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"Effect of Staff Adherence to Sterile Handling Protocols on the Post-Sterilization Contamination of Surgical Instruments"

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Abstract:

Maintaining the sterility of surgical instruments is one of the most critical components of infection prevention and patient safety in healthcare facilities. While sterilization effectively eliminates microorganisms, the period following sterilization remains highly vulnerable to contamination if proper handling procedures are not followed. This study examines the effect of staff adherence to sterile handling protocols on post-sterilization contamination of reusable surgical instruments. A descriptive analytical design was employed to assess the relationship between compliance with established sterile handling guidelines and the likelihood of contamination after sterilization. The study emphasizes the significance of human behavior, organizational systems, and training in preserving instrument sterility. Findings reveal that consistent adherence to sterile handling protocols—such as correct use of personal protective equipment (PPE), aseptic transfer techniques, and controlled storage conditions—plays a decisive role in preventing microbial recontamination. Conversely, non-compliance, time pressure, and inadequate supervision are major contributors to post-sterilization contamination. The research highlights the necessity of continuous education, regular audits, and a strong culture of safety to sustain high adherence levels among reprocessing staff. Strengthening institutional support and reinforcing compliance can significantly enhance sterilization outcomes, reduce the risk of surgical site infections, and promote overall patient safety.

Keywords:

Sterilization; Post-sterilization contamination; Staff adherence; Sterile handling protocols; Surgical instruments; Infection prevention; Instrument reprocessing.

المستخلص:

يُعد الحفاظ على تعقيم الأدوات الجراحية أحد أهم مكونات الوقاية من العدوى وسلامة المرضى في مرافق الرعاية الصحية. فبينما يقضي التعقيم بفعالية على الكائنات الدقيقة، تظل الفترة التي تعقب التعقيم معرضة بشدة للتلوث في حال عدم اتباع إجراءات المناولة السليمة. تبحث هذه الدراسة في تأثير التزام الموظفين ببروتوكولات المناولة المعقمة على تلوث الأدوات الجراحية القابلة لإعادة الاستخدام بعد التعقيم. وقد استُخدم تصميم تحليلي وصفي لتقييم العلاقة بين الامتثال لإرشادات المناولة المعقمة المعمول بها واحتمالية التلوث بعد التعقيم. وتؤكد الدراسة على أهمية السلوك البشري والأنظمة التنظيمية والتدريب في الحفاظ على تعقيم الأدوات. وتكشف النتائج أن الالتزام المستمر ببروتوكولات المناولة المعقمة - مثل الاستخدام الصحيح لمعدات الوقاية الشخصية (PPE) وتقنيات النقل المعقمة وظروف التخزين الخاضعة للرقابة - يلعب دورًا حاسمًا في منع إعادة التلوث الميكروبي. وعلى العكس من ذلك، فإن عدم الامتثال وضغط الوقت وعدم كفاية الإشراف هي عوامل رئيسية تساهم في تلوث ما بعد التعقيم. يُسلط البحث الضوء على ضرورة التعليم المستمر، والتدقيق الدوري، وترسيخ ثقافة السلامة للحفاظ على مستويات التزام عالية بين العاملين في إعادة المعالجة. إن تعزيز الدعم المؤسسي وتعزيز الامتثال يُمكن أن يُحسن بشكل كبير نتائج التعقيم، ويُقلل من خطر عدوى موقع الجراحة، ويُعزز السلامة العامة للمرضى.

الكلمات المفتاحية: التعقيم؛ التلوث بعد التعقيم؛ التزام العاملين؛ بروتوكولات التعامل المعقم؛ الأدوات الجراحية؛ الوقاية من العدوى؛ إعادة معالجة الأدوات.

Introduction:

Surgical instruments are sterilized as one of the pillars of infection prevention and patient safety in healthcare facilities. In spite of the improved levels of sterilization procedures and well-managed standards of procedures, the problem of surgical site infection (SSI) is still a major source of postoperative morbidity and mortality in hospitals across the globe. Although sterilization is an effective method of eliminating microbial life under controlled conditions, the post sterilization period, namely during handling, transportation and storage, is an important weakness. Any of the small infractions in protocols of sterile handling will result in recontamination of instruments, compromising the entire sterilization process and contributing to the spread of the infection to the patients (Mohammad Ali Nejad et al., 2018).

The compliance of the staff to the sterile handling measures is thus a critical determinant of the sterilization effect. These protocols include procedures like the use of proper protective clothing, aseptic technique in the course of packaging and transfer, checking of indicators of sterilization and integrity of sterile barriers. Lack of noncompliance, be it through a lack of training, excessive workload or being supervised, can lead to post sterilization contamination which can endanger patient safety and institute performance in infection control. Even under the condition of properly implemented sterilization cycles, healthcare staff that works with sterile equipment and lacks appropriate aseptic awareness facilitates microbial contamination (Owusu et al., 2022).

The compliance with standardized practices of sterile handling in most hospital environments especially the central sterile services departments (CSSDs) is affected by both personal and organizational aspects. These are the quality of professional training, policies in institutions, surveillance, and the presence of sterile storage. Lapses in protocol compliance do not only lead to a greater contamination of the instruments, but also raise the expenses of the operations by requiring re-sterilization and postponing the surgical operation. Therefore, to determine the points of procedural vulnerability and enhance the general infection prevention process, it is crucial to assess the connection between the compliance of staff and the post-sterilization contamination issue (Ahmed et al., 2017).

The aim of the study is to determine the role of the compliance with sterile handling measures by the staff in the post-sterilization contamination of surgical tools. This study will aid in optimal evidence-based recommendations on enhancing the sterilization in hospital environments by setting the degree by which adherence to the handling standards influences microbial contamination levels. Finally, the results should contribute to the improvement of patient safety, reinforcement of infection control initiatives, and ongoing professional growth in the staff of sterilization.

Problem Statement:

Regardless of the strict sterilization measures being practiced in the health care institutions, the issue of post sterilization contamination of the surgical instruments is a consistent challenge. When sterility of instruments is not properly maintained by the healthcare staff members when the latter failed to adhere to sterile practice, then that risk may significantly undermine the sterility of instruments once sterilized, causing rising levels of surgical site infections (SSIs) and other healthcare-associated infections (HAIs). In several clinical practices, failures in aseptic technique, including poor storage, poor use of personal protective equipment, or use of unsterile gloves on sterilized equipment may reinstate microorganisms onto sterilized equipment.

This is a critically important problem since it can impair the efficiency of sterilization technologies and measures that are aimed at eradicating microbial contamination. Although a lot of research has been conducted to enhance the techniques and technologies of sterilization, less research has been done on the human aspect of sterilization, that is the compliance of the staff with the procedures of the post-sterilization handling procedures. This irregularity in following sterile handling practices is not only a risk to the patients, but also a risk on healthcare systems due to the increased hospital stay, subsequent treatment, and expenses.

Thus, this research will focus on the impact of compliance with sterile handling rules by the staff on the post sterilization contamination of the surgical tools. The significance of this relationship is based on the need to identify key areas of contamination risk and place-specific interventions that could be used to improve compliance and guarantee safer surgical outcomes.

Study Objectives:

1. To show the organizational or individual factors influence staff adherence to sterile handling protocols in surgical instrument reprocessing units.
2. To identify common breaches in sterile handling practices that contribute to post-sterilization contamination.
3. To develop evidence-based recommendations for enhancing compliance with sterile handling protocols and reducing post-sterilization contamination risks.

Study Significance:

The relevance of the study is that it will enhance the use of infection control strategies through focusing on the human factor that determine the practice of keeping surgical instruments sterile. Although, the sterilization processes are now much advanced, due to technology, the second step after the sterilization process is handling the instruments and it happens to be the weak area in the overall process as any contamination can be easily made once the correct procedures have not been followed. This study is an important study that evaluates the impact of the compliance of the staff with sterile handling policies and measures because it touches on a significant yet undervalued factor of surgical safety and patient outcomes.

This research paper adds to the world of healthcare quality and patient safety by indicating how adherence to sterile handling practices can help prevent cases of postoperative infections and other associated complications. The findings of this study can be used to guide healthcare facilities to create specific education, develop universal operating protocols, and install surveillance systems that support compliance with aseptic practices in employees. Moreover, the results of the study may be used as the evidence-based basis of making the policy and the accreditation criteria designed to reduce the risk of infections and provide the maximum sterilization integrity.

In a larger scope, the research serves to advance the international agenda of enhancing patient safety in the operating room, which is advanced by international organizations like the World Health Organization. Increasing the adherence of staff to the sterile handling practices is not only protective to the patients but will also help the hospital to utilize its resources more efficiently, decrease the rates of healthcare-associated infections, and increase the reputation of the institution. Finally, this study can create an atmosphere of responsibility and ongoing betterment in the sterilization and surgical departments.

Limitations of the study:

1. Restricted Generalizability:

The research will be performed within a particular cohort of healthcare facilities, potentially constraining the applicability of the results to all hospitals or surgical centers. Variations in sterilizing technologies, staff training standards, and infection control protocols among institutions may affect outcomes.

2. Dependence on Self-Reported Data:

Certain information concerning staff compliance with sterile handling guidelines may be obtained through self-reported surveys or interviews. This method poses a danger of response bias, as participants may exaggerate their compliance due to social desirability or apprehension of assessment.

3. Constraints of Microbial Assessment:

The determination of contamination during sterilization is contingent upon the sensitivity and precision of the employed microbiological testing methodologies. Divergences in sample methodologies, laboratory environments, or contamination limits may influence the dependability of outcomes.

4. Restricted Observation Duration:

The study's observation period may fail to account for fluctuations in adherence or contamination levels throughout several shifts or seasons. Short-term evaluations may neglect enduring patterns in employee conduct and contamination hazards.

5. Uncontrollable External Factors:

Elements such as environmental sanitation, air quality, humidity, or unforeseen human interaction in the sterile storage room may affect post-sterilization contamination yet remain outside the researcher's complete control.

Definition of key terms:

1. Sterilization:

The process of eliminating all viable microorganisms such as spores, bacteria, fungi, and viruses on surgical equipment and medical devices is referred to as sterilization. It may be done by use of physical means (e.g., pressure steam, dry heat) or by chemicals (e.g., ethylene oxide, hydrogen peroxide). Sterilization guarantees that instruments are entirely devoid of pathogens prior to the surgical procedure and, therefore, avoids healthcare-associated infections (Loy et al., 2022).

2. Post-Sterilization Contamination:

The post-sterilization contamination is defined as the unwanted addition of microorganisms to sterilized equipment after sterilization and before it is used in the clinical setting. It is usually caused by mishandling, nonsterile packaging, airborne contamination, or poor storage. Even small violations of sterility in the process of transferring or storing may result in surgical site infections.

3. Staff Adherence:

Staff adherence is the adherence rate of healthcare workers following the set standards of aseptic and sterilization practices. It entails proper conduct, keen attention to detail, and adherence to all the rules of infection prevention within the sterilization process. This results in high adherence as a culture of accountability and patient safety and lapses that may result in recontamination of sterile instruments (Babore et al., 2024).

4. Sterile Handling Protocols:

Sterile handling procedures are detailed guidelines and procedures that are dedicated to ensure sterility once the sterilization process has been done. These involve the proper wearing of the personal protective equipment (PPE), aseptic transfer method, minimum handling of the sterile equipment, application of the sterile barriers and the proper environmental control parameters like humidity, air filtration and temperature. These guidelines will reduce the likelihood of exposing a patient or a medical worker to harm (Link, 2019).

5. Reusable Surgical Instruments:

Reusable surgical equipment is long-lasting equipment built of stainless steel, titanium, or other sterilizable materials, intended to be used in a number of operations in various surgical procedures. These instruments should be decontaminated, inspected, sterilized and aseptically handled after use to guarantee patient safety. Failure to follow these processes can enhance the chances of microbial contamination left behind and damage of instruments with time.

6. Healthcare-Associated Infections (HAIs):

Healthcare-associated infections (HAIs) are those diseases that patients contract during medical care in hospitals or any other medical institutions. Ordinary examples are surgical site infections, bloodstream infections, and urinary tract infections. HAIs are frequently the result of poor sterilization or aseptic technique violation and are one of the indicators of significant hospital safety performance (Dadi et al., 2021).

7. Sterile Field:

The sterile field is an area of a surgical site or sterile items that should be free of microorganisms. It encompasses the decontaminated equipment, drapes, and the tables in the operating room. The integrity of sterile setup is undermined by any contamination of this field, which poses a risk of postoperative infections.

8. Aseptic Technique:

Aseptic technique is a group of practices and procedures involving careful control to reduce the potential of introducing pathogens. It includes hand hygiene, the use of sterile gloves and gowns and the contact between sterile and non-sterile objects. The ability to handle the aseptic technique is required to ensure the sterility during the manipulation of surgical instruments (Nursing et al., 2023).

9. Instrument Reprocessing:

The process of cleaning, disinfecting, inspecting, repackaging, and sterilizing reusable surgical instruments and thereby making them available to be used safely again is known as instrument reprocessing. Both stages have to be carefully executed in order to avoid the survival of microbes or inter-patient cross-contamination. Surgical instruments are kept intact and operational through proper reprocessing.

10. Sterilization Integrity:

Sterilization integrity is a term that is used to give an assurance that surgical instruments are kept sterile until the next time they are used. The concept involves the preservation of packaging materials and materials, ensuring the correct packing of the materials, storage environments, and storage conditions, and the handling of the materials during the transportation process. The discontinuity of any of these chains may jeopardize the level of sterility assurance (SAL) of the instruments.

Literature Review:

1. Organizational or Individual Factors Influencing Staff Adherence to Sterile Handling Protocols in Surgical Instrument Reprocessing Units:

Compliance with sterile handling procedures on the part of healthcare staff is a multifaceted behavior that is determined by both organizational and personal factors. At the organizational level, the institutional culture, administrative dedication, workload, and resource provision influence adherence. The presence of good infection prevention and control (IPC) culture in a healthcare facility is a great boost to adherence to sterilization and handling practices. The hospitals, which recognize infection control as one of the standards of their operations, have better adherence rates because of the regular leadership involvement, presence of training interventions, and the implementation of standard operating procedures (SOPs) (Cen et al., 2025).

Supervision and leadership are key factors that affect behavior of staff. By showing proper handling methods, conducting compliance audits, and giving constructive feedback, the staff will be more inclined to absorb safe practices, when shown proper handling techniques by the supervisors. On the other hand, inadequate supervision and accountability usually lead to shortcuts during the process particularly in high-pressure areas like the surgical departments. In addition, the pressure of work and understaffing have been popularly cited as hindrances to compliance. Patient turnover, working hours, and the need to have the instruments turnover quickly can cause the procedural lapse of sterilization and post-sterilization handling (Huang et al., 2019).

Regarding the availability of resources, insufficient supply of sterilization packaging materials, broken autoclave, and unsuitable PPE (gloves, masks, gowns) hamper compliance among educated employees. This process of adherence should be monitored by constantly tracking supply chain logistics so as to ensure that sterilization material and maintenance tools are never out of stock.

In the personal level, knowledge, training, motivation, and perception of risk are important. Employees that have received frequent training on the basics of infection control and have been made to realize the dire effects of microbial infection are the ones who will generally adhere to protocols. Staff in healthcare who report a perceived high risk of infection both to themselves and their patients shows better adherence practices (Brooks et al., 2021). Moreover, psychological elements such as exhaustion, burnout and complacency might diminish vigilance in the sterile handling practice.

Finally, to increase the compliance of the staff, a holistic strategy that incorporates institutional policy, behavioral interventions, and lifelong education are the necessary measures. Healthcare organizations should not just settle on a single training program as a document that ends after training but should provide a culture of sustained safety aimed at benefiting the patient and professional responsibility.

2. Common Breaches in Sterile Handling Practices that Contribute to Post-Sterilization Contamination:

Despite the successful sterilization, surgical equipment is susceptible to post-sterilization contamination that may happen because of the failures in handling, storage, or environmental factors. Such breaches as improper packaging, unsafe transportation means, poor storage conditions, and mistakes during surgical preparation are common.

Poor storage facilities are among the most common contamination sources. Other environmental contaminants that the instruments stored in open or poorly ventilated areas are prone to include dust and humidity, and microorganisms present in the air. A clean environment of controlled temperature with minimal exposures to non-sterile materials should be used to store sterile packages. The lack of compliance with these environmental controls may lead to the destruction of the sterility of instruments prior to their use (Manikonda et al., 2025).

The other significant violation is at the time of handling and transportation. Recontamination can happen when sterile packages are transported without protective wraps, when personnel work with contaminated gloves, or touching sterile surfaces with their hands. It is important to note that (Bali, 2021) highlight the mishandling of mistakes as one of the causes of post-sterilization contamination, including opening sterile trays prematurely before the surgery area is prepared. Moreover, sterilization indicators or packaging integrity may not be checked appropriately before use and may lead to the usage of non-sterile equipment in surgical operations.

Sterile and non-sterile space cross-contamination in the same working area is also a major threat. This problem is normally associated with ineffective layout planning within the sterilization department or a combination of dirty and clean work routes. In cases where sterile and contaminated instruments are stored or transported on the same paths, the chances of transmitting the microbes are high.

Also, the inability to conduct regular audits and environmental surveillance restricts the capabilities of an institution to address and rectify the violations. The sources of contamination are not detected without the regular microbial testing of the storage areas and surfaces. Lack of awareness or monitoring of staff also contributes to the problem through staff noncompliance.

To deal with such violations, there is a need to address them on a systems level:

- Routine checking and confirmation of sterilization packaging.
- Strict isolation of clean and dirty areas.
- Educating the personnel about aseptic methods of transport.
- Installation of surveillance systems to track the handling processes and monitor violations in real-time.
- Finally, the constant compliance with sterilized handling is vital to patient safety, healthcare-associated infections (HAIs), as well as the long-term practicality of sterilization procedures.

3. Recommendations for Enhancing Compliance with Sterile Handling Protocols and Reducing Post-Sterilization Contamination Risks:

To improve adherence to sterile handling techniques, a policy involving the combination of education, supervision, technological innovation, and policy reinforcement is strategic and evidence based.

To begin with, the healthcare institutions must establish systematic training and competency evaluation programs that are based on the particular functions of the sterilization and surgical staff. Such programs must consist of theoretical and practical training- microbiology, aseptic technique and prevention of contamination. Periodic refresher training programs provide a way of maintaining awareness and avoiding procedural drift. Living education is also associated with enhanced compliance and a decrease in cases of contamination (Sweet et al., 2020).

Second, it is necessary to promote a good infection prevention culture. Hospitals are encouraged to practice a shared responsibility model and ensure that each of the staff members understands their role in ensuring sterility. Positive behaviors are strengthened by leadership dedication to infection control, frequent conveying of safety targets, as well as reward programs to compliant employees.

Third, monitoring and compliance can be enhanced dramatically in terms of technological improvements. Tracking systems based on Internet of Things (IoT), such as the ones used to trace sterilization processes, count the handling time, and provide alerts in the case of instruments being exposed to non-sterile conditions (Aljasham et al., 2024). The traceability and accountability are also improved by automated documentation systems because of less human error.

The other building block of proper compliance is policy enforcement. The creation of the standard operating procedures (SOPs) that are easily available, updated periodically and audited can be used to make sure that all the personnel follow similar standards. The errors can be identified and corrected by regularly conducting audits, as well as feedback sessions.

Moreover, interdepartmental cooperation among sterilization departments, surgical teams and infection control departments will help to ensure open communication and quick reaction to incidents of contamination. Regular assessments of incident reports may aid in enhancing the procedures and eradicating consistent problems.

Last but not the least, shortcuts in the procedures can be avoided by addressing workforce-related factors, including staffing levels and workload management. Sufficient breaks, ergonomic arrangement of working space, and mental assistance is a way to minimize fatigue and increase concentration in sterile handling tasks (Simion Luduşanu et al., 2025).

Education, technology, and organizational culture can help healthcare institutions to establish a sustainable environment that puts the emphasis on sterility, reduces the risks of contamination, and eventually leads to better patient safety and surgical outcomes.

Previous studies:

In the study of (Uzun et al., 2020) The Time-dependent surgical instrument contamination and the effect of covering during arthroplasty have not been examined. The purpose of the study was to assess time dependent contamination of surgical instruments and the impact of covering on contamination and to also bacterial type contaminated samples. It was hypothesized that the contamination rates would reduce when the surgical instruments were covered. Sixty patients undergoing total knee arthroplasty underwent randomization and were divided into two categories, namely, surgical instruments covered with a sterile towel or surgical instruments uncovered. Microbiological samples were extracted by using K- wires. K-wires were put in liquid culture medium 0, 15, 30, 60, 90 and 120 min. Swabs were used to transfer the liquid cultures to blood agar after the incubation period of 24-h. Growing samples upon the 48 h-period were regarded as contaminated. Bacterial typing was done using microscopic, staining, and biochemical properties. The growth of bacteria began at 30 and 60 min in the uncovered and covered groups respectively. The number of K-wires that the time contaminated increased. Bacterial load of at least 10,000 CFU/mL was noticed in the samples of the culture. The degree of contamination was higher in the uncovered group. The difference between the uncovered and covered groups in contamination was statistically significant with 30-, 60-, 90-, and 120 min

(($p=0.035$, $p=0.012$, $p=0.024$, and $p=0.037$, respectively). Coagulase-negative Staphylococci (60.4%), *Staphylococcus aureus* (22.9%), and *Streptococcus agalactia* (16.7), respectively, were the most common bacteria on the contaminated instruments. The threat of contamination is aggravated with time. But it can be reduced in case surgical instruments are covered. Empiric antibiotic regimens basing on the type of identified microorganisms in this study can be developed in the clinical practice to be used in the postoperative periprosthetic joint infection prophylaxis.

According to (Ndu et al., 2022) Bacterial contamination of operating theaters is a primary causative factor of high rates of the post-operative nosocomial infections. Identification of the varying trends in counts of microbes and microflora is central to curbing microbial contamination and good antibiotic stewardship. This research was conducted with an aim of determining the presence of bacterial colonies on surfaces and equipment in the operating theater in the Enugu State University Teaching Hospital. It was also intended to identify the sensitivity patterns of the colonized surfaces. The proposed study was a cross-sectional study carried out in the Main Theater of the Enugu State University Teaching Hospital (ESUTH) in Parklane, Enugu, Nigeria. The equipment, operating room surface and cleaning solutions were sampled. Bacterial growth was evidenced in 47 (51.1) out of 92 samples taken in the different locations. The most prevalent isolate (36.2) was Coagulase-negative Staphylococcus (CoNS), and the most common one was *Staphylococcus aureus* (34%). Those *S. aureus* isolates containing 43.8% of methicillin-resistant *S. aureus* (MRSA), and the rest contained methicillin-susceptible *S. aureus* (MSSA). Gram-negative Gram-negative resistance was high to meropenem. Imipenem was susceptible to all the Gram-negative isolates. The commonest isolates were CoNS and *S. aureus*. More efforts should be done to decrease the number of healthcare-associated and surgical site infections in the operating theaters.

Methodology:

1. Study Design:

The research is based on the analytical descriptive design to examine the relationship between the rate of compliance with sterile handling practice by staff members and the amount of contamination on the post-sterilization reusable surgical equipment. The reason why this design is suitable is the possibility of systematic observation and measuring of the existing conditions without controlling the variables. The descriptive element will help determine the existing adherence practices and the analytical one will enable the investigation of the relationship between the level of adherence and the contamination results. This type of approach assists in the creation of empirical evidence that can help in infection control improvement in healthcare institutions. As (Asenahabi, 2019) states, descriptive analytical design works well in the health sciences research since it presents measurable information about behavioral and environmental determinants of clinical outcomes.

2. Research Method:

The research design of the study is quantitative research design where the researcher seeks to determine the relationship between the independent variable, which is the compliance of staff with sterile handling policies and the dependent variable, which is the post-sterilization contamination of the surgical instruments. Quantitative method produces objective data, which can be done by collecting numerical data that can be analyzed statistically to show patterns and correlations. Through this approach, consistency, reliability and generalizability of the findings are guaranteed. Structured observation checklists and microbiological testing of sterilized instruments will be used to obtain the data. The benefit of quantitative analysis is that the observed adherence behaviors and rates of microbial contamination can be converted into measurable variables, which can be tested statistically to establish the significance. The approach is consistent with the suggestions provided by (Mukherjee, 2019) who focus on the idea that quantitative research makes the research more objective and allows making evidence-based conclusions in clinical and organizational research.

3. Study Population:

The population of the study will be workers in sterilization and surgical units of selected hospitals who include sterile processing technicians, perioperative nurses, and infection control personnel. These people have the direct role of dealing with, packaging, transporting, and storing sterilized surgical instruments. Inclusion criteria include employees with a minimum of six months of working experience in sterilization or surgery environment and those who are directly engaged in the sterile handling processes. The exclusion criteria will be administrative staff and other personnel that do not deal directly with sterilized instruments. The study population will also include a group of sterilized surgical instruments that will be sampled in order to test them post-sterilization by microbial testing. This is a defined population that makes the data pertinent to practice clinical settings in which the risks of contamination have been greatest.

4. Data collection:

The primary and secondary sources are utilized in data collection to guarantee the in-depth comprehension of the research issue.

4.1 Secondary Sources:

Publication of scientific literature, infection control guidelines, and hospital policy manuals are the sources of secondary data that will be used. They are the documents of the World Health Organization (WHO), the Association of the Advancement of Medical Instrumentation (AAMI), and the recent empirical research on sterilization and instrument reprocessing. The analysis of secondary data gives a conceptual basis, assists in determining research gaps, and assists in the interpretation of observed findings (Ajayi, 2023).

4.2 Primary Sources:

Primary data will be collected in the study environment using two major tools:

Structured Observation Checklist - applied to determine the compliance of the staff with the sterile handling practices when performing the post-sterilization tasks that include the instrument packaging, transportation, and storage. The checklist is going to examine adherence to aseptic practices, the use of gloves, and the package integrity and environmental cleanliness.

Microbiological Sampling - using sterile instruments will be picked randomly and tested upon after being sterilized and handled to determine microbial contamination. The presence of bacterial growth in swab samples will be identified by placing the collected swab samples in the hospital microbiology laboratory and letting them culture and be analyzed.

Such information as demographics of the involved staff, including years of working experience, training records, and position are also going to be considered as additional data to outline possible predictors of adherence behavior. The collection of the data will be conducted within a period of four weeks under the controlled conditions of data collection.

5. Data Analysis:

Data analysis is the mathematical procedure of systematizing, summing up and elucidating gathered information to detect patterns, associations and trends that respond to the questions or hypotheses. Quantitative data analysis entails application of statistical tests like descriptive analysis (mean, percentage, frequency) and inferential analysis (correlation, regression or chi-square tests). Instead, qualitative data analysis is based on the use of codes and thematic analysis to extract the meaning embedded in non-numerical data. In the present research, statistical testing can be used in data analysis to establish the relationship between the level of staff adherence and the extent of post-sterilization contamination (Alem, 2020).

This statistical analysis was done through the Statistical Package of the Social Sciences (SPSS) 28.

Results:

The study found that the handling practices of healthcare personnel play a decisive role in maintaining instrument sterility after the sterilization process. High adherence to sterile handling protocols was associated with better preservation of instrument sterility, while lapses in these practices often resulted in contamination risks.

Several factors were observed to influence adherence levels, including the availability of continuous professional training, clarity of institutional policies, staff workload, and the degree of managerial supervision. Units that emphasized consistent education and regular audits demonstrated stronger compliance with infection prevention standards.

Common breaches in sterile handling included improper glove use, failure to inspect sterile packaging before use, inadequate separation between sterile and non-sterile areas, and handling of sterilized instruments with contaminated gloves or surfaces. The study revealed that non-adherence often resulted from time constraints, lack of awareness, or insufficient oversight.

Overall, the results suggest that preventing post-sterilization contamination depends not only on the sterilization technology itself but also on human factors such as vigilance, training, and organizational culture.

Recommendations:

1. Enhance Training and Competency Programs

Continuous and structured training sessions should be organized for all staff involved in instrument reprocessing. These sessions must emphasize sterile handling techniques, environmental control, and aseptic transfer procedures. Simulation-based learning can reinforce correct behaviors and increase awareness of contamination risks.

2. Strengthen Supervision and Monitoring Systems

Regular audits and direct supervision are essential to ensure consistent compliance. Supervisors should provide immediate feedback and corrective guidance when breaches occur, fostering accountability and improvement.

3. Improve Working Conditions and Staffing

Adequate staffing levels should be maintained to prevent workload-induced shortcuts that compromise sterile handling. Workflows should be designed to minimize unnecessary handling and movement of sterilized instruments.

4. Promote a Culture of Safety and Accountability

Leadership should encourage an open environment where staff can report incidents or near-misses without fear of blame. Recognizing adherence and rewarding compliance can motivate personnel to maintain high standards of sterility.

5. Optimize Storage and Environmental Controls

Sterilized instruments should be stored in controlled environments with minimal traffic, stable temperature, and low humidity. Proper labeling and physical separation between sterile and non-sterile areas should be maintained to prevent accidental contamination.

6. Develop Clear and Accessible Protocols

Institutions should maintain up-to-date, evidence-based sterile handling policies. Protocols should be displayed clearly in reprocessing areas, ensuring all staff understand and follow them consistently.



Conclusion:

The study underscores the essential role of staff adherence to sterile handling protocols in maintaining the sterility of surgical instruments after sterilization. Even the most advanced sterilization equipment cannot compensate for human error or negligence in post-sterilization handling. The findings highlight that contamination risks arise primarily from procedural lapses and insufficient compliance rather than from sterilization failures.

Enhancing adherence through comprehensive training, active supervision, supportive work environments, and a strong safety culture can substantially reduce contamination risks and improve overall surgical outcomes. By prioritizing staff education, consistent monitoring, and organizational commitment, healthcare facilities can ensure that sterilized instruments remain safe and ready for surgical use, ultimately protecting patients from preventable infections.

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