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Role of The Operating Room Technician in Implementing Surgical Counting and Its Impact on Patient Safety in Public Hospitals – Sana'a

Research Project Submitted in partial fulfillment of the requirements for the Diploma degree in the Scrub Nurse Faculty of Applied Medical Sciences at 21 September University

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الاستهــــــــــــــلال

سُورَةُ طه

بِسۡمِ ٱللَّهِ ٱلرَّحۡمَٰنِ ٱلرَّحِيمِ

فَتَعَٰلَى ٱللَّهُ ٱلۡمَلِكُ ٱلۡحَقُّۗ وَلَا تَعۡجَلۡ بِٱلۡقُرۡءَانِ مِن قَبۡلِ أَن يُقۡضَىٰٓ إِلَيۡكَ وَحۡيُهُۥۖ وَقُل رَّبِّ زِدۡنِي عِلۡمٗا ١١٤

Dedication

Thank God thank you very much

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

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

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

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

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

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

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

Acknowledgment

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

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The Researchers

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Abbreviations

Abbreviations	Term
AI	Artificial Intelligence
ANOVA	Analysis of Variance
AORN	Association of Perioperative Registered Nurses
COVID-19	Coronavirus Disease 2019
FRAM	Functional Resonance Analysis Method
HF	Human Factors
HFE	Human Factors and Ergonomics
HROs	High Reliability Organizations
HSOPSC	Hospital Survey on Patient Safety Culture
OR	Operating Room
ORTs	Operating Room Technicians
OTAS	Observational Teamwork Assessment for Surgery
PNDS	Perioperative Nursing Data Set
RF / RF scanning	Radiofrequency (scanning)
RFID	Radio-Frequency Identification
RSIs	Retained Surgical Items
SAQ	Safety Attitudes Questionnaire
SD	Standard Deviation
SEIPS 2.0	Systems Engineering Initiative for Patient Safety (version 2.0)
SPSS	Statistical Package for the Social Sciences
SSC	Surgical Safety Checklist
STAMP	Systems-Theoretic Accident Model and Processes
TGS	Task-Grabbing System
UAE	United Arab Emirates
USA / United	United States of America
VR	Virtual Reality
WHO	World Health Organization
χ^2	Chi-square (test)

ABSTRACT

Background: Surgical counting is a core perioperative safety practice to prevent retained surgical items (RSIs). In resource-limited public hospitals in Sana'a, Yemen, the consistency of this practice among operating room technicians remains insufficiently studied. **Objective:** To assess the role of operating room technicians in implementing surgical counting and determine its impact on patient safety in public hospitals in Sana'a City, Yemen. **Methods:** An analytical cross-sectional study was conducted in five public hospitals. Using convenience sampling, 201 eligible operating room technicians completed a structured self-administered questionnaire covering demographics/work profile, surgical counting practices, and patient safety. Descriptive and inferential statistics, including Pearson correlation, were applied. **Results:** The findings revealed a significant implementation gap, with 50.2% of technologists reporting low levels of protocol adherence. Critical weaknesses were identified in procedural documentation (45.8% disagreement) and "speaking up" during count discrepancies (48.8% disagreement). Over half of the participants (52.7%) had received no formal training in surgical counting. A very strong positive correlation was found between the implementation of surgical counting and patient safety ($r = 0.980$, $p < 0.001$). Higher safety compliance was significantly associated with being female, having fewer years of experience (< 6 years), and managing lower surgical volumes (< 20 cases/month). **Conclusion:** Surgical counting implementation in Sana'a's public hospitals is suboptimal and highly variable. The strong correlation between counting adherence and patient safety indicates that current inconsistent practices pose a substantial risk of preventable surgical errors. Systemic barriers, including high workloads and a lack of specialized training, are the primary drivers of non-compliance. **Recommendations:** Public hospitals should mandate standardized counting protocols and introduce competency-based certification in surgical counting. Further multi-center studies—including private hospitals and additional provinces- are needed to develop a national profile of counting practices and patient safety.

Keywords: Surgical counting, ; Patient safety, Operating room technician, Public hospitals, Sana'a, Yemen

CHAPTER ONE

INTRODUCTION

CHAPTER ONE: INTRODUCTION

I. Background:

One of the most important aspects of modern healthcare is ensuring patient safety in the operating room (OR). Surgical procedures require intricate interactions among multidisciplinary teams, and communication breakdowns, time constraints, and procedural complexities may result in significant adverse outcomes, including retained surgical items (RSIs). Research indicates that sentinel events during surgery might result in catastrophic outcomes for patients and institutions, illustrating the need for safety mechanisms, such as surgical counting, to prevent them (Mann, 2018).

Surgical counting, which is keeping track of instruments, sponges, and sharps in a methodical way during procedures, is a key way to avoid RSIs. Despite its simplicity, many hospitals, particularly public ones, report poor adherence and variations in its implementation (Al-Wesabi, 2020). Research in Turkey found that over half of hospitals allowed untrained staff to assist with counts, increasing the risk of errors and endangering patient safety (Bahar et al., 2017).

Operating room technicians (ORTs) are crucial for counting during surgery because they are directly involved in preparing and handling instruments. Being careful and knowing the rules can help reduce counting mistakes. Research from 2024 showed that new technologies, such as the "Task-Grabbing System," gave surgical professionals greater power, making their work more efficient and helping them complete tasks.

OR technicians play a very important role, yet they often struggle with communication and hierarchy. These constraints can make it hard to get accurate surgical counts and talk openly about differences. Ethnographic research in Australia showed that power dynamics among nurses, technologists, and surgeons frequently influence the execution of surgical

counts, resulting in the normalization of dangerous procedures (Riley, Manias & Polglase, 2006).

The World Health Organization (WHO) Surgical Safety Checklist (SSC) is a global guideline for making surgery safer, including counting surgeries. However, OR staff have quite different levels of expertise and ability to use what they know. Recent findings in Pakistan indicate that although 93.3% of OR staff were aware of the SSC, a significant number still considered it time-consuming, thereby affecting full compliance (Gul et al., 2024).

There is a direct correlation between operating room staff participating in SSC and counting processes and fewer surgical mistakes that may have been avoided. A 2023 study in the UAE emphasized the importance of improving collaboration, communication, and learning among surgical staff, including technicians, to ensure adherence to safety regulations (Singh & Arulappan, 2023).

The culture of patient safety in public hospitals is generally not as strong as in private hospitals, since they lack the resources and training. Studies conducted in Tunisia and Nigeria indicated that OR personnel in public hospitals saw their patient safety culture as inadequate, highlighting underreporting of errors and the absence of non-punitive methods as significant impediments to safe surgical practices (Aouicha et al., 2022; Nwosu et al., 2022).

In public hospitals, surgical counting is often incorrect or omitted, a problem that persists. A Brazilian investigation found that surgical counts were not completed for all surgeries observed, indicating problems with following safety rules (Calegari et al., 2018).

Training and ongoing professional development for OR technicians have demonstrated improvements in patient safety performance. Research indicates that specialized perioperative training and adherence to counting standards are significantly associated with reduced count discrepancies and enhanced collaboration within surgical teams (Mukantwari et al., 2019).

Therefore, the operating room technician's adherence to surgical counting rules is vital for maintaining patient safety in public hospitals. But differences in practice, communication problems, and insufficient training make it challenging to do your best work. To make surgical environments safer and reduce RSIs, it is important to strengthen the culture of patient safety, encourage cooperation, and standardize counting methods (Gomes et al., 2023; Mistri et al., 2023).

II. Problem Statement:

Patient safety during surgical procedures is a worldwide issue, especially in places with few resources, like public hospitals in Yemen. Retained surgical items (RSIs) represent a significant surgical error that can be preventable. They happen when surgical counts are not done correctly or completely. These events cause serious problems, more illnesses, longer hospital stays, and higher healthcare expenses. Surgical counting is a basic safety measure, but mistakes, communication problems, and failure to follow rules often lead to it being performed incorrectly.

Operating room technicians (ORTs) are crucial to ensuring that instrument and material counts are accurate. However, in many public hospitals, such as those in Sana'a City, the position of surgical counts is sometimes not well defined. They don't have enough training or supervision, and their roles aren't clear (Al-wesabi, 2012).. Previous research has predominantly focused on nurses and surgeons, leaving a dearth of studies examining the role of ORTs in

enhancing surgical safety standards. This absence of systematic evaluation impedes the formulation of effective treatments to improve counting accuracy and avert retained surgical items within the Yemeni healthcare framework.

III. Justification of the Study:

This study is warranted by the pressing necessity to enhance patient safety protocols in the operating theaters of public hospitals in Sana'a City, Yemen. It is important to know what Operating room technicians do in surgical counts so that we can find problems with the present methods and come up with ways to reduce retained surgical items. Improving Operating room technicians' knowledge, skills, and sense of responsibility can greatly enhance surgical outcomes and keep patients overall safer.

This study will also show how well-defined counting techniques, proper training, and coordination across fields can make surgical environments safer. The results will help policymakers and healthcare administrators in Yemen create consistent rules, ongoing education programs, and monitoring systems that work in a country with few resources. In the end, this study's goal is to help improve the culture of safety and quality of care in public hospitals.

Aim of study

General Objective:

To assess the role of operating room technicians in implementing surgical counting and determine its impact on patient safety in public hospitals in Sana'a City, Yemen

Specific Objectives:

1. To assess the level of implementation of surgical counting practices among operating room technicians across the following domains:
2. To identify the level of patient safety as perceived by operating room technicians
3. To examine the relationship between surgical counting implementation and patient safety in public hospitals in Sana'a City.
4. To determine whether surgical counting implementation and patient safety differ according to demographic and work-related characteristics (e.g., qualification, years of experience).

Research question:

1. What is the level of surgical counting implementation among operating room technicians?
2. What is the level of patient safety as reported by operating room technicians?
3. Is there a significant association between surgical counting implementation and patient safety?
4. Do surgical counting implementation and patient safety scores differ by demographic and work-related factors (hospital, educational level, years of experience)?

CHAPTER TOW

LITERATURE REVIEW

LITERATURE REVIEW

2.1. Overview

The operating room is still one of the most complicated and dangerous places in healthcare, and it needs to be carefully planned and followed safety rules. Surgical counting, which is the systematic checking of surgical tools, sponges, and sharps before, during, and after surgery, is one of them. It is very important to stop retained surgical items (RSIs), which are a severe and avoidable hazard to patient safety. The operating room technician (ORT) is very important for making sure that surgical counts are correct, keeping aseptic practices, and helping the surgery go more smoothly. Recent studies show that ORTs are playing a bigger role in making the culture of surgical safety better by improving communication, responsibility, and following standard protocols (Afrooghe et al., 2023; Gomes et al., 2023).

Surgical technologists, often known as operating room technicians, are an important part of the processes that happen during surgery to protect patients' health. Preparing, managing, and finally checking surgical products are their main jobs when it comes to surgical counting. Descriptive research in Turkey found that scrub nurses and ORTs did 95% of surgical counts, which shows how important they are in reducing RSIs (Bahar et al., 2017). Even if there are set rules, differences in how institutions count show that there is a need for consistent counting systems and professional responsibility.

A Rwandan study investigating the knowledge and practices of surgical counting among perioperative workers revealed that 78% have adequate theoretical understanding, although only 42% exhibited practical adherence. Some of the biggest problems were limited experience, lack of monitoring, and poor compliance (Mukantwari et al., 2019). The results show how important it

is to keep training technicians and make sure they know what their tasks are to avoid mistakes in surgical counts.

Studies repeatedly show that following surgical counting guidelines leads to better patient safety outcomes. A 2023 study conducted in Turkey revealed that instrument counts were neither audibly executed nor confirmed in 100% of observed procedures, highlighting considerable patient safety hazards and institutional noncompliance (Calegari et al., 2018). This shows that mistakes in counting during surgery directly contribute to a higher chance of leaving foreign bodies behind, which is a major cause of difficulties and lawsuits after surgery.

In a larger context of safety, the WHO Surgical Safety Checklist (SSC) has proven very helpful in making counting protocols a part of perioperative routines. Research conducted in Pakistan and Finland demonstrates that the proficient execution of the SSC markedly diminishes wound complications, readmissions, and intraoperative errors (Gul et al., 2024; Lepänluoma et al., 2014). However, how well the implementation works depends a lot on how knowledgeable, positive, and compliant the OR technicians are. They are often in charge of making sure that checklists are followed during operations.

New technologies have changed the OR technician's job to make it safer and more efficient. The Task-Grabbing System (TGS), which was based on app-based task management, was found to make the operating room more efficient and cut down on turnover time. This gave surgical personnel more control over intraoperative logistics (Chen et al., 2024). Complementary technologies such as radiofrequency identification (RFID) and bar-coded sponges have enhanced technicians' ability to maintain precise counts and avert repetitive strain injuries (RSIs) (Rigamonti et al., 2025). These technologies help keep track of items accurately and also make people more responsible and able to check things in real time, which is very important for patient safety.

Organizationally, promoting a robust safety culture in the operating room profoundly impacts personnel' compliance with counting rules. Research underscores that collaboration, effective communication, and a non-punitive stance towards mistakes improve adherence and attentiveness during surgical counts (Nwosu et al., 2022; Arad et al., 2022).

Even while policies and technology have gotten better, studies show that OR techs and nurses still don't know enough, don't have the right mindset, and don't do things the right way. A 2023 evaluation in Pakistan indicated that although the majority of operating room staff endorsed the WHO checklist, misconceptions regarding its time efficiency impeded complete adherence (Ullah et al., 2023). Also, not enough training, a heavy workload, and depending on people who aren't experts make counts less accurate and raise the risk of bad things happening.

To deal with these problems, it is important to keep learning, test your skills, and get support from leaders. A 2024 Korean study stressed that regular training on infection control, counting instruments, and managing specimens should be a top priority to reduce the gap between what people know and what they do (Shin & Kim, 2024). Furthermore, fostering a culture of psychological safety—where technicians feel encouraged to report inconsistencies without fear of retribution—can enhance surgical counting techniques and safeguard patient outcomes.

2.1 Conceptual and Operational Definitions

Operating Room Technician / Scrub Technician

The operating room (OR) technician, also known as a scrub technician, is an important member of the perioperative team. They help surgeons during operations by keeping the area clean, managing tools, and making sure that aseptic principles are followed. The function is different in different healthcare systems, and it typically overlaps with the duties of a perioperative nurse. Scrub technicians are in charge of getting surgical tools ready, passing instruments, and counting surgical things with circulating nurses to make sure that no surgical items are left behind (RSIs). Recent studies show that working together and communicating well among OR staff greatly improves surgical safety outcomes (Kertesz, 2018). Likewise, variations in vocabulary and breadth among institutions highlight the necessity of precise role definition to uphold responsibility in surgical procedures (Mhlaba et al., 2016).

Counting for Surgery:

In theory, surgical counting is the methodical process of checking all surgical tools, sponges, sharps, and other materials used during surgery to make sure that none are accidentally left within the patient. It is an important part of surgical safety and is done at important times: the first (baseline), intraoperative, and closure (final) phases. In practice, surgical counting means that scrub and circulating personnel talk to each other in a controlled way, follow set rules, and write down what they do in surgical records. Evidence underscores that adherence to standardized counting techniques mitigates RSIs and improves patient safety (Freitas et al., 2016; Warwick et al., 2021; Gomes et al., 2023). Studies indicate that even "accurate" counts may obscure inherent cultural or procedural dangers (Rigamonti et al., 2025).

Safety of Patients During Surgery:

In theory, surgical patient safety is avoiding, stopping, and fixing bad things that happen as a result of surgery. It means following safety rules, encouraging teamwork, and building a culture of reliability to reduce injury that could have been avoided. Safety in the OR is checked by using safety checklists, reporting near misses, and taking safety climate surveys. Research indicates that regular utilization of the WHO Surgical Safety Checklist markedly diminishes near-miss occurrences and fosters interdisciplinary teamwork (Bozkurt & Tüzer, 2023; Gul et al., 2024). The culture of communication and error control in the operating room (Hu & Greenberg, 2012) is also very important for patient safety.

Retained Surgical Items (RSI):

An RSI is any object that is left inside a patient's body after surgery by mistake. This could be sponges, instruments, or needles. There are incident reporting systems, clinical audits, and root-cause analysis of sentinel occurrences that measure it in terms of operations. RSIs are still one of the most serious yet avoidable surgical mistakes. They are commonly caused by poor communication, not following counting rules, and not using technological aids properly (Erkan & Er, 2024; Rigamonti et al., 2025). Recent studies have linked RSIs to organizational culture and leadership involvement in patient safety measures (Osborne et al., 2021; Susmallian et al., 2022).

Near-Misses and Discrepancies

Near-miss occurrences are incidents that could have been harmful to patients but were stopped before they could happen. In theory, they show how strong surgical safety measures are, and in practice, they show how well errors are found and reported. Research indicates a discrepancy between awareness

of near-miss notions and actual reporting behaviors, with frequent underreporting attributed to fear of accountability or insufficient organized mechanisms (Bozkurt & Tüzer, 2023; Ma et al., 2025). Systematic detection and analysis of near-misses assist in selecting risk reduction techniques.

Public Hospital Safety Indicators:

In terms of operations, safety indicators are the number of incident reports, the number of adverse event reports, the number of times surgical safety regulations are followed, and the results of safety audits. These factors show how well the institution follows safety rules and how safe the culture is in general. Structured counting systems, incident-reporting transparency, and interdisciplinary safety training enhance compliance rates and diminish adverse events (Gomes et al., 2023; Angelilli, 2024).

2.3 Theoretical and Conceptual Frameworks Relevant to Surgical Counting

The dependability of surgical counting—an important protection against retained surgical items (RSIs)—is based on a number of interconnected theoretical and conceptual frameworks. These frameworks are based on human factors engineering, systems safety science, teamwork theories, and healthcare quality models. Each of these fields offers a different way to look at how surgical teams may avoid counting mistakes and make patients safer (Qabban, Al-Wesabi, et al., 2025).

Human Factors and Ergonomics in the Operating Room

Human Factors and Ergonomics (HFE) offer a fundamental framework for examining the impact of attention, cognitive load, multitasking, fatigue, and interruptions on surgical performance and counting reliability. HFE focuses on how people, tools, processes, and environments operate together and how

design and workflow might make things safer or more likely to go wrong. Research indicates that elevated cognitive load and frequent work interruptions heighten the probability of counting discrepancies, particularly during crucial surgical transitions (Kelly et al., 2023).

Catchpole et al. (2022) emphasized that the allocation of workload and failures in communication during robotic and traditional operations immediately affect the attentional capacity of scrub nurses and circulating personnel, hence impacting the reliability of counting (Catchpole et al., 2022). Holden et al. (2013) created the SEIPS 2.0 model, which sees healthcare systems as sociotechnical environments where human behavior, task demands, tools, and organizational factors all work together to affect outcomes. Recent evaluations underscore that the implementation of ergonomics in healthcare improves system resilience by addressing issues like as weariness, interruptions, and cognitive overload, which are critical to counting accuracy (O'Dea et al., 2025). These discoveries indicate that counting errors are infrequently attributable to individual shortcomings, but are instead emergent characteristics of intricate human–system interactions.

Systems and Safety Science Perspectives:

From the perspectives of systems and safety science, frameworks such as Reason's Swiss Cheese Model and the principles of High Reliability Organizations (HROs) clarify how various defensive layers—human vigilance, standardized processes, and environmental controls—can fail in the presence of latent and active defects. Surgical counting errors frequently occur when latent factors (e.g., insufficient staffing, unsuitable tools) coincide with active failures (e.g., misunderstanding or weariness).

Incorporating human aspects into safety management is in line with HRO concepts, which stress standardization, redundancy, and being aware of

how things are working. Rodríguez and Hignett (2021) suggested an integrated systems model for healthcare resilience, promoting the concurrent implementation of safety principles at micro (individual), meso (team), and macro (organizational) levels (Rodríguez & Hignett, 2021).

Jackson et al. (2025) also discovered that systems HFE methods like Functional Resonance Analysis Method (FRAM) and Systems-Theoretic Accident Models (STAMP) are good ways to find failure sites in surgical operations and improve system redundancies (Jackson et al., 2025). These frameworks show that the reliability of surgical counting depends on more than just following the rules; it also depends on the design of the system and how it gets feedback.

Teamwork and Communication Frameworks:

Surgical counting is a team-dependent process that needs everyone to have the same mental models, be able to work together clearly, and be able to speak up. Theoretical models of cooperation in healthcare stress the importance of interdisciplinary collaboration, clear roles, and situational leadership to avoid mistakes.

The creation of observational frameworks, exemplified by the Observational Teamwork Assessment for Surgery (OTAS) introduced by Healey et al. (2004), facilitates the systematic evaluation of team behaviors—such as cooperation, leadership, and situational awareness—that are crucial for effective counting (Healey et al., 2004).

Zulkifli et al. (2024) put out a theoretical model employing a genetic algorithm for the establishment of surgical teams to enhance collaboration, communication, and safety—principles that are directly relevant to the reliability of surgical counts (Zulkifli et al., 2024).

Furthermore, communication breakdowns persist as a primary cause of intraoperative damage, especially in teams sensitive to hierarchy. Valen Waehle et al. (2012) discovered that adherence to checklists is significantly influenced by social acceptance and team dynamics, underscoring the necessity of open communication channels for precise surgical counts (Valen Wæhle et al., 2012).

Quality-of-Care Models Applied to Surgical Counting:

The Donabedian Model—made up of Structure, Process, and Outcome—gives a systematic way to look at surgical counts in the context of healthcare quality frameworks.

Structure: This includes things like the number of staff, the availability of counting equipment, and the execution of policies. Holden et al. (2011) showed that having enough workers and designing things in an ergonomic way makes counting more consistent by reducing cognitive load.

Process: This means following counting rules, resolving discrepancies quickly, and keeping records. Research indicates that robust process standardization and checklist utilization—congruent with SEIPS and HFE principles—substantially diminish retained items (Saver, 2022).

Outcomes: Include safety climate, frequency of near misses, and injury to patients. Integrating human aspects into systems has been shown to create a culture of resilience and ongoing quality improvement (Privitera, 2020; Shamlan & Al-Wesabi, 2026).

The Donabedian approach puts surgical counting in context by integrating structure, procedure, and outcomes. It shows that it is both a clinical duty and a way to measure how safe an organization is.

2.4 Patient Safety in the Operating Room

Overview of Surgical Patient Safety Risks

The operating room (OR) is one of the most complicated and dangerous places in modern healthcare. It is a dynamic socio-technical system where people, technology, and the environment all interact all the time under a lot of time pressure and a lot of effort. In this complicated system, even slight changes can lead to bad things happening. There are many reasons why surgical patients might not be safe, such as technical mistakes, human issues, system-level failures, and communication problems. Research shows that around 11% of hospital patients have adverse events, and more than half of those occurrences are related to surgery (Ram & Boermeester, 2013). The intraoperative phase is still a hot location for bad occurrences because interdisciplinary teams have to think and move quickly (Hu & Greenberg, 2012).

Some of the most common dangers that happen during surgery are retained surgical items (RSI), wrong-site or wrong-procedure procedures, surgical site infections, and equipment malfunctions. System-level communication or verification problems are often the cause of each of these events. Surgical counting methods, which have long been seen as a simple but important way to keep things under control, are important protections against RSI episodes. But these kinds of activities only work if people work together, stay alert, and follow the safety culture (Hurlbert & Garrett, 2009). The use of Human Factors Engineering (HFE) principles, initially developed from aviation and nuclear safety, has greatly enhanced the comprehension of the impact of workflow design, tiredness, and ergonomics on surgical safety (Al-Wesabi & Shamlan, 2022). Tsianos (2020) says that HFE doesn't get rid of human error; instead, it tries to "engineer resilience" into OR systems so that they can handle unexpected problems (Tsianos, 2020).

Recent conceptual advancements characterize the operating room as a “theatrical performance,” wherein each team member executes a specific role with precision and coordination—highlighting preparation (briefing), live performance (intraoperative collaboration), and post-performance reflection (debriefing) as critical phases of safe surgical practice (Rarani, 2025). These comparisons show how important it is to practice on purpose, hold each other accountable, and communicate in a systematic way to avoid injury that could have been avoided.

Safety Culture and Safety Climate in Hospitals

Safety culture and safety climate are separate but connected ideas that help us understand how well an organization works in the OR. Safety culture is the set of strongly held views, values, and conventions regarding safety that everyone in a company shares. Safety climate, on the other hand, is how staff members feel about those principles at any given time. The Safety Attitudes Questionnaire (SAQ) and the Hospital Survey on Patient Safety Culture (HSOPSC) are the main tools used to measure these areas (Aouicha et al., 2022).

Strong safety cultures are linked to better adherence to protocols, more open communication, and more people "speaking up." Using the World Health Organization's Surgical Safety Checklist and its offshoots, including the "Five Steps to Safer Surgery," has been found to greatly improve safety climate scores, teamwork, and how often people talk to one other in operating rooms (Hill et al., 2015). On the other hand, places that punish people for making mistakes make it less likely that people would disclose them and learn from them. at a mixed-methods study conducted at Tunisian university hospitals, only 26.3% of respondents indicated open communication, while 22.9%

reported a non-punitive response to error, highlighting the ongoing prevalence of a "blame culture" in surgical environments (Aouicha et al., 2022).

Nursing views elucidate discrepancies between safety policies and quotidian behaviors. In a 2023 cross-sectional survey, surgical nurses indicated modest levels of safety culture, with “teamwork within units” rated best and “non-punitive response to errors” rated lowest (Yavuz, 2023). An Indian research of OR nurses found similar results, with stress, poor communication, and a lack of management support being major obstacles to keeping a solid safety climate (Sethi, 2023).

In public hospitals, safety habits are greatly affected by a lack of staff, a high turnover rate, and a lack of resources. Research from developing nations indicates that the underreporting of adverse events is frequently associated with workload demands and hierarchical obstacles (Vinagre & Marques, 2018). In Colombia, operating room professionals identified inadequate safety climates in the areas of “nonpunitive response to error” and “workload,” with positive responses at 49.4% and 59.3%, respectively. Nurses scored lower than physicians, indicating disparities across professional hierarchies (Arias-Botero et al., 2020).

Recent studies indicate a positive correlation between experience, age, and safety attitudes. Experienced nurses frequently report enhanced management support and job satisfaction; nonetheless, they indicate decreased stress recognition relative to their younger counterparts, suggesting effective adaptation to high-pressure settings (Nyberg et al., 2024).

2.5 Surgical Counting: Purpose, Processes, and Standards

Surgical counting is still one of the most important safety rules in perioperative treatment. Its goal is to stop retained surgical items (RSIs), which are known as "never events" everywhere. Even if safety measures have gotten better, RSIs still happen all over the world. This is because of systemic, procedural, and human aspects that need to be improved and standardized all the time. The following section brings together the academic and scientific literature on the reasons for surgical counting, the steps involved, how to handle differences, and the rules for following them.

Rationale for Surgical Counting:

The main reason for surgical counting is to stop RSIs, which are a severe but completely avoidable cause of illness and death in surgical care. Because they may be avoided by standardized counting and verification processes, RSIs are called "never events." Research consistently emphasizes that precise surgical counts function not only as a safeguard for patient safety but also as a mechanism of ethical accountability and medico-legal documentation that meticulously records every surgical instrument, sponge, and sharp object utilized during procedures (Osborne et al., 2021).

From a patient safety standpoint, accurate counting reduces the risks of infection, reoperation, persistent pain, and psychological stress linked to RSIs (Park et al., 2025). Keeping accurate counts is an ethical duty of care for both the nurse and the surgeon since it makes sure that everything is clear, accountable, and documented so that any differences can be checked (Freitas et al., 2016).

Surgical Counting Procedures (Process Description)

The surgical count procedure usually follows set "count moments," such as before the incision, before the cavity is closed, during staff relief or team handover, after objects are added, and following skin closure. The Association of Perioperative Registered Nurses (AORN) and the World Health Organization (WHO) both say that these checkpoints are the least safe standards (Cochran, 2022). There are soft goods (sponges, gauze), sharps (needles, blades), instruments, and other parts like drains and device fragments that need to be counted.

Count boards, whiteboards, and preprinted count sheets are examples of visual controls that keep track of counts in a way that can be checked later (Caputo & Faust, 2024). In advanced operating suites, adjunct technologies like barcoded sponges and radiofrequency identification (RFID) systems have been included to help with manual counts. This makes it easier to track things down and makes mistakes less likely (Steelman, 2014).

Counting Discrepancies: Causes and Management:

Count disparities happen for a number of reasons, including emergency operations, tight deadlines, personnel turnover, distractions, and surgical trays that aren't uniform (Nelson, 2021). Research indicates that 70–80% of RSI cases transpire despite "accurate" counts, frequently attributable to cognitive overload or inadequate interprofessional communication (Endicott et al., 2020). The suggested course of action is as follows:

1. The same team members should count again right away.
2. A planned search of the sterile field, instrument tables, and trash cans.
3. The surgeon checks the wound to make sure the cavity is clear.

4. Use of intraoperative imaging (radiography) if the disparity is still not fixed (Trieu et al., 2023).
5. Official reporting and debriefing to record the event, look at what caused it, and reinforce what was learned to avoid it happening again.

The combination of risk modeling and interdisciplinary debrief systems, like those used by Memorial Sloan Kettering, has led to longer durations without RSI, lasting more than 1,000 days. This shows how useful systemic prevention frameworks may be (Duggan et al., 2018).

Compliance, Monitoring, and Auditing:

Routine audits, ongoing education, and leadership control are all important for making sure that surgical counts are accurate. Direct observation, retrospective documentation review, and discrepancy log analysis are all modern ways to undertake audits. Quality assurance systems that check for compliance with procedures and find training shortages generally include these (Sebastian et al., 2020).

Understaffing, inconsistent adherence to protocols, and reliance on manual processes are all things that make it hard for hospitals that see a lot of patients or don't have a lot of resources to follow the rules all the time (Bahar et al., 2017). Conversely, facilities utilizing AI-assisted counting or RFID-enhanced systems exhibit enhanced accuracy and less cognitive burden among surgical personnel (Deol et al., 2024).

Regular performance audits, like AORN guideline compliance assessments, can cut down on mistakes by up to 70% in just eight weeks (Nelson, 2021). Ongoing professional education and training that uses simulations help surgical teams stay safe and hold each other accountable (Sirikunsathean, 2017).

2.6 Operating Room Technician: Scope, Responsibilities, and Competencies

Operating Room Technicians (ORTs), often known as surgical technologists, are very important members of the perioperative team. They connect the technical and human components that make surgery safe. Their job requires a wide range of technical skills, the ability to work together on procedures, and the ability to communicate with people from different professions in order to maintain sterile integrity and operational efficiency. Recent studies show that their skills go beyond only managing instruments. They also need to be aware of their surroundings, interact well with others, and follow safety rules for patients, all of which are important for the effectiveness of surgical procedures.

Operating Room Technician Role in the Surgical Team:

Operating Room Technicians help keep the sterile field clean, take care of surgical instruments, and keep the flow of procedures going. Their main job is to make sure that all of the equipment, sponges, and devices are clean, working, and easy for the surgeon to find at all times during the procedure. Studies show that skilled OR technicians help the surgery go smoothly by anticipating the surgeon's needs, managing complicated equipment, and keeping things clean. All of these things lead to shorter surgery times and better outcomes for patients (Pasquer et al., 2024).

The surgeon is in charge of the procedure, the circulating nurse is in charge of patient care and paperwork, and the OR technician is in charge of a specific technical duty. The distinction between these positions is delineated by accountability boundaries, wherein the technician is tasked with instrument management, maintaining sterile field integrity, and providing support

throughout the operating process (Al-Wesabi, Jarallah, et al., 2024). At the same time, shared duties including communication, checking for safety, and being ready for procedures need the team to work together to be accountable (Ioannis et al., 2022).

Operating Room Technician Responsibilities in Surgical Counting:

The surgical counting process, which is essential for avoiding retained surgical items, necessitates the active involvement of the OR technician at the baseline (preoperative setup), intraoperatively (when items are added or replaced), and during closure. Recent research emphasizes that precise counting constitutes a collaborative cognitive and communicative endeavor between the scrub technician and the circulating nurse, requiring closed-loop communication to validate items and resolve differences (Singh & Arulappan, 2023).

Coordination requires boldness, particularly in times of discrepancy where technicians must swiftly escalate issues and convey results properly to the surgical team. 63% of the operations we saw showed worrying patterns of verbal communication that affected performance and safety (Garosi et al., 2020). This shows that communication problems are still a substantial source of risk. So, technicians need to show that they can communicate clearly and accurately by using organized closed-loop communication and keeping correct records to keep surgery accountable.

Required Competencies of **Operating Room Technician**:

A. Technical Competencies:

Operating Room Technicians need to know how to use surgical instruments, keep things clean, put together trays, and run equipment. Their technical expertise guarantees procedural efficacy and patient safety. Research

highlights the correlation among technical skills, leadership, and patient outcomes, stressing the importance of structured feedback, simulation-based learning, and ongoing competency evaluation as vital elements of professional development (Andereggen et al., 2022).

B. Non-Technical Competencies:

Non-technical abilities like teamwork, communication, leadership, situational awareness, and the ability to "speak up" in important situations are just as important. Recent research identifies these as fundamental to intraoperative safety. The Delphi study conducted by Sirevåg et al. (2021) delineated essential non-technical domains—situational awareness, decision-making, communication, and teamwork—crucial to both scrub and circulating tasks. Likewise, Malaysian research underscored proactive planning, decision-making under duress, emotional regulation, and conflict resolution as essential competences for scrub nurses, directly relevant to OR techs (Rashid et al., 2025).

C. Education and Continuing Development:

Structured education and continued professional development are necessary for competency assurance. Simulation-based human factors (HF) training, which includes modules on cooperation and communication, has been demonstrated to improve overall surgical safety and coordination (Lee et al., 2022). Also, interdisciplinary training and accreditation frameworks make sure that OR technicians stay up-to-date on their skills and follow evidence-based standards of practice. Evidence shows that temporary OR personnel, when appropriately taught, keep communication and safety behaviors on par with permanent teams (Butler et al., 2025). This shows how important it is to keep learning.

2.7 Factors Influencing OR Technician Effectiveness in Surgical Counting

Being able to count correctly during surgery is very important for keeping patients safe, avoiding retained surgical items (RSIs), and making sure that the whole procedure goes well. Recent studies show that many other elements, such as the person, the team, the organization, and the procedure, all affect how well OR technicians can do accurate counts.

A. Individual-Level Factors:

Individual factors like experience, weariness, and cognitive load have a big effect on how well someone can count during surgery. A 2025 study found that mental exhaustion in operating room nurses is strongly linked to missed perioperative care. This shows how bad cognitive overload and long shifts may be (Rahmani et al., 2025). Burnout and stress were also shown to make it harder to pay attention and make decisions, which made it more likely that the counts would be wrong (Madrid et al., 2025).

The quality of training and clinical experience is very important for building vigilance and consistency in procedures. Research in the UAE found that operating room nurses who had organized education and standardized training were more conscious of safety measures and followed count protocols better (Singh & Arulappan, 2023). Also, psychological safety, or the ability to challenge team decisions or interrupt a senior surgeon, was shown to be important for stopping count mistakes (Higgins & MacIntosh, 2010).

B. Team and Communication Factors:

For surgical counting to work, the team needs to work together and talk to each other freely. However, hierarchy and interprofessional relations

sometimes get in the way of this. Perioperative nurses often say that communication breaks down because of disruptive conduct, unclear delegating, and a lack of respect for each other, which can put patients' safety at risk (Işık et al., 2020).

Team stability is important too. When surgical teams work together consistently, they build trust and a shared understanding of the issue, which cuts down on count interruptions. A 2024 VR-based intervention showed that immersive cooperation training enhanced 90% of the safety behaviors that were measured during surgical cases. This shows how important structured, simulation-based communication development is (Mazur et al., 2024). Interruptions during counts, frequently resulting from relief breaks or emergency handoffs, significantly elevate the probability of procedural deviation (Alfredsdottir & Bjornsdottir, 2008; Al-wesabi, 2017).

C. Organizational and Environmental Factors in Public Hospitals

At the institutional level, staffing shortages, heavy workloads, and bad resource distribution make it hard to get accurate surgery counts. Global shortages in perioperative nursing are associated with heightened turnover and weariness, resulting in adverse implications for patient safety (Xie et al., 2024). Likewise, public hospitals in underdeveloped areas that don't have enough resources reported not having uniform trays, not having enough protective gear, and not getting enough help from administration, which made it more likely that mistakes would happen during the COVID-19 pandemic (Jafree et al., 2020).

The credibility of the count is also affected by leadership and the enforcement of policies. Facilities that put in place standardized counting procedures and regular training for their staff saw almost 100% compliance with surgical count rules within a few months (Hurley & Meyer, 2015).

Additionally, a company culture that encourages feedback loops and learning enhances adherence to safety requirements (Obalannavar, 2025).

D. Procedural and Case Factors:

The effectiveness of counting also depends on the context in which it is done. Murphy et al. (2024) say that complex or multi-cavity surgeries, high turnover patients, and emergency operations are more likely to have counting errors because of time constraint and having to transfer tasks quickly. In particular, emergency scenarios often make it hard to stick to tight numbers. Also, poor scheduling and a lot of cases might make cognitive overload worse, especially in places where there isn't a lot of staff support (Zhang et al., 2025).

Hospitals that use digital systems or adaptive technology, like the Digital Operating Room Assistant, have the potential to make counting procedures more consistent and cut down on mistakes by providing real-time decision support (Geudon, 2016).

2.8 Technological and Procedural Innovations Supporting Surgical Counting:

One of the main goals of surgical safety systems is still to stop retained surgical items (RSIs). Recent improvements in both technology aids and standardization of procedures have tried to make traditional manual counting better by adding smart, traceable, and auditable systems that reduce human error and make the operating room (OR) safer.

I. Adjunct Technologies

Radiopaque Materials and Imaging Protocols:

Radiopaque sponges and equipment are still the simplest and most useful additions to manual counting. These materials have markers built in that can be seen on X-rays, which makes it easier to find them during postoperative imaging in suspected RSI instances. Their major use is in situations where a lot of fluid is needed, like emergencies or unexpected cavity extensions. But their limits are clear: radiopaque markers can fold or become hidden, and imaging during surgery exposes patients to more radiation while also making the procedure longer and more expensive (Kim et al., 2015).

Barcode Systems and RFID Sponge Tracking:

Barcode and Radio-Frequency Identification (RFID) technologies are a big change from counting items passively to tracking them actively. RFID-tagged sponges and tools make it possible to check and track their locations in real time, which greatly lowers the number of RSIs. A 2024 review showed that combining RFID with machine learning makes it possible to automatically find RSIs with great accuracy, which cuts down on the need for human attention and makes workflows more efficient (Abo-Zahhad et al., 2024). Studies on AI-

enhanced RFID analytics show that they are more sensitive than manual counts, which helps find mistakes early in complicated surgeries.

But cost and practicality are problems, especially in public hospitals were maintaining and building RFID technology takes a lot of money and time. Barcode systems are less expensive, but they rely on people and are prone to scanning mistakes and misreads (Al Khatib et al., 2024).

Implementation Risks and Usability Concerns:

Adding technological adjuncts can make new kinds of risks possible. These include devices that are hard to use, too much reliance on automated systems, and too much training for perioperative staff. Using RFID solely for sponges and not for instruments is an example of partial adoption that creates broken safety nets and makes the system less reliable (Gibbs, 2012). For implementation to be successful, users must accept it, be willing to learn, and the culture of the institution must support reporting mistakes and learning from them.

II. Standardization Tools and Communication Aids:

Surgical Safety Checklists and Counting Checkpoints:

The WHO Surgical Safety Checklist and its offshoots are still the most important tools for making procedures more consistent. Adding counting checkpoints at key moments in the procedure, such as before incision, closure, and after closure, has been demonstrated to increase counting accuracy by encouraging team communication and shared accountability (Preckel et al., 2020). More and more, these checklists are connected to electronic record systems so that documentation and compliance tracking can happen in real time.

Counting Algorithms and Discrepancy Pathways

Structured counting algorithms help people make decisions when there are count differences, which reduces the need for subjective judgment. Modern protocols use closed-loop communication and read-back verification to make sure that every difference sets off an escalation route. A scoping review underscored the imperative for redundant verification systems similar to those in aviation, wherein separate confirmations mitigate cognitive gaps and miscommunication (Igesund et al., 2021).

Visual Management and Documentation Standardization

Count boards, digital dashboards, and standardized documentation formats are all examples of visual tools that help people in the OR be more aware of what's going on. Digital count boards that work with RFID or barcode readers can automatically update and let the team know about any differences right away. A 2025 study on perioperative care planning utilizing the Perioperative Nursing Data Set (PNDS) architecture demonstrated that organized visual and communication tools improve interdisciplinary teamwork and compliance with counting protocols (Chaiyaroj & Pichaiphanupatt, 2025).

2.9 Impact of Surgical Counting on Patient Safety Outcomes

Evidence Linking Counting to retained surgical items (RSIs) Prevention

Surgical counting is a basic way to protect against retained surgical items (RSIs), which are one of the most common and preventable problems in operative care. Recent research indicates that rigorous compliance with counting standards markedly diminishes the occurrence of RSIs. A comprehensive descriptive analysis conducted in the United States from 2016 to 2023 revealed a decrease in the incidence of RSI from 1.63 to 1.08 per 10,000 procedures. This drop is attributed to enhancements in standardized surgical counting methodologies and supplementary technology (Mayan et al., 2025). A 2025 systematic study in Korea corroborated that RSIs persist as a preventable yet ongoing issue, highlighting that the surgical counting procedure is fundamental to RSI prevention, notwithstanding human and systemic failures (Park et al., 2025).

Following established protocols is closely linked to better outcomes for patient safety. When surgical counts are done correctly and on a regular basis, perioperative teams are less likely to leave foreign objects behind. A recent psychometric assessment of the Retained Surgical Items Risk Assessment Scale demonstrated that consistent counting techniques and preoperative verification substantially diminished RSI risk, attaining 93% specificity and 87% sensitivity in identifying high-risk cases (Erkan & Er, 2024).

Nonetheless, difficulties in measurement endure. Underreporting and variations in RSI definitions hinder precise prevalence estimation. Case analyses using Australian legal databases (1981–2018) indicated that despite accurate documentation of counts, RSIs persisted due to detection biases, normalization of deviance, and systematic communication inadequacies

(Osborne et al., 2021). These results emphasize the necessity for enhanced reporting methods and the international harmonization of RSI definitions.

New technologies that work with manual counting, such radiofrequency (RF) scanning, have been shown to be useful. An integrated review showed that RF systems had almost flawless detection rates, which cut down on counting mistakes and costs while making real-time verification during surgery easier (Peng et al., 2022). Consequently, the amalgamation of manual and electronic counting systems becomes the most thorough strategy for RSI prevention.

Impact Beyond retained surgical items (RSIs):

Surgical counting has effects that go beyond preventing RSI. It also affects patient safety, team communication, and how well the operation runs. The surgical count is a very participatory process that needs nurses, surgeons, and anesthetists to talk to each other well. Ethnographic studies indicated that communication breakdowns and hierarchical power dynamics frequently undermine count integrity and lead to negative outcomes (Riley et al., 2006). When teams communicate openly and hold each other accountable, the perceived safety culture gets better, which encourages everyone to take responsibility and be on the lookout.

A 2019 study in Rwanda found that operating room staff who communicated better and were more accountable for their procedures made fewer mistakes and followed the rules better, even though the actual observed adherence was still not perfect (Mukantwari et al., 2019). Likewise, the use of standardized counting techniques in delivery rooms enhanced team cooperation and achieved consistent 100% adherence rates within four months (Hurley & Meyer, 2015).

Counting failures not only endanger safety, but they also create significant fiscal and operational challenges. RSIs result in reoperations, extended hospitalizations, and legal liabilities. Case reports show that patients who have things left inside them have long-term discomfort, mental suffering, and a lower quality of life, all of which raise the cost of healthcare (Osborne et al., 2021). Additionally, healthcare organizations risk damaging their reputations and facing fines for surgical mistakes that could have been avoided.

2.10 Summary of Previous Studies

Prior studies have continually underscored the essential function of operating room (OR) personnel in ensuring patient safety via precise surgical counting methodologies. Surgical counting, which involves checking sponges, tools, and needles in a methodical way before, during, and after surgery, is still one of the best ways to avoid retained surgical items (RSIs), which are some of the most dangerous yet preventable problems after surgery. Many studies have found differences between the safety protocols that are suggested and the ones that are actually used in operating rooms, especially in public institutions. These disparities frequently arise from insufficient training, procedural inconsistencies, and inadequate compliance with established norms (Bahar et al., 2017; Mukantwari et al., 2019; Calegari et al., 2018).

Evidence from several nations indicates that, while operating room personnel often have a solid theoretical grasp of surgical counting processes, compliance with proper counting methods is still lacking. A comprehensive study in Turkey indicated that scrub nurses and OR technicians performed the bulk of counts—95% of which involved sponges and pads—yet inconsistencies were prevalent, especially when untrained people were involved in surgical procedures (Bahar et al., 2017). Research in Rwanda showed that 78.2% of OR staff knew how to count surgeries correctly, but only 42.2% did it correctly.

Training and work experience were important factors in how accurate they were (Mukantwari et al., 2019). Research in Brazil revealed that counting was inconsistently executed in all observed instances in a public teaching hospital, signifying widespread disregard for safety requirements (Calegari et al., 2018). These findings collectively indicate that procedural non-compliance, insufficient staff training, and the lack of consistent counting techniques persistently jeopardize patient safety across diverse healthcare systems.

The literature also stresses that OR technicians' duties go beyond counting surgical instruments to making sure the surgical setting is safe and ready for surgery. Recent research has examined enhancements designed to enhance technician involvement and procedural precision. Chen et al. (2024) published a study that presented the "Task-Grabbing System," a digital workflow model that improved intraoperative efficiency by assigning and monitoring technician tasks in real time. This led to higher motivation and better performance in surgical preparation and counting. A 2025 study showed that temporary OR staff, such surgical technicians, kept up high standards of communication and teamwork that were similar to those of permanent staff when they were following standardized safety protocols (Butler et al., 2025). These studies jointly emphasize the necessity for organized training frameworks, supporting leadership, and digital engagement technologies to enhance OR technicians' contributions to surgical safety.

Surgical counting is also closely linked to larger systems of team communication and safety checks, such as the World Health Organization (WHO) Surgical Safety Checklist (SSC). Research indicates that although awareness of the SSC is elevated, practical adherence continues to be variable. For example, a study in Pakistan found that although while more than 90% of OR staff knew of and had positive feelings about the WHO SSC, there were still big gaps in how it was actually put into practice, especially among

technicians and support staff (Gul et al., 2024). A 2023 study also indicated that surgical technicians and nurses often didn't follow checklists because they didn't know enough or had bad feelings about them, which led to near-miss incidents (Ullah et al., 2023). In addition to these findings, Bozkurt and Tüzer (2023) showed that surgical checklists stopped up to 37% of near-miss occurrences, however underreporting was still a problem (Bozkurt & Tüzer, 2023). These studies collectively underscore that the active involvement of operating room professionals in checklist procedures enhances team communication, diminishes human error, and cultivates a resilient safety culture.

The operating room safety culture is a key factor that affects how well surgical counting and other safety practices work. A study in Nigeria revealed that, although teamwork among operating room personnel was robust, the mechanisms for open communication and error reporting were deficient, highlighting the necessity for cultural transformation to enhance safety initiatives (Nwosu et al., 2022). A comprehensive study conducted across 29 hospitals shown a direct correlation between collaboration and preoperative safety checks with enhanced intraoperative performance and psychological safety among personnel (Arad et al., 2022). Rigamonti et al. (2025) suggested that retained surgical items frequently signify more profound organizational culture challenges, including ambiguous role delineations, inadequate accountability, and insufficient leadership dedication to safety. These findings collectively illustrate that a robust, open, and collaborative safety culture—anchored on communication and accountability—is crucial for enhancing surgical count accuracy and patient outcomes.

Finally, the literature has started to look at how using technology might help cut down on mistakes made by people when counting during surgery. Advanced systems like radiofrequency identification (RFID)-tagged sponges

and bar-coded surgical instruments have been shown to greatly lower the number of surgical items that are left behind. However, public hospitals are still not using them much because they are too expensive and hard to train staff to use (Rigamonti et al., 2025). Digital task management solutions, shown by Chen et al.'s (2024) Task-Grabbing model, illustrate the efficacy of automation and accountability tracking in enhancing surgical workflow efficiency and minimizing counting errors (Chen et al., 2024). Collectively, these studies indicate that the amalgamation of technology with safety culture and systematic training signifies a possible avenue for the enhancement of surgical safety standards in the future.

CHAPTER THREE

RESEARCH

METHODOLOGY

CHAPTER THREE: METHODOLOGY

Study Design

This study employed an analytical cross-sectional design to assess the role of surgical technologists in implementing surgical counting and determine its impact on patient safety in public hospitals in Sana'a.

Study Setting:

This study was conducted at five main public hospitals in Sana'a City, Yemen: Al-Thawra General Hospital, Republican Teaching Hospital, Kuwait University Hospital, Military Hospital, and Al-Sabeen Hospital. The selected hospitals represent the largest tertiary and referral centers in the capital, providing a comprehensive array of surgical services and utilizing multidisciplinary perioperative teams, which include operating room technicians. Their diverse surgical departments provide an appropriate framework for assessing the implementation of surgical counting practices and their relationship with patient safety.

Study Population:

The study population comprised all operating room technicians currently working in the surgical departments of the selected public hospitals in Sana'a City during the study period.

Sample size calculation

A total of 201 operating room technicians employed in the surgical departments across three shifts (morning, evening, and night) were included through a convenience sampling technique. Participation was available to all qualified operating room technicians working in operating room care at the five selected hospitals, provided they met the specified inclusion and exclusion criteria. The sample size was determined based on the number of operating room

technicians employed in these hospitals, with a minimum inclusion of 201 technicians to ensure sufficient statistical power.

Inclusion and Exclusion Criteria:

Inclusion Criteria:

- Operating room technicians who have worked in the operating theater for at least six months.
- Those directly involved in surgical counting during operative procedures.
- Willing participants who provide informed consent to participate in the study.

Exclusion Criteria:

- Operating room technicians who are on extended leave during the study period.
- Newly employed technicians with less than six months of experience.
- Technicians who decline to participate or provide incomplete responses.

Tools of data collection:

Data were collected using a structured, self-administered questionnaire adapted from the literature and previously validated tools on surgical safety and surgical counting practices. The questionnaire comprised three sections:

Section I: Demographic and work-related characteristics:

This section collects demographic and professional characteristics, including sex, age group, hospital, educational qualification, years of operating-room experience, average monthly number of surgeries participated in, work shift, training exposure (attendance and number of courses), and surgical department.

Section II: Surgical counting:

This section assessed surgical technologists' self-reported implementation of surgical counting. It included 37 items rated on a 5-point Likert scale and was organized into four domains:

1. Compliance with surgical count procedures (10 items)
2. Communication and teamwork during counting (10 items)
3. Human factors and the work environment (10 items)
4. Leadership and training (7 items)

Section III: Patient safety:

This section measured self-reported patient safety using 23 items rated on a 5-point Likert scale across three domains:

1. Quality of care (10 items)
2. Reduction of medical errors (7 items)
3. Prevention of patient harm (6 items)

Validity and Reliability

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

Reliability was established through pilot testing and standardization of the data collection procedures. Internal consistency reliability was assessed using Cronbach's alpha for the main questionnaire domains. The Cronbach's alpha coefficients demonstrated acceptable to excellent reliability across sections, including Surgical counting items, and Patient safety items, with coefficients ranging from 0.93 and 0.91 respectively, indicating strong internal consistency.

Pilot of the Study:

A pilot study was conducted among 21 operating room technicians (10% of the calculated sample) who were subsequently excluded from the main study. The pilot was undertaken to assess the clarity, feasibility, and applicability of the questionnaire, as well as to estimate the average time required for completion. Based on the pilot findings, necessary modifications were made to improve the wording and organization of the tool.

Data Collection:

Data were collected from December to January 2026, three days per week, across the selected public hospitals. Data collection was organized in coordination with operating room administration and shift schedules to ensure participant accessibility during morning, evening, and night shifts. The researchers obtained institutional permission and presented the official approval letter to the relevant hospital authorities and operating-room supervisors before commencing data collection.

Eligible scrub nurses were approached individually in appropriate areas within the operating suite to ensure privacy. The researchers introduced themselves, explained the aim and procedures of the study, and obtained oral informed consent prior to distributing the questionnaire. Participants received a printed copy of the structured questionnaire along with standardized instructions on how to complete it. The questionnaire was completed in a single session, and participants were given sufficient time (approximately 15–20 minutes) depending on their responses and work demands. Completed questionnaires were reviewed immediately by the researchers to confirm completeness and minimize missing data.

Ethical Considerations:

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

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

Data Processing and Statistical Analysis:

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

CHAPTER

FOUR RESULTS

Table (1): Socio-demographic and work-related characteristics of among operating room technicians (N=201)

Variables	operating room technicians (N=201	
	No	**%**
Gender:		
• Male	112	55.7
• Female	89	44.3
Age groups:		
• < 25 years	40	19.9
• 25 – 35 years	127	63.2
• > 35 years	34	16.9
Qualification		
• Intermediate Diploma	24	11.9
• Higher Diploma	75	37.3
• Bachelor's	83	41.3
• Postgraduate	19	9.5
Years of experience as a surgical technologist:		
• < 3 years	57	28.4
• 3 – 6 years	71	35.3
• 7 – 10 years	56	27.9
• > 10 years	17	8.5
Number of surgeries participated in per month		
• < 20 operations	71	35.3
• 20 – 40 operations	84	41.8
• > 40 operations	46	22.9
Work shift:		
• Morning	168	83.6
• Evening	24	11.9
• Night	9	4.5
Attended training courses on surgical counting		
• Yes	95	47.3
• No	106	52.7

Table 1 shows that the operating room technician workforce (N = 201) is predominantly male (55.7%) and largely concentrated in the 25–35-year age group, which represents nearly two-thirds of participants (63.2%), indicating a mainly early-career to mid-career profile. Educational attainment is relatively high, as more than half hold at least a bachelor’s degree (41.3%) or higher diploma (37.3%), suggesting a

generally well-qualified staff base. Experience levels are fairly evenly distributed across the first decade of practice, with the largest proportion reporting 3–6 years of experience (35.3%), while only a small minority have more than 10 years (8.5%), reinforcing the overall impression of a comparatively younger, less long-tenured workforce.

In terms of workload, most technicians participate in 20–40 surgeries per month (41.8%), and over one-fifth report performing more than 40 surgeries per month (22.9%), reflecting substantial routine exposure to operative procedures. Work scheduling is strongly skewed toward morning shifts (83.6%), with limited representation from evening and night shifts. Importantly, training exposure appears insufficient: a slight majority (52.7%) had not attended surgical counting training, highlighting a potentially critical gap given the centrality of counting practices to patient safety and error prevention in the operating room.

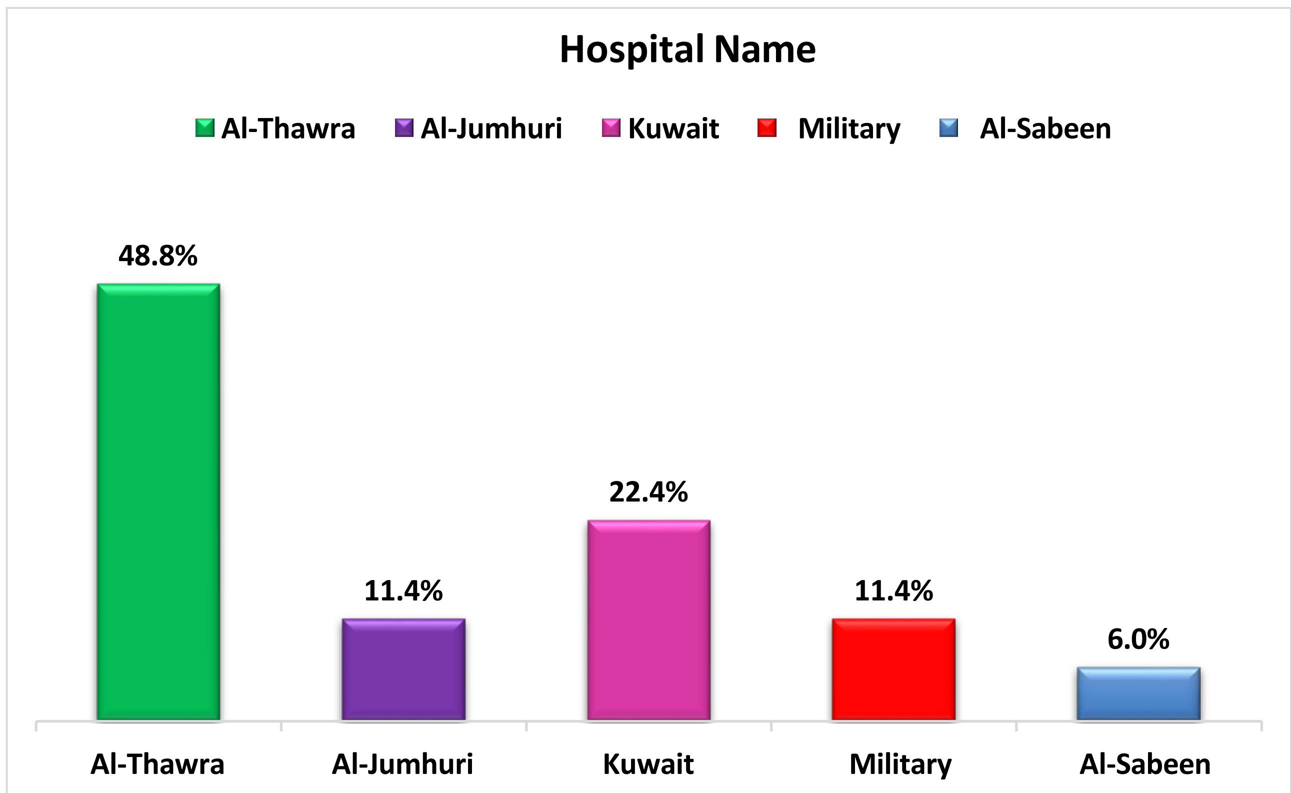

Figure (1): Distribution of operating room technicians among five hospitals

Figure 1 indicates the distribution of operating room technicians across the five hospitals. Al-Thawra Hospital concentrates nearly half of the sample (48.8%). Kuwait Hospital represents the second-largest share (22.4%), accounting for roughly one-fifth of participants, while Al-Jumhuri and the Military Hospital contribute identical, comparatively modest proportions (11.4% each). Al-Sabeen Hospital is minimally represented (6.0%).

Table (2): Compliance with Surgical Count Procedures among Operating Room Technicians (N=201)

	Items	Strongly disagree		Disagree		Neutral		Agree		Strongly agree	
		No.	%	No.	%	No.	%	No.	%	No.	%
1	Performs the initial count immediately before surgery begins	41	20.4	43	21.4	21	10.4	40	19.9	56	27.9
2	Participates in counting during different stages of surgery	52	25.9	33	16.4	20	10	47	23.4	49	24.4
3	Performs the final count before wound closure	58	28.9	31	15.4	16	8	34	16.9	62	30.8
4	Verifies sponges, needles, and instruments separately and accurately	45	22.4	40	19.9	21	10.4	29	14.4	66	32.8
5	Counts any item added during the procedure immediately upon introduction	53	26.4	33	16.4	21	10.4	34	16.9	60	29.9
6	Refuses wound closure if an unresolved discrepancy exists	56	27.9	32	15.9	22	10.9	28	13.9	63	31.3
7	Repeats the count when a surgical team member is replaced	49	24.4	34	16.9	25	12.4	36	17.9	57	28.4
8	Documents count results in approved forms/records	46	22.9	46	22.9	23	11.4	39	19.4	47	23.4
9	Checks waste bins when a shortage is suspected	54	26.9	36	17.9	18	9	38	18.9	55	27.4
10	Adheres to the approved counting protocol without deviation	41	20.4	46	22.9	20	10	45	22.4	49	24.4

Table 2 reveals inconsistent compliance with surgical count procedures, with responses clustering around a near-split between agreement and disagreement for most core practices. For key steps—like doing the first count before surgery (47.8% agree/strongly agree vs. 41.8% disagree/strongly disagree), counting at different surgical stages (47.8% vs. 42.3%), and doing the final count before closing the wound (47.7% vs. 44%)—some items show more strong agreement, especially for checking sponges, needles, and instruments separately (32.8% strongly agree) and not closing a wound if there are unresolved discrepancies (31.3% strongly agree), but many still disagree, indicating that these practices The most prominent weakness is documentation: recording count results on approved forms shows the lowest overall agreement (42.8%) and the highest disagreement (45.8%), highlighting a critical gap in procedural accountability and traceability. Overall, the data indicate that many technicians report following counting procedures, but the high disagreement rates across items suggest inconsistent practices that could pose risks to patient safety, particularly in documentation and in how procedures are carried out.

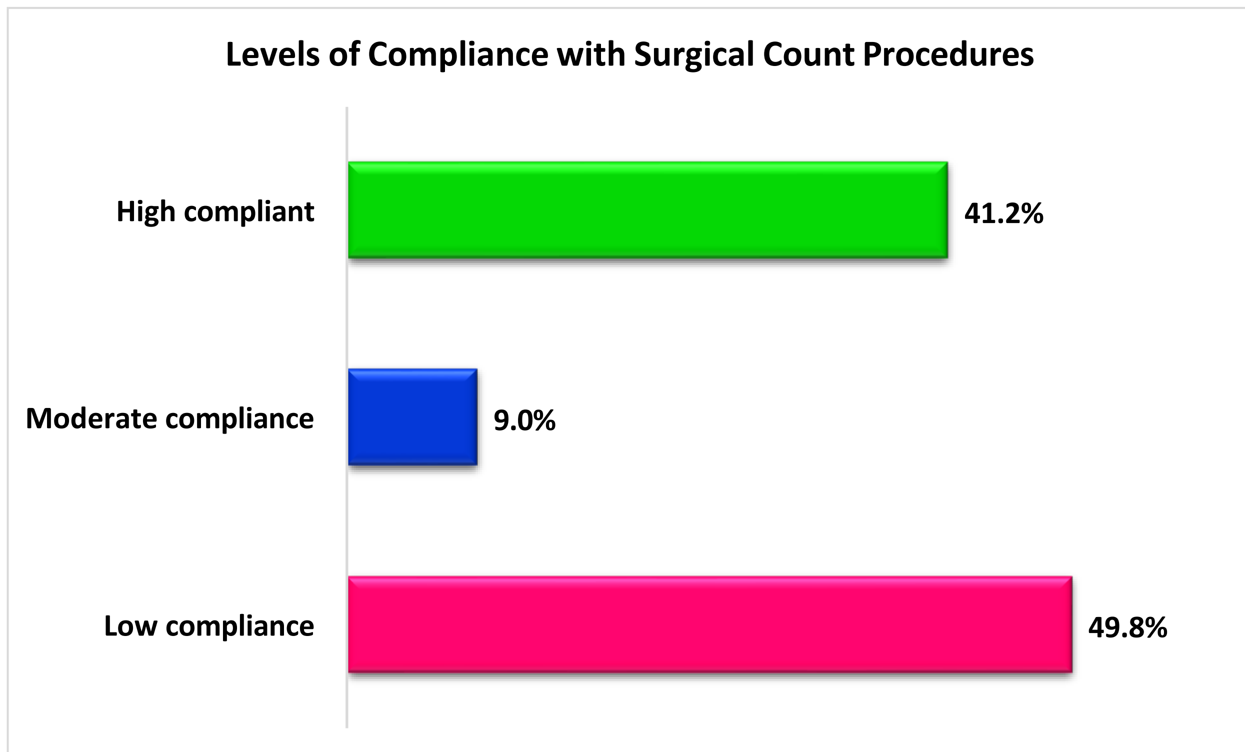

Figure (2): Levels of Compliance with Surgical Count Procedures among Operating Room Technicians (N=201)

Figure 2 shows that nearly half of operating room technicians demonstrate low compliance with surgical count procedures (49.8%), a major concern given the direct link between counting practices and the prevention of retained surgical items. In contrast, 41.2% report high compliance. Notably, only 9.0% fall into the moderate category. Overall, the results show that many technicians are not following the rules properly, indicating that specific actions—such as consistent enforcement, monitoring, and training—are needed to help the majority adopt safer practices by becoming compliant.

Table (3): Communication and Teamwork during Surgical Count among Operating Room Technicians (N=201)

	Items	Strongly disagree		Disagree		Neutral		Agree		Strongly agree	
		No.	%	No.	%	No.	%	No.	%	No.	%
1	Announces count results clearly to the surgical team	36	17.9	59	29.4	13	6.5	49	24.4	44	21.9
2	Collaborates with the circulating nurse during all counting stages	28	13.9	63	31.3	15	7.5	60	29.9	35	17.4
3	Immediately informs the team of any discrepancy	47	23.4	49	24.4	8	4	41	20.4	56	27.9
4	Requests pausing the procedure until an unmatched count is resolved	53	26.4	43	21.4	9	4.5	35	17.4	61	30.3
5	Uses clear and understandable language during counting	53	26.4	41	20.4	10	5	31	15.4	66	32.8
6	Professional opinion is respected when counts are in doubt	51	25.4	47	23.4	8	4	39	19.4	56	27.9
7	Transfers counting responsibility in an organized manner when the team changes	58	28.9	37	18.4	10	5	41	20.4	55	27.4
8	Reduces unnecessary interruptions during the final count	45	22.4	45	22.4	17	8.5	41	20.4	53	26.4
9	Alerts the team about closure time to complete the count	53	26.4	43	21.4	9	4.5	36	17.9	60	29.9
10	Confirms completion of the count with the team before ending the operation	46	22.9	47	23.4	12	6	24	11.9	72	35.8

Table 3 highlights notable weaknesses in communication and teamwork during surgical counting, with many items showing that disagreement is as common as, if not more common than, agreement. For several key behaviors, a large number of people reported disagreeing or strongly disagreeing, such as clearly announcing count results (47.3% disagree vs. 46.3% agree), working together with the circulating nurse during counting stages (45.2% disagree vs. 47.3% agree), and quickly telling the team about any mistakes (47.8% disagree vs. 47.7% agree). More concerning are items reflecting assertiveness and escalation, where disagreement is particularly high: requesting a pause until an unmatched count is resolved shows 47.8% disagreement compared with 47.7% agreement, suggesting that many technicians may hesitate to halt workflow despite unresolved count issues. Similarly, perceptions that technicians' professional opinions

are respected when counts are in doubt remain limited, with 48.8% disagreeing versus 47.3% agreeing, implying a potentially problematic team culture that may undermine speaking up. The strongest area appears to be confirming completion of the count before ending the operation, with 47.7% strongly agreeing/agreeing, including the highest "strongly agree" response in the table (35.8%), yet even this item still has nearly half reporting disagreement (46.3%). Overall, the pattern shows that teamwork is not working well and safety communication is inconsistent, especially when it comes to raising issues, valuing input, and properly handing over information when teams change—these issues can directly affect the reliability of the surgical count

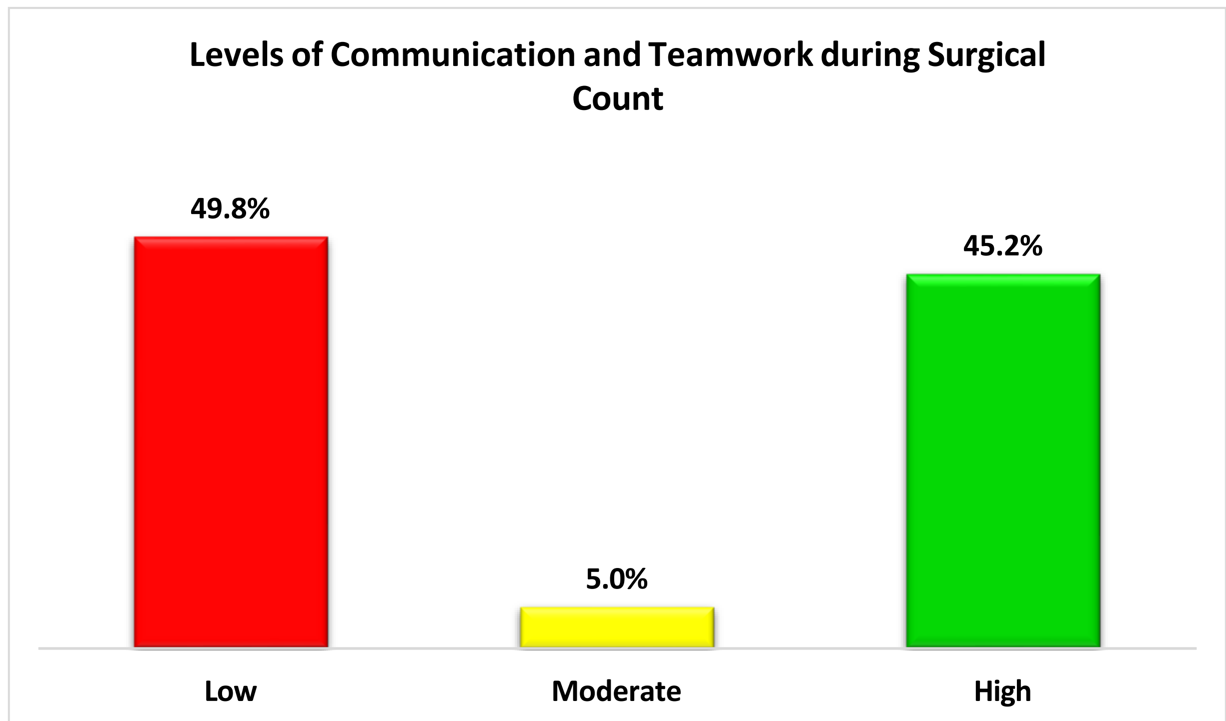

Figure (3): Levels of Communication and Teamwork during Surgical Count among Operating Room Technicians (N=201)

Figure 3 demonstrates a split pattern in communication and teamwork during surgical counting. About half of the technicians report low levels (49.8%), indicating that communication breakdowns and suboptimal teamwork are widespread and may meaningfully compromise the reliability of the counting process. At the same time, a substantial proportion (45.2%) demonstrate high levels, showing that effective teamwork practices are present in nearly as many technicians, but they are not consistently adopted across the workforce. Only 5.0% of technicians fall into the moderate category. Overall, this distribution signals an urgent need to strengthen a team-based counting culture and standardized communication behaviors to shift the large, low-performing segment toward consistently high-performance practices.

Table (4): Human Factors and Work Environment Affecting Operating Room Technicians during Surgical Count (N=201)

	Items	Strongly disagree		Disagree		Neutral		Agree		Strongly agree	
		No.	%	No.	%	No.	%	No.	%	No.	%
1	Time pressure does not affect accuracy of surgical counting	34	16.9	31	15.4	70	34.8	32	15.9	34	16.9
2	High case volume does not lead to neglecting count steps	38	18.9	51	25.4	43	21.4	31	15.4	38	18.9
3	Unnecessary interruptions are avoided during counting	39	19.4	48	23.9	27	13.4	44	21.9	43	21.4
4	Maintains focus during counting in complex surgical operations	45	22.4	46	22.9	21	10.4	38	18.9	51	25.4
5	Adheres to count procedures during night shifts and emergencies	36	17.9	62	30.8	12	6	45	22.4	46	22.9
6	Physical fatigue does not affect counting accuracy	41	20.4	43	21.4	51	25.4	30	14.9	36	17.9
7	Organized operating room environment improves counting accuracy	43	21.4	52	25.9	15	7.5	37	18.4	54	26.9
8	Instruments are arranged to facilitate the counting process	45	22.4	50	24.9	9	4.5	38	18.9	59	29.4
9	Work environment is controlled/adjusted to ensure accurate counting	42	20.9	51	25.4	13	6.5	47	23.4	48	23.9
10	Considers surgical counting an essential professional responsibility	55	27.4	40	19.9	6	3	35	17.4	65	32.3

Table 4 shows that human factors and the work environment make it challenging to count accurately during surgery, with many people feeling unsure and often disagreeing about whether they can maintain accuracy under pressure. For key stressors such as time pressure, the largest proportion of technicians selected neutral (34.8%), while a combined 32.3% agreed that time pressure affects accuracy—suggesting many are either unsure or implicitly acknowledge its negative impact. Similarly, perceptions about high case volume are mixed, but many (44.3%) agree or strongly agree that high volume leads to neglecting steps, indicating that workload is widely seen as a threat to procedural consistency. Performance under challenging conditions is also a concern: adherence to count procedures during night shifts and emergencies shows that almost half (48.7%) disagree, pointing to vulnerability when conditions are most demanding.

Fatigue appears influential as well, with 41.8% disagreeing that physical fatigue does not affect counting accuracy, reinforcing its practical role as a risk factor in daily practice. Views on environmental and system supports are also mixed: many technicians disagree about the organization, arrangement of instruments, and control of the work environment, with around 40% expressing concerns, suggesting that many technicians face conditions that may make accurate counting difficult. Interestingly, even with these difficulties, many professionals feel strongly about their duty—almost half (49.7%) believe that surgical counting is very important, with 32.3% strongly agreeing; however, this is countered by a significant number who disagree (47.3%), showing a concerning divide in attitudes towards safety. Overall, the findings indicate that stress, heavy workloads, fatigue, and disorganized work environments are significant obstacles to accurate counting, and that strengthening support systems and promoting accountability are essential for better safety outcomes.

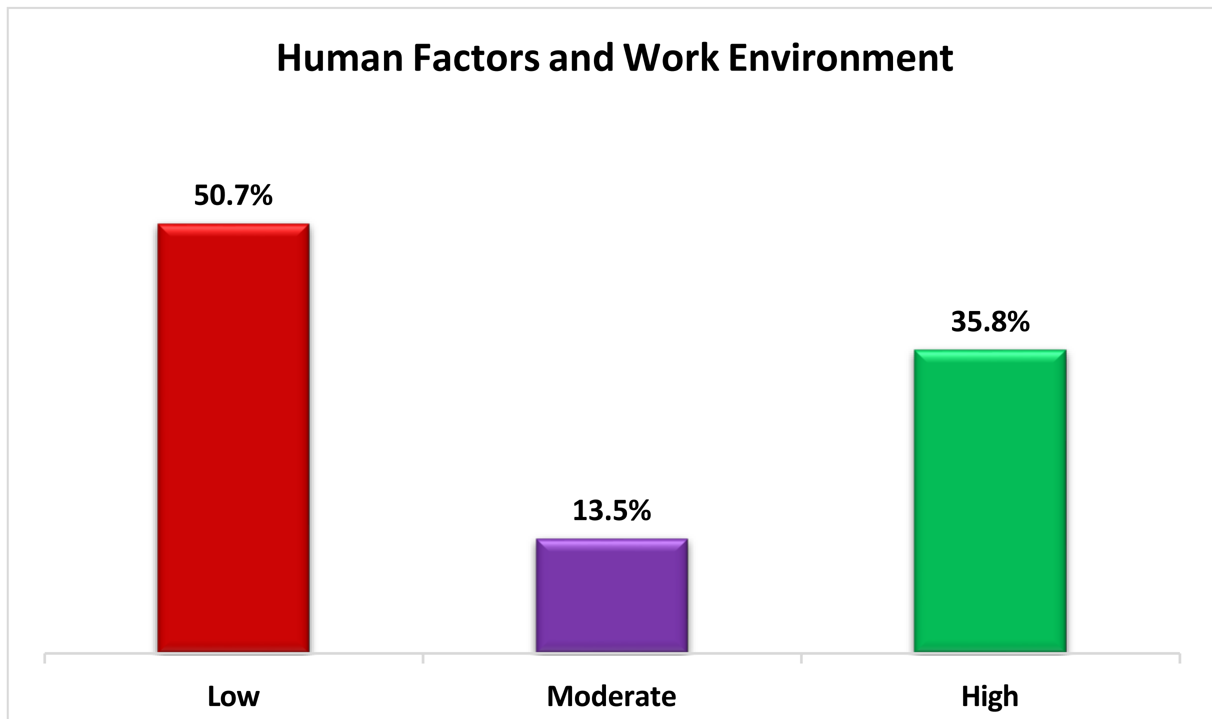

Figure (4): Levels of Human Factors and Work Environment Affecting Operating Room Technicians during Surgical Count (N=201)

Figure 4 illustrates that human factors and work-environment support are generally weak among operating room technicians during surgical counting. Over half report low levels (50.7%), indicating that many technicians work under conditions where factors such as pressure, fatigue, interruptions, and environmental organization are not adequately controlled to support accurate counting. Only 35.8% report high levels, suggesting a smaller group is more likely to be in conditions that make it easier to perform reliably. The moderate group is limited (13.5%). Overall, this distribution shows a significant weakness in the system: improving staffing, workflow control, fatigue management, and OR organization could be crucial for helping most people move from low to better supportive conditions for safe counting practice.

Table (5): Leadership and Training regarding Surgical Count among Operating Room Technicians (N=201)

	Items	Strongly disagree		Disagree		Neutral		Agree		Strongly agree	
		No.	%	No.	%	No.	%	No.	%	No.	%
1	Team leader encourages adherence to count procedures	51	25.4	41	20.4	12	6	54	26.9	43	21.4
2	Management provides periodic training on surgical counting	49	24.4	42	20.9	30	14.9	46	22.9	34	16.9
3	Management updates counting policies in line with approved practices	49	24.4	42	20.9	23	11.4	53	26.4	34	16.9
4	Management encourages reporting of errors without fear of punishment	52	25.9	33	16.4	33	16.4	38	18.9	45	22.4
5	Management provides sufficient time to perform counting without pressure	53	26.4	39	19.4	26	12.9	39	19.4	44	21.9
6	Counting is regarded as part of the patient safety culture	51	25.4	41	20.4	12	6	51	25.4	46	22.9
7	Management addresses causes of previous count errors to prevent recurrence	56	27.9	32	15.9	27	13.4	37	18.4	49	24.4

Table 5 suggests that leadership support and training for surgical counting are inconsistent and, for many technicians, insufficient, with responses frequently split between agreement and disagreement across all items. While almost half (48.3%) felt that the team leader supports following counting procedures, a similar number (45.8%) disagreed, showing that support for counting standards is not One major problem is training: less than half (39.8%) said that management offers regular surgical counting training, while 45.3% disagreed, showing a big gap in ongoing skill development. A similar trend is seen with updates to policies that match approved practices, where 43.3% agree and 45.3% disagree, indicating that many technicians feel that counting protocols are not regularly updated or improved. Elements of safety culture are weak: only 41.3% support reporting mistakes without fear of punishment, while 42.3% do not, suggesting people may not feel safe enough to report issues openly. Likewise, only 41.3% agreed that management provides sufficient time to count without pressure, while

45.8% disagreed, aligning with earlier indications that workload and time pressure undermine compliance. Many people are unsure whether counting is important for patient safety: 48.3% agree and 45.8% disagree. Fewer than half think management is trying to address the causes of past counting mistakes to prevent them from happening again (42.8%). Overall, the findings indicate a lack of strong leadership and training in the system, where inconsistent support from management, insufficient training, and weak rules for reporting mistakes without punishment could be major obstacles to achieving reliable, uniform surgical counting practices.

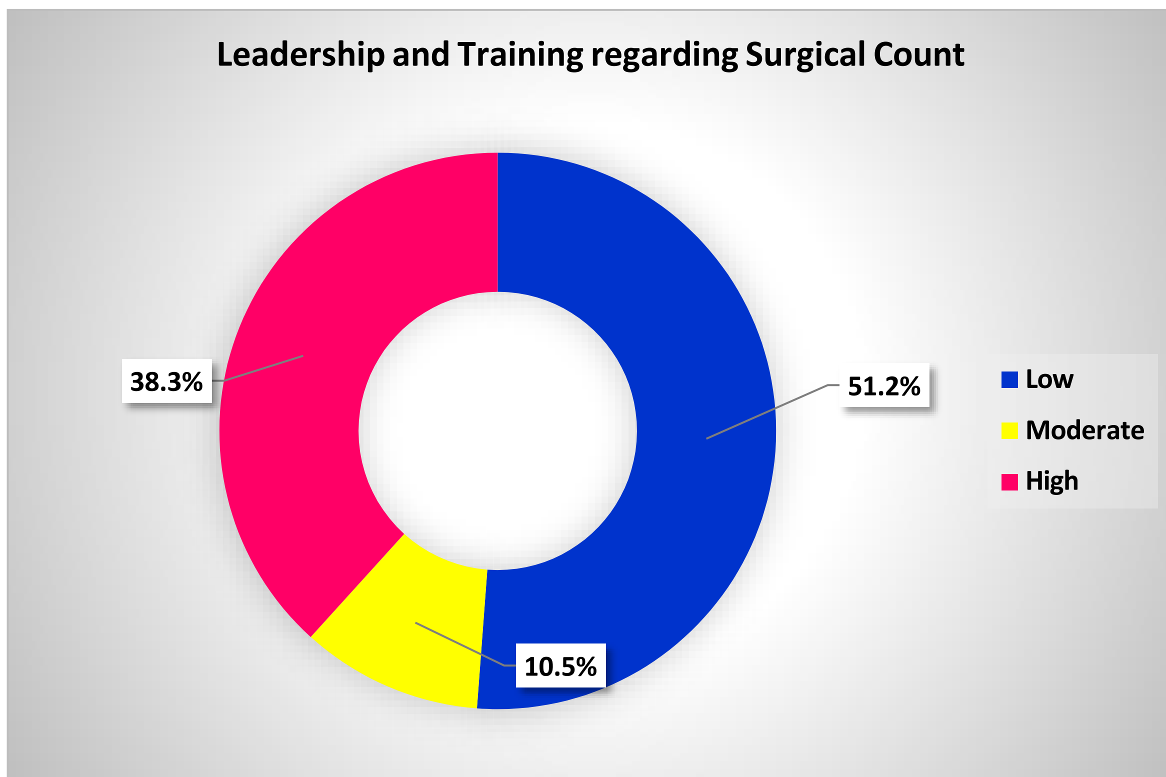

Figure (5): Levels of Leadership and Training regarding Surgical Count among Operating Room Technicians (N=201)

Figure 5 indicates that leadership and training support for surgical counting is predominantly weak among operating room technicians. A slight majority reported low levels (51.2%), indicating that more than half perceive limited managerial reinforcement, inadequate training opportunities, or insufficient support for safety culture to ensure consistent counting practices. In contrast, 38.3% reported high levels, showing that strong leadership and training structures do exist for a substantial minority, but they are not widespread or consistently experienced across the workforce. The moderate category is small (10.5%). Overall, this distribution highlights leadership and training as a key system gap that likely contributes to variability in counting compliance and underscores the need for standardized training, active supervision, and a stronger institutional safety culture.

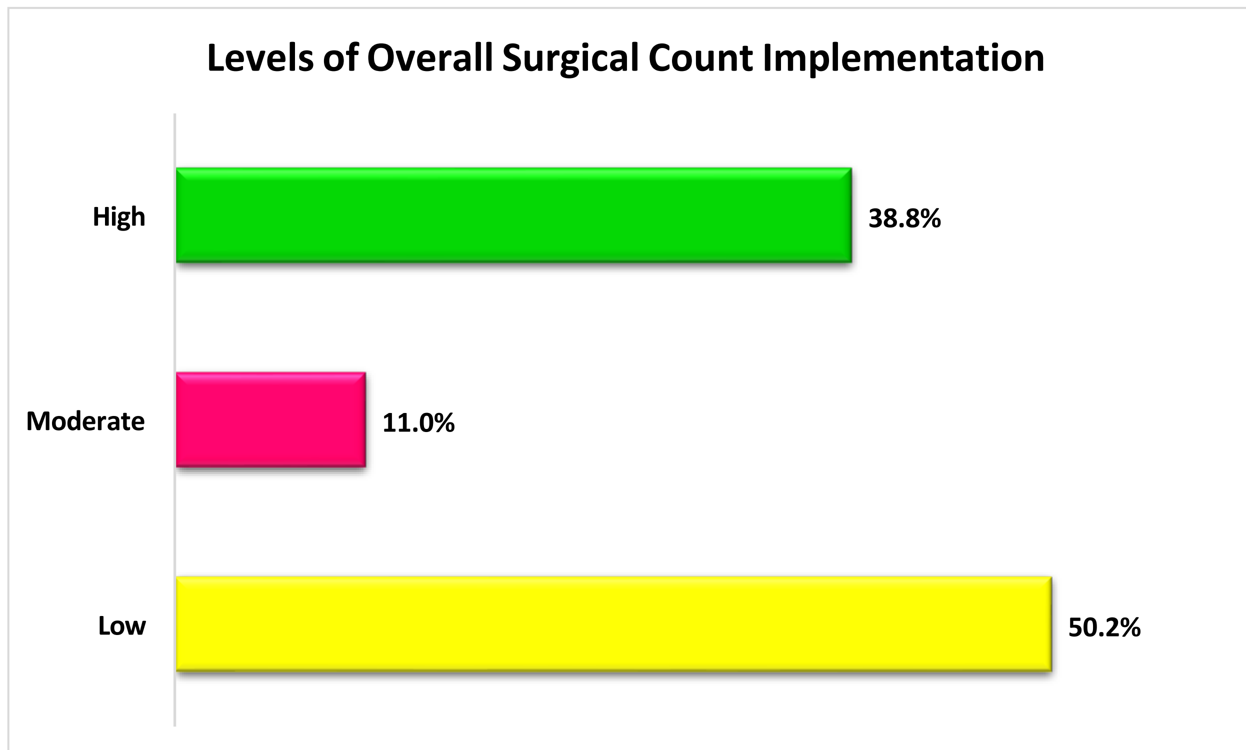

Figure (6): Levels of Overall Surgical Count Implementation among Operating Room Technicians (N=201)

Figure 6 illustrates that overall surgical count implementation is suboptimal among operating room technicians. About half of the participants fall in the low implementation category (50.2%), indicating that consistent application of counting procedures is lacking for a large segment of the workforce and potentially placing patients at risk of preventable counting errors. While 38.8% report high implementation, demonstrating that strong practice is achievable, it remains confined to a minority rather than representing a shared standard. The moderate group is small (11.0%). Overall, the findings highlight significant differences in how well things are being done and show a need for improvements across the board through standard procedures, oversight, and training to help everyone perform.

Table (6): Quality of Care among Operating Room Technicians (N=201)

	Items	Strongly disagree		Disagree		Neutral		Agree		Strongly agree	
		No.	%	No.	%	No.	%	No.	%	No.	%
1	Patient is not allowed to leave the OR before any discrepancy is resolved	48	23.9	46	22.9	15	7.5	41	20.4	51	25.4
2	Need for radiographic imaging decreases due to adherence to counting	34	16.9	46	22.9	37	18.4	51	25.4	33	16.4
3	No cases occur in which instruments/sponges are forgotten inside the patient	35	17.4	43	21.4	50	24.9	35	17.4	38	18.9
4	Discrepancies are resolved early without delaying the procedure	40	19.9	46	22.9	28	13.9	39	19.4	48	23.9
5	Complications from retained instruments/sponges decrease	48	23.9	36	17.9	43	21.4	39	19.4	35	17.4
6	Wound is not closed before confirming the final count	58	28.9	33	16.4	14	7	39	19.4	57	28.4
7	Need for additional surgical procedures decreases due to counting errors	50	24.9	34	16.9	30	14.9	46	22.9	41	20.4
8	Missing instruments are discovered before patient leaves the operating room	46	22.9	44	21.9	21	10.4	39	19.4	51	25.4
9	Rare discrepancy cases are documented for improvement	47	23.4	41	20.4	25	12.4	49	24.4	39	19.4
10	Patient safety problems related to counting errors decrease	54	26.9	43	21.4	16	8	43	21.4	45	22.4

Table 6 shows that people think the results of surgical counting are inconsistent, with many responses evenly split between agreeing and disagreeing, suggesting that the safety benefits of counting are not consistently achieved in real situations. For several critical safety behaviors, sizable proportions of respondents disagreed or strongly disagreed, including the belief that patients should not be allowed to leave the operating room before discrepancies are resolved (46.8% disagree vs. 45.8% agree) and that missing instruments should be discovered before the patient leaves (44.8% disagree vs. 44.8% agree), indicating uncertainty about the reliable containment of risks within the operating room. The item about closing the wound before confirming the final count is especially concerning because there is a big split in adherence to one of the most important safety steps: 45.3% disagree and 47.8% agree. The views on the results of counting practices are mixed: less than half of the people agreed that following these

practices leads to fewer issues with radiographic imaging (41.8% agree), fewer complications from items left inside patients (36.8% agree), or fewer patient safety problems from counting mistakes (43.8% agree), with many disagreeing just as much or more—indicating that technicians don't always see clear benefits in patient outcomes from the current counting Documentation for learning also seems poorly supported, as only 43.8% agreed that rare discrepancy cases are documented for improvement, while 43.8% disagreed. This makes it harder to systematically prevent these cases. Overall, the trend shows that the hoped-for improvements in patient safety and quality from surgical counting are not always met, which matches previous findings about inconsistent teamwork, support from the environment, and leadership encouragement.

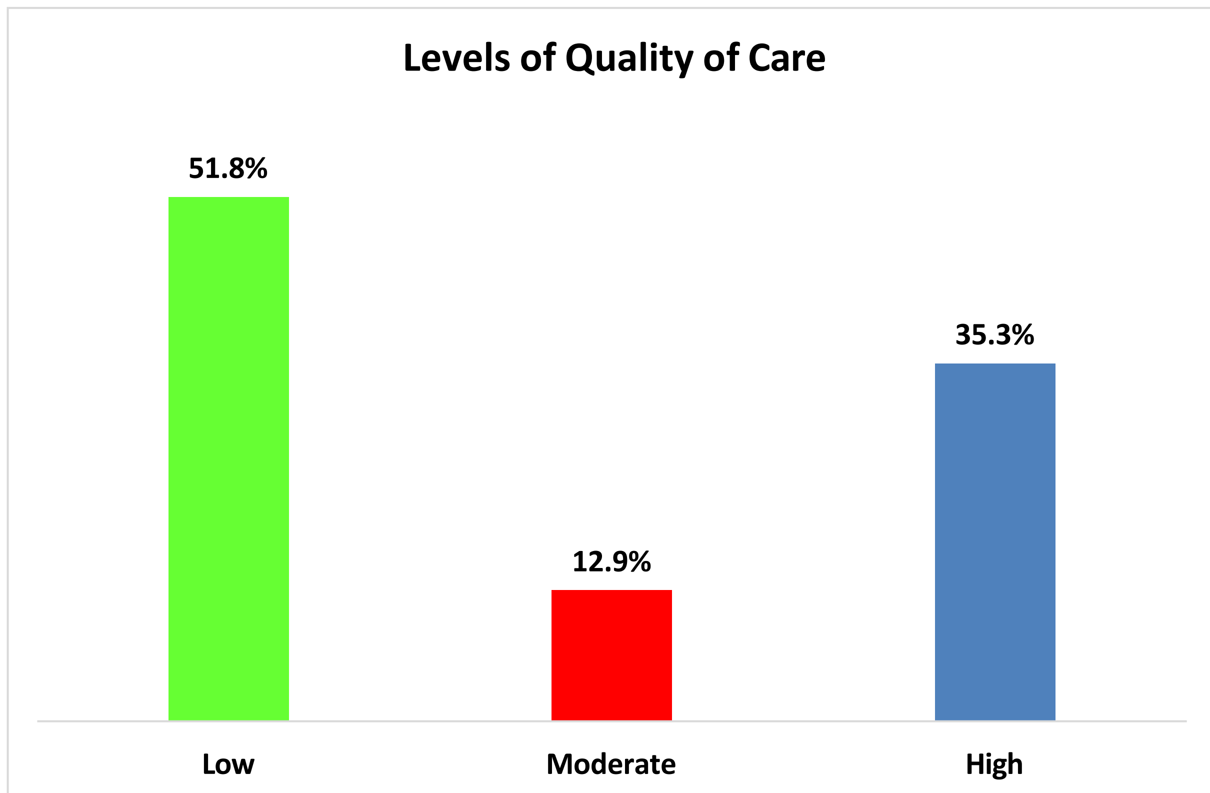

Figure (7): Levels of Quality of Care among Operating Room Technicians (N=201)

Figure 7 shows that most operating room technicians believe the quality of care is low regarding surgical counting outcomes. More than half of the participants (51.8%) fall into the low-quality category. This means that many technicians don't always see the benefits of current counting practices for patient safety and quality. Only 35.3% report high-quality care, indicating that optimal outcomes are achieved by a minority rather than being the standard across settings. Only 12.9% of technicians belong to the moderate group. Overall, this distribution reinforces a substantial quality gap and suggests that it requires system-wide strengthened counting implementation, teamwork, and organizational support to shift quality outcomes toward consistently higher levels.

Table (7): Reduction of Medical Errors among Operating Room Technicians (N=201)

	Items	Strongly disagree		Disagree		Neutral		Agree		Strongly agree	
		No.	%	No.	%	No.	%	No.	%	No.	%
1	Team adheres to preventive procedures to avoid errors	54	26.9	46	22.9	6	3	35	17.4	60	29.9
2	Team follows safety standards during care delivery	47	23.4	49	24.4	7	3.5	40	19.9	58	28.9
3	Team periodically monitors implementation of safety protocols	40	19.9	55	27.4	11	5.5	50	24.9	45	22.4
4	Team applies immediate corrective actions when a potential error is identified	49	24.4	46	22.9	9	4.5	46	22.9	51	25.4
5	Team documents near-miss events for analysis	40	19.9	50	24.9	18	9	52	25.9	41	20.4
6	Team analyzes causes of previous errors to avoid recurrence	40	19.9	55	27.4	12	6	52	25.9	42	20.9
7	Team collaborates with other departments to ensure procedural safety	41	20.4	55	27.4	14	7	60	29.9	31	15.4

Table 7 shows that people have mixed and polarized views on how to reduce medical errors. Many items show a near balance between agreement and disagreement, which suggests that error-prevention systems are not always used in routine practice. For the most fundamental indicators, less than half of technicians agreed that the team adheres to preventive procedures (47.3% agree/strongly agree) or follows safety standards during care delivery (48.8%). Disagreement remains high (49.8% and 47.8%, respectively), indicating that standard safety behaviors are perceived unreliably across teams. Similarly, monitoring and improvement mechanisms appear inconsistent: only 47.3% agreed that the team periodically monitors safety protocol implementation, and 46.8% agreed that immediate corrective actions are applied when risks are identified—yet disagreement is nearly the same, highlighting variability in responsiveness and oversight. Importantly, learning-oriented practices show only modest strength: near-miss documentation is endorsed by 46.3%, while 44.8% disagreed; and analysis of prior errors to prevent recurrence is supported by 46.8%, versus 47.3% disagreement,

suggesting that organizational learning and feedback loops may be weak or inconsistently applied. The relatively strongest area is collaboration with other departments to ensure procedural safety (45.3% agree), but even here, disagreement is substantial (47.8%). Overall, the findings suggest that while a sizeable proportion of technicians engage in active error-reduction behaviors, the persistently high disagreement rates across all items indicate fragile safety systems, limited consistency in monitoring and learning practices, and a need for stronger standardization, a reporting culture, and continuous quality improvement.

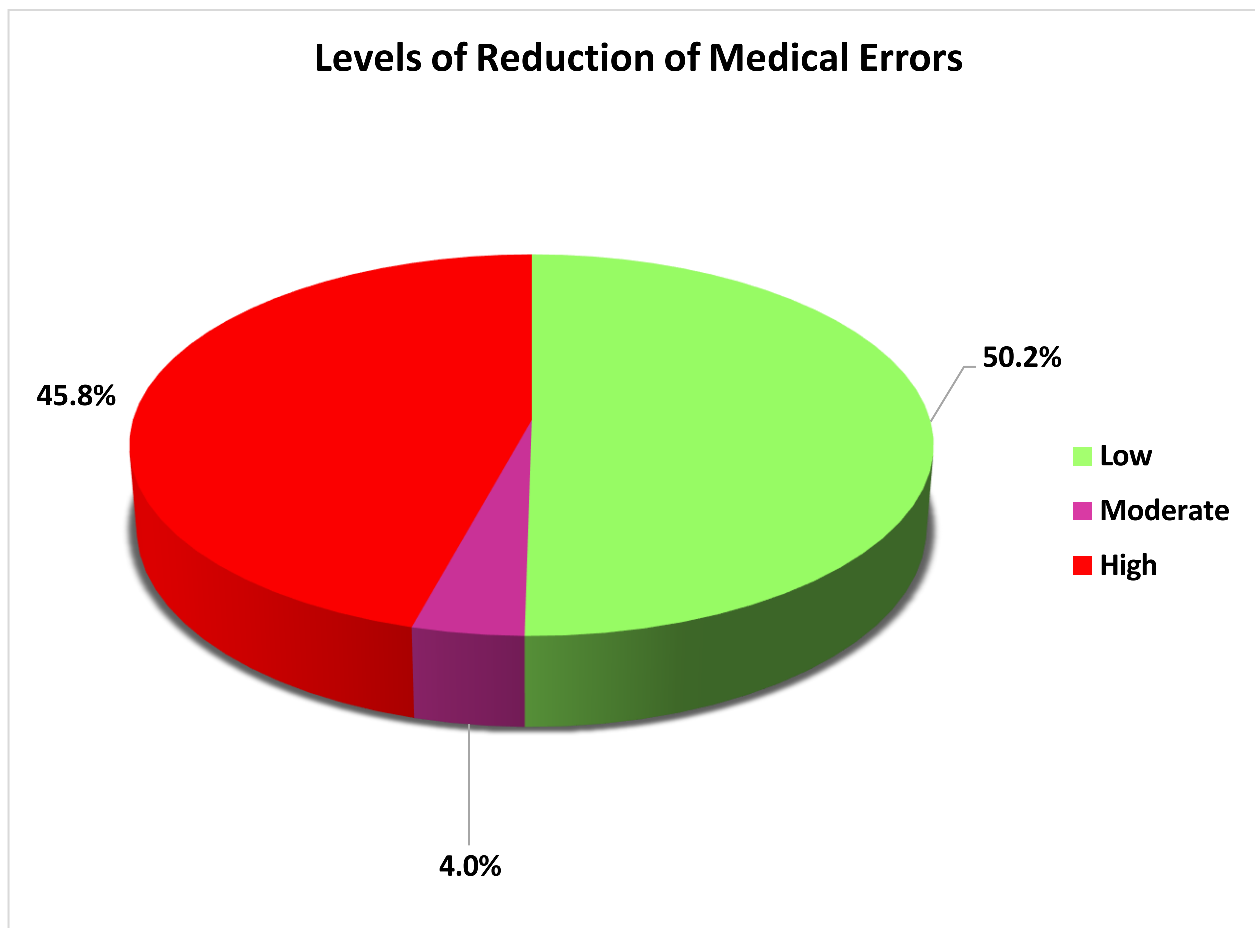

Figure (8): Levels of Reduction of Medical Errors among Operating Room Technicians (N=201)

Figure 8 shows that about half of participants report low levels (50.2%), indicating that many technicians do not perceive consistent or effective error prevention, monitoring, and corrective practices within their teams. In contrast, a substantial proportion (45.8%) report high levels, suggesting that strong error-reduction practices are present among nearly as many technicians, but they are not uniformly implemented across settings. The moderate category is very small (4.0%). Overall, the results show a significant difference in safety performance and indicate that to improve the lower-performing group, there needs to be consistent rules and support across the entire system to enable better error-reduction practices.

Table (8): Patient Harm Prevention among Operating Room Technicians (N=201)

Items		Strongly disagree		Disagree		Neutral		Agree		Strongly agree	
		No.	%	No.	%	No.	%	No.	%	No.	%
1	Team monitors patients to detect potential warning signs	41	20.4	54	26.9	10	5	54	26.9	42	20.9
2	Team follows preventive measures to reduce complications	51	25.4	44	21.9	9	4.5	44	21.9	53	26.4
3	Team follows up with patients during/after surgery to ensure safety	53	26.4	44	21.9	5	2.5	47	23.4	52	25.9
4	Team participates in case review meetings	52	25.9	39	19.4	15	7.5	43	21.4	52	25.9
5	Team provides preventive recommendations to protect patients	55	27.4	43	21.4	8	4	43	21.4	52	25.9
6	Team implements rapid response plans when complications occur	55	27.4	40	19.9	14	7	34	16.9	58	28.9

Table 8 indicates that patient-harm prevention practices are inconsistent and polarized among operating room technicians, with substantial proportions reporting agreement and disagreement across all items. For core surveillance behaviors, such as monitoring patients for warning signs, responses are evenly split: 47.8% agree/strongly agree compared with 47.3% disagree/strongly disagree, suggesting that systematic monitoring is not uniformly applied. A similar pattern is seen for preventive measures to reduce complications (48.3% agree vs. 47.3% disagree) and follow-up during/after surgery (49.3% agree vs. 48.3% disagree), indicating variability in continuity of safety practices across teams. Participation in case review meetings—a key learning mechanism—also appears limited and inconsistent, with 47.3% agreement and 45.3% disagreement, implying that structured reflection and learning may not be embedded routinely. Likewise, providing preventive recommendations to protect patients shows only 47.3% agreement, compared with 48.8% disagreement, pointing to gaps in proactive risk reduction. Notably, the highest "strongly agree" response is to

implementing rapid response plans when complications occur (28.9%), yet overall agreement remains modest (45.8%) and is matched by high disagreement (47.3%), suggesting that escalation systems may be present but not consistently activated. Overall, the findings reflect a fragile, uneven patient-safety culture, where essential harm-prevention behaviors are practiced by many technicians but are not consistently standardized across the workforce.

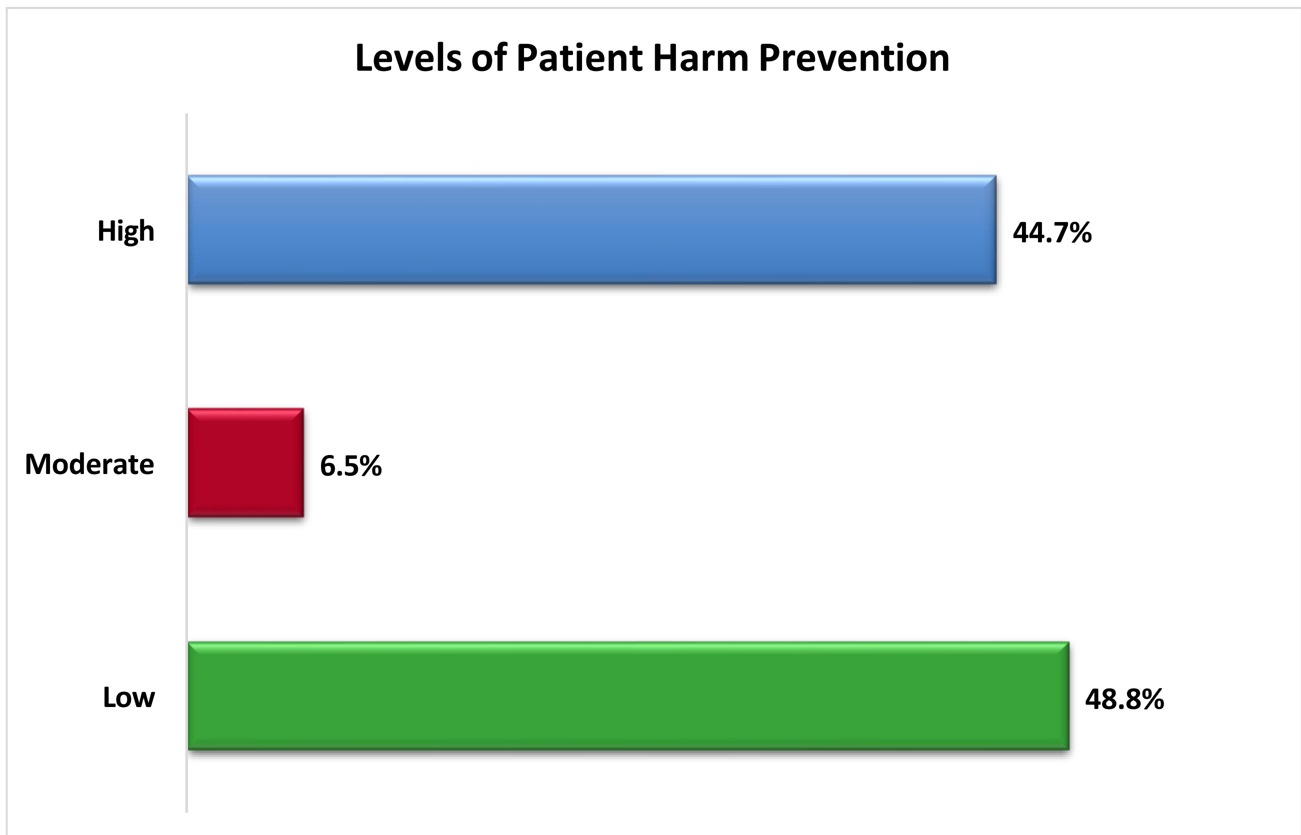

Figure (9): Levels of Patient Harm Prevention among Operating Room Technicians (N=201)

Figure 9 demonstrates that almost half (48.8%) of people say patient-harm prevention is low, meaning many workers do not consistently use important safety practices, such as regular checks, preventive actions, follow-ups, and quick responses to problems. At the same time, 44.7% report high levels, suggesting that strong harm-prevention behaviors are achievable and already practiced by many, but not yet standardized across all teams. Only 6.5% of respondents fall into the moderate category. Overall, the results show significant differences in patient-safety practices and indicate that improvements are needed across the entire system to help the large group that is not performing well move toward consistently better harm-prevention efforts.

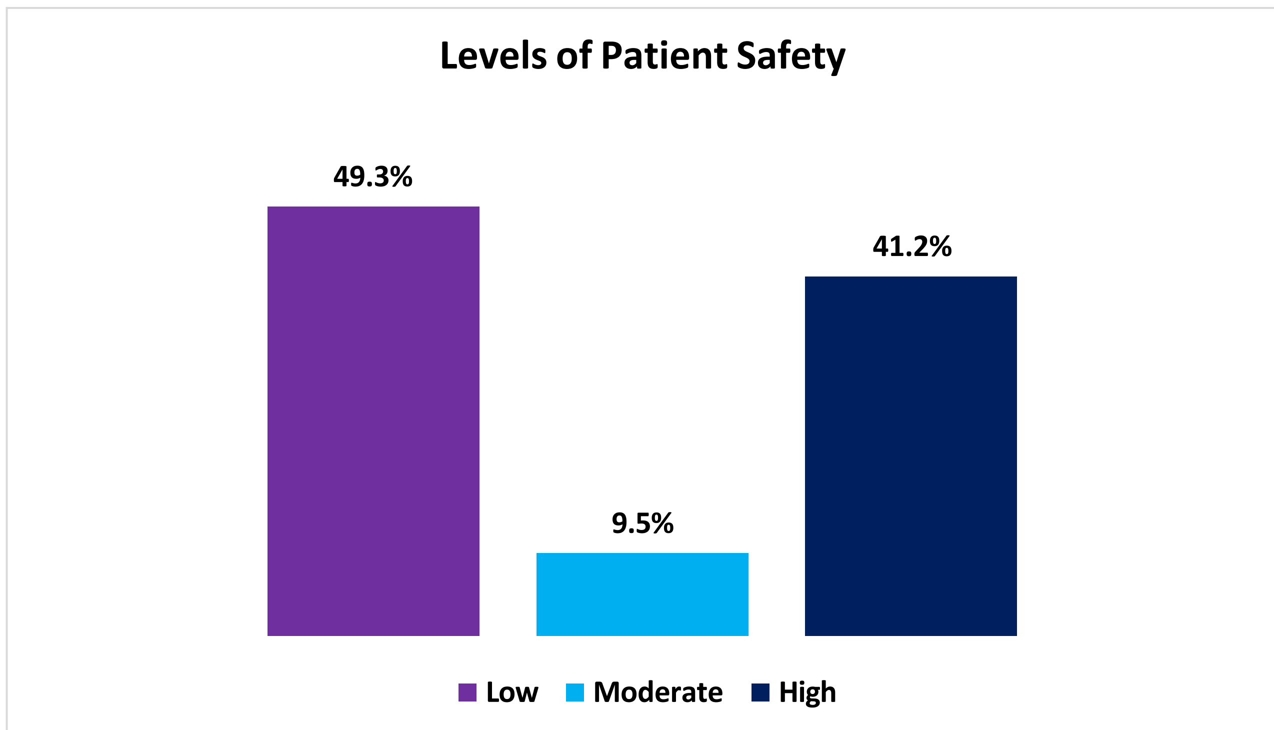

Figure (10): Levels of Patient Safety among Operating Room Technicians (N=201)

Figure 10 indicates that patient safety performance is generally suboptimal among operating room technicians. Nearly half of participants report low patient safety (49.3%), suggesting that safe practices are not consistently implemented and that a substantial proportion of technicians operate under conditions or behaviors that may increase risk. Although 41.2% report high patient safety, this figure represents a minority and shows that strong safety performance is achievable but not yet the dominant standard. The moderate category is small (9.5%). Overall, these findings reveal a significant gap in patient safety and indicate that we need stronger support across the system, especially through regular practices, teamwork, strong leadership, and training, to help the larger group with low safety improve and maintain high performance.

Table 9: Pearson correlation between Surgical Count Implementation and Patient Safety among Operating Room Technicians (N=201)

		Patient Safety
Surgical Count Implementation	r-value	0.980
	P-value	**<0.001***

*

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

Table 9 shows a very strong positive link between how often surgical counts are performed and the safety of patients among operating room technicians ($r = 0.980$), indicating that performing surgical counts more often is closely associated with feeling that patients are safer. The association is highly statistically significant ($p < 0.001$). In practical terms, this strong correlation means that how well surgical counts are performed is a key factor in ensuring patient safety in the operating room: better, more consistent counting according to protocols is likely to lead to significant improvements in safety outcomes.

Table (10): Relationship between Socio-demographic and work-related characteristics and Surgical Count Implementation and Patient Safety among Operating Room Technicians (N=201)

Variables	Surgical Count	Patient Safety
	Mean±SD	Mean±SD
Gender:		
• Male	88.92±43.18	54.26±25.38
• Female	143.58±40.60	89.62±25.42
t (P. value)	-9.152 (**<0.001***)	-9.805 (**<0.001***)
Age groups:		
• < 25 years	133.33±47.32	82.93±27.90
• 25 – 35 years	108.74±49.87	66.63±31.25
• > 35 years	105.74±48.91	66.88±29.40
F (P. value)	4.256(**0.015***)	4.601(**0.011***)
Qualification		
• Intermediate Diploma	99.33±48.73	59.58±28.10
• Higher Diploma	105.93±48.98	65.24±29.47
• Bachelor's	116.72±47.95	72.34±30.43
• Postgraduate	143.21±54.17	90.84±32.46
F (P. value)	3.705(**0.013***)	4.817(**0.003***)
Years of experience as a surgical technologist:		
• < 3 years	121.44±47.30	76.11±29.71
• 3 – 6 years	121.99±51.72	76.89±31.25
• 7 – 10 years	97.43±47.66	58.73±29.49
• > 10 years	99.94±47.79	56.88±24.02
F (P. value)	3.639(**0.014***)	5.832(**<0.001***)
Number of surgeries participated in per month		
• < 20 operations	129.23±49.43	79.94±30.74
• 20 – 40 operations	104.02±47.35	65.02±29.33
• > 40 operations	104.89±50.47	63.37±30.43
F (P. value)	5.976(**0.003***)	6.143(**0.003***)
Work shift:		
• Morning	111.27±49.34	69.24±30.64
• Evening	124.54±53.90	76.54±34.10
• Night	117.33±53.61	64.78±26.23
F (P. value)	0.771(0.464)	0.7160.490)
Attended training courses on surgical counting		
• Yes	123.05±53.04	75.95±31.95
• No	104.23±45.57	64.51±28.92
t (P. value)	2.706(**0.007***)	2.664(**0.008***)
Hospital Name:		
• Al-Thawra	117.59±45.61	71.59±28.26
• Al-Jumhuri	108.52±55.23	69.39±34.87
• Kuwait	115.62±54.78	73.02±33.36
• Military	77.30±38.61	46.78±22.91
• Al-Sabeen	144.75±45.01	89.92±26.59
F (P. value)	4.753(**0.001***)	5.062(**<0.001***)

Table 10 shows that surgical count implementation and patient safety vary significantly by several technician and workplace characteristics, with particularly large differences by gender, training, and hospital. Female technicians had much better surgical count implementation and patient safety than male technicians, with scores of 143.58±40.60 compared to 88.92±43.18 for count, and 89.62±25. Younger staff (<25 years) performed better than older groups on both outcomes (F=4.256, p=0.015 for count; F=4.601, p=0.011 for safety). A clear educational gradient was evident: scores increased with higher qualification, with postgraduates achieving the highest means in both surgical count and safety (F=3.705, p=0.013; F=4.817, p=0.003). Notably, greater years of experience did not correspond to better outcomes; technicians with <6 years showed higher implementation and safety than those with ≥7 years (F=3.639, p=0.014; F=5.832, p<0.001), suggesting possible effects of fatigue, complacency, or heavier responsibilities over time. Workload also mattered: technicians involved in <20 surgeries/month reported higher implementation and safety than those with higher caseloads (F=5.976 and 6.143, p=0.003 for both), consistent with performance degradation under sustained volume. In contrast, work shift was not significantly associated with either outcome (p=0.464 and 0.490). Importantly, attending surgical counting training was associated with significantly higher implementation and safety (t=2.706, p=0.007; t=2.664, p=0.008). Finally, the results varied greatly between hospitals (count: F=4.753, p=0.001; safety: F=5.062, p<0.001), with Al-Sabeen having the highest average scores and the Military hospital the lowest.

CHAPTER FIVE

DISSCUSION

CHAPTER FIVE: DISSCUSION

Public hospitals with inadequate resources, large patient numbers, and systemic issues are at risk of preventable adverse events in the operating room. Complex, high-risk surgical operations require precise multidisciplinary team coordination to reduce errors such retained surgical objects, wrong-site surgery, and procedural omissions (Al-Akwa et al., 2024). International surgical safety criteria are not followed closely in public hospitals. Compliance is particularly low in the closing stages of surgery, when attentiveness is low (Calegari et al., 2018; El-Sayed, 2021). In high- risk contexts, surgical counting is crucial and cost-effective for preventing retained surgical objects and associated morbidity, mortality, and medical or legal consequences. Human performance, communication, and protocol compliance affect the surgical count process, making it prone to tiredness, workload, and hierarchical team dynamics (Riley et al., 2006). Despite official policies, surgical count knowledge and practice differ in public and teaching hospitals in low- and middle-income countries, posing a risk to patient safety (Mukantwari et al., 2019).

Operating room personnel are sometimes neglected yet play a vital role in surgical counting and safety. As frontline workers, technicians prepare equipment, aid with intraoperative workflows, and participate in count operations, which affects surgical count accuracy and dependability. Research shows that training, experience, institutional support, and safety culture affect technicians' consistency and efficacy (Bahar et al., 2017; Filiz, 2023). In public hospitals with personnel shortages and high workloads, technicians ensure safe surgical conditions. Teamwork and safety culture are becoming recognized as factors in patient outcomes, but there is little study on the operating room technician's role in surgical counting and its impact on patient safety. Many studies disregard technicians as surgical team safety agents, focusing instead on nurses or surgeons

(Kwon et al., 2019). This gap emphasizes the need for specialized research on how technicians' demographics, training, and workplace settings affect surgical counts and patient safety in public hospitals. This study examines how operating room workers improve patient safety in resource-limited healthcare systems using surgical counting.

The demographic profile identified in this study, marked by a predominantly male workforce and a concentration within the 25–35-year age group, aligns with findings from various operating room (OR) studies that characterize perioperative personnel as relatively young and at early stages of their professional careers. Research in various hospital environments has indicated mean ages ranging from the late twenties to early thirties, suggesting a workforce that possesses the physical ability to meet the rigorous demands of the operating room, yet may still be in the process of achieving professional maturity and clinical judgment (Uğurlu et al., 2015). Some literature indicates a female predominance among OR nurses; however, gender distribution varies by role and context. Technician-focused studies frequently show higher male representation, indicating partial agreement rather than a uniform consensus across perioperative roles (Mukantwari et al., 2019).

This study's identification of relatively high educational attainment corresponds with recent findings that modern operating room environments increasingly depend on academically trained personnel to address technological complexity and patient safety needs. Multicenter studies indicate that elevated educational levels among operating room staff correlate with enhanced perceived competence and safer practices; however, education alone does not ensure optimal performance in the absence of continuous institutional support (Cheraqpur et al., 2022; Alsalit, Al-Wesabi, Jowah, et al., 2026). Some studies indicate that younger employees, despite possessing

bachelor's degrees or higher diplomas, may exhibit deficiencies in general practical skills, highlighting the necessity for ongoing professional development beyond formal qualifications (Uçak & Cebeci, 2025).

The experience distribution in the current sample indicates that the majority of technicians have less than six years of practice, with only a small number surpassing a decade, highlighting a relatively young and less experienced workforce. Studies indicate that OR staff experience tends to cluster in the early stages of their careers, primarily as a result of workforce turnover and challenging working conditions (Uğurlu et al., 2015). Several studies align with the current findings, indicating that experience significantly predicts competency and safety-related behaviors, such as adherence to surgical protocols. However, some researchers caution that extended exposure without structured training may not necessarily lead to improved practice (Cheraqpur et al., 2022).

The reported workload indicates that a significant number of technicians engage in over 20 surgeries monthly, highlighting the demanding nature of operating room work and aligning with research that documents extensive procedural exposure among operating room staff. Studies indicate that these workloads may improve technical familiarity while also elevating fatigue, stress, and occupational risk, which could jeopardize safety if not properly managed (Uğurlu et al., 2015). Recent observational evidence indicates that high workloads correlate with increased interruptions and errors during critical tasks, such as surgical counting, particularly in fast-paced surgical environments (Lujun et al., 2024).

This study's observation of morning shift predominance aligns with scheduling patterns noted in numerous hospital systems, where elective procedures are primarily scheduled for earlier in the day. Although this may

mitigate circadian disruption relative to night work, research indicates that daytime workload clustering can still result in cognitive overload, particularly under suboptimal staffing conditions (Khodayari-zarnaq et al., 2020). This indicates that workload distribution is essential for sustaining performance and safety, rather than shift timing alone.

The finding that over fifty percent of technicians lacked surgical counting training is concerning and is well-documented in the literature. Numerous studies indicate that insufficient formal training significantly contributes to inadequate counting practices and the retention of surgical items, despite staff claiming sufficient theoretical knowledge (Mukantwari et al., 2019). Qualitative and observational studies indicate that counting errors are multifactorial, significantly worsened by inadequate training, interruptions, and organizational constraints (Mahdood et al., 2023). Intervention studies consistently show that structured education and ongoing training significantly enhance adherence to counting protocols and overall patient safety, underscoring the necessity for targeted educational programs in contexts akin to the current study (Hassan et al., 2022).

The results of this study indicate significant variability in adherence to surgical count procedures, especially during critical counting phases and documentation practices. The nearly equal division of agreement and disagreement regarding essential practices—such as initial counts, counts at various surgical stages, and final counts prior to wound closure—indicates that surgical counting is not consistently integrated into standard operating room procedures. This pattern aligns with evidence suggesting that retained surgical items (RSIs) are less influenced by patient factors and more significantly correlated with variations in operating room practices and safety culture. Research consistently indicates that deficiencies in counting processes, teamwork, and

communication are prevalent precursors to RSIs, even in the presence of formal counting policies (Gibbs, 2011; Rigamonti et al., 2025). The findings corroborate the current results, indicating that partial adherence to step counting may foster a misleading sense of safety, thereby leaving patients vulnerable to preventable harm.

The current data demonstrates a significant strength in the higher agreement regarding specific safety-critical behaviors, including the separate counting of sponges, needles, and instruments, as well as the refusal of wound closure when discrepancies are unresolved. This is consistent with the literature highlighting that strict adherence to discrepancy resolution is fundamental to RSI prevention. Nonetheless, numerous studies indicate that despite staff reporting adherence to these practices, human-dependent counting systems are fundamentally prone to errors. Reviews and observational studies indicate that accurate counts are often recorded in instances where RSIs subsequently arise, underscoring the shortcomings of manual counts in the absence of standardized procedures, oversight, and technological support (Feldman, 2011; Hariharan & Lobo, 2013). While strong agreement on selected items is encouraging, it does not entirely alleviate the risks associated with inconsistent overall practice.

This study identifies poor documentation of count results as a significant weakness, reflecting a commonly reported deficiency in surgical safety research. Documentation is crucial for ensuring accountability, traceability, and facilitating post-event investigations; however, it is often overlooked or executed inconsistently. Case analyses and legal reviews indicate that deviations from documentation protocols frequently occur in RSI events, with records often reflecting completed or “correct” counts despite subsequent identification of retained items (Osborne et al., 2021). Qualitative analyses of root cause

investigations have similarly identified inadequate or absent documentation as a recurring contributing factor, which undermines the effectiveness of otherwise well-designed counting policies (Hibbert et al., 2020). The findings provide substantial evidence that documentation constitutes a significant vulnerability within patient safety systems.

The compliance distribution illustrated in Figure 2 underscores these concerns, revealing that nearly half of operating room technicians exhibit low compliance, while only a minor fraction reports moderate adherence. This polarized pattern has been noted in various low- and middle-income, as well as high-income contexts, where self-reported knowledge of counting procedures is frequently high, yet observed practice is consistently inadequate. Research conducted in Rwanda and Turkey indicated that, although the majority of operating room personnel recognized counting protocols, adherence and uniformity were inconsistent, especially during staff transitions, emergencies, or extended procedures (Mukantwari et al., 2019; Bahar et al., 2017). The findings align with the current study, indicating that absent consistent enforcement, monitoring, and ongoing training, compliance is likely to be fragmented and unreliable.

Evidence from quality improvement initiatives indicates that compliance can be significantly enhanced through the implementation of standardized protocols, clear role delineation, regular audits, and leadership support. Interventions adhering to AORN guidelines and utilizing structured documentation tools have demonstrated a significant reduction in incorrect counts and the elimination of RSIs in certain environments (Nelson, 2021). Moreover, adjunct technologies like radiofrequency or barcode systems have demonstrated the ability to mitigate human error and enhance safety outcomes, especially in

settings characterized by inconsistent manual compliance (Peng et al., 2022). The current findings reveal a discrepancy between recommended best practices and actual implementation, emphasizing the necessity for system-level interventions to enhance compliance and ensure patient safety.

The results presented in Table 3 indicate significant deficiencies in communication and teamwork within the surgical counting process, especially regarding behaviors dependent on assertiveness, mutual respect, and the escalation of concerns. The significant level of disagreement concerning the clear announcement of count results, collaboration with the circulating nurse, and timely communication of errors indicates that fundamental safety behaviors are not consistently implemented. This pattern corresponds with evidence indicating that communication failures are a prevalent factor contributing to intraoperative errors, particularly in high-pressure settings like the operating room (Etherington et al., 2019). Recent observational and qualitative studies indicate that ambiguous verbal communication, insufficient closed-loop communication, and disjointed coordination during perioperative tasks compromise shared situational awareness and elevate the risk of safety incidents (Mortazavinasiri et al., 2019).

The pronounced disagreement regarding the necessity of speaking up and pausing workflow in the presence of an unresolved unmatched count is particularly concerning. Almost 50% of technicians express hesitance to request a pause or feel that their professional opinions lack respect, indicating a deficiency in psychological safety within teams. This finding aligns with recent mixed-methods research indicating that inadequate psychological safety and hierarchical power dynamics inhibit staff from expressing concerns, even when patient safety is compromised (Arad et al., 2022). Both ethnographic and survey-based studies indicate that nurses and technicians frequently perceive themselves as undervalued

during essential safety tasks, such as surgical counts. This perception contributes to the normalization of risk-taking behaviors and undermines escalation practices (Tørring et al., 2019; Kwon et al., 2019).

The observation that confirming the completion of the count prior to concluding the operation was the most effective indicator implies that teams may emphasize formal task completion rather than the quality of interaction throughout the process. This aligns with studies indicating that checklists and structured protocols enhance compliance with end-point safety measures (Urban et al., 2021); however, other research warns that merely completing checklists does not ensure effective teamwork or communication. Insufficient engagement, shallow participation, and absence of collective ownership frequently restrict the effectiveness of these tools, potentially accounting for the nearly half of respondents in this study who expressed disagreement regarding this item (Erestam et al., 2017).

Figure 3 underscores these concerns by illustrating a polarized workforce, with nearly equal proportions of technicians exhibiting low and high levels of communication and teamwork during surgical counting. This division reflects recent findings suggesting that effective teamwork practices are present within the same organization but are inconsistently distributed due to variations in leadership, team stability, and local culture (Pasquer et al., 2024). Research indicates that effective teamwork enhances surgical teams' abilities to identify, communicate, and rectify errors; in contrast, inadequate teamwork correlates with elevated stress levels, impaired coordination, and heightened safety risks (Kang & Yang, 2023; Alyahawi, Al-Wesabi & ,ALKaf, 2022).

The current study's findings underscore the significant impact of human factors and work environment conditions on the accuracy of surgical counting, a conclusion that is well-supported by existing literature. A significant number of

technicians indicated uncertainty or agreement regarding the negative impact of time pressure on counting accuracy. This observation is consistent with human factors research that shows temporal demands and situational stress can impair attention, working memory, and procedural adherence in the operating room (Tsianos et al., 2020). Experimental and observational studies of surgical workload indicate that time pressure and high cognitive load elevate the risk of omissions and procedural shortcuts, especially in routine yet safety-critical tasks like surgical counts (Wilson et al., 2011). The findings indicate that, despite a lack of overt agreement from staff, neutral responses may signify the normalization of stressors that are recognized as detrimental to performance.

A significant challenge identified was high case volume, with many participants concurring that an increased workload results in the omission of steps in the counting process. This observation aligns with research indicating that high workload intensity and frequent workflow disruptions impair procedural consistency and task sequencing in the operating room (Wiegmann & Sundt, 2019). Empirical evidence indicates that interruptions during surgical counts are prevalent and primarily detrimental, especially during the initial count phase, where attention is divided by instrument preparation and environmental noise (Lujun et al., 2024). The findings support the conclusion of the current study that workload and case volume directly threaten reliable counting practices.

Performance degradation during night shifts and emergency situations, reported by nearly half of respondents, is corroborated by existing literature. Fatigue and threat stress are recognized as significant performance-shaping factors in surgical environments, having substantial weight and a detrimental effect on task execution (Nodoushan et al., 2021). Research on operating room personnel indicates that night shifts and cumulative fatigue correlate with diminished

concentration, memory lapses, and heightened error rates (Ismail et al., 2021). The results align with the current study's finding that physical fatigue is widely regarded as a significant risk factor for inaccuracies in counting.

Concerns regarding environmental organization, including instrument arrangement and control of the work environment, are consistent with research in human factors and ergonomics. Poor layout, clutter, and inconsistent organization of instruments are established factors that contribute to prolonged search times, cognitive overload, and distractions in the operating room (Lowndes & Hallbeck, 2014). Recent evidence suggests that ergonomic and system-level enhancements can reduce fatigue and enhance task reliability, thereby indirectly facilitating more accurate surgical counts (Kumar et al., 2024). The dissatisfaction articulated by technicians concerning their work environment indicates a broader, well-documented systemic issue rather than isolated individual deficiencies.

Despite these challenges, the pronounced sense of professional responsibility expressed by numerous participants aligns with findings from patient safety literature, which indicates that healthcare professionals typically prioritize safety practices, even in the absence of adequate systemic support (Ram & Boermeester, 2013). The significant percentage of respondents who disagreed with the importance of surgical counting is concerning and may indicate safety culture fatigue or normalization of deviance, which have been previously associated with inconsistent protocol adherence and underreporting of errors (Vinagre & Marques, 2018). This divergence in attitudes highlights the necessity for organizations to strengthen accountability and promote shared responsibility.

The current findings, bolstered by a significant amount of recent evidence, demonstrate that stress, excessive workloads, fatigue, interruptions, and disorganized environments are ongoing and interconnected obstacles to precise

surgical counting. The literature highlights that dependence on human performance alone is inadequate; system-level interventions—such as standardized counting processes, workflow control, staffing optimization, and ergonomic redesign—are crucial for enhancing reliability and patient safety (Koek et al., 2020). Enhancing environmental supports and safety culture is essential for addressing the weaknesses highlighted in Figure 4 and for improving surgical counting outcomes.

The results presented in Table 5 and Figure 5 indicate a disjointed framework for leadership support and training in surgical counting, which is consistent with existing literature on operating room safety culture. The almost equal division between agreement and disagreement concerning leadership support for counting procedures indicates a lack of consistency in managerial involvement. Studies indicate that inadequate or inconsistent management support negatively impacts adherence to safety protocols in the operating room, despite the presence of written policies (Nwosu et al., 2022; Alsalit et al., 2026). Root cause analyses of retained surgical items consistently identify leadership and organizational factors as predominant contributors, rather than individual negligence. This reinforces the interpretation that inconsistent leadership support undermines reliable counting practices (Tabibzadeh & Kumari, 2024).

Insufficient and irregular training, evidenced by fewer than 40% of technicians indicating regular surgical counting education, constitutes a significant concern. This finding is substantiated by evidence indicating that continuous training correlates with improved perceptions of safety culture and increased adherence to surgical safety practices (Dığın et al., 2024). Lack of structured education is a significant barrier to safe practice. Research in low- and middle-income contexts indicates that possessing good knowledge does not lead to

accurate counting behavior without ongoing training and supervision (Mukantwari et al., 2019). Intervention studies indicate that the integration of standardized education with policy revision can swiftly normalize counting practices and attain near-complete compliance, underscoring deficiencies in the current environment (Hurley & Meyer, 2015).

The inadequate perception of a non-punitive environment for error reporting identified in this study reflects a widely recognized issue in operating room safety culture. Repeated reports indicate low scores for non-punitive responses to errors and communication openness, with staff frequently attributing underreporting of mistakes to fear of blame, time pressure, and insufficient feedback (Aouicha et al., 2022; Yavuz, 2023). The findings corroborate the current results, indicating that approximately 40% of participants felt secure in reporting counting errors. Research indicates that reforms in safety culture driven by leadership lead to enhanced psychological safety and increased error reporting when management prioritizes learning over punitive measures (Rigamonti et al., 2025).

Time pressure and workload, identified by many respondents in this study as barriers to accurate counting, are consistently noted in the literature as contributors to counting errors and safety lapses. Operating room professionals often indicate that the demand for rapid work and insufficient staffing directly lead to missed counts and unreported discrepancies (Vinagre & Marques, 2018). Qualitative studies indicate that these pressures diminish nurses' capacity to exercise leadership and implement safety checks, despite their acknowledgment of their significance (Peñataro-Pintado et al., 2020).

The prevalence of inadequate leadership and training support illustrated in Figure 5 aligns with global findings indicating that the patient safety culture in

operating rooms is typically moderate to weak. Leadership involvement and ongoing training are critical determinants for enhancement (Nwosu et al., 2022; Bake et al., 2025). Some institutions exhibit strong leadership and effective training systems, as evidenced by the high-support subgroup in this study; however, the lack of uniformity indicates systemic gaps. The literature consistently indicates that the absence of standardized training, evident leadership commitment, and a non-punitive reporting culture renders surgical counting susceptible to variability and error, thereby elevating the risk of retained surgical items and jeopardizing patient safety.

The current study's findings indicate that nearly 50% of operating room technicians exhibit inadequate adherence to surgical count practices. This observation is corroborated by existing literature, which emphasizes that inconsistent compliance with counting protocols remains a significant patient safety issue. Numerous studies indicate that while surgical count policies are frequently established, their implementation differs significantly across institutions and personnel. This variability is primarily attributed to human factors, ambiguous role delineation, and inconsistent supervision (Bahar et al., 2017; Mukantwari et al., 2019). Consistent with the current findings, these studies indicated that a significant number of perioperative staff either inadequately implement or inconsistently adhere to counting procedures, despite possessing sufficient knowledge, which heightens the risk of retained surgical items (RSIs).

The limited number of participants in the high-implementation category in this study corresponds with findings suggesting that while effective surgical count practices can be achieved, they are not consistently integrated as a standard of care. Research on quality improvement and interventional studies indicates that the implementation of standardized protocols, clear accountability, and structured

documentation tools significantly enhances compliance with surgical counts and can lead to a reduction or elimination of RSIs (Nelson, 2021; Van Anderson et al., 2025). The findings indicate that the high-implementation group identified in this study exemplifies optimal practice environments characterized by supportive systems, leadership, and team culture for compliance measurement.

The prevalence of low and moderate implementation levels identified in this study aligns with existing research that highlights the inherent susceptibility to error in manual counting, especially within complex, lengthy, or high-turnover surgical environments. Root cause analyses and sentinel event reviews consistently identify incorrect or omitted counts, staff turnover, communication breakdowns, and insufficient standardized oversight as significant contributors to RSIs (Rigamonti et al., 2025; Seabra et al., 2023). The studies support the current findings, indicating that variability in practice is not solely an individual performance concern, but rather indicative of systemic deficiencies in training, supervision, and organizational safety culture.

Certain literature presents a partial contrast to the current findings, indicating that technological adjuncts, such as radiofrequency identification (RFID) or barcode-assisted counting systems, may significantly reduce the risks linked to inadequate manual count execution. Integrative reviews and case series indicate that these technologies enhance detection accuracy and decrease dependence on human memory, even in settings with low baseline compliance (Peng et al., 2022; Steelman et al., 2018). These studies highlight that technology cannot substitute for essential compliance with standardized counting procedures, and its effectiveness is optimized only when incorporated into a robust safety culture.

Table 6 presents findings that indicate a significant lack of confidence

among operating room technicians concerning the reliability and safety outcomes associated with surgical counting practices. The literature consistently demonstrates that manual counting alone is an inadequate safety barrier, often compromised by human and systemic factors. Numerous studies indicate that retained surgical items (RSIs) frequently arise even when counts are deemed "correct," highlighting the inadequate sensitivity of counting procedures. This underscores the division among respondents in the current study regarding the reliable resolution of discrepancies prior to patient discharge from the operating room (Steelman, 2014; Feldman, 2011). Extensive analyses of sentinel events indicate that a significant number of retained items arise in situations where counts were recorded as accurate. This highlights the concern expressed by nearly half of the participants in the current study regarding the identification of missing instruments prior to patient transfer (Steelman et al., 2018).

The pronounced division in perspectives regarding the closure of wounds prior to final count verification indicates a more profound concern related to operating room culture, hierarchy, and communication practices. Qualitative and review studies highlight that counting transcends a technical task, functioning as a socially negotiated process shaped by time constraints, power dynamics, and conflicting priorities, which may lead to the normalization of deviations from established policy (Riley et al., 2006; Gibbs, 2011; Al-Saleet et al., 2025). Recent evidence further delineates retained foreign objects as indicators of unsafe operating room environments, where policies are present but inconsistently enforced due to insufficient leadership support and a fragile safety culture (Rigamonti et al., 2025). This aligns with the current study's finding that adherence to essential safety procedures is inconsistent rather than universally integrated into practice.

Literature reflects the perception that surgical counting does not

consistently lead to improved patient outcomes, including reductions in imaging issues, complications, or safety incidents. Numerous reviews indicate that although counting is fundamental, its independent effect on reducing outcomes is restricted, particularly in complex or high-risk procedures (Feldman, 2011; Gibbs, 2012). In contrast, studies assessing adjunct technologies like radiofrequency (RF) detection systems indicate more pronounced and consistent decreases in retained items. This suggests that the skepticism voiced by technicians may arise from their direct experiences with the shortcomings of manual counts (Peng et al., 2022). This contrast may elucidate why respondents do not consistently link current counting practices to observable safety enhancements.

The limited consensus on documenting rare discrepancy cases for learning and improvement highlights a significant gap noted in previous research. Inadequate or inconsistent intraoperative documentation hinders organizational learning and contributes to the recurrence of errors, as evidenced by integrative reviews on perioperative documentation and patient safety (Akbari et al., 2025). Research across various contexts indicates that although staff may have sufficient understanding of counting principles, their actual practices and documentation frequently fall short, especially in resource-limited or high-workload settings (Mukantwari et al., 2019).

The distribution depicted in Figure 7 indicates that more than half of technicians assess the quality of care concerning surgical counting outcomes as inadequate, thereby supporting the conclusion that existing systems do not consistently provide reliable safety. Internationally, similar discrepancies between policy and perceived quality have been observed, with research indicating significant variability in implementation fidelity despite established counting protocols (Bahar et al., 2017). In contrast, evidence from environments that

integrate standardized protocols with effective leadership, teamwork training, and audit-feedback mechanisms shows significant enhancements in safety culture and clinical outcomes, reinforcing the notion that comprehensive system-wide reinforcement is crucial (Savage et al., 2017). The current findings align with existing literature, indicating that surgical counting, when insufficiently supported by culture, teamwork, technology, and learning systems, fails to provide the intended patient safety improvements.

The results presented in Table 7 indicate nearly equal proportions of agreement and disagreement regarding most error-reduction indicators. This observation is well-supported by current patient-safety literature, which highlights the inconsistent implementation of safety practices among healthcare teams. Numerous studies indicate that frontline healthcare workers frequently exhibit only moderate compliance with safety protocols and preventive measures, highlighting the presence of fragmented safety cultures instead of fully integrated systems. Studies involving nurses and allied health professionals consistently indicate moderate perceptions of safety culture and variable application of standard precautions. This observation corresponds with the current finding that fewer than half of technicians perceived reliable adherence to preventive procedures or safety standards (Ebrahim & Ismail, 2021; Kim et al., 2018). The findings indicate that although safety regulations are documented, their implementation in clinical practice is inconsistent, reflecting the polarized responses noted in the current study.

The near equilibrium of consensus and dissent concerning monitoring and corrective mechanisms highlights established deficiencies in organizational oversight and feedback systems. Research indicates that the periodic auditing of safety protocols and the implementation of timely corrective actions are frequently

inconsistent, largely influenced by local leadership and workload demands. A recent systematic review on near-miss reporting identified leadership support and structured monitoring as essential determinants of effective safety practices, indicating that their absence results in variability in responsiveness across units (Alfayez et al., 2025). Intervention studies indicate that enhancing monitoring systems via education and feedback leads to significant improvements in reporting and corrective actions. This suggests that the elevated disagreement rates observed in the current study likely stem from deficiencies in system-level enforcement rather than individual reluctance (Craig et al., 2024).

Learning-oriented practices, including near-miss documentation and analysis of prior errors, are notably deficient in the current findings. This observation aligns with extensive evidence demonstrating ongoing underreporting and restricted organizational learning within healthcare. Numerous studies indicate that near-miss reporting rates are relatively low and significantly affected by perceptions of blame, insufficient feedback, and ambiguous reporting processes (Yang & Liu, 2021; Dwidar et al., 2025). The findings of these studies align with the current results, indicating that weak feedback loops impede error learning and restrict the preventive efficacy of reporting systems. Conversely, environments that explicitly implement “just culture” principles and organized learning forums demonstrate significantly greater involvement in error analysis, suggesting that the limited support noted in this study is not a given but rather contingent on the system in place.

Figure 8 supports this interpretation by demonstrating a bifurcated safety performance pattern, with nearly equal proportions of technicians indicating low and high levels of error-reduction practices. This polarization is extensively documented in the literature and indicates variations in local safety climates within

the same health system. Multisite research indicates that safety culture and reporting behaviors can differ significantly across departments, despite the presence of uniform institutional policies (Davis et al., 2025). Research indicates that units characterized by robust leadership engagement and well-defined reporting expectations are more likely to be categorized as “high,” whereas others fall short, resulting in the stark contrast observed in the current findings. The current results and recent evidence indicate that enhancing error reduction necessitates system-wide standardization, non-punitive reporting cultures, and continuous quality improvement mechanisms to minimize variability and ensure consistent application of effective safety practices across all teams.

The results in Table 8 indicate significant inconsistency and polarization in patient-harm prevention practices among operating room technicians, corroborating previous research that reveals uneven safety cultures in operating room settings. Research evaluating safety culture among operating room staff consistently indicates low to moderate compliance with essential patient-safety behaviors, especially in areas such as surveillance, communication, and standardized preventive practices (Carvalho et al., 2015) (Filiz, 2023). The observed near-equal proportions of agreement and disagreement in patient monitoring and complication prevention indicate that these critical safety behaviors rely more on individual or team norms than on established organizational practices. International studies have reported similar variability, indicating that safety attitudes and compliance vary significantly among professional groups and institutions. This suggests the presence of fragile safety cultures rather than mature, standardized systems (Memarbashi et al., 2020).

The irregular involvement in follow-up care and attendance at case review meetings highlighted in this study emphasizes shortcomings in learning-focused safety systems. Case reviews and morbidity and mortality discussions are acknowledged as essential for organizational learning and error prevention. However, evidence indicates that these activities are frequently inconsistently executed in operating room environments, especially in contexts characterized by hierarchical cultures and time limitations (Santana et al., 2016). Research on the implementation of the WHO Surgical Safety Checklist indicates that safety tools can enhance teamwork and monitoring behaviors. However, their effectiveness is largely contingent upon consistent usage, leadership support, and team acceptance (Santana et al., 2016). The varied responses in this study indicate that while reflective and preventive mechanisms may theoretically exist, they are not yet fully incorporated into everyday practice.

The elevated proportion of “strongly agree” responses regarding rapid response actions during complications reflects an awareness of escalation protocols; however, the concurrent high levels of disagreement indicate a lack of consistency in their implementation. This finding aligns with existing literature that suggests escalation systems in operating rooms tend to be reactive rather than proactive, potentially hindered by communication barriers, ambiguous role delineation, and fear of blame (El-Sayed et al., 2021). Research indicates that the effectiveness of rapid responses is significantly associated with non-technical skills, including teamwork, shared situational awareness, and psychological safety—elements often inadequately developed in environments characterized by poor safety cultures (Kertesz, 2018).

Figure 9 illustrates a bifurcated pattern in overall patient-harm prevention performance, thereby reinforcing these observations. Almost fifty percent of

respondents indicated low levels of harm-prevention behaviors, aligning with cross-sectional studies across various countries that reveal a significant portion of operating room personnel view safety culture as insufficient, especially regarding management support, working conditions, and error reporting (Filiz, 2023). The substantial number of individuals indicating high levels of safety practice implies that effective harm-prevention behaviors are achievable and currently exist in certain areas of the system. Interventional studies indicate that the systematic implementation of targeted training, structured checklists, and continuous education can markedly enhance safety practices and decrease variability (Mazur et al., 2022).

The current findings align with existing literature that illustrates operating room safety culture as inconsistent and largely influenced by local practices instead of standardized systems. Although certain technicians exhibit a strong commitment to harm-prevention practices, the inconsistency observed throughout the workforce indicates lost opportunities for comprehensive learning and risk mitigation. Research indicates that enhancing leadership engagement, normalizing participation in case reviews, improving communication, and integrating preventive practices into standard workflows are crucial for transforming low-performing groups into consistently high-performing ones in patient safety (Gutierres et al., 2018).

The results depicted in Figure 10 indicate that almost 50% of operating room technicians report low patient safety performance. This observation is consistent with existing literature that suggests patient safety in the operating room is precarious and significantly influenced by organizational and behavioral factors, rather than solely by technical competence. Numerous studies indicate that inadequate safety performance in perioperative environments is frequently

associated with deficiencies in safety culture, inconsistent compliance with standard practices, and restricted psychological safety among personnel. Qualitative evidence from operating room personnel indicates that the absence of continuous training, clear instructions, and sufficient human and logistical resources leads to a decline in safety behaviors, thereby increasing patient risk (Mousavi & Imani, 2020). The observations indicate that the low safety performance observed among a significant number of technicians is indicative of systemic deficiencies rather than isolated individual failures.

The significant percentage of technicians indicating low patient safety aligns with research highlighting the importance of teamwork and communication in the operating room. Research in surgical environments consistently indicates that communication failures, ambiguous roles, and hierarchical obstacles significantly contribute to unsafe practices. Research on operating room debriefing indicates that insufficient leadership support and low psychological safety hinder staff from voicing concerns about risks, consequently elevating the risk of errors (McElroy et al., 2023). Systematic reviews indicate that routine debriefing and structured teamwork practices are challenging to maintain without robust managerial commitment. This observation elucidates the persistence of low safety performance among technicians in the context of inconsistent leadership engagement (Skegg et al., 2023).

The finding that 41.2% of participants reported high patient safety performance indicates that strong safety outcomes can be attained in supportive environments. Research from both interventional and observational studies demonstrates that structured teamwork training, including programs like TeamSTEPPS and multidisciplinary team-based initiatives, can markedly enhance safety culture and observable safety behaviors in operating rooms (Harun et al.,

2020). Recent studies employing innovative methods, such as simulation and virtual reality training, have demonstrated measurable enhancements in non-technical skills and safety behaviors after targeted interventions (Mazur et al., 2024). The findings indicate that technicians exhibiting high safety performance are likely situated in environments characterized by robust leadership, well-defined protocols, and continuous training.

The strong positive correlation observed in this study ($r = 0.980, p < 0.001$) highlights the importance of frequent and consistent surgical counting practices in improving patient safety in the operating room. This finding is consistent with extensive evidence indicating that adherence to structured surgical count protocols is essential for preventing retained surgical items (RSIs), which are acknowledged as significant and largely preventable patient safety incidents. Integrative and systematic reviews indicate that precise and repeated surgical counts markedly decrease the risk of retained surgical items (RSIs) and related morbidity. This reinforces the belief among operating room personnel that meticulous counting directly contributes to improved patient outcomes (Freitas et al., 2016; Hariharan & Lobo, 2013).

Empirical studies examining operating room practices corroborate the current findings, indicating that increased adherence to counting frequency and standardized protocols correlates with enhanced safety culture and a decrease in counting errors. Research involving perioperative nurses indicates that consistent counting—especially when conducted audibly by designated personnel and reiterated at critical surgical phases—improves team communication and accountability, thereby reinforcing perceptions of patient safety (Bahar et al., 2017; Mukantwari et al., 2019). The findings align with the robust association identified in this study, indicating that operating room technicians may associate

frequent counting with increased vigilance and enhanced control over surgical risks.

Some studies, however, partially contest the assumption that surgical counts alone are adequate for ensuring patient safety. Research indicates that RSIs may still arise even with "correct" final counts, frequently attributed to communication failures, workflow disruptions, or the normalization of deviations from established protocols. The studies indicate that frequent counting is crucial, yet its efficacy is significantly influenced by the overall operating room culture and interdisciplinary collaboration (Gibbs, 2011; Osborne et al., 2021). This perspective indicates that the strong correlation observed in the current study may reflect technicians' confidence in well-organized systems rather than merely counting frequency in isolation.

Recent literature highlights that frequent surgical counts are most effective when combined with standardized protocols, clear role delineation, and supportive technologies. Research on adjunct technologies, including radiofrequency identification and barcode systems, demonstrates that these tools improve the accuracy of manual counts, especially in complex or high-risk procedures, thus enhancing patient safety outcomes (Endicott et al., 2020; Peng et al., 2022). The findings of this study indicate that frequent counting functions as a fundamental safety behavior, which is enhanced by system-level supports.

The results of this study reveal significant gender-based disparities in surgical count implementation and patient safety, with female technicians exhibiting superior performance compared to their male counterparts. The findings are substantiated by evidence from Rwanda, indicating that female gender was independently linked to improved surgical counting practices among

operating room personnel (Mukantwari et al., 2019). Broader operating room safety research indicates that nurses, who are predominantly female in many contexts, exhibit a greater recognition of count errors and possess stronger safety attitudes than physicians (Kwon et al., 2019). The findings indicate that gender differences may be attributed to professional role socialization, increased adherence to protocols, or heightened risk sensitivity, rather than biological factors.

The current study revealed an inverse relationship between age and experience with performance, indicating that younger technicians and those with less experience attained higher scores in surgical count implementation and patient safety. This contrasts with studies indicating that greater experience correlates with more favorable safety attitudes (Nyberg et al., 2024). The current findings align with human factors research, which suggests that extended exposure to high-risk environments can result in fatigue, diminished vigilance, and the normalization of deviance over time (Tsianos et al., 2020). Junior personnel may gain from contemporary education that highlights patient safety culture and standardized protocols.

This study's evident educational gradient corresponds with existing literature indicating that enhanced academic preparation correlates with better adherence to safety practices. Research indicates that personnel with advanced qualifications or specialized training demonstrate improved compliance and safer practices regarding surgical safety checklist implementation (Kusumaningrum et al., 2020). Education enhances technical knowledge and critical thinking, allowing technicians to identify risks and respond effectively during complex surgical procedures.

Workload was identified as a crucial factor influencing performance, as

technicians participating in a lower number of surgeries monthly exhibited superior surgical count implementation and enhanced patient safety. This finding is substantiated by qualitative and quantitative studies indicating that high workload and time pressure adversely impact staff performance, augment cognitive load, and heighten the risk of error (Handoko & Irawan, 2025; Remulla et al., 2025). The findings underscore the significance of adequate staffing and effective workload management as fundamental strategies for patient safety.

The significant positive impact of participating in surgical counting training in this study is corroborated by existing evidence. Numerous studies indicate that structured training programs enhance compliance with surgical counts and safety checklists, frequently resulting in sustained improvements over time (Hurley & Meyer, 2015; Al-Qahtani, 2017). Training improves shared mental models, enhances communication, and strengthens accountability among surgical teams.

The significant variation in outcomes among hospitals underscores the impact of organizational culture and institutional support on patient safety. Inter-hospital variations in compliance and safety performance are frequently documented, typically associated with leadership commitment, resource availability, and the enforcement of standardized protocols (Bahar et al., 2017; Yaseen et al., 2025; Qabban et al, 2026). The enhanced performance of specific hospitals in this study likely indicates a more robust safety culture, improved training systems, and more efficient management practices, highlighting the necessity for interventions at the system level in conjunction with individual-level enhancements (Alyahawi et al., 2024).

CHAPTER SEX

CONCLUTION

RECOMMENDATIONS

CHAPTER SIX: CONCLUSION AND RECOMMENDATION

Conclusion

This study assessed surgical count implementation and its association with patient safety among 201 surgical technologists in Sana'a, Yemen. Overall, compliance was suboptimal, with 50.2% demonstrating low adherence, particularly in documentation and performing standardized final counts before wound closure. The implementation of counting demonstrated an extraordinarily robust positive correlation with patient safety ($r = 0.980$, $p < 0.001$), indicating that consistent compliance is crucial for preventing retained surgical items

Performance was limited by factors such as a heavy workload of more than 40 surgeries a month and a poor safety culture. Importantly, 48.8% of respondents felt they were not treated with enough respect when pointing out mistakes, indicating that there are issues. Despite generally high educational levels, 52.7% had not received specialized counting training, implying that academic preparation does not substitute for targeted perioperative safety competency. Higher compliance among female technologists and those with <6 years of experience suggests that fatigue or procedural complacency may contribute to reduced adherence among more senior staff.

Recommendations

1. Adopt a mandatory, standardized surgical count checklist across public hospitals to reduce practice variation and strengthen compliance.
2. Implement a protected “Stop-the-Line” protocol enabling technologists to pause the procedure to reconcile count discrepancies without professional reprisal.
3. Require structured, competency-based certification in surgical counting for perioperative personnel rather than reliance on general orientation.
4. Provide periodic refresher training—particularly for senior staff—to sustain adherence and reduce complacency.
5. Optimize staffing and shift allocation to limit fatigue among technologists with high monthly surgical volume, supporting safer counting performance (Qabban & Al-Wesabi, 2025).
6. Establish non-punitive, preferably anonymous, near-miss reporting systems to promote learning and system-level improvement.
7. Incorporate direct observation or audit-based methods to minimize self-report and social desirability bias.
8. Conduct multi-center, longitudinal studies including private hospitals and additional provinces to generate a national profile of counting practices and patient safety.

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APPENDICES

Republic of Yemen University September 21st, Deanship of Environment and Community Service Medical Center for Training and Rehabilitation		الجمهورية اليمنية جامعة ٢١ ستمبر عمادة البيئة وخدمة المجتمع المركز الطبي للتدريب والتاهيل

رقم الاستبيان (   )   "استبيان"

أخي/أختي فني العمليات،

نحن طلاب فنيي العمليات نقوم ببحث علمي حول "دور فنيي العمليات في تطبيق العد الجراحي وأثره على سلامة المرضى في المستشفيات الحكوميه بأمانه العاصمه صنعاء"

يطيب لنا أن نضع بين أيديكم هذه الاستبانة، نظرًا لما تتمتعون به من خبرة ومعرفة كونكم من أهل الاختصاص، وذلك بهدف التعرف على آرائكم حول فقرات الاستبانة المتعلقة بدور فنيي العمليات الجراحية في تطبيق إجراءات العدّ الجراحي، وبيان أثر هذا التطبيق على سلامة المرضى داخل غرف العمليات.

نود إحاطتكم علمًا بأن المعلومات التي سيتم جمعها ستُستخدم **لأغراض البحث العلمي فقط**، وستُعامل بسرية تامة دون ذكر أي بيانات تعريفية، ولن يُطلب منكم تدوين أسمائكم أو أي معلومات شخصية.

نأمل منكم التكرم بالإجابة على فقرات هذه الاستبانة بكل موضوعية وصدق، لما لذلك من أهمية في دعم البحث العلمي وتحسين ممارسات العدّ الجراحي وتعزيز سلامة المرضى.

"علماً بأن: موافق بشدة = 5 ، موافق = 4 ، محايد = 3 ، لا أوافق = 2 ، لا أوافق بشدة = 1 "

شاكرين ومقدّرين لكم حسن تعاونكم ودعمكم للطلبة والباحثين

أولاً: البيانات الديموغرافية للمشاركين

الجنس	ذكر ( )		أنثى ( )		
العمر	أقل من 25 سنة ( )	25 – 35 سنة ( )	36 – 45 سنة ( )	أكثر من 45 سنوات ( )	
المستشفى	الثورة ( )	الجمهوري ( )	الكويت ( )	العسكري ( )	السبعين ( )
المؤهل العلمي	دبلوم متوسط فأقل ( )	دبلوم عالي ( )	بكالوريوس ( )	دراسات عليا ( )	
سنوات الخبرة كفني عمليات	أقل من 3 سنوات ( )	3-6 سنوات ( )	7-10 سنوات ( )	أكثر من 10 سنوات ( )	
معدل العمليات الجراحية التي تشارك فيها شهرياً	أقل من 20 عملية ( )	20 - 40 عملية ( )	أكثر من 40 عملية ( )		
نظام الدوام	صباحاً ( )	مساءً ( )	ليلاً ( )		
هل حضرت دورات تدريبية حول العدّ الجراحي	نعم ( )	لا ( )	عدد الدورات التي حظرتها		

الصفحة 1

Republic of Yemen University September 21st, Deanship of Environment and Community Service Medical Center for Training and Rehabilitation		الجمهورية اليمنية جامعة ٢١ ستمبر عمادة البيئة وخدمة المجتمع المركز الطبي للتدريب والتاهيل

القسم الجراحي الذي تعمل فيه: ....

ثانياً: العد الجراحي (Surgical Count)

البعد الأول: الالتزام بإجراءات العدّ الجراحي (Compliance with Surgical Count Procedures)

م	العبارة	لا أوافق بشدة	لا أوافق	محايد	أوافق	أوافق بشدة
1	يُجري فني العمليات العدّ الأولي للأدوات والمستلزمات قبل بدء الجراحة مباشرة.					
2	يشارك بفاعلية في عملية العدّ خلال مراحل الجراحة المختلفة.					
3	يُجري العدّ النهائي للأدوات والشاش قبل إغلاق الجرح.					
4	يتحقق من عدّ الشاش والإبر والأدوات كلٌّ على حدة وبدقة.					
5	يعدّ أي أداة أو شاش يتم إضافته أثناء العملية فور إدخاله.					
6	يرفض إغلاق الجرح في حال وجود اختلاف غير محسوم في العدّ.					
7	يعيد العدّ عند تغيير أحد أفراد الفريق الجراحي.					
8	يوثق نتائج العدّ في النماذج والسجلات المعتمدة.					
9	يفحص سلال النفايات عند الاشتباه بوجود نقص في العدد.					
10	يلتزم بتطبيق بروتوكول العدّ الجراحي المعتمد دون تجاوز.					

البعد الثاني: الاتصال والعمل الجماعي أثناء العدّ (Communication and Teamwork during Surgical Count)

م	العبارة	لا أوافق بشدة	لا أوافق	محايد	أوافق	أوافق بشدة
11	يُعلن نتائج العدّ بوضوح لجميع أفراد الفريق الجراحي.					
12	يتعاون مع الممرض/ة المناول/ة أثناء جميع مراحل العدّ.					
13	يُبلغ الفريق الجراحي فورًا عند وجود أي اختلاف في نتائج العدّ.					
14	يطلب إيقاف الإجراء الجراحي عند عدم تطابق العدّ حتى يتم حله.					
15	يستخدم لغة واضحة ومفهومة أثناء عملية العدّ.					
16	يحظى رأيه المهني بالاحترام عند وجود شك في عدد الأدوات.					
17	ينقل مسؤولية العدّ بشكل منظم عند تبديل طاقم العمل.					
18	يقلل من المقاطعات غير الضرورية أثناء العدّ النهائي.					
19	ينبه الفريق الجراحي بموعد الإغلاق النهائي لإتمام العدّ.					
20	يؤكد اكتمال العدّ مع الفريق قبل إنهاء العملية.					

الصفحة 2

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الجمهورية اليمنية
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المركز الطبي للتدريب والتاهيل

البعد الثالث: العوامل البشرية وبيئة العمل المؤثرة على أداء فني العمليات
(Human Factors and Work Environment)

م	العبارة	لا أوافق بشدة	لا أوافق	محايد	أوافق	أوافق بشدة
21	لا يؤثر ضغط الوقت على دقة تنفيذ العدّ الجراحي.					
22	لا تؤدي كثرة العمليات الجراحية إلى إهمال خطوات العدّ.					
23	يتم تجنب المقاطعات غير الضرورية أثناء العدّ.					
24	يحافظ على التركيز أثناء العدّ في العمليات الجراحية المعقدة.					
25	يلتزم بإجراءات العدّ الجراحي في المناوبات الليلية والطوارئ.					
26	لا يؤثر الإرهاق البدني على دقة العدّ الجراحي.					
27	تساعد بيئة غرفة العمليات المنظمة على دقة العدّ.					
28	يتم ترتيب الأدوات بطريقة تسهّل عملية العدّ.					
29	يتم ضبط بيئة العمل بما يضمن دقة العدّ الجراحي.					
30	يعتبر العدّ الجراحي جزءًا أساسيًا من مسؤولياته المهنية.					

البعد الرابع: القيادة والتدريب
(Leadership and Training)

م	العبارة	لا أوافق بشدة	لا أوافق	محايد	أوافق	أوافق بشدة
31	يشجع قائد الفريق الالتزام بإجراءات العدّ الجراحي.					
32	توفر الإدارة تدريبًا دوريًا لفنيي العمليات حول العدّ الجراحي.					
33	تُحدّث الإدارة سياسات العدّ الجراحي وفق الممارسات المعتمدة.					
34	تشجع الإدارة الإبلاغ عن أخطاء العدّ دون خوف من العقوبة.					
35	توفر الإدارة وقتًا كافيًا لإجراء العدّ دون ضغط.					
36	يُنظر إلى العدّ الجراحي كجزء من ثقافة سلامة المرضى.					
37	تعالج الإدارة أسباب أخطاء العدّ السابقة لمنع تكرارها.					

الصفحة 3

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جامعة ٢١ سبتمبر
عمادة البيئة وخدمة المجتمع
المركز الطبي للتدريب والتاهيل

ثالثاً المتغير التابع: سلامة المرضى

(Dependent Variable: Patient Safety)

البعد الأول: جودة الرعاية

(Quality of Care)

م	العبارة	لا أوافق بشدة	لا أوافق	محايد	أوافق	أوافق بشدة
38	لا يُسمح بمغادرة المريض غرفة العمليات قبل حل أي اختلاف في العدّ.					
39	تقل الحاجة إلى التصوير الشعاعي بسبب الالتزام الجيد بالعدّ.					
40	لا تحدث حالات نسيان أدوات أو شاش داخل جسم المريض.					
41	يتم حل اختلافات العدّ في وقت مبكر دون تأخير العملية.					
42	تقل المضاعفات الناتجة عن أدوات أو شاش منسية.					
43	لا يتم إغلاق الجرح قبل التأكد من العدّ النهائي.					
44	تقل الحاجة إلى عمليات جراحية إضافية بسبب أخطاء العدّ.					
45	يتم اكتشاف الأدوات المفقودة قبل مغادرة المريض غرفة العمليات.					
46	يتم تسجيل حالات اختلاف العدّ النادرة بهدف التحسين.					
47	تنخفض مشكلات سلامة المرضى المرتبطة بأخطاء العدّ الجراحي.					

البعد الثاني: تقليل الأخطاء الطبية

(Reduction of Medical Errors)

م	العبارة	لا أوافق بشدة	لا أوافق	محايد	أوافق	أوافق بشدة
48	يلتزم الفريق الجراحي بالإجراءات الوقائية لتجنب الأخطاء.					
49	يلتزم الفريق الجراحي بمعايير السلامة أثناء تقديم الرعاية.					
50	يتابع الفريق الجراحي تنفيذ بروتوكولات السلامة بشكل دوري.					
51	يطبق الفريق الجراحي التصحيح الفوري عند اكتشاف أي خطأ محتمل.					
52	يسجل الفريق الجراحي الحوادث القريبة من الخطأ لتحليلها.					
53	يحلل الفريق الجراحي أسباب الأخطاء السابقة لتفادي تكرارها.					
54	يتعاون الفريق الجراحي مع الأقسام الأخرى لضمان سلامة الإجراءات.					

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المركز الطبي للتدريب والتاهيل

البعد الثالث: حماية المرضى من المضاعفات
(Patient Harm Prevention)

م	العبارة	لا أوافق بشدة	لا أوافق	محايد	أوافق	أوافق بشدة
55	يراقب الفريق الجراحي المرضى لاكتشاف علامات الخطر المحتملة.					
56	يلتزم الفريق الجراحي بالإجراءات الوقائية لتقليل المضاعفات.					
57	يتابع الفريق الجراحي المرضى أثناء وبعد العملية لضمان سلامتهم.					
58	يشارك الفريق الجراحي في اجتماعات مراجعة الحالات.					
59	يقدم الفريق الجراحي توصيات وقائية لحماية المرضى.					
60	يطبق الفريق الجراحي خطط استجابة سريعة عند حدوث مضاعفات.					

شاكرين تعاونكم ومشاركتكم القيّمة، لما لها من دور في تحسين ممارسات العدّ الجراحي وتعزيز سلامة المرضى داخل غرف العمليات.

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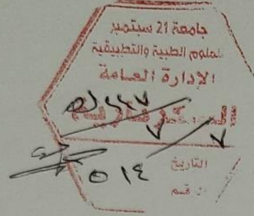
الجمهورية اليمنية
جامعة 21 سبتمبر للعلوم الطبية والتطبيقية
رئاسة الجامعة



الاستاذ الدكتور/ محمد جحاف

رئيس هيئة المستشفى الجمهوري التعليمي المحترم

الموضوع: تسهيل مهمة بحث

تهديكم جامعة 21 سبتمبر للعلوم الطبية والتطبيقية أطيب تحياتها وتقديرها وإشارة إلى الموضوع أعلاه تكرموا مشكورين بالتوجيه الى من يلزم بتسهيل مهمة بحث طلاب المركز الطبي تخصص فني عمليات المستوى الثالث، تحت اشراف أ.م.د/منير الوصابي، لمدة ثلاث اشهر بحسب عنوان البحث الموضح قرين اسمائهم:-

م	الاسم	عنوان البحث
١	سارة حسين عبده عبدالرب الصلوي	دور فنيي العمليات في تطبيق العد الجراحي وأثره على سلامة المرضى في المستشفيات الحكومية بأمانة العاصمة صنعاء
٢	هناء يحيى قاسم صالح كباس	
٣	انهار محمد احسن المطري	
٤	شروق محمد علي المروعي	
٥	رفيدة علي عبدالله احمد عامر	
٦	مريم صالح محمد العولقي	
٧	شيماء قاسم مرشد الذارحي	
٨	رغد علي يوسف جعفر	
٩	ذكرى علي ابراهيم علي دويله	
١٠	عماد حسين علي سعيد المقطري	
١١	زكريا محمد طاهر الدبيس	
١٢	بدر قاسم احمد الحبيشي	

" تفضلوا بقبول خالص تحياتي وعميق احترامي "

أ.د/مجاهد علي معصار
رئيس الجامعة

27 DEC 2025

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صنعاء :- شارع تعز- السواد- مبنى2 :- الخمسين – شارع 20
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رئاسة الجامعة

الدكتور/ عباس نجم الدين
مدير عام المستشفى العسكري المحتـــرم

الموضوع: تسهيل مهمة بحث

تهـــديكم جامعـــة 21 ســـبتمبر للعلـــوم الطبيـــة والتطبيقيـــة أطيـــب تحياتهـــا وتقـــديرها وإشـــارة إلـــى الموضـــوع أعـــلاه تكرمـــوا مشـــكورين بالتوجيـــه الـــى مـــن يلـــزم بتســـهيل مهمـــة بحـــث طلاب المركز الطبي تخصص فني عمليات المستوى الثالث، تحت اشراف أ.م.د/منير الوصابي، لمدة ثلاث اشهر بحسب عنوان البحث الموضح قرين اسمائهم:-

م	الاســـم	عنوان البحث
١	سارة حسين عبده عبدالرب الصلوي	دور فنيي العمليات في تطبيق العد الجراحي وأثره على سلامة المرضى في المستشفيات الحكومية بأمانة العاصمة صنعاء
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٤	شروق محمد علي المروعي	
٥	رفيدة علي عبدالله احمد عامر	
٦	مريم صالح محمد العولقي	
٧	شيماء قاسم مرشد الذارحي	
٨	رغد علي يوسف جعفر	
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١٠	عماد حسين علي سعيد المقطري	
١١	زكريا محمد طاهر الدبيس	
١٢	بدر قاسم احمد الحبيشي	

،، تفضلوا بقبول خالص تحياتي وعميق احترامي ،،،

أستاذ دكتور/
مجاهـــد علـــي معصـــار
رئـــيس الجامعـــة

27 DEC 2025

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صنعاء :- شارع تعز- السواد. مبنى2 :– الخمسين – شارع 20
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رئاسة الجامعة

الاستاذ الدكتور/ عبداللطيف ابو طالب
مدير عام مستشفى الكويت الجامعي المحترم

الموضوع: تسهيل مهمة بحث

تهديكم جامعة 21 سبتمبر للعلوم الطبية والتطبيقية أطيب تحياتها وتقديرها وإشارة إلى الموضوع أعلاه تكرموا مشكورين بالتوجيه الى من يلزم بتسهيل مهمة بحث طلاب المركز الطبي تخصص فني عمليات المستوى الثالث، تحت اشراف أ.م.د/منير الوصابي، لمدة ثلاث اشهر بحسب عنوان البحث الموضح قرين اسمائهم:-

م	الاسم	عنوان البحث
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١٢	بدر قاسم احمد الحبيشي	

،، تفضلوا بقبول خالص تحياتي وعميق احترامي ،،

استاذ دكتور/
مجاهد علي معصار
رئيس الجامعة

27 DEC 2025

صنعاء :- شارع تعز- السواد- مبنى 2 - الخمسين - شارع 20
ص.ب(17021) تلفون: (692100) فاكس: (01/696585)
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ARABIC SUMMARY

الملخص باللغة العربية

خلفية الدراسة: يُعدّ العدّ الجراحي ممارسةً أساسيةً لسلامة المريض في الفترة المحيطة بالجراحة بهدف منع بقاء الأدوات أو المواد الجراحية داخل جسم المريض (RSIs). وفي المستشفيات الحكومية محدودة الموارد في صنعاء–اليمن، ما تزال درجة اتساق هذه الممارسة لدى فنّيّي غرف العمليات غير مدروسة بالشكل. **الهدف من الدراسة:** تقييم دور فنّيّي غرف العمليات في تطبيق العدّ الجراحي وتحديد أثره على سلامة المرضى في المستشفيات الحكومية بمدينة صنعاء، اليمن. **المنهجية:** أُجريت دراسة تحليلية مقطعية في خمسة مستشفيات حكومية. وباستخدام أسلوب العينة المتاحة، استكمل 201 من فنّيّي غرف العمليات المؤهلين استبيانًا منظّمًا ذاتيّ التعبئة شمل الخصائص الديموغرافية/الوظيفية، وممارسات العدّ الجراحي، وسلامة المرضى. وتم تطبيق الإحصاءات الوصفية والاستدلالية، بما في ذلك معامل ارتباط بيرسون. **النتائج:** كشفت النتائج عن فجوة ملحوظة في التطبيق؛ إذ أفاد 50.2% من المشاركين بانخفاض مستوى الالتزام ببروتوكولات العدّ. وتبيّن وجود نقاط ضعف حرجة في توثيق الإجراءات (45.8% عدم موافقة) وفي ‘‘التحدّث/الإبلاغ’’ عند حدوث اختلافات في العدّ (48.8% عدم موافقة). كما أن أكثر من نصف المشاركين (52.7%) لم يتلقّوا تدريبًا رسميًا على العدّ الجراحي. وظهر ارتباط إيجابي قوي جدًا بين تطبيق العدّ الجراحي وسلامة المرضى ($r = 0.980$، $p < 0.001$). وارتبط الامتثال الأعلى للسلامة بشكل دال إحصائيًا بكون المشارك أنثى، وبسنوات خبرة أقل (< 6 سنوات)، وبحجم عمليات شهري أقل (< 20 حالة/شهر). **الاستنتاج:** إن تطبيق العدّ الجراحي في المستشفيات الحكومية بصنعاء دون المستوى المطلوب ويتسم بتباينٍ كبير. وتشير العلاقة القوية بين الالتزام بالعدّ وسلامة المرضى إلى أن الممارسات غير المتسقة الحالية تُشكّل خطرًا ملموسًا لوقوع أخطاء جراحية يمكن الوقاية منها. وتُعدّ العوائق النظامية—ومنها ارتفاع عبء العمل ونقص التدريب المتخصص—من أبرز أسباب عدم الامتثال. **التوصيات:** ينبغي على المستشفيات الحكومية إلزام تطبيق بروتوكولات موحّدة للعدّ الجراحي وإدخال اعتماد/شهادة قائمة على الكفاءة في العدّ الجراحي. كما تُوصى دراسات متعددة المراكز—تشمل المستشفيات الخاصة ومحافظات أخرى—لبناء صورة وطنية شاملة حول ممارسات العدّ وسلامة المرضى.

الكلمات المفتاحية: العدّ الجراحي؛ سلامة المرضى؛ فنّي غرفة العمليات؛ المستشفيات الحكومية؛ صنعاء؛ اليمن.

الجمهورية اليمنية وزارة التعليم العالي

للبحث العلمي

جامعة 21 سبتمبر للعلوم الطبية والتطبيقية

المركز الطبي للتدريب و التأهيل

فني عمليات

دور فنيي العمليات في تطبيق العد الجراحي وأثره على سلامة المرضى في المستشفيات الحكومية - صنعاء

مشروع بحثي مقدم كجزء من متطلبات الحصول على درجة الدبلوم في فنيي العمليات الجراحية من كلية العلوم الطبية التطبيقية في جامعة 21 سبتمبر

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