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The Role of the Nursing, Anesthesia, and Operating Room Technician Teams in Enhancing Patient Safety During Surgical Procedures: Systematic Review

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ABSTRACT

Background: Patient safety during surgical procedures relies on the coordinated performance of perioperative nursing teams, anesthesia providers, and operating room technicians. These professionals collectively contribute to preventing adverse events, maintaining sterile technique, ensuring equipment functionality, and fostering effective communication. As surgical procedures become increasingly complex, understanding the specific roles and collaborative practices that enhance patient safety has become essential.

Methods: A systematic review was conducted to evaluate the contributions of perioperative nurses, anesthesia teams, and operating room technicians to patient safety in surgical settings. A comprehensive database search was performed using predefined keywords related to perioperative practice and safety outcomes. Studies were screened using established eligibility criteria, followed by full-text assessment. Data were extracted using a structured form, and quality appraisal tools appropriate for each study design were applied. Due to heterogeneity among study methodologies, a narrative synthesis approach was used. After modifications, four studies met all inclusion criteria and were incorporated into the final analysis.

Results: The synthesis of the four studies revealed three major themes: direct safety contributions of perioperative team roles, the centrality of communication and interprofessional collaboration, and systemic challenges influencing team performance. Nursing teams were shown to play key roles in preventing surgical site infections, ensuring accurate surgical counts, and supporting safety protocols. Anesthesia teams, including technicians, contributed to risk reduction by ensuring equipment readiness, maintaining physiological stability, and adhering to medication safety standards. Operating room technicians supported workflow efficiency through equipment maintenance and sterile processing. Barriers such as hierarchical communication, environmental distractions, staffing shortages, and inconsistent use of safety checklists were frequently identified, while interventions such as structured communication tools, psychological safety, and simulation-based team training were effective in improving safety outcomes.

Conclusion: This review demonstrates that perioperative nurses, anesthesia teams, and operating room technicians collectively create a robust safety framework in surgical environments. Their effectiveness depends on clear communication, mutual respect, adequate staffing, and strong organizational support. Interprofessional teamwork and a positive safety culture are essential for minimizing preventable harm and optimizing surgical patient outcomes

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1. INTRODUCTION

Patient safety in the surgical environment has become a central focus of modern healthcare systems as surgical procedures continue to increase in complexity and volume. Operating rooms are high-risk settings where multiple processes occur simultaneously under strict time pressures, making the risk of adverse events significant. Ensuring patient safety requires seamless coordination among all professionals involved, particularly nursing staff, anesthesia providers, and operating room technicians. Their combined efforts form the structural foundation of safe and effective perioperative care (Lemos & Poveda, 2022).

The expansion of surgical technologies, including minimally invasive procedures and robotic systems, has increased the demands placed on perioperative teams. These advancements have improved surgical outcomes but have also introduced new challenges that require specialized skills and heightened vigilance. As a result, the roles of nurses, anesthesiologists, and technicians have evolved to involve not only technical tasks but also cognitive, communicative, and decision-making responsibilities that directly influence patient safety (Chellam Singh & Arulappan, 2023).

Operating room nurses play a pivotal role in maintaining a sterile field, preparing the environment, anticipating surgical needs, and supporting the surgeon throughout the procedure. Their responsibilities extend beyond technical duties to include patient advocacy, intraoperative monitoring, and early identification of potential safety hazards. Their ability to integrate clinical judgment with hands-on skills positions them as essential contributors to safe surgical outcomes (Krupic et al., 2022).

Anesthesia team members are responsible for maintaining physiological stability from preoperative assessment through recovery. Their role requires continuous monitoring, rapid responsiveness, and the ability to make precise decisions under pressure. Beyond administering anesthesia, they ensure adequate communication with surgeons and nurses to prevent complications such as hypoxia, hemodynamic instability, and airway compromise. Their vigilance is a cornerstone of intraoperative patient safety (van Beuzekom et al., 2012).

Operating room technicians support the surgical team by preparing instruments, managing equipment, and ensuring adherence to sterilization protocols. Their expertise reduces technical errors, delays, and contamination risks that may lead to surgical site infections or procedural mishaps. Their role has expanded to include assisting with newer technologies, navigating complex devices, and ensuring optimal workflow throughout the operation (Urban et al., 2021).

Interprofessional collaboration has emerged as a critical determinant of patient safety within surgical settings. Communication failures and teamwork breakdowns are major contributors to preventable adverse events during surgery. Effective coordination among nurses, anesthesiologists, and technicians minimizes errors by promoting shared situational awareness, timely information exchange, and mutual support. Structured communication strategies and team-based practices have shown significant impact in reducing intraoperative risks (Cenacchi et al., 2025).

Human factors and system-level characteristics influence how perioperative teams function under pressure. Fatigue, distractions, unclear protocols, and resource limitations can increase the likelihood of errors. Understanding these factors has encouraged healthcare organizations to adopt safety-oriented practices such as standardized checklists, simulation-based training, and continuous performance evaluation. These approaches aim to strengthen team reliability and resilience in high-stress environments (Kisacik & Cigerci, 2019).

The culture of safety within the operating room also depends on the empowerment of team members to speak up when risks arise. Psychological safety encourages open communication and reduces the likelihood of overlooking warning signs. When nurses, anesthesia providers, and technicians feel supported in voicing concerns, the team is better equipped to prevent complications and intervene before harm occurs (Nwosu et al., 2022).

Global health systems have emphasized the need to standardize perioperative processes to reduce variability in care. Quality improvement initiatives, accreditation requirements, and national safety guidelines have reinforced the importance of structured teamwork. These strategies highlight the critical link between workforce competence, system design, and patient protection in the surgical environment (Arad et al., 2022).

As surgical care continues to advance, understanding the specific contributions of nursing, anesthesia, and operating room technician teams is essential for improving patient outcomes. Examining their roles collectively allows for a comprehensive assessment of how multidisciplinary collaboration enhances safety. A systematic review of existing evidence provides deeper insight into effective strategies, persistent challenges, and opportunities for strengthening perioperative safety practices (Kabo et al., 2023).

Methodology

Study Design

This research was conducted as a systematic review aimed at synthesizing evidence on the role of nursing, anesthesia, and operating room technician teams in enhancing patient safety during surgical procedures. The review followed established evidence-synthesis principles to ensure comprehensiveness, transparency, and methodological rigor. All procedures were carried out systematically and in accordance with predefined criteria to minimize bias.

Research Question and Framework

The research question was formulated using the Population–Intervention–Outcome (PIO) framework. The population focused on patients undergoing surgical procedures and the perioperative teams caring for them. The interventions examined were the roles, practices, and safety-enhancing activities performed by nursing, anesthesia, and operating room technician teams. The primary outcomes of interest were improvements in patient safety, reduction of adverse events, and enhancement of surgical workflow efficiency. This framework guided the search terms, screening approach, and selection of eligible studies.

Eligibility Criteria

Eligibility criteria were established before the literature search. Studies were eligible if they investigated the contributions of perioperative nurses, anesthesia providers, or operating room technicians to patient safety in surgical settings. Only empirical research published in peer-reviewed journals was included, and both qualitative and quantitative designs were considered. Studies were excluded if they did not address patient safety outcomes, focused solely on surgical techniques, or involved non-perioperative personnel. Review articles, editorials, conference abstracts, and non-research papers were also excluded.

Search Strategy

A comprehensive search strategy was developed to identify relevant literature. Multiple academic databases were searched using combinations of predefined keywords and Boolean operators related to perioperative nursing, anesthesia teams, operating room technicians, and patient safety. Additional synonyms and controlled vocabulary terms were incorporated to maximize sensitivity. The search process aimed to retrieve all potentially relevant publications without restriction on language or publication year. Reference lists of included studies were also screened manually to ensure completeness.

Study Screening and Selection

The screening process involved two phases: title-and-abstract screening followed by full-text assessment. All retrieved records were first screened for relevance based on titles and abstracts, and those meeting the initial criteria proceeded to full-text evaluation. Full texts were then reviewed in detail to confirm eligibility in accordance with the predefined inclusion criteria. Disagreements between reviewers were resolved through discussion until consensus was reached. Ultimately, five studies met all eligibility criteria and were included in the final synthesis.

Data Extraction

A standardized data extraction form was developed and used to collect relevant information from each included study. Extracted data included study design, sample characteristics, perioperative roles examined, interventions or practices described, safety outcomes measured, and key findings. Data extraction was performed independently by the reviewers to reduce the risk of error, and all extracted information was cross-checked for accuracy and consistency.

Quality Appraisal

The methodological quality of each included study was assessed using established quality-assessment tools appropriate for the study design. Criteria evaluated included clarity of objectives, adequacy of methodology, validity of measurement tools, ethical considerations, and completeness of reporting. Each study was assigned a quality rating based on these criteria. The appraisal process ensured that the interpretation of findings considered the strengths and limitations of each included study.

Data Synthesis

A narrative synthesis approach was employed due to the heterogeneity of study designs, interventions, and outcome measures. Studies were grouped according to the perioperative team roles examined and the specific safety outcomes reported. The synthesis integrated common themes, patterns, and differences across studies, highlighting how nursing, anesthesia, and technician teams contributed to patient safety. Quantitative outcomes were summarized descriptively when applicable, and qualitative findings were interpreted thematically.

Ethical Considerations

As this research involved the analysis of previously published studies and did not include human participants, formal ethical approval was not required. All included studies were assumed to have obtained ethical clearance from their respective institutions.

Results

Study Selection and Characteristics

The systematic search and screening process culminated in the inclusion of four studies that met the predefined eligibility criteria. The key characteristics of these studies are summarized in Table 1.

Table 1: Characteristics of Included Studies

Study (Author, Year)	Country	Study Design	Study Focus / Aim	Sample Size & Population
Almutairi et al., (2024)	Saudi Arabia	Comprehensive Analysis / Review	To analyze the role of anesthesia technicians in mitigating risks and enhancing patient safety.	N/A (Profession-focused analysis)
Kabo et al., 2023	USA	Cross-sectional, Mixed-Methods	To examine how the spatial topology of the OR impacts surgical team communication.	204 clinicians; 137 surgical teams (Observations)
Arad et al., 2022	Israel	Mixed-Methods	To predict teamwork during surgery based on safety standards and explore factors affecting patient and staff psychological safety.	2,184 surgical cases (Observations) + 25 interviews
Sillero Sillero & Bull, 2021	Spain	Qualitative, Phenomenological	To explore the perspectives of surgical teams on interprofessional collaboration and improvement strategies.	16 participants (8 nurses, 4 surgeons, 4 anesthesiologists)

Methodological Quality of Included Studies

The methodological quality of the included studies was variable but overall satisfactory. The quantitative components of the mixed-methods studies (Kabo et al., 2023; Arad et al., 2022) employed robust statistical analyses and large sample sizes. The qualitative study (Sillero Sillero & Bull, 2021) and qualitative components of the mixed-methods studies demonstrated rigor through the use of established analytical frameworks (e.g., Thematic Analysis, Colaizzi's method) and triangulation. The comprehensive analysis by Almutairi et al. provided a detailed, evidence-based overview but was not a primary research study. All studies clearly addressed their research aims with appropriate methodologies.

Synthesis of Findings

The findings from the four studies were synthesized into three overarching themes that describe the contributions and challenges of perioperative teams in enhancing patient safety.

1. Critical Roles and Direct Contributions to the Safety Net

Each member of the perioperative team performs specific, high-leverage functions that constitute a multi-layered defense against errors. The specific responsibilities and their impact on safety, as detailed across the studies, are summarized in Table 2.

Table 2: Direct Safety Contributions of Perioperative Team Roles

Team Role	Key Safety Functions	Impact on Patient Safety	Supporting Evidence
Anesthesia Team	- Meticulous pre-use check of anesthesia machines and emergency equipment. - Sterile preparation and labeling of medications. - Real-time monitoring and troubleshooting of equipment and patient physiology. - Management of airway and fluid therapy.	Prevents catastrophic events like hypoxic gas delivery, drug errors, and inability to ventilate. Ensures continuous physiological stability.	(Almutairi et al.; Arad et al.)
Nursing Team	- Maintenance of sterile field and aseptic technique. - Performing and documenting surgical counts. - Patient advocacy and vigilant monitoring for clinical deterioration.	Prevents surgical site infections, retained foreign objects, and wrong-site surgery. Acts as a final safety checkpoint.	(Sillero Sillero & Bull; Arad et al.)

	- Ensuring completion of pre-operative checklists (e.g., Sign-in, Time-out).		
OR Technician Team	- Preparation, operation, and maintenance of specialized surgical equipment. - Technical support for complex procedures (e.g., cell saver, rapid infusers). - Terminal cleaning and sterilization of reusable instruments. - Ensuring availability and functionality of all necessary supplies.	Reduces technical errors, procedural delays, and infection transmission between patients.	(Almutairi et al.)

2. The Centrality of Interprofessional Collaboration and Communication

All four studies unanimously identified effective teamwork and communication as the fundamental mechanism through which individual roles translate into safe patient outcomes.

- **Quantitative Evidence:** Arad et al. found that a lack of teamwork in the preoperative "Sign-in" and "Time-out" phases nearly doubled the chances of poor teamwork during surgery (Odds Ratios: 1.97 and 2.14, $p<0.001$).
- **Spatial Dynamics:** Kabo et al. demonstrated that the physical layout of the OR influences communication. Surgical suites with higher spatial centrality (i.e., located in high-traffic, central hubs) were associated with **significantly lower communication scores**, likely due to increased distractions and interruptions.
- **Qualitative Insights:** Sillero Sillero & Bull identified "disruptive behaviors" and "professional hierarchies" as major barriers. Participants reported that surgeons sometimes viewed nurses as a "control system" rather than collaborators, while nurses felt perceived as "subordinates," which inhibited speaking up. Conversely, Arad et al. highlighted that **"psychological safety"**—a shared belief that one can speak up without risk—was essential for teams to manage errors and prevent "Never Events."

3. Systemic Challenges and Enabling Strategies

The studies identified several systemic challenges that undermine team effectiveness and, consequently, patient safety. They also proposed evidence-based strategies to overcome these barriers, as detailed in Table 3.

Table 3: Challenges and Strategies for Enhancing Perioperative Team Performance

Category	Identified Challenges	Proposed Interventions & Enabling Strategies
Workforce & Resources	- Chronic understaffing and high workload. - High levels of occupational burnout and staff turnover. - Lack of professional recognition for technicians.	- Adhere to recommended staffing ratios (e.g., one anesthesia tech per 3 rooms). - Implement measures to improve well-being and reduce burnout. - Provide formal recognition and career advancement pathways.
Team Dynamics & Culture	- Hierarchical structures that suppress input from nurses/technicians. - Role ambiguity and interpersonal conflicts. - Lack of psychological safety.	- Conduct interprofessional team-building and simulation training. - Clarify and respect professional roles and responsibilities. - Foster leadership that promotes flat hierarchies and open communication.
Processes & Training	- Inconsistent use of safety checklists and protocols.	- Mandate and standardize the use of checklists (WHO SSC) and communication tools.

	- Barriers to accessing continuing education. - Ineffective handovers during staff breaks.	- Invest in regular, joint, simulation-based training for all team members. - Create fixed, designated teams for specific surgeries to improve familiarity.

A critical finding from Arad et al. quantified the impact of staff turnover: each increase in physician turnover during a surgery **reduced the chance of teamwork by 73%**. This underscores the challenge of ad-hoc teams and supports the strategy of creating consistent, familiar teams.

Discussion

The findings of this systematic review demonstrated that perioperative nursing, anesthesia teams, and operating room technicians collectively form a multilayered defense system against surgical risks. Across the included studies, it was evident that each team member performs tasks that reduce the probability of equipment failures, communication gaps, and human error, which remain among the leading causes of adverse surgical outcomes. The integration of these professional roles created a synergistic safety structure that aligned with contemporary models of high-reliability healthcare systems (Arad et al., 2022).

One of the dominant themes in the reviewed studies was the indispensable contribution of anesthesia teams to intraoperative safety. Their vigilance during monitoring, equipment preparation, and drug delivery was essential in preventing life-threatening complications. Almutairi et al. (2024) emphasized that anesthesia technicians played significant roles in preventing hypoxic gas delivery, medication errors, and airway complications through strict adherence to safety checks and equipment readiness protocols. These findings echoed the broader recognition that anesthesia personnel serve as a critical safety checkpoint throughout the perioperative period.

Nursing teams were also found to be central in maintaining sterile technique, monitoring patient status, and preventing surgical site infections, retained surgical items, and wrong-site surgery. Studies such as Sillero Sillero and Bull (2021) highlighted how nurses' clinical judgment and anticipatory skills were crucial in detecting deviations from expected surgical progress and prompting timely interventions. Furthermore, nurses' advocacy roles allowed them to identify risks that other team members may have overlooked, underscoring the necessity of strong nursing presence in the operating room.

The review also supported the expanding technical role of operating room technicians, who contributed significantly to workflow efficiency and equipment safety. Their involvement in preparing and maintaining surgical instruments reduced procedural delays and minimized contamination risks. The analysis by Almutairi et al. (2024) reinforced that skilled technicians prevented technical failures that could otherwise disrupt surgical flow or cause harm. As surgical procedures grow increasingly technology-driven, the importance of technician expertise becomes even more pronounced.

Interprofessional teamwork emerged as a consistent determinant of patient safety across all included studies. Ineffective communication, hierarchical barriers, and lack of shared situational awareness were identified as major contributors to adverse events. Arad et al. (2022) found that deficiencies in the "Sign-in" and "Time-out" steps significantly increased the likelihood of poor teamwork during surgery. This finding underscored the importance of structured communication protocols in maintaining synchronization among team members throughout the surgical process.

The physical layout and environmental conditions of the operating room were also shown to influence communication patterns. Kabo et al. (2023) demonstrated that surgical suites with high spatial centrality were associated with reduced communication quality due to increased traffic and distractions. This finding emphasized that patient safety is not only influenced by human factors but also by architectural and environmental design, which may enhance or hinder collaborative practice.

Psychological safety was another vital theme, particularly in relation to communication and speaking up. Sillero Sillero and Bull (2021) reported that nurses often felt perceived as subordinates, which discouraged them from voicing concerns during critical moments. In contrast, Arad et al. (2022) highlighted that when psychological safety was present, teams were more willing to report errors, anticipate complications, and coordinate effectively. Thus, improving psychological safety directly enhances error prevention and team adaptability in dynamic surgical settings.

Findings across the studies also identified disruptive behaviors, professional hierarchies, and role ambiguity as persistent barriers to effective collaboration. These interpersonal challenges not only affected communication quality but also created stress and decreased situational awareness. Evidence from Sillero Sillero and Bull (2021) suggested that interprofessional respect and role clarity were fundamental for enabling efficient teamwork and reducing conflicts during surgery.

Staffing challenges emerged as an important organizational factor influencing safety. High workload, understaffing, and increased turnover were shown to diminish teamwork quality. Arad et al. (2022) quantified this effect, noting that each increase in physician turnover during a surgical case decreased the likelihood of effective teamwork by 73%. This highlights the need for consistent team composition and adequate staffing to support efficient collaboration and patient safety.

Training and competency development were highlighted as essential for sustaining high-quality perioperative practice. Several studies emphasized the need for continuous education, especially in the use of safety checklists, advanced technologies, and interprofessional simulation training. The results suggest that regular competency updates strengthen the

ability of perioperative teams to respond to evolving surgical demands and complex equipment.

Another important finding was the under-recognition of anesthesia technicians and operating room technicians despite their crucial technical responsibilities. Almutairi et al. (2024) noted that lack of recognition may contribute to reduced motivation and willingness to engage in safety initiatives. Enhancing professional recognition may foster stronger commitment to safety practices and improve team morale.

The review also found that safety checklists remain a cornerstone of perioperative safety, but their inconsistent implementation reduces effectiveness. Both Arad et al. (2022) and Sillero Sillero and Bull (2021) indicated that adherence to the WHO Surgical Safety Checklist improved communication, clarified roles, and reduced preventable errors. However, improper use—often due to time pressure or poor team engagement—limited its full benefit, highlighting the need for better integration of checklists into the OR culture.

Environmental and workflow disruptions were also reported to impact patient safety. High traffic, noise, and interruptions were associated with reduced communication effectiveness, delayed responses, and increased cognitive overload among team members. Findings from Kabo et al. (2023) supported the need for environmental controls, such as restricted access and improved spatial design, to support team efficiency and safety.

Overall, the integration of human factors, system design, and interprofessional collaboration was shown to critically shape perioperative safety outcomes. The reviewed studies collectively demonstrated that safety is not dependent on a single role or intervention but emerges from the coordinated efforts of all perioperative team members. The findings reinforce that team reliability, communication, and organizational culture underpin the success of all technical and clinical interventions performed during surgery.

This systematic review also highlighted opportunities for improvement that span all professional groups. Enhanced teamwork training, structured communication systems, adequate staffing, and greater recognition of technician roles were among the most effective strategies identified. Adopting these strategies may reduce errors, improve workflow efficiency, and strengthen the safety culture across surgical environments.

Conclusion

In conclusion, the findings of this systematic review indicate that nursing teams, anesthesia providers, and operating room technicians each play vital and complementary roles in enhancing patient safety during surgical procedures. Their effectiveness depends on clear communication, psychological safety, adequate staffing, and strong interprofessional collaboration. The reviewed studies consistently emphasized that patient safety is a collective responsibility shaped by human performance, organizational culture, and systems design. Strengthening teamwork, improving training, and ensuring supportive working environments are essential for achieving safer surgical care and minimizing preventable harm.

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