training	8	5.10
Cleaner safety	4	2.55
Manufacturer’s instructions	3	1.91
Recommendations	12	7.64
Responsibility	9	5.73
Risks	7	4.46
TOTAL (valid)	157	100.00

4.5 Presentation of IDI findings

Four major themes and 13 sub themes emerged during data analysis. These include cleaning equipment, cleaning methods, chemicals and human resources. **Table 4.6** below summarizes this information.

Table 4. 7: Themes and sub- themes

Themes	Sub-themes
1. Cleaning equipment/handling and care	1.1. Types of mops 1.2. Cloths 1.3. Wet vacuum 1.4. Buckets
2. Cleaning methods	2.1. Cleaning practices 2.2. Cleaning intervals/sequence 2.3. Monitoring
3. Chemicals/products	3.1. Name of chemicals/products 3.2. Risks 3.3. Manufacturer's instructions 3.4. Cleaner safety
4. Human resource	4.1. Responsibility 4.2. Training

4.6 Theme 1: Cleaning equipment/handling and care

Theme	Sub-theme/s
Cleaning equipment/handling and care	• Mops, • Cloths • Wet vacuum and • Buckets

The first theme was related to cleaning equipment that should be used in the operating theatre. Cleaning equipment in the peri-operative area has been described as the utilization of mops, cloths, chemical disinfectant wipes, lint-free cloths, wet vacuum, and buckets (Branch and Amiri, 2020).

Participants from the in-depth interviews supported the literature by stating that theatres are cleaned with cloths, even though the participants were not specific as to whether is lint-free or microfiber. What transpired is that clothes should be disposable. Participants also make mention of the mops. However, there is a variation in terms of the types, others have indicated that mops should be color-coded and be used in designated areas. The following statements bear evidence:

"Generally, they're using a blue coded cloth and a bucket, and it should be dedicated to each theatre. Each theatre should have its cleaning equipment so that there's no spread of infection where equipment is shared from one theatre to the other." [P4]

"They *still use the spaghetti mops because they deal with blood spills, only for that specific reason and thereafter make sure that it is correctly decontaminated."*

She further mentioned "*We use the color-coding system and the disposable cloths which are changed at the end of the shift or when they are looking tacky and highly discourage the utilization of the brooms. We do not use brooms in our health care facilities at all due to the risk of aerosolizing the organisms, instead, we use what we call the flat mop sleeves, which will be moistened with the solution".* [P3]

"*With the cleaning equipment, as I've mentioned earlier on, we have moved from mops…. Mm-mm. We are now using, I can't, and I've forgotten the name of that thing that they are using. It's a cloth that has a sticky part underneath that sticks to that. I think they call it flat mops. Afterward, they've got a bigger bin in the sluice room where they, they, they do their mixture and put those, um… flat mops in and they wash them and take them for autoclaving".* [P1]

[P2] stated that there are different color-coded cloths for different purposes, so as mops." *You need to use the red cloth in the toilet where they belong, so it's the same as in the theatres. Red mops for the blood and your green or blue mops will go for the normal general theatre, so the passage and stuff. And then the other thing is the double bucket system, you need the detergent in the red bucket and your water in the blue bucket". No brooms are allowed in the operating theatres, only the special mops, that is: flat mops".*

4.7 Theme 2: Cleaning methods

Theme	Sub-theme/s
Cleaning methods	• Cleaning practices • Cleaning intervals/sequence • Monitoring

4.7.1 Cleaning practices

Cleaning methods are described as best practices for the frequency, method, and process for cleaning (Centers for Disease Control and Prevention, 2019). Participants of the IDIs were in support of the literature searched during the scoping review. This is illustrated in the quotes from participants in the study mentioned below:

"I've observed that the theatre staff in the morning clean the theatre with a bleach solution before the first patient is placed on the theatre bed and that's when we talk about damp dusting" Then in between procedures all the blood is removed with soap and water followed by the bleach solution and a special red mop need to be used and cleaning needs to be from the outer side to the theatre bed. So, they start from the clean part to the dirty part" [P1].

"I've observed, um, operating rooms are exceedingly particular and restricted areas with a mechanically controlled environment where surgical procedures are performed and require three (3) distinct environmental cleaning intervals throughout the day". [P2]

"*Ok, so currently the operating room cleaning practices are obviously between cases. So, our environment, in the private sector, obviously entails that the housekeeping staff cleans the floors and beds, umm and then the nursing staff is supposed to clean the equipment between patients"* [P3].

"*And so the cleaning of the operating theatres is generally split into two, is a between list which is a quick go through between patients' cases. And then there's an end of the list cleaning that should be happening, which is complete push out of the theatres".* [P4]

4.7.2 Cleaning intervals

Cleaning in the operating theatre is done before the first case is placed on the table, cleaned again after each patient or between cases, and lastly at the end of the day's list. According to Alblas, Bartel, and Beaudry (2022), the operating or procedure room should be

damp dusted with a clean, lint-free cloth moistened with an EPA-registered hospital detergent/disinfectant immediately before the first case of the day, in between cases, and a terminal cleaning is performed at the end of the list.

Participants have also concurred with the literature searched as supported by the direct quotes below:

"*It's before the first procedure, meaning where we are doing damp dusting. And then the second one is between the procedures. The third of which is the last one for the day, it's after the last procedure, which is normally called terminal, cleaning, others they are calling it push out. Yes."* [P1]

"*So in between cases, obviously and then after the list I do a full push out, or they're supposed to do a full push out with a full cleaning of that theater. And obviously if they've done a case that has been isolated or that has an infectious disease, we do terminal cleaning and then obviously zapping or fogging after the case as well."* [P3]

4.7.3 Monitoring

In a study conducted by Carling and Huang (2013), substantial gains have been achieved in ensuring strong adherence through enhancements in monitoring and feedback mechanisms. Alternative methods have successfully enhanced the assessment and quality of cleaning and disinfection due to findings suggesting that visual inspection alone is not enough to guarantee the proper removal of crucial healthcare-related pathogens. Participants have supported the literature searched; the following statements bear evidence:

"*They will go to the third step, and they will either use fogging or UV lights to determine whether the terminal cleaning was effective". "They will have to wait for two (2) hours before the theatre can be used for the next patient".* [P1]

"*After the list then they do a full push out and if they have done a case that has been isolated or that has an infectious disease, we do terminal cleaning and then obviously zapping or fogging after the case as well, then the Unit Manager or the link nurse will conduct the UV checks". "So, in our facilities, we do particle counts every six months, then we also do legionella counts throughout the facility at least once a year".* [P3]

"*Ok, they are monitoring generally using a cleaning checklist and the other thing is that the area will probably be audited by your Infection Control Sister and all protocols and procedures need to be checked".* [P4]

4.8 Theme 3: Chemicals/products

Theme	Sub-theme/s
Chemicals/Products	• Sodium Hypochlorite (Chlorine) • Others: Hydrogen peroxide Peracetic acid

4.8.1 Sodium Hypochlorite

There are three levels of disinfection: High, intermediate, and low. High-level disinfection kills all organisms, except high levels of bacterial spores and prions. Intermediate-level disinfection kills mycobacteria, most viruses, and bacteria with a chemical germicide registered as tuberculocidal by the Environmental Protection Agency (EPA). Low-level disinfection kills some viruses and bacteria with a chemical germicide registered as a hospital disinfectant by the EPA (Majumdar and Venkatesh, 2011). The recommended disinfectants for use in hospitals are 1) Chlorine-releasing agent – hypochlorite (strength: 1,000-10,000 ppm), 2) Alcohol-based (70%-90%) agent, and 3) Quaternary ammonium compounds (QAC) and other chemicals available on the market (Practical Manual, 2021).
This was supported by the participants during the in-depth interviews:

Participant 1 specified the strength of the chlorine depending on the organism cultured and the type of surface. She stated that:

"You *need to use 250ppm Chlorine according to the hospital protocol. If a gram-negative organism was cultured, then you will need 4000ppm Chlorine and 6000ppm Chlorine for Candida Aureus and on plastic".* [P1]

"*Yes, there is what we call Chlorine, which is called bleach in our domestic setting. They use that, and it has a specific strength according to manufacturer's instructions".* [P2]

"*So, if we look at chemicals and we use hypochlorite solution. So throughout and if you look at our SOP's as well, surface decontamination is done with 1000ppm, and the floors are decontaminated with 500ppm".* [P3]

"Basically what they are doing is they're using a detergent to do a pre-clean and a disinfectant after that and so the detergent is used to pick up as much bio load as possible in the theatre before the disinfectant is used, to increase effectiveness of the disinfectant and mostly Chlorine is used and Chlorine based disinfectants. Usually, the floors are done with 1500ppm, and the contact surfaces are done with 1000ppm Chlorine". [P4]

4.9 Others

The other disinfectants that were mentioned by 2 participants that supports the literature are stated in the following statements:

"*In order to kill the Candida Aureus, you need to use Chlorine and peracetic acid".* [P1]

"*fogging is done with the use of peroxide hydrogen".* [P3]

4.10 Risks and Cleaner safety

These sub-themes emanated from the questions that were asked to the participants during the IDI's and none of these surfaced in the publications during scoping review. They go hand in hand for every risk presented there should be a safety measure. The following quotes from participants support these statements:

"*Normally if you use soap and water, it's not harmful for the cleaner but the blood and blood products may be harmful to the cleaner, so cleaner needs to use the Personnel Protective Equipment (PPE)". Also, cleaners should use PPE when using chlorine-based chemicals as they are corrosive".* [P1]

Participant 2 mentioned that *"So when they are using, especially the mixing part of the disinfectant, they should have uh, uh, uh, PPE, meaning they should have goggles, uh, uh, apron and gloves. They are at risk like for instance, if one can inhale it, it will affect or erode the respiratory system and the eyes".*

"Ok, so as long as the solution is mixed according to manufacturer's instructions and according to the strength, obviously during mixture of these solutions, it's just to make sure that the staff mixing them does not inhale the solutions so that they know what to follow and how to effectively manage it. We should have images available showing how to manage, should staff member have a splash or inhalation or anything", [P3]

"*There's actually and most of our products are pretty safe for use, so if they are going to use PPE, it's generally for protection from infection more than the chemical"." Cleaners though should be inoculated for hepatitis B and make sure they have proper PPE".* [P4]

4.11 Theme 4: Human Resource

4.11.1 Sub –theme: Responsibility

Cleaning the perioperative environment is a basic principle for all perioperative team members (Spruce and Wood, 2014 and Centers for Disease Control and Prevention (CDC), 2019).

"Registered nurse has an ultimate responsibility for cleanliness of the surgical invasive areas, but according to the Health and Safety Act, it is everyone's responsibility to keep the working environment safe" [P1].

"*Us nurses will clean the equipment, push out and put it in the passage and allow the cleaners to clean the walls and the floor."* [P2]

Participant 3 indicated that it is *"Theatre Unit Manger's ultimate responsibility to ensure that her theatre or her environment is cleaned properly and that the risk is reduced in her facility."*

"OK, so you've got degrees of responsibility, as far as I'm concerned with theatres, the main responsibility for a complex relies entirely on the theatre matron. She may not be involved daily, but

she needs to know what's going on. And I also believe that the nursing staff and the cleaners too are responsible." [P4]

4.11.2 Sub –theme: Training

All staff must be trained in the correct methods of cleaning and disinfection relating to their job category (Practical Manual, 2021). Participants supported the literature searched and the following statements bear evidence:

"*Training is important because you need a lot of information to clean properly, and knowledge is power. Without knowledge, you cannot win, you are fighting a losing battle.*" [P1]

"*There are in-service trainings that are conducted for the nursing staff every second week, so now of late, we've decided to include the cleaning team as well, because we are working as a team."* [P2]

"OK, so training is very important for housekeeping as well as nursing staff, so obviously housekeeping staff needs to know the type of equipment, the type of solutions that is used." [P3]

"So, I think training is really, really important as far as the cleaning staff are concerned." [P4]

4.12 Discussion of the findings (scoping review and IDIs)

During the scoping review 12 publications were reviewed to respond to the first objective, to determine the current evidence-based literature published on intra-operative environmental management and categories were formed that described the cleaning practices. There were 5 categories namely cleaning equipment/handling and care, cleaning methods, chemicals/products, intervals/sequence and human resources. Four participants took part in the in-depth interviews, where they were responding to semi- structured questions that were developed by the researcher. There were 7 questions in total that were asked ranging from cleaning practices, cleaning chemicals/products, cleaning methods, cleaning intervals, cleaning equipment, responsibility and cleaner safety.

4.12.1 Cleaning equipment/handling and care

Studies indicated that mops in conjunction with the buckets should be utilized for cleaning the floors in the OR. It was also indicated that floors should be cleaned with a wet vacuum after the last case of the day or night. Surfaces to be cleaned with hospital grade EPA registered low- level disinfectants (Chinn and Sehulster, 2017). Other studies stated that the OR should be damp dusted with a clean lint-free cloth or microfiber cloths moistened in a disinfectant or even disinfectant wipes. Cloths to be changed daily or when they get soiled. The person performing the cleaning should wear Protective Personnel Equipment (Seavey,2010).

Participants indicated that surfaces are cleaned with disposable cloths that are colour coded and each theatre has a dedicated bucket that is colour coded as well. Somehow other institutions are still using spaghetti mops when they are dealing with the spillage. The general cleaning of the floors is done with flat mops sleeves that are moistened with a disinfectant and have strongly disagreed to the usage of the brooms in the theatre. They also echoed the same sentiment with the publications in terms of the PPE. Cleaners should wear the PPE when mixing the cleaning solution and when cleaning.

4.12.2 Cleaning practices

Cleaning practices recommendations state that application of pressure during physical wiping should be done with chemical disinfectant wipes or cloths. Wet dusting horizontal surfaces daily with cleaning cloths pre-moistened with detergent or an EPA-registered hospital disinfectant or disinfectant wipes. Branch and Amiri (2020) pointed out that the mop head should be changed at the start of the day and as required by facility policy, or after cleaning up large spills of blood or other body substances. Wet vacuum or mop operating room floors after the last surgical procedure of the day or night, with a single-use mop and an EPA-registered hospital disinfectant. According to Chinn and Schuster (2003), and Seavey (2010) indicated that when reusable cloths and mops are used for cleaning, they should be decontaminated or changed after each use to prevent surface contamination during cleaning and subsequent transfer of organisms. Once used, cleaning mops or cloths should not be returned to the cleaning solution container, in other words, no “double dipping.

Horizontal surfaces should be damp dusted with a lint-free cloth moistened with low-level disinfectant (Alblas, Bartel and Beaudry, 2022). According to Gupta, Vanathi and Tandon (2015) and Dighe *et al.* (2020) stated floors should be cleaned with vacuum cleaner or wet mops, and brooms are not recommended as it increases bacterial flora in the environment. Rooms to be cleaned after each operation for the next one with a wet mop, washing with hot water and a general-purpose detergent. If single-use, disposable mops, and cloths are not used, mop heads and cloths should be cleaned after each use and allowed to dry before reuse. After the last surgical operation of the day or night, operating theatre floors should be wet-vacuumed or wet-mopped with a single-use mop and disinfectant (Al-Benna, 2012).

4.12.3 Cleaning methods

Start cleaning from the least soiled to the most soiled areas and from higher to lower. Hand touch surfaces should be prioritized, wiping systematically without going over the same place twice. Surface disinfectants should be applied to maintain enough wetness to achieve the contact time (Branch and Amiri, 2020). Damp dust horizontal surfaces before the beginning of the first case. Clean and disinfectant any furniture or equipment that came in contact with the patient or may have become soiled or damp, including operating table, surgical lights, blood pressure cuffs, and tourniquets. Remove trash and ensure that colour coded waste collecting bags are placed in the bins (Mathege and Prasad, 2021).

This question seems to have been a challenge to the participants as all 4 participants have responded to the cleaning methods the same as the cleaning intervals, which are cleaning the theatre before the first patient is placed on the theatre bed. Secondly theatres are cleaned in between the surgical procedures or after each case and lastly at the end of the list where they are performing the terminal cleaning. Prioritize cleaning of hand-touch sites, wiping systematically without going over the same area twice. Follow the principle of one wipe, one site, and one direction. Any subsequent equipment should be wiped down before it is transported into the operating or procedure room day using disinfectant and microfiber cloths (Seavey, 2010). According to Alblas, Bartel, and Beaudry, (2022), cleaning should start at higher surfaces and work down clockwise. Equipment should be damp dusted before it is brought into or out of the OR theatre. Inspect OR Theatre lights for cleanliness before

the first case of the day. Equipment leaving the OR Theatre is cleaned and disinfected with hospital-approved disinfectant. Each OR must be cleaned and disinfected immediately after each case. Before cleaning, remove all trash, linen, and recycling from the room including soiled anesthesia equipment and supplies. All surfaces in direct or indirect contact with the patient or body fluids are considered contaminated and therefore cleaned/ disinfected with a hospital-approved disinfectant (Alblas, Bartel, and Beaudry, 2022). This is supported by guidelines (Best Practices for Environmental Cleaning in Healthcare Facilities in Resource-Limited Settings), that indicated that effective environmental cleaning techniques lower the likelihood of transmission, according to growing, albeit incomplete, evidence

4.12.4 Cleaning intervals

Cleaning of the theatres occurs when preparing a new theatre, every day before the first surgery begins, between patients and after the last operation of the day also known as terminal cleaning (Mathenge and Prasad, 2021). According to Dallolio *et al.* (2018) it was mentioned that cleaning should be conducted Between each operation and at the end of the daily operating session. Cleaning conducted in between one operation and the next follows a sequence. According to Seavey (2010) Terminal cleaning and disinfection procedures should be performed when the scheduled procedures are completed for the day, and each 24-hour period during the regular work week. Theaters are to be terminally cleaned at minimum once every 24 hours during a regular work week regardless of whether the theatre has been used (Alblas, Bartel and Beaudry, 2022).

This question seems to have been a challenge to the participants as they have responded to the cleaning methods the same as the cleaning intervals, which are cleaning the theatre before the first patient is placed on the theatre bed. Secondly the theatres are cleaned in between the surgical procedures or after each case and lastly at the end of the list where they perform the terminal cleaning.

4.12.5 Chemicals/products

Studies indicates that surfaces should be cleaned with sodium hypochlorite, a blend of hydrogen peroxide, surfactants, and wetting and chelating agents, phelolics, alcohol and quaternary ammonium compounds. Other chemicals include a chlorine releasing solution 1000ppm (e.g. Presept, Haztabs, Sanichlor or household bleach at 1 part bleach to 10 parts

water) that should be used for surfaces contaminated with body fluids (Al-Benna, 2012). Dichlorosocyanurate granules or solution at 10,000ppm for blood spillage. Floors are cleaned with Phenol in the concentration of 1:10. Cleaning solutions should be prepared daily or as needed according to manufacturer's instructions.

As much as so many cleaning products were mentioned in the publications, the participants indicated that surfaces should be cleaned with chlorine-based disinfectants. One participant added to say that there is a specific organism (Candida Aureus) that needs peracetic acid and chlorine to kill it. It was also mentioned that fogging is done with peroxide hydrogen.

4.12.6 Human resources

Cleaning should be carried out by trained and competent personnel (Dallalio *et al*., 2017). It should be a team approach. Other studies indicated that it should be carried out by theatre personnel or by the perioperative nurse.

In the IDI's participants had different views and some indicated that cleaning should be done by a Registered nurse whom has an ultimate responsibility towards ensuring cleanliness in the theatre. Others mentioned that it is everyone's responsibility and also the Unit Manager has an ultimate responsibility to ensure that the theatre environment is cleaned properly.

The following topics were addressed in the IDI's. During the literature search the researcher identified that there are areas that are important that needed to be explored as might answer some of the research question or even respond to the objectives, and they were taken up as questions that were posed during the IDI's.

4.12.7 Training

Branch and Amiri (2020) stated that staff members should receive proper education and training in environmental surface hygiene practices. During the IDI's the participants stated that training is important as far as cleaning staff is concerned. There should be in-service trainings rendered that covers all staff members including cleaners.

4.12.8 Risks and cleaner safety

The risks that were highlighted by the participants were of the chemicals and the exposure to communicable diseases. Participants mentioned that the cleaners should always follow the manufacturer's instructions when mixing the chemicals/products. As some of the chemicals and blood products might be harmful to the cleaners, they should always wear PPE to ensure safety towards splashes. The other aspect that was highlighted was that cleaner should be inoculated for Hepatitis B.

4.12.9 Monitoring

A study conducted by Ling *et al.* (2015) suggested that processes should be in place to measure the quality of cleaning in the health care setting. Conventional visual assessment and/or fluorescent marking should be used as one of the measures used to assess or monitor cleanliness. During the IDI's the participants addressed the monitoring processes. It was indicated that fogging or UV lights should be used to determine the effectiveness of the terminal cleaning in case there was a patient with cultured organisms that was operated on. They also mentioned that a particle count should be performed every six months.

4.13 Conclusion

Studies have repeatedly demonstrated that the operating room serves as a secondary reservoir for microorganisms that could potentially infect surgical patients. Cleaning and disinfection are both required to reduce the possibility of healthcare workers and patients coming into contact with potentially infectious bacteria. Environmental cleaning encompasses routine housekeeping tasks that need to be scheduled and recorded on a weekly or monthly basis, end-of-procedure cleaning, also referred to as between-case or room turnover cleaning, and terminal cleaning, which is cleaning done at the end of the day list.

CHAPTER 5 : THE DEVELOPMENT OF AN ENVIRONMENTAL HYGIENE MANAGEMENT AUDIT TOOL

5.1 Introduction

The data collected from Phase 1 and Phase 2 of the study was used to develop the standardized audit tool for intra-operative environmental management in the operating rooms. In Phase 1 of the study, a scoping review was conducted which provided the researcher with a clear picture of the evidence-based publications that are out there on the cleaning practices in the operating rooms. In Phase 2 of the study, the In-Depth Interviews were conducted with experts to gather multiple viewpoints on the intraoperative environmental cleaning practices. Findings of the scoping review, and In-depth interviews were presented and discussed. The findings then informed the development of a standardized audit tool.

In this chapter, the development of a standardized audit tool based on Donabedian's (1988) theoretical framework of the structure, process, and outcomes was done. This chapter only covered the development. The feedback from the supervisor was effected to improve the draft audit tool. The validation of the audit tool will be part of the doctoral studies.

5.2 The process followed

The development of the standardized audit tool followed the Donabedian (1988) theoretical framework. Three crucial elements are presumed to exist in a Donabedian paradigm for evaluating quality i.e. Structure, process, and outcome. Donabedian (2005) states that the locations of medical facilities and the instruments utilized in each product are part of the structure. Aspects of the patient, the service provider, or the system may also be included.

The collection of actions between professionals, experts, and patients is referred to as the "process." It consists of both technical and interpersonal elements. Donabedian (1988) defined outcomes as the impacts on the health and well-being of individuals and society at large. These effects include clinical results, quality of life, and satisfaction with the care received. The findings of the scoping review and the IDIs identified themes, sub-themes, and categories, which enabled the researcher to extract items that would best fit each element of the Donabedian (1988) theoretical framework. Figure 5.1. below depicts the indicators that form the part of the structure, process, and outcome. Under the structure, six indicators are deemed as organizational features that influence the delivery of care. Under the process, there are five indicators which are activities undertaken by healthcare professionals to ensure the delivery of quality patient care. Lastly, under outcome, three indicators mark the results or the outcome of the interventions rendered toward the delivery of patient care.

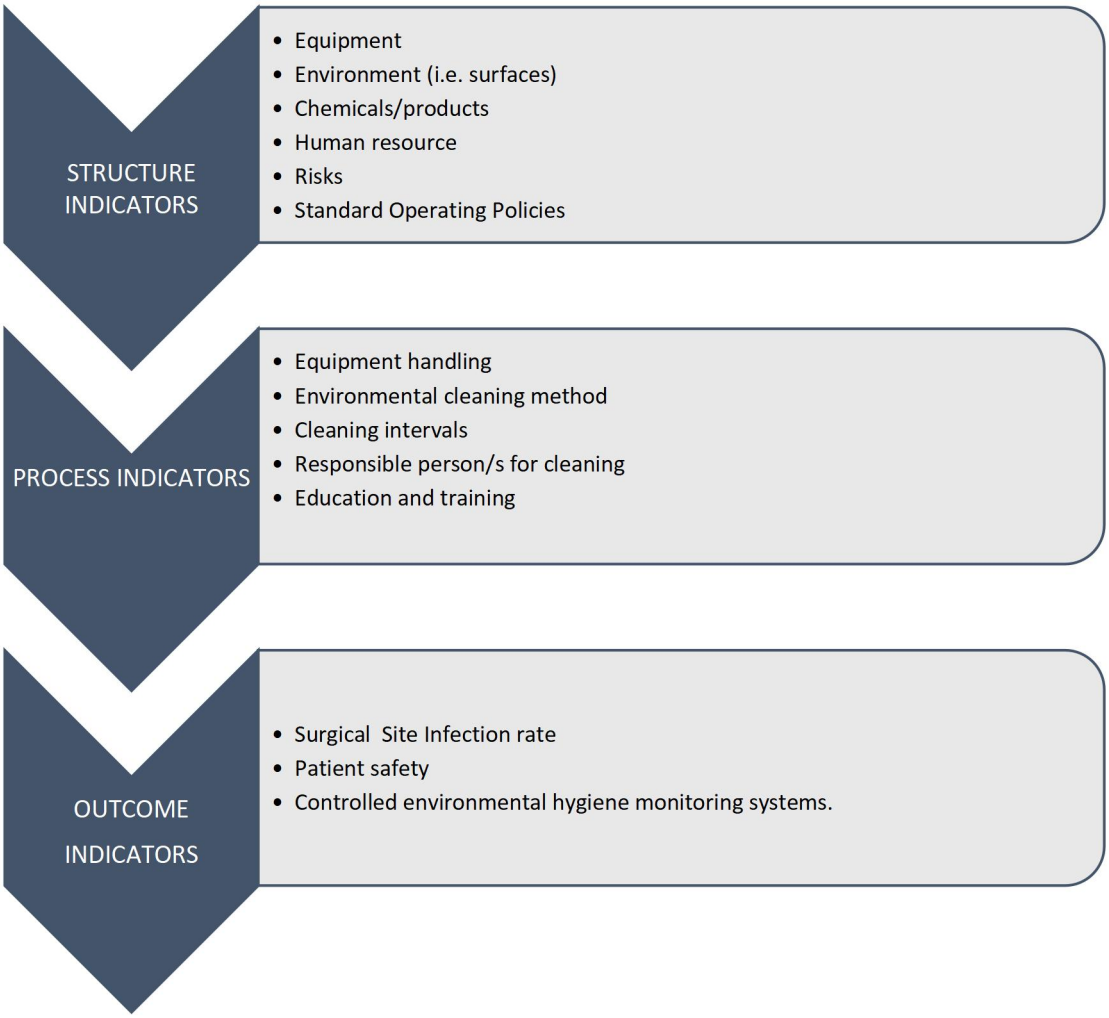


Figure 4: Donabedian's (1988) theoretical framework of the structure, process, and outcomes.

5.3 Structure indicators

5.3.1 Equipment

During the scoping review, in the publications that were searched, they mentioned a mop and a bucket system as the equipment of choice, followed by a wet vacuum system and then the utilization of a lint-free cloth. The utilization of brooms was not recommended. In

one publication the utilization of chemical disinfectant wipes was mentioned. As for the Personnel Protective Equipment, it was mentioned only in one publication. During the IDIs, participants mentioned spaghetti mops that are color-coded and bucket systems for cleaning i.e. red for blood, green or blue for general use. The utilization of flat mops that are damp for cleaning the floor in between cases (Chinn ans Sehulster, 2017). Disposable lint-free cloths to be used for dusting. It was also mentioned that no brooms are allowed in the operating rooms (Dighe et al., 2018). It was said that cleaners should use PPE when cleaning, this was mentioned by all the participants unlike in the scoping review. This is further supported by the Practical Manual for Implementation of the National Infection Prevention and Control Strategic Framework (2020), where a mop and bucket system is used for cleaning the floors. Surfaces are dusted with a lint-free cloth that is disposable and dry cleaning i.e. sweeping using brooms is not advocated for. Therefore Standard 1: *"Equipment needed to perform cleaning of the operating room evident".*

5.3.2 Environment (i.e. surfaces)

Surfaces that have been mentioned in the publications that form part of the structure are 1). Horizontal surfaces. 2). High/hand touch surfaces for example control panels, switches, knobs, anesthetic machines, monitors, and anesthetic trolleys. 2). the theatre bed and its accessories. 3). Blood pressure cuffs, tourniquets, drip stands, surgical lights, leads, and any other surface, including furniture that has come into contact with the patient's body fluids. 4) Walls and floors. 5) Scrub basin and taps (Mathege and Prasad, 2021). Standard 2: *"Environmental management of relevant surfaces performed".*

5.3.3 Chemicals/products

The literature reviewed states that surfaces should be cleaned with Hospital-grade EPA-registered low-level chemical disinfectants. From two (2) to one (1) publication different cleaning solutions were mentioned such as Sodium hypochlorite, A blend of hydrogen peroxide, Quaternary ammonium compounds, Active chlorine 1080 ppm, A chlorine-releasing solution of 1000 ppm, and Floors will be done with active chlorine 540 ppm Alcohol, Phelolics, and peracetic acid. Sodium hypochlorite and Quaternary ammonium compounds are the most stated. In the IDIs, participants had a different view of the chlorine

strength. Participant 4 stated that Floors are done with 1500 ppm chlorine and contact surfaces with 1000 ppm chlorine. With Participant 1, the strength was dependent on the wound type. For a clean patient clean with 250 ppm chlorine, 500 ppm chlorine for Clostridium Difficile, 4000 ppm chlorine for Candida Auris, and sometimes increase to 6000 ppm chlorine to clean plastic. Participant 3 said that the surface is cleaned with 1000 ppm chlorine and floors 500 ppm chlorine (Al-Benna, 2012). The two participants interchangeably used jik/bleach solution with chlorine. The other chemicals/products that were mentioned were alcohol-based solutions, peracetic acid, and hypochlorite solutions. Standard 3:" *Chemicals used as per hospital protocol and manufacturer's instructions".*

5.3.4 Human resource

According to the data collected from the scoping review, the human resource mentioned was said to be theatre personnel, perioperative nurses, and interdisciplinary team (Dallalio *et al*., 2017). In the in-depth interviews, participants had a different view and stated that the human resource comprises the Registered Nurse, while others stated that it comprises everyone in the theatre and the Unit Manager as the responsibility remains with her/him. Therefore, Standard 4: "*The cleaning team fully represented"*

5.3.5 Risks

During the in-depth interviews, participants mentioned that the chemicals used for cleaning pose a risk to the person mixing them if not used as per the manufacturer's instructions and used in the absence of PPE. Chemicals may irritate the respiratory system and the eyes. Spraying directly onto a surface should never be done since this can irritate the respiratory tract and aerosolize any contaminants present. It is best to spray chemicals onto a cloth before wiping off a surface. Standard 5: *"Chemicals mixed according to the manufacturer's instruction for volume and contact time".*

5.3.6 Standard Operating Policies

According to (World Health Organization, 2020) it is said that a multifaceted strategy is needed for environmental cleaning as a measure to align infection prevention and control

interventions. This may require reminders such as SOPs that are displayed in strategic locations, teaching, auditing, monitoring, and feedback. Standard 6: *"Communication strategies regarding environmental cleaning".*

5.4 Process indicators

5.4.1 Equipment handling

During the scoping review, it was stated in the publications that mop heads were to be changed at the beginning of the day or after cleaning up large spills of blood or other body substances. Reusable cloths to be changed or decontaminated after use. Mop heads and cloths should be cleaned after the last surgical procedure and allowed to dry before use (Chinn and Sehulster, 2017). This was echoed during the in-depth interviews as well, where participants stated that mops are disinfected at the end of the list, and in the other institutions they even take the mops for sterilization in the autoclaves. Cloths should be disposed of after the end of the list or once it becomes dirty.

5.4.2 Environmental cleaning methods

The environmental management of surfaces was best described and quoted as cleaning methods which state that cleaning should be done from higher to lower, from the cleanest area to the dirtiest, and wet dusting horizontal surfaces daily with cleaning cloths. It was also mentioned in three publications that any subsequent equipment should be wiped down before it is transported into the operating room and all surfaces that have come into contact with blood or bloody fluids and high-touch surfaces are treated with a detergent and disinfectant of active chlorine (Mathege and Prasad, 2021). This was cited in the publications that were searched during the scoping review. During the IDIs, the participants stated that cleaning should take place from high to low. One participant mentioned" elbow grease" which is a process of removing debris before cleaning the surfaces. Cleaning to occur from the cleanest area to the dirtiest. All horizontal surfaces should be damp-dusted. This practice was also stated in the Practical Manual for Implementation of the National Infection Prevention and Control Strategic Framework (2020).

5.4.3 Cleaning intervals

Cleaning of the theatres occurs when preparing a new theatre, every day before the first surgery begins, between patients, and after the last operation of the day also known as terminal cleaning. After each operation, clean and disinfect any soiled areas of the floor. Terminally clean operating and procedure rooms each day rooms are used (Mathege and Prasad, 2021).

This question seems to have been a challenge to the participants as they have responded to the cleaning methods the same as the cleaning intervals, which are cleaning the theatre before the first patient is placed on the theatre bed. Secondly, theatres are cleaned in between the surgical procedures or after each case, and lastly at the end of the list where they are performing the terminal cleaning.

5.4.4 Responsible person/s for cleaning

The literature reviewed in five (5) publications individually states its responsible person that cleaning should be carried out by trained and competent personnel. According to Link (2021), it should be a team approach. The perioperative nurse and the Interdisciplinary team are the ones responsible for cleaning the theatre (Dallalio *et al*, 2017). During the interviews, participants indicated that cleaning the theatres is everyone's responsibility. A registered nurse is responsible for the cleanliness of the surgical invasive procedure areas. Cleaners are also responsible for cleaning the theatres; however, they should be overseen by the cleaning supervisor. According to Ogunsola and Mehtar (2020) Cleaners are often supervised by a nurse or cleaning supervisor who are usually not trained nor specialised in the cleaning field.

Participants indicated the demarcation as to who is responsible for cleaning what e.g. nurses are responsible for equipment and cleaners the floors and walls.

5.4.5 Education and training

In the reviewed literature, it is important for staff to receive proper education and training in environmental surface hygiene practices (Branch and Amiri, 2020). The participants

supported the literature by stating that the nursing and housekeeping staff should receive training in environmental hygiene management.

5.5 Conclusion

In a study conducted by Yezli et al. (2014) the inanimate environment of the operating room, including medical equipment is highly likely to be contaminated with pathogens that can cause SSIs despite adherence to standard environmental practices. The results of the scoping review in Phase 1 and the results of the In-Depth interviews informed the development of the audit tool that may be utilized to improve the standard of care and the cleaning practices in the operating theatres. The tool below has responded to the research question: What can be done by theatre staff to audit environmental hygiene? The draft audit tool was discussed with the supervisor and the comments were effected . The validation and implementation of the draft audit tool is outside the scope of this dissertation, it will be part of doctoral studies.

Table 5. 1: An environmental hygiene audit tool

STANDARD 1: STRUCTURE: Equipment needed to perform cleaning of the operating room evident. (C = Compliant; PC = Partially Compliant; NA = Non-Compliant; N/A = Not Applicable).							
NO	**CRITERIA**	**C (2)**	**PC (1)**	**NC (0)**	**N/A**	**INDICATORS**	**SOURCE OF EVIDENCE**
1.	Equipment is used according to the guidelines and policies					1. Colour-coded bucket system	Observation
						2. Colour-coded mop system	Observation
						3. Microfiber mop	Observation
						4. Two-way bucket system	Observation
						5. The non-utilization of brooms	Observation
						6. Wet vacuum system	Observation
	Score per category:						
	The total score obtained:						
	Percentage:						
	Date:						
	Auditor:						
STANDARD 2: STRUCTURE: Environmental management of relevant surfaces performed. (C = Compliant; PC = Partially Compliant; NA = Non-Compliant; N/A = Not Applicable).							
	Environment cleaned (before the 1st patient is placed on the table)					7. Cleaning performed on all horizontal surfaces	Demonstration
						8. High/hand touch surfaces are cleaned	Demonstration
						9. Damp dust all horizontal surfaces before the first scheduled surgical case	Demonstration

						10. Methodically perform damp dusting from higher to lower	Demonstration
						11. The patient bed and its attachments, poisoning devices, and transfer devices are wiped.	Demonstration
						12. Dust all the trollies, and shelves in the ante-room where all sterile equipment is kept.	Demonstration
						13. Clean scrub basins, taps, and walls and check for any leaks.	Demonstration
						14. Wipe the soap and antiseptic solution bottles at the scrub basin (check that they are full and refill them if needed.	Demonstration
						15. Use a clean, low-linting cloth moistened with an EPA-registered hospital-grade disinfectant	Demonstration
						16. Prepare waste bins by inserting color-coded waste collection bags.	Demonstration
						17. Finally, clean and disinfect the floor.	Demonstration
						18. Close the doors for ventilation for at least 10 – 15 minutes.	Demonstration
	Environment (In between each patient)					19. Cleans and disinfects operating rooms after each operation.	Demonstration
						20. Clean and disinfect any furniture or equipment that came in contact with the patient or may have become soiled or damp, including the operating table, surgical lights, blood pressure cuffs, and tourniquets.	Demonstration
						21. Cleans and disinfects high-touch objects after each patient's use (e.g. the anesthetic machine and trolley).	Demonstration
						22. Cleans progressing from clean to dirty	Demonstration
						23. Clean and disinfect the floor around the operating table.	Demonstration

						24. Collect and remove waste from the kick bucket and remove all other waste; replace all bin liners.	Observation
						25. Remove waste from equipment such as suction machines and clean and disinfect them.	Observation
						26. Do not use dry methods of cleaning e.g. sweeping	Observation
	Environment (At the end of the list)					27. Remove waste and laundry, and place them in designated leak-proof containers.	Demonstration
						28. Switch equipment off at the mains. Wipe down electrical cables carefully using a cloth dampened with a small amount of alcohol or other disinfectant and wipe down the equipment such as (Diathermy machines), run them over a wet towel, and push them out.	Demonstration
						29. Clean the legs and wheels of trolleys and tables, run them over a wet towel, and push them out.	Demonstration
						30. Clean anesthesia machines and trolleys, IV poles, and patient monitors.	Demonstration
						31. Clean the operating theatre table, remove the mattress, and wipe it down. Clean all the grooves and the attachments.	Demonstration
						32. Wipe down the operating theatre lights and walls.	Demonstration
						33. Clean the floors.	Demonstration
	Chemicals/products					34. Clean with hospital-grade EPA-registered low-level chemical disinfectants including sodium hypochlorite, a blend of hydrogen peroxide, active chlorine, phelolics, alcohol, and quaternary ammonium compounds.	Demonstration
						35. Chemicals to be used per the manufacturer's instructions	In-service

							training records
	Human Resources					36. Implements cleaning and disinfection procedures when needed, in collaboration with other perioperative and environmental services personnel.	In-service training records
						37. All staff must be trained in the correct methods of cleaning and disinfection.	In-service training records
	Risks					38. Wears personal protective equipment.	Demonstration
						39. Follows standard precautions when cleaning.	Demonstration
						40. Wears proper respiratory protection if cleaning procedures are expected to generate infectious aerosols.	Demonstration
						41. Cleans and disinfect surfaces or equipment as soon as possible when there is visible soiling by blood, body fluid, or other potentially infectious materials.	Demonstration
						42. Performs hand hygiene when gloves are removed and as soon as possible when hands are soiled.	Demonstration
	Standard Operating Policies (SOP)					43. Handles contaminated disposable and reusable items according to SOP	Demonstration
						44. Cleans operating rooms according to stipulated intervals.	Demonstration
						45. Completes required documentation related to environmental cleaning accurately, legibly, and completely according to the facility or healthcare organization's policies and procedures.	Demonstration
						46. Participates in assigned quality improvement activities related to environmental cleaning.	Attendance register

	C				
	PC				
	NC				
	Final score %				
	DATE:				
	AUDITOR:				

KEYS:

C = Compliant

PC = partially compliant

NC = Not compliant

CHAPTER 6 : DISCUSSION, LIMITATIONS, STRENGTHS AND RECOMMENDATIONS

6.1 Introduction

In the previous chapter, a standardized audit tool was developed using the Donabedian Framework (1988) of structure, process, and outcomes. In this final chapter, a summary of the scoping review, the in-depth interviews, and the developed audit tool were discussed. The study limitations and recommendations for nursing practice, nursing education, and research are provided, followed by the conclusion.

6.2 Summary

The purpose of the study was to contribute to a safe operating room environment and environmental management practices through the development of an environmental audit tool that could contribute to the quality of care of all patients in the operating room. The research question for each phase was:

Phase 1: What literature is currently available that describes environmental cleaning practices in intra-operative room environments?

Phase 2: What elements should be included in an Environmental Hygiene Audit Tool, according to the outcome of the in-depth interview?

Phase 3: Can an Environmental Hygiene Audit Tool be developed based on data collected from the previous two phases of the study?

This study employed a scoping review to explore the existing literature on the management of environmental hygiene in operating rooms. A scoping review was followed by an in-depth interview. The data collected from both the scoping review and the in-depth interviews were used to develop a standardized audit tool for the management of environmental hygiene in the operating rooms. The development of the audit tool used the Donabedian Framework (1988), which is of structure, process, and outcomes.

6.3 LIMITATIONS

6.3.1 Scoping Review

The scoping review included 12 publications from which results and conclusions were drawn. The researcher included publications that addressed the management of environmental hygiene. Five (5) of the publications used were guidelines, mostly from Europe and Australia. Seven (7) were from the journals. South African guidelines were excluded as they were not specific to operating rooms, they addressed environmental hygiene generally. Therefore findings might not be relevant to South Africa, as the burden of disease is not the same.

6.4 STRENGTHS

6.4.1 In-Depth Interviews

In-depth interviews were conducted with experts from different backgrounds in infection prevention and control in the operating rooms. Interviews were conducted with the Infection Prevention Practitioner (IPP) regional manager, national hygiene consultant, national health laboratory services practitioner, and a Perioperative Nursing educator. The results yielded results that were reached with expert information. A focus group interview could have turned out to be a showground, judging from the diversity of the group.
The developed standardized audit tool

A research question was answered and the answer was yes the audit tool could be developed from the results of the data collected from the two previous phases. Data was collected from the two phases independently and individually. Then the results were compared and analysed and findings were drawn, which enabled the researcher to develop the audit tool from the findings.

6.5 RECOMMENDATIONS

6.5.1 Nursing Research

Research on environmental hygiene management in operating rooms is critical for ensuring patient safety and preventing healthcare-associated infection. It is therefore recommended that current practices are reviewed i.e. to conduct a comprehensive review of current environmental hygiene practices in operating rooms. This should include an assessment of cleaning protocols, disinfection methods, frequency of

cleaning, and adherence to established guidelines and protocols. Consider conducting longitudinal studies to evaluate the sustainability of improvements in environmental hygiene practices over time. This could involve ongoing monitoring and feedback to ensure continued adherence to best practices. Foster collaboration between nursing researchers, infection control specialists, environmental services staff, and other stakeholders to share best practices and lessons learned in environmental hygiene management. This interdisciplinary approach can lead to more comprehensive and effective strategies for maintaining a clean and safe operating room environment. Conduct comparative studies of different cleaning agents, techniques, and equipment to determine the most effective strategies for maintaining a clean and hygienic environment.

6.5.2 Nursing Practice

Maintaining high standards of environmental hygiene in operating rooms is crucial for preventing infections and ensuring patient safety. It is recommended that a strict schedule for routine cleaning and disinfection of all surfaces in the operating room, including floors, walls, countertops, and equipment is implemented. Use EPA-approved disinfectants and follow manufacturer instructions for proper dilution and contact time. Conduct thorough terminal cleaning of the operating room after each surgical procedure. This involves a comprehensive cleaning of all surfaces, equipment, and fixtures using appropriate disinfectants and cleaning agents. Identify potential risk factors for contamination and transmission of pathogens in the operating room environment. This may include factors such as high patient turnover, inadequate cleaning supplies, improper disinfection techniques, and environmental factors such as temperature and humidity. Assess healthcare workers' compliance with established cleaning protocols and guidelines. This could involve direct observation, surveys, or audits to identify barriers to compliance and develop strategies to improve adherence to best practices. Implement proper waste management protocols to safely dispose of bio-hazardous materials, sharps, and other surgical waste generated during procedures. Use designated containers for different types of waste and ensure timely removal and disposal. Investigate the impact of environmental hygiene on patient outcomes, including rates of surgical site infections (SSIs) and other healthcare-associated infections (HAIs). This could

involve retrospective analysis of patient records to identify correlations between environmental cleanliness and infection rates. Explore the role of emerging technologies in improving environmental hygiene management in operating rooms. This may include using UV-C light disinfection systems, antimicrobial surfaces, and automated cleaning robots to supplement traditional cleaning methods.

6.5.3 Nursing Education

Education should be provided to all the staff members (including cleaners) of the institution and not only the nurses. Orientation programs and in-service training should be considered with an aim to empower staff members and cleaners on the management of environmental hygiene in the operating rooms. Provide a curriculum that comprehensively covers microbiology and the management of environmental hygiene. Provide comprehensive education and training programs for operating room staff on proper hygiene protocols and infection control practices. Ensure that all staff members are aware of their responsibilities in maintaining a clean and safe environment.

6.6 Conclusion

The researcher came to a conclusion that the literature prooved that there has been a rise in the number of surgical site infections, however, the cause is pointing in many directions and one of them is the environmental cleanliness. It has been highlighted that cleaning should be done with lint-free cloths that are dipped in a hospital-grade EPA-registered low-level disinfectant, used as per the manufacturer’s instructions. Cleaning should be performed in intervals and it should follow a sequence. A bucket and a mop system to be used and the use of a broom was discouraged. Cleaning should be done by personnel who have donned their PPE. Environmental cleanliness requires environmental cleaning teams that are guided by clear instructions and training, and simple methods of assessing cleanliness, which cannot be done by visual assessment.

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UNIVERSITY OF THE WITWATERSRAND, JOHANNESBURG

Appendix A: Participants' information letter

STUDY INFORMATION SHEET FOR PARTICIPATION IN THE SEMI-STRUCTURED INTERVIEW

Good day.

My name is Patience Mahlangu, a Master of Nursing Science (Perioperative Nursing) student at the University of the Witwatersrand in the Department of Nursing Education. The objectives of my study is to determine evidence-based intra-operative environmental cleaning practices, and to develop an intra-operative environmental management audit tool.I would like to invite you to participate in the phase 2 of this study conducted through a semi structured interview. You will be expected to engage in an in- depth interview with the researcher.

Procedures

The interview will be facilitated as a face-to-face session or virtually via Microsoft Teams or Zoom session. You will be provided with Interview questions prior the interview, based on the phase 1 results which was conducted through a scoping review. The interview will take approximately 45 minutes – 1 hour.

Potential risks of being involved in the study

There are no anticipated risks in participating in this study. You will be requested to sign a consent document as well as a document for audio recording.

Benefits of being in the study

Participation in this study will be of no direct personal benefit to individual participants, but it may provide operating room practitioners with a guideline and structure to implement safe environmental practices. This may contribute to the utilization of cleaning practices universally among all the public sectors in Gauteng to effectively manage environmental risk factors in the operative environment, to enhance quality intra-operative patient care.

Participation in the study is totally voluntary and please be informed that if you decide not to participate this will not affect you in any way. You have the right to withdraw from the study at any time if you wish to.

Payment for participation

No payment shall be received for participation in the study.

Participation and withdrawal

Participation in this study is voluntary. If you consent to participate in this study, you may withdraw the consent at any time without consequences of any kind.

Confidentiality

Personal information will be treated in the strictest confidence and will only be available to the researcher and her Supervisor. The only exceptions - and all of them are rare - would normally be:

1. Personal information may be disclosed if required by law.
2. The Human Research Ethics Committees of the University may exceptionally require personal data to respond to a formal complaint, or for a compliance audit.

Electronic data will be stored on the researcher's password-protected computer and network drives.

If results are published, this may, exceptionally, lead to cohort, or more rarely, individual identification. All data collected in the course of the study will be securely retained for five (5) years.

Contact details of researcher:

For further information or if you have any questions or concerns about the research, kindly contact the Principal investigator or the research supervisor.

Patience Mahlangu on; 0730614790 or email; 2370691@students.wits.ac.za
(MSc Perioperative Nursing Student)

Mrs. L. Engelbrecht on; 0721207692; email; linette.engelbrecht@wits.ac.za
(Research Supervisor)

Outputs

The results of the study will form part of a research report and the findings will be shared with the interested participants after the study is completed.

Contact details of HREC administrator and chair

This study has been approved by the Human Research Ethics Committee (Medical) of the University of the Witwatersrand, Johannesburg ("Committee"). A principal function of this Committee is to safeguard the rights and dignity of all human subjects who agree to participate in a research project and the integrity of the research.

If you have any concern over the way the study is being conducted, please contact the Chairperson of this Committee who is Professor Clement Penny, who may be contacted on telephone number 011 717 2301, or by e-mail on Clement.Penny@wits.ac.za. The telephone numbers for the Administrative officer are 011 717 2700 and the e-mail address are zanele.ndlovu@wits.ac.za

UNIVERSITY OF THE WITWATERSRAND, JOHANNESBURG

Appendix B: Consent form

1. I have been given a Participant Information Sheet which explains the nature and processes involved in this study, which is attached hereto;
2. I was given time to read it, or had it read to me, in the language I best understand;
3. I was given time to ask any questions I wanted to and found any answers given to me to be reasonable and satisfactory;
4. I fully understand why the study is being conducted and what the intended outcomes will be;
5. I understand that there will be no immediate benefit to me, should I agree to participate, nor will I receive any payment; conversely, participation will not cost me anything but my time;
6. I understand that, even if I initially consent to take part in the study, I may subsequently withdraw at any time and would not be required to give any reasons; if that happened, any data collected about me for the purposes of the study would immediately be destroyed, unless I give consent for it to be retained
7. I have been given a range of contact details, listed below. If I require further information or become concerned about any aspect of this study, I am free to speak to any of these contacts.
8. I (Name & Surname) …… hereby give consent to participate in the study.

Contact details:

Patience Mahlangu (Principal researcher) on; 0730614790 or by email at 2370691@students.wits.ac.za

Mrs. L. Engelbrecht (Supervisor) on 0721207692 or by e-mail at linette.engelbrecht@wits.ac.za
Professor CB Penny, Chairperson of the Human Research Ethics Committee (Medical) at the University of Witwatersrand, on telephone no. 011 717 2301, or by e-mail at clement.penny@wits.ac.za.
Ms. Z. Ndlovu, Administrative officer on telephone no. 011 717- 2700 or by e-mail at: zanele.ndlovu@wits.ac.za

Name of Participant: _____

Date: _____

Place: _____

Signature: _____

UNIVERSITY OF THE WITWATERSRAND, JOHANNESBURG

Appendix C: Participant consent sheet: audio tape recording

I confirm that I have been informed by the researcher about the nature of the study. I have read/ it was read to me and I understood the information sheet and have had the opportunity to ask questions.

I understand that my participation is voluntary and that I am free to withdraw at any time without giving any reasons and without judgment. I understand that as the interview is taking place, an audio recording of the interview will be taken. I agree to be audio recorded.

I understand that sections of my work history may be looked at by the researcher and her supervisors. I am aware that questions on the intra-operative environmental cleaning practices will be asked. The findings will be anonymously processed into a computerized system. If results are published, this may, exceptionally, lead to cohort, or more rarely, individual identification. All data collected in the course of the study will be securely retained for five (5) years.

Should you wish to contact me at any stage regarding consent you can contact me as the **Principal investigator: Cell no:** 0730614790 or by email at 2370691@students.wits.ac.za

Supervisor: Cell no: 0721207692 or by e-mail at linette.engelbrecht@wits.ac.za

Professor CB Penny, Chairperson of the Human Research Ethics Committee (Medical) at the University of Witwatersrand, on telephone no. 011 717 2301, or by e-mail at Clement.Penny@wits.ac.za. Ms. Z. Ndlovu or Mr Rhulani Mkansi, Committee Secretariat, telephone nos.: 011 717 2700 or 1234, or by e-mail at: Zanele.Ndlovu@wits.ac.za or Rhulani.Mkansi@wits.ac.za

I agree to take part in the above-mentioned study. I hereby give consent for my work history to be used as per the above-mentioned conditions.

_____	_____	_____
Name and Surname of participant	Signature	Date

Appendix D: Interview guide for semi-structured interview

Question 1:

In your experience, can you please share with me the most common Operating Room (OR) cleaning practices you have observed?

Question 2:

How would you describe the evidence-based environmental hygiene management? In relation to the chemicals or products that are used.

What are the names of the chemicals or products that are commonly used and what are the risks if any?

Question 3:

According to the scoping review that was conducted, it was found that operating rooms should be cleaned in intervals. In your experience how would you describe the operating room cleaning intervals?

Question 4:

What are the common methods to manage surface decontamination in the OR?

Question 5:

What would be your recommendations be with regards to cleaning equipment?

Question 6:

Who would you say is responsible for the management of the environmental hygiene in the OR and why?

Follow- up questions: Is training important for the staff on how to manage the environmental hygiene? How is the cleanliness verified or monitored? Is particle count monitoring or microbiological count necessary, if yes, which of the two is the most reliable and comes highly recommended?

Question 7:

Most of the cleaning services are outsourced in our OR's. What is the responsibility of the healthcare facility with regards to cleaner safety?

Thank you for your valuable contribution.

Appendix E : Demographic data sheet

The participant is requested to complete the following information. Please note that as stipulated in the participant's information letter, the information will remain confidential. The information will be used to assist the researcher only.

Participant Code: _____

Professional qualification	
Years of experience	
Age	
Nationality	
Gender	
Current Designation	
Are you employed in the public sector?	
Are you employed in the private sector?	

Appendix F: Invitation to take part in the study

Dear Ms.……., Colleague

My name is Patience Mahlangu, a Master of Nursing Science (Perioperative Nursing) student at the University of the Witwatersrand in the Department of Nursing Education. I would like to invite you to participate in a semi structured interview as an expert in the field of Infection Prevention and Control in the Operating Room. The title of my study is: The development of an intra-operative environmental management audit tool for operating rooms.

This study has been approved by the Human Research Ethics Committee (Medical) of the University of the Witwatersrand, protocol number M210310. The supervisor is Linette Engelbrecht. The interviews will be conducted by myself as face- to- face or via TEAMS/ZOOM sessions. The length of the interview will be 45 minutes to 1 hour.

Once you agree to participate, you will be provided with the consent documents as well as interview guide with possible questions.

Thank you for your time.

Kind Regards

Patience Mahlangu

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Appendix G: Approval of a title

UNIVERSITY OF THE WITWATERSRAND, JOHANNESBURG

Private Bag 3 Wits, 2050
Fax: 027117172119
Tel: 02711 7172076

Reference: Mrs Sandra Benn
E-mail: sandra.benn@wits.ac.za

04 May 2021
Person No: 2370691
PAG

Mrs P Mahlangu
5691 Mokoka Street
Pimville Zone 5
Klipspruit
1809
South Africa

Dear Mrs Patience Mahlangu

Master of Science in Nursing: Approval of Title

We have pleasure in advising that your proposal entitled *The development of an Intra-operative Environmental Management Audit Tool for Operating Rooms* has been approved. Please note that any amendments to this title have to be endorsed by the Faculty's higher degrees committee and formally approved.

Yours sincerely

Mrs Sandra Benn
Faculty Registrar
Faculty of Health Sciences

Appendix H: Permission letter from the institution

UNIVERSITY OF THE WITWATERSRAND, JOHANNESBURG

DEPARTMENT OF NURSING EDUCATION

RE: PERMISSION TO USE A SMALL TUTORIAL ROOM IN THE DEPARTMENT OF NURSING EDUCATION (AREA 261)

Mrs Patience Mahlangu a registered MSc Nursing Student in the Department of Nursing Education, is granted permission to conduct focus group discussion according to COVID-19 protocols, as part two of her study in a suitable venue (small tutorial room) in the Department of Nursing, Faculty of Health Sciences of the University of the Witwatersrand.

Her research study is entitled: *THE DEVELOPMENT OF AN INTRA-OPERATIVE ENVIRONMENTAL MANAGEMENT AUDIT TOOL FOR OPERATING ROOMS*. Her student number is 2370691 and being supervised by our staff member Mrs Linette Engelbrecht.

Should you require additional information, I can be contacted on the email: Shelley.schmollgruber@wits.ac.za

Kind regards

Professor Shelley Schmollgruber
HOD: Department of Nursing Education

11th June 2021

Department of Nursing Education | School of Therapeutic Sciences | Faculty of Health Sciences
7 York Road, Parktown, 2193, South Africa, Tel: +27 11 488-4272 | Fax: +27 11 488-4195
www.wits.ac.za/therapeuticsciences/nursing

Appendix I: Approval of the protocol

UNIVERSITY OF THE WITWATERSRAND, JOHANNESBURG

HUMAN RESEARCH ETHICS COMMITTEE (MEDICAL)

UNIVERSITY OF THE WITWATERSRAND, JOHANNESBURG
Office of the Deputy Vice-Chancellor Research & Post Graduate Affairs

MEMORANDUM

TO: Mrs Patience Mahlangu
Department of Nursing Education
E-mail: 2370691@students.wits.ac.za

FROM: Ms Zanele Ndlovu
Administrative Officer: Human Research Ethics Committee (Medical)
Tel: 011 717-2700
e-mail: zanele.ndlovu@wits.ac.za

DATE: 29 April 2021

REF: *R14/49*

PROTOCOL No: M210310 MED21-02-039 (*This is your ethics application study reference number. Please quote this reference number in all correspondence relating to this study*)

PROJECT TITLE: The Development of an Intra-Operative Environmental Management Audit Tool for Operating Rooms

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The protocol below was considered at a meeting of the Human Research Ethics Committee (Medical) on Friday 26 March 2021.

Decision Deferred:

(This memo is not a clearance certificate, no research should commence prior to obtaining a clearance certificate).

Comments: Submit two hard copies of the following as stipulated below: **Do not submit amendments online.**

- Covering letter (summary of changes)
- Signed Declaration.
- *Application form:*
  - The information given in the HREC document's summary of the research (point 3.3) simply gives the rational for the study and states that a scoping review will be performed, the committee is unable to adequately assess the proposal as there is insufficient information regarding:
    - Procedures (what, who, where, why, how, when)
    - Permission
    - Evidence of Graduate studies review/permission
    - Instrument/tools/method
    - Funding
- *Protocol:*
  - Provide research protocol and research tools.
- *Permission/s:*
  - Provide scientific assessment approval from postgraduate assessor committee.
  - Provide written permission to conduct the study from the HOD and CEO of the study site.
- *Condition/s:*
  - Amended documents, submit one copy including track changes and supporting documents. One clean copy including supporting documents in the following order: cover letter/summary of changes letter, signed

declaration and only the required documents listed under comments above.

- Amendments must be submitted within 6 months after submission from the date that this memo was received. After this period, the application will be considered null and void. To re-apply, you will need to restart application process.
- The default in the research office is hard copies. Emailed amendments will not be considered.
- Delivery Address for amendments: Research Office, Faculty of Health Sciences, Offices 301/302/304, Phillip Tobias Building, third floor, 29 Princess of Wales Terrance, Parktown,2193. Office hours: 08h30-16h30

Annexure 4. 4: Scoping review data presentation

Color	Document name	Segment	Code
●	Semi - structured interview_2023-07-21 (1)	Before the 1st patient is placed on the theater bed and damp dusting is done.	Cleaning intervals
●	Semi - structured interview_2023-07-21 (1)	Before the 1st patient is placed on the theater bed and damp dusting is done.	Cleaning practices
●	Semi - structured interview_2023-07-21 (1)	Then between procedures, the theater is mostly full of blood and all the blood is removed from by soap and water then the bleach solution as special red mops need to be used and cleaning needs to be from the outer side of the theater to the bed.	Cleaning intervals
●	Semi - structured interview_2023-07-21 (1)	Then between procedures, the theater is mostly full of blood and all the blood is removed from by soap and water then the bleach solution as special red mops need to be used and cleaning needs to be from the outer side of the theater to the bed.	Methods
●	Semi - structured interview_2023-07-21 (1)	Then between procedures, the theater is mostly full of blood and all the blood is removed from by soap and water then the bleach solution as special red mops need to be used and cleaning needs to be from the outer side of the theater to the bed.	Cleaning practices
●	Semi - structured interview_2023-07-21 (1)	And at the end of the day this year of at the end of the theater list, the theater is pushed out.	Cleaning intervals
●	Semi - structured interview_2023-07-21 (1)	And at the end of the day this year of at the end of the theater list, the theater is pushed out.	Cleaning practices
●	Semi - structured interview_2023-07-21 (1)	They disinfect and terminal clean so that mean they clean the instruments, they put them out the outside of the theater and then they are doing it two times.	Cleaning practices

●	Semi - structured interview_2023-07-21 (1)	If by any chance there's a septic patient on the list they will go to a third step and they will either use fogging ATP to see if it's clean enough and fogging or UV lights.	Monitoring
●	Semi - structured interview_2023-07-21 (1)	If by any chance there's a septic patient on the list they will go to a third step and they will either use fogging ATP to see if it's clean enough and fogging or UV lights.	Cleaning practices
●	Semi - structured interview_2023-07-21 (1)	If you use the fogging solution and the spray solution then you need to wait two hours before you can place a patient.	Cleaning practices
●	Semi - structured interview_2023-07-21 (1)	But if you use the UV lights after I've done the whole procedure with the lights and they remove the lights, then the next patient can go on the table	Cleaning practices
●	Semi - structured interview_2023-07-21 (1)	normal soap and water, it's not harmful for the for the cleaner	risks
●	Semi - structured interview_2023-07-21 (1)	bleach solution for cleaning the theater can be harmful for the cleaner, so the cleaner needs to use the PPE for that and then.	risks
●	Semi - structured interview_2023-07-21 (1)	bleach solution for cleaning the theater can be harmful for the cleaner, so the cleaner needs to use the PPE for that and then.	Cleaning equipment
●	Semi - structured interview_2023-07-21 (1)	Chlorine based commonly known as bleach.	Products or chemicals
●	Semi - structured interview_2023-07-21 (1)	No organisms was cultured, then you need to use for example 250 PPM chlorine.	Products or chemicals
●	Semi - structured interview_2023-07-21 (1)	So they increase it to 6000 PPM and they said on plastic it's thrive very long and you cannot get it clean.	Products or chemicals
●	Semi - structured interview_2023-07-21 (1)	Peracetic acid	Products or chemicals
●	Semi - structured interview_2023-07-21 (1)	The manufacturer's guidelines and they will tell you what to clean that with.	Manufacturer’s instructions
●	Semi - structured interview_2023-07-21 (1)	Manufacturer’s guidelines and they will tell you what to clean that with.	Cleaning practices

●	Semi - structured interview_2023-07-21 (1)	Alcohol based wipes to wipe the equipment, yes.	Products or chemicals
●	Semi - structured interview_2023-07-21 (1)	Alcohol based wipes to wipe the equipment, yes.	Cleaning practices
●	Semi - structured interview_2023-07-21 (1)	So how I understand the intervals of cleaning it is all horizontal surfaces that should be damp dusted before the first case of the day.	Cleaning intervals
●	Semi - structured interview_2023-07-21 (1)	So how I understand the intervals of cleaning it is all horizontal surfaces that should be damp dusted before the first case of the day.	Methods
●	Semi - structured interview_2023-07-21 (1)	Every operating room should be terminal clean when the schedule list is finished, and the cleaning is also done after every patient.	Cleaning intervals
●	Semi - structured interview_2023-07-21 (1)	High to low and it needs to be cleaned out and it needs to be recorded.	Methods
●	Semi - structured interview_2023-07-21 (1)	So you need to take off all the debris, all the all you need is to clean the surfaces.	Methods
●	Semi - structured interview_2023-07-21 (1)	double bucket system	Cleaning equipment
●	Semi - structured interview_2023-07-21 (1)	Red mops for the blood and your green or blue mops will go for the normal general theatre,	Cleaning equipment
●	Semi - structured interview_2023-07-21 (1)	Signage when you you're cleaning and they need them to know about the signage.	Cleaning equipment
●	Semi - structured interview_2023-07-21 (1)	The PPE that we already mentioned.	Cleaning equipment
●	Semi - structured interview_2023-07-21 (1)	No brooms in the operating room	Cleaning equipment
●	Semi - structured interview_2023-07-21 (1)	Flat mops.	Cleaning equipment
●	Semi - structured interview_2023-07-21 (1)	Registered nurse has ultimate responsibility for cleanliness of the surgical invasive procedure areas.	responsibility

●	Semi - structured interview_2023-07-21 (1)	Infection prevention and control is a subject and subsection of the occupational health and Safety Act and according to your infection control, their need to it's very important to work in a clean environment and it's everyone's responsibility.	responsibility
●	Semi - structured interview_2023-07-21 (1)	And the cleaners is also responsible, but they are overseen by and the supervisors	responsibility
●	Semi - structured interview_2023-07-21 (1)	And you need a lot of information to clean properly and knowledge is power.	Training
●	Semi - structured interview_2023-07-21 (1)	Most often, there's checklists.	Monitoring
●	Semi - structured interview_2023-07-21 (1)	I already said it ATP machines and then none such methods to go in combination for cleaning and that needs to be recorded as well.	Monitoring
●	Semi - structured interview_2023-07-21 (1)	So the particle counts is most often to see is your place clean enough after they work on it?	Monitoring
●	Semi - structured interview_2023-07-21 (1)	That is, when you evaluate what is the bacteria in your account in your operating theater after you cleaned?	Monitoring

●	Semi - structured interview_2023-07-21 (1)	So policies, I refer to the South African accent and for cleaning and environmental clean cleaning and to protect themselves is and for instance, your environmental cleaning acts and that will tell you about when they need to clean with what how they need to protect themselves and your health and Safety Act is going to come in here as well because they need to know they need to work safe and the employer need to give them safe work environment and then they'll lost thing is, and the new standard precautions framework that they published in 2020 deportment of Health also needs to come in here because we need to protect that cleaner against Needle sticks. They need to use their PPE.	cleaner safety
●	RESEARCH INTERVIEW_2023-09-01	There's a between list cleaning.	Cleaning practices
●	RESEARCH INTERVIEW_2023-09-01	And so the cleaning of operating theatres is generally split into two is a between list the meaning and which is a quick go through between patient cases	Cleaning practices
●	RESEARCH INTERVIEW_2023-09-01	And then there's an end of list cleaning that should be happening, which is a complete push out of the theaters and.	Cleaning practices
●	RESEARCH INTERVIEW_2023-09-01	In my experience and a lot of the theaters are not doing that full push out on a daily basis.	Cleaning practices
●	RESEARCH INTERVIEW_2023-09-01	OHS we that should be actually the procedure as far as I'm concerned and the between lists cleans is often under pressure because one patient is going out, another patients coming in and the setup and everything is happening and they don't have much more than two minutes to get in.	recommendations

	RESEARCH INTERVIEW_2023-09-01	n my experience and a lot of the theaters are not doing that school push out on a daily basis, so we that should be actually the procedure as far as I'm concerned and the between list cleans is often under pressure because what patient is going out and the patients coming in and the set up and everything is happening and they don't have much more than two minutes to getting the clean out.	recommendations
	RESEARCH INTERVIEW_2023-09-01	In the morning they go in and they wipe everything down once again with the disinfectant.	Cleaning practices
	RESEARCH INTERVIEW_2023-09-01	Basically what they're doing is they're using a detergent to do a pre clean and a disinfectant after that, and so the detergent is used to pick up as much bio load as possible in the theater before I disinfectant is used to increase the effectiveness of the disinfectant, but mostly chlorine is used and chlorine based disinfectants.	Products or chemicals
	RESEARCH INTERVIEW_2023-09-01	bio side	Products or chemicals
	RESEARCH INTERVIEW_2023-09-01	Generally, they're using a blue color coded cloth and bucket and that is should be dedicated to each theater.	Cleaning equipment
	RESEARCH INTERVIEW_2023-09-01	Each theatre should have its own cleaning equipment, so that's and you don't have a case where equipment is shared and infection could be spread from one theater to the next and.	Cleaning equipment
	RESEARCH INTERVIEW_2023-09-01	So each theater will have its own blue bucket, blue cloth for the day and mopping system and spray bottles and chemicals that are dedicated to that theater.	Cleaning equipment
	RESEARCH INTERVIEW_2023-09-01	That solution is then discarded before the next case in the list, and fresh and solution is used for each case.	Cleaning practices

	RESEARCH INTERVIEW_2023-09-01	The surface then get wiped down with the disinfectant after the detergent, and this should have a contact time of at least two minutes that the surface is wet and which is different to the end of list that the end of list.	Cleaning practices
	RESEARCH INTERVIEW_2023-09-01	And at the push out, those surfaces should be wet for at least 10 minutes, and generally the floors and that are done with 1500 PPM and the contact surfaces are done with 1000 PPM chlorine.	Products or chemicals
	RESEARCH INTERVIEW_2023-09-01	And at the push out, those surfaces should be wet for at least 10 minutes, and generally the floors and that are done with 1500 PPM and the contact surfaces are done with 1000 PPM chlorine.	Cleaning practices
	RESEARCH INTERVIEW_2023-09-01	Each sachet delivers 250 parts per million per 10 liter, which means that if they put four sachets in there, they'll get 1000ppm liters. If they put two in there, they'll get 500 PPM, yes. Which means that if the performing their dusting in 1000 liters and put two in there, they'll get 500 PPM.	Manufacturer's instructions
	RESEARCH INTERVIEW_2023-09-01	At the end of the day, the solution should be discarded.	Cleaning practices
	RESEARCH INTERVIEW_2023-09-01	So the main thing is that they are diluting the sachet into the bucket, giving enough time to dissolve and then it's not in hot water because the evaporation will weaken the solution causing it to be less effective.	risks
	RESEARCH INTERVIEW_2023-09-01	So the main thing is that they are diluting the sachet into the bucket, giving enough time to dissolve and then it's not in hot water because the evaporation will weaken the solution causing it to be less effective.	Manufacturer's instructions

●	RESEARCH INTERVIEW_2023-09-01	Generally, in a theater they are using gloves anyway, so there's no issue with that and there will be wearing and some kind of mask as well.	Cleaning equipment
●	RESEARCH INTERVIEW_2023-09-01	There's, actually most of our products are pretty safe for use, so if they're using PPE, it's generally as a protection from infection more than from the chemical.	risks
●	RESEARCH INTERVIEW_2023-09-01	First cleaning of the day before the list begins, a wipe down of the surfaces with a disinfectant wipe cloth and then the patient goes in.	Cleaning intervals
●	RESEARCH INTERVIEW_2023-09-01	Patient comes out and a cleaner will go in and clean the floors, pick up any DEBRIS that on the floor.	Cleaning intervals
●	RESEARCH INTERVIEW_2023-09-01	Anybody fluid set up in spots on the floor and they should be as much as possible spot cleaned and so that the body fluids are not spread across the floor.	Cleaning intervals
●	RESEARCH INTERVIEW_2023-09-01	Anybody fluid set up in spots on the floor and they should be as much as possible spot cleaned and so that the body fluids are not spread across the floor.	Cleaning practices
●	RESEARCH INTERVIEW_2023-09-01	The surfaces that have been utilized during the process and that's generally is sufficient and until the next patent comes in, it'll take 2 minutes or so between this cases.	Cleaning intervals
●	RESEARCH INTERVIEW_2023-09-01	Electronic equipment that needs to be wiped down Is generally dealt with by the nursing staff	responsibility
●	RESEARCH INTERVIEW_2023-09-01	Then at the end of the list.	Cleaning intervals
●	RESEARCH INTERVIEW_2023-09-01	And a full push out is done	Cleaning intervals
●	RESEARCH INTERVIEW_2023-09-01	Everything else is pushed to one side of the theater, and generally we have what we call a like a visa versa tool with a disinfectant in a bucket and this is applied to all the walls so that the walls are wet properly with a disinfecting solution.	Cleaning practices

●	RESEARCH INTERVIEW_2023-09-01	So they start from the top, working their way down.	Cleaning practices
●	RESEARCH INTERVIEW_2023-09-01	There is usually a clock in the theater which they used to make sure that the disinfectant has a good 10 minute contact time.	Cleaning practices
●	RESEARCH INTERVIEW_2023-09-01	And while the equipment is on The Dirty side, it is wiped down before it's moved on to the clean side of the theater.	Cleaning practices
●	RESEARCH INTERVIEW_2023-09-01	So everything is clean when it moves right down to the wheels, the overhead lights, all the equipment is wiped down and then moved back to the clean site.	Cleaning practices
●	RESEARCH INTERVIEW_2023-09-01	Medical waste is put into the red bags.	Cleaning practices
●	RESEARCH INTERVIEW_2023-09-01	And it should be removed before cleaning.	Cleaning practices
●	RESEARCH INTERVIEW_2023-09-01	So during the day between cases they're going to use a mop, a blue bucket, a blue cloth and for cleaning out the floors and the surfaces at the end of list they should actually have a scrubbing machine.	Cleaning equipment
●	RESEARCH INTERVIEW_2023-09-01	So once they've cleaned the walls, they move down to the floor, which should be scrubbed and water should generally be sucked up with a water vacuum cleaner and because this is more efficient than mopping cause, mopping tends to leave a residue on the floor.	Cleaning equipment

●	RESEARCH INTERVIEW_2023-09-01	So once they've cleaned the walls, they move down to the floor, which should be scrubbed and water should generally be sucked up with a water vacuum cleaner and because this is more efficient than mopping cause, mopping tends to leave a residue on the floor.	Cleaning practices
●	RESEARCH INTERVIEW_2023-09-01	The cloth set the end of the day should be discarded.	Cleaning practices
●	RESEARCH INTERVIEW_2023-09-01	I know generally the private sector have moved to flat mops microfiber mops and they are way to easier to maintain.	Cleaning equipment
●	RESEARCH INTERVIEW_2023-09-01	Put through a washing machine and best if they are put through a washing machine.	Cleaning practices
●	RESEARCH INTERVIEW_2023-09-01	They should be cleaned at a temperature above 70 degrees to for at least 20 minutes so that bacteria are destroyed in the cleaning process.	Cleaning practices
●	RESEARCH INTERVIEW_2023-09-01	And between the cases they can use a flat mop system with a new sleeve between each list.	Cleaning practices
●	RESEARCH INTERVIEW_2023-09-01	A Velcro tool and once it's used it goes into The Dirty bag and that gets laundered at the end of the day and reissued for the next day.	Cleaning practices
●	RESEARCH INTERVIEW_2023-09-01	Issue for the next day and generally I would say that the government here today using spaghetti mops and the issue with spaghetti mops says they.	recommendations
●	RESEARCH INTERVIEW_2023-09-01	Lint creates dust and when they do get laundered, they end up all those strings end up in knots and take ages to clean to keep them to get them usable again.	recommendations

●	RESEARCH INTERVIEW_2023-09-01	There's a couple of sites now that have taken on the microfiber sleeves, and hopefully that'll start growing and but they still need to put in proper laundering processes for it and that's where my issue is with the spaghetti mops and most of your public hospitals.	recommendations
●	RESEARCH INTERVIEW_2023-09-01	The cleaners are expect to wash those by hand that washing by hand to me is a health hazard.	risks
●	RESEARCH INTERVIEW_2023-09-01	It's a health violation, actually because a cleaner can be pricked by a needle, or even be pricked by just a simple staple, something that's scratches the skin and they can pick up infectious blood that's entrance into their own bodies.	risks
●	RESEARCH INTERVIEW_2023-09-01	While I'm using it for a day or it should be a daily cloth and I'm using it for three or four days, by the time we throw their cloth away it is.	recommendations
●	RESEARCH INTERVIEW_2023-09-01	While I'm using it for a day or it should be a daily cloth and I'm using it for three or four days, by the time we throw their cloth away it is.	Cleaning practices
●	RESEARCH INTERVIEW_2023-09-01	Degrees of responsibility, as far as I'm concerned with theatres and the main responsibility for a complex really lies with the theatre matron.	responsibility
●	RESEARCH INTERVIEW_2023-09-01	I also believe that the nursing staff, so a lot of the time the cleaning staff, are they on a daily basis, their supervision is not there all the time	responsibility
●	RESEARCH INTERVIEW_2023-09-01	So the cleaning staff should be trained.	Training

●	RESEARCH INTERVIEW_2023-09-01	If somebody is sick, they should have backup of a trained staff to take your place, or if they're on need and there should not be bringing in somebody who's usually cleans public areas into your theater, they need to be specialist.	recommendations
●	RESEARCH INTERVIEW_2023-09-01	If somebody is sick, they should have backup of a trained staff to take your place, or if they're on need and there should not be bringing in somebody who's usually cleans public areas into your theater, they need to be specialist.	Training
●	RESEARCH INTERVIEW_2023-09-01	And I think training and shadowing that all needs to happen before across this occurs	Training
●	RESEARCH INTERVIEW_2023-09-01	So I think training is really, really important as far as the cleaning staff are concerned	Training
●	RESEARCH INTERVIEW_2023-09-01	OK, they are monitoring their stage and generally a cleaning checklist is used and environmental cleaning checklist for theaters.	Monitoring
●	RESEARCH INTERVIEW_2023-09-01	And the other thing is that the area will probably also be audited by your infection control sister and all protocols and procedures need to be checked.	Monitoring
●	RESEARCH INTERVIEW_2023-09-01	And in my experience, and that needs to be trained and it needs to be in reiterated to everybody who comes into that theater so that we not skipping areas, you got one piece of equipment that's not being clean because the theater takes its cleaning	recommendations

●	RESEARCH INTERVIEW_2023-09-01	And the nursing staff thought the cleaner should be doing it.	recommendations
●	RESEARCH INTERVIEW_2023-09-01	The demarcation of responsibility.	recommendations
●	RESEARCH INTERVIEW_2023-09-01	And if they are picking up infections in the theater, they will resort to swabbing or particle counts.	Monitoring
●	RESEARCH INTERVIEW_2023-09-01	If there's building happening in the area, they will do the particle counts again and I think particle counts anyway happen on a periodic basis and swabbing.	Monitoring
●	RESEARCH INTERVIEW_2023-09-01	I like the idea of using an ATP meter.	Monitoring
●	RESEARCH INTERVIEW_2023-09-01	Because an ATP meter, although and doesn't really just measure your bacteria, ATP picks up any particles and biological particles on the surface.	Monitoring
●	RESEARCH INTERVIEW_2023-09-01	Is to me it's preferable to swabbing unless you're trying to deal with a particular bacterial infection because ATP doesn't measure the doesn't tell you what type of bacteria is cultured	Monitoring
●	RESEARCH INTERVIEW_2023-09-01	The doesn't tell you what bacteria or present, but it does tell you if a surface has been efficiently cleaned and I think from cleaning point of view that's more important and it's immediate within 30 seconds you got your result, whereas if you do a a swab test that goes away, you might get it back in two or three days and by which time, how many cases have gone through that environment already?	recommendations

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●	RESEARCH INTERVIEW_2023-09-01	Cleaners, insourced or outsourced, the company who it's outsourced too, is responsible to make sure that the cleanings have had the hepatitis inoculations that they've got the correct PPE.	cleaner safety
●	RESEARCH INTERVIEW_2023-09-01	Cleaners, insourced or outsourced, the company who it's outsourced too, is responsible to make sure that the cleanings have had the hepatitis inoculations that they've got the correct PPE.	cleaner safety > Sentiment > Neutral
●	RESEARCH INTERVIEW_2023-09-01	Procedures for needle stick injuries.	cleaner safety
●	RESEARCH INTERVIEW_2023-09-01	Procedures for needle stick injuries.	cleaner safety > Sentiment > Negative
●	RESEARCH INTERVIEW_2023-09-01	All the procedures and policies that are put in place to prevent infections from happening to any people in the environment and that is generally put in place by the hospital and the cleaning staff, need to comply with that and PPE, as most of your environments where the cleaner needs to put on PPE, that is supplied generally by the hospital, except for when they are when they are wearing gloves, if they are wearing gloves while they're doing cleaning, that is provided by the cleaning contractor and.	cleaner safety

●	RESEARCH INTERVIEW_2023-09-01	All the procedures and policies that are put in place to prevent infections from happening to any people in the environment and that is generally put in place by the hospital and the cleaning staff, need to comply with that and PPE, as most of your environments where the cleaner needs to put on PPE, that is supplied generally by the hospital, except for when they are when they are wearing gloves, if they are wearing gloves while they're doing cleaning, that is provided by the cleaning contractor and.	cleaner safety > Sentiment > Slightly Positive
●	RESEARCH INTERVIEW_2023-09-01	In fact, in most environments there should probably have an alcohol hand rub on the cleaning trolley so that cleaners should use it after they take off the gloves.	recommendations
●	RESEARCH INTERVIEW_2023-09-01	The responsibilities definitely with the contractor to make sure that everything is available, that the training is done and it's definitely a partnership between the hospitals.	Training
●	160125_0018	It's before the first procedure,	Cleaning intervals
●	160125_0018	It's before the first procedure, meaning where we are doing damp dusting. And then the second one is between the procedures. The third of which is the last one for the day, it's after the last procedure which is normally called terminal, cleaning, others they are calling it push out. Yes.	Cleaning practices
●	160125_0018	Now they are using, I've seen they've got this, um, sticky pads.	Cleaning equipment
●	160125_0018	Each room has its own cloth.	Cleaning practices

●	160125_0018	On the flat surface that has a stick, that they're using a spray bottle to spray that disinfectant and wipe it off.	Cleaning equipment
●	160125_0018	On the flat surface that has a stick, that they're using a spray bottle to spray that disinfectant and wipe it off.	Cleaning practices
●	160125_0018	there is what we call chlorine, which is called bleach in our domestic setting	Products or chemicals
●	160125_0018	Purpose alcohol based disinfectant that they also use.	Products or chemicals
●	160125_0018	And they've got Progen. It's also an all-purpose non-alcohol based disinfectant.	Products or chemicals
●	160125_0018	Checklists.	Monitoring
●	160125_0018	There are risks because, like, as I've said, this chlorine is a, a, a jik, like, in a domestic setting. And same with this, uh, proclean and progen. They are, um, having risks, like, for instance, if one can inhale it. It will affect or erode the respiratory system and the eyes.	risks
●	160125_0018	So when they are using, especially the mixing part of this, uh, disinfectant, they have to have, uh, uh, um, uh, PPE, that's personal protective equipment, meaning they have to have goggles on, uh, apron and gloves. Same when they are cleaning, they have to have gloves and the goggles as well. That's, that's actually mandatory.	Cleaning equipment
●	160125_0018	We do have in-service trainings with, we've got the in-service training program.	Training

●	160125_0018	Uh, it can be a hand towel, but we've got a packaging that has all the things that needs to be used during that. So as nurses, we have to use either paper towels or hand towels to remove the excess and then they come after it and remove the rest. So why, the reason why I've said we've turned or decided to include them in our in service training, so that everybody can be aware that everyone is aware of what's going on.	Cleaning practices
●	160125_0018	Everyone's responsibility.	responsibility
●	160125_0018	Damp dusting. And then they... The second phase of cleaning, which is between the procedures, I think I'm still, uh, within the, the,	Cleaning intervals
●	160125_0018	And then the after, uh, uh, list cleaning of which is the one that I've called the terminal cleaning. That it's called, others they are calling it push out.	Cleaning intervals
●	160125_0018	Uh, there are two, there's physical and chemical means.	Methods
●	160125_0018	Okay, the physical means is, uh, is the, it's when, uh, uh, uh, during that process, what I will say we are removing or gets removed during that time is the contaminants. And then they deactivate contaminates by the chemicals, which, which we use the, what is it by the way, disinfectants to decontaminate those contaminants.	Methods
●	160125_0018	Rightfully, we have to start from the clean area to the dirty. Because starting from the dirty area to the clean area, then we are actually bringing the dirt to clean. So for us to say we have really used an effort to minimize the growth and multiplication of the microorganisms.	Methods
●	160125_0018	Uh, we don't have brooms where I'm working.	Cleaning equipment

●	160125_0018	Nurses. I'm saying nurses because we can't shift our responsibility to other people. We are the ones. Who are fully responsible, accountable for the patient because the equipment, even the equipment, you can't let the cleaners to touch.	responsibility
●	160125_0018	We tend to involve the cleaners so that we do that together and we know what is expected of us, uh, in that particular, uh, uh, uh, uh, and uh, task.	Training
●	160125_0018	Checklists. Yes. Within the theaters.	Monitoring
●	160125_0018	It's quarterly depending. If there is a, a, um, what's this, reconstruction in place, normally they conduct it monthly.	Monitoring
●	160125_0018	Them, they have to make sure that they supervise the services that they've outsourced, and they give in service training, proper in service training to make sure that everything It's done according to ISO standards.	responsibility
●	RESEARCH INTERVIEW (1)	OK, so currently operating room cleaning practices is obviously between cases. So in our environment, in the private sector, it obviously entails that the housekeeping stuff cleans the floors and the beds.	Cleaning practices
●	RESEARCH INTERVIEW (1)	And then the nursing staff is supposed to clean the equipment between patients. However, we all know that does not happen always.	Cleaning practices
●	RESEARCH INTERVIEW (1)	So in between cases, obviously and then after the list I do a full push out, or they're supposed to do a full push out with a full cleaning of that theater. And obviously if they've done a case that has been isolated or that has an infectious disease, we do terminal cleaning and then obviously zapping or fogging after the case as well.	Cleaning intervals

●	RESEARCH INTERVIEW (1)	So in between cases, obviously and then after the list I do a full push out, or they're supposed to do a full push out with a full cleaning of that theater. And obviously if they've done a case that has been isolated or that has an infectious disease, we do terminal cleaning and then obviously zapping or fogging after the case as well.	Cleaning practices
●	RESEARCH INTERVIEW (1)	So we fogging, obviously you know after you fogged a area, it needs to be closed for two hours for the hydrogen peroxide to settle on the surfaces and there's infect where with UVC technology zapping at most likes 3 minutes and the room is ready for use immediately thereafter.	Products or chemicals
●	RESEARCH INTERVIEW (1)	So we fogging, obviously you know after you fogged a area, it needs to be closed for two hours for the hydrogen peroxide to settle on the surfaces and there's infect where with UVC technology zapping at most likes 3 minutes and the room is ready for use immediately thereafter.	Cleaning practices
●	RESEARCH INTERVIEW (1)	You know, they do it between and after say if I think about our theaters in, in, in our group, if the theatre hasn't been in use the previous day or just before I came on duty, they would obviously do damp dusting.	Cleaning intervals
●	RESEARCH INTERVIEW (1)	You know, they do it between and after say if I think about our theaters in, in, in our group, if the theatre hasn't been in use the previous day or just before I came on duty, they would obviously do damp dusting.	Cleaning practices