



## **Impact of Operating Room and Anesthesia Technicians' Coordination on Surgical Team Performance and Operating Room Efficiency**

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**Abstract:**

The coordination between Operating Room Technicians (ORTs) and Anesthesia Technicians (ATs) serves as a critical linchpin for the entire surgical ecosystem, directly determining both the safety climate and operational throughput of the operating room. Their specialized, interdependent roles—the ORT managing the sterile surgical process and the AT ensuring physiological stability—create a vital interface where seamless collaboration enhances team communication, builds shared situational awareness, and establishes robust error-trapping mechanisms. This synergy translates into tangible gains in efficiency by optimizing preoperative setups, minimizing intraoperative delays, and accelerating turnover times, thereby maximizing the use of costly OR resources. Ultimately, investing in and strengthening this specific technical partnership is not merely an operational concern but a foundational strategy for building high-reliability surgical teams capable of delivering superior patient outcomes consistently.

**1. Introduction**

The modern operating room (OR) represents one of the most complex and high-stakes environments in healthcare. It is a dynamic ecosystem where advanced technology, precise protocols, and human expertise converge to achieve a singular goal: positive patient outcomes. While surgeons and anesthesiologists are often the most visible figures in this theatre, the smooth and efficient functioning of the OR is fundamentally dependent on a broader, highly skilled team. Within this cadre, Operating Room Technicians (ORTs), also known as Surgical Technologists or Scrub Nurses, and Anesthesia Technicians (ATs) form the essential backbone of procedural support. Their specialized, yet interdependent, roles are critical in transforming the OR from a mere physical space into a functional unit capable of safe and effective surgery.

The pursuit of efficiency in the OR is driven by relentless pressures to increase surgical volume, reduce costs, and optimize the use of scarce and expensive resources, including OR time and personnel [1]. Inefficiency manifests as case delays, prolonged turnover times, procedural interruptions, and increased overtime, all of which carry significant financial and clinical implications. Simultaneously, the demand for impeccable team performance, characterized by flawless communication, situational awareness, and mutual support, is underscored by the imperative to minimize preventable adverse events. The landscape of surgery is perpetually evolving with the introduction of sophisticated technologies such as robotics, advanced imaging, and complex anesthesia delivery systems. This technological progression, while beneficial, adds layers of complexity to the OR environment, placing greater demands on the technical and coordination skills of all team members, particularly support staff [2].

Operating Room Technicians are the custodians of the sterile field and the surgical process. Their responsibilities span from preoperative

preparation—ensuring all instruments, supplies, and equipment are available and functional—to intraoperative anticipation of the surgeon’s needs, and finally to postoperative accounting of instruments and specimens. Their role requires an in-depth understanding of surgical procedures, anatomy, and aseptic technique. Conversely, Anesthesia Technicians are the dedicated assistants to the anesthesia care team. Their domain encompasses the preparation, calibration, and maintenance of anesthesia machines, ventilators, monitors, and a vast array of pharmacological agents and airway equipment. They are experts in the technical setup that ensures the patient’s physiological stability is monitored and supported from induction through emergence [3]. The distinct nature of these roles creates a natural interface—a “seam”—in the OR where activities and responsibilities intersect. It is at this seam that coordination becomes vital.

Traditionally, the focus of OR research and management has been on the surgeon-anesthesiologist dyad or on nursing leadership. The specific collaboration between ORTs and ATs has received less scholarly attention, often being relegated to an assumed component of general teamwork. However, this specific coordination is a unique nexus of sterile and non-sterile domains, of surgical progression and physiological maintenance. A failure in this interface can have cascading effects. For instance, an AT troubleshooting a monitor may need to breach the periphery of the sterile field, requiring clear communication with the ORT to maintain asepsis. An ORT’s request for a specific positioning device may have implications for anesthesia circuit management and vascular access, necessitating early consultation with the AT [4]. These micro-interactions, repeated dozens of times during a single procedure, collectively define the rhythm and safety of the operation.

Theoretical frameworks from high-reliability organizations (HROs) and crew resource

management (CRM), adopted from aviation and other complex industries, emphasize that optimal performance in risky environments is less about individual heroism and more about collective mindfulness, flattened hierarchies, and resilient communication systems [5]. The OR is a quintessential HRO. Applying these principles, the coordination between ORTs and ATs can be viewed as a critical sub-system within the larger OR team. Their ability to share mental models—a common understanding of the procedure's phases, potential pitfalls, and each other's tasks—allows for predictive behavior and proactive support, rather than reactive problem-solving [6]. This shared cognition reduces cognitive load on the entire team, allowing surgeons and anesthesiologists to focus on their most critical decision-making.

Furthermore, the economic argument for investing in this coordination is compelling. OR time is among the most costly resources in a hospital. Delays in anesthesia readiness or surgical instrument availability, often stemming from poor preparation or miscommunication between support technicians, can result in significant idle time for the entire expensive team and facility [7]. Efficient turnover between cases, a process heavily reliant on the parallel workflow of ORTs breaking down one set and preparing for the next, and ATs cleaning anesthesia equipment and restocking drugs, is a direct contributor to daily OR throughput. Studies have shown that structured protocols and enhanced teamwork can reduce non-operative time substantially, freeing up capacity for additional procedures [8].

## 2. OR Technicians and Anesthesia Technicians

The Operating Room Technician is the surgical proceduralist's primary technical partner. Their role begins in the preoperative phase with meticulous planning. They review the surgical schedule and procedure specifics to create a comprehensive "pick list" of instruments, implants, sutures, and disposable supplies. This requires not only knowledge of standard sets but also anticipation of potential variations or complications based on the patient's pathology or the surgeon's preferences. Setting up the sterile back table and Mayo stand is a ritual of precision and organization, ensuring that hundreds of instruments are arranged logically for sequential use during the operation [9]. During surgery, the ORT functions with heightened situational awareness, passing instruments in a manner that is both efficient and respectful of the surgical field (e.g., avoiding sudden movements that could cause tissue trauma). They are responsible for maintaining the integrity of the

sterile field, managing specimens, and accounting for all sponges, needles, and instruments—a critical patient safety function. In complex cases involving robotics or advanced energy devices, the ORT often serves as the operator of that technology at the sterile field, coordinating its use with the surgeon's actions [10].

The Anesthesia Technician operates in the distinct but adjacent domain of physiological support and monitoring. Their core responsibility is to ensure the anesthesia work environment is fully prepared and failsafe. This involves a detailed pre-use check of the anesthesia machine, verifying the integrity of the breathing circuit, the availability of oxygen and anesthetic gases, and the functionality of the ventilator and suction apparatus [11]. They prepare and organize a vast array of drugs, including induction agents, analgesics, paralytics, vasoactive medications, and emergency drugs, often employing strict labeling systems to prevent errors. Airway management equipment—laryngoscopes, endotracheal tubes, stylets, and rescue devices like laryngeal mask airways—must be checked and available in multiple sizes. Intraoperatively, the AT acts as an extension of the anesthesia provider, assisting with tasks such as securing intravenous lines, obtaining blood samples, setting up transfusion or warming equipment, and troubleshooting monitor issues. During critical events like massive hemorrhage or cardiac arrest, the AT's role becomes paramount in rapidly providing specialized equipment and drugs, effectively serving as a force multiplier for the anesthesiologist [12]. The interdependence of these roles is manifest at numerous points. Patient positioning, orchestrated by the ORT and surgical team, must be coordinated with the AT to ensure anesthesia tubing, vascular access lines, and monitoring cables are not dislodged and remain accessible [13]. The introduction of intraoperative imaging (e.g., C-arm fluoroscopy) requires the ORT to manage the sterile draping and the AT to oversee the repositioning of anesthesia equipment and protection of the patient from radiation. The administration of certain drugs by anesthesia may have surgical implications (e.g., timing of antibiotic re-dosing, use of dyes), requiring clear verbal alerts. Most tangibly, the physical space itself is a shared resource; the AT's need to access the anesthesia machine or drug cart must be balanced with the ORT's need to maintain a spacious and organized sterile field. Effective coordination ensures these interfaces are managed seamlessly, preventing conflicts, contamination, or delays.

## 3. Coordination in High-Reliability Surgical Teams

The operating room is a canonical example of a High-Reliability Organization (HRO)—an institution that operates consistently under trying conditions and achieves a level of safety and failure avoidance that is exemplary despite inherent risks [5]. HRO theory provides a valuable lens through which to examine ORT-AT coordination. HROs cultivate a preoccupation with failure, reluctance to simplify interpretations, sensitivity to operations, commitment to resilience, and deference to expertise [14]. The coordination between technicians directly embodies several of these principles.

Sensitivity to operations, or maintaining awareness of the real-time state of the system, is crucial. The ORT and AT, positioned at the heart of the procedural and physiological workflows respectively, are vital sensors for the team. The ORT might notice subtle changes in surgical progress that could signal impending blood loss, prompting a quiet alert to the anesthesia team. The AT, observing a gradual drop in blood pressure, might inform the ORT that a rapid instrument change or a specific hemostatic agent may soon be required. This cross-monitoring creates a resilient system where potential problems are detected early through multiple lenses [15].

Furthermore, HROs flatten hierarchies when situational expertise trumps formal authority. While a clear chain of command exists, a proficient ORT or AT is expected to speak up if they identify a safety concern, such as a break in sterile technique or a potential equipment malfunction, regardless of the seniority of the person involved. This psychological safety is a cornerstone of effective coordination. If an AT hesitates to inform a surgeon that they are too close to non-sterile anesthesia equipment, or if an ORT does not question an unclear medication label being passed to the field, the system becomes brittle [16].

Crew Resource Management (CRM), a set of training procedures developed in aviation to reduce human error, has been successfully adapted to medicine. CRM emphasizes skills like leadership, assertiveness, decision-making, and communication [17]. Key CRM tools are directly applicable to ORT-AT coordination. For instance, the use of closed-loop communication—where a message is sent, received, and confirmed back—is vital during critical moments like surgical counts or the administration of a high-risk drug. Shared mental models, another CRM concept, refer to team members having a common understanding of the plan, their roles, and the current situation. When ORTs and ATs participate in preoperative briefings, they develop a shared mental model of the case, allowing them to anticipate each other's needs and

work in synchrony rather than in mere parallel [18]. This theoretical grounding illustrates that their coordination is not just a practical necessity but a manifestation of the core principles that enable complex teams to succeed safely.

#### 4. Impact on Surgical Team Performance

The quality of coordination between ORTs and ATs profoundly influences the performance of the entire surgical team. This impact can be assessed through several key dimensions: communication efficacy, shared situational awareness, error prevention and mitigation, and overall team morale and climate.

#### 5. Enhanced Communication and Information Flow

Communication in the OR is the lifeblood of safety. The ORT-AT interface is a major conduit for this flow. Effective coordination establishes clear, standardized channels for information exchange. For example, during a long case, the AT might inform the ORT of the plan to administer a reversal agent for muscle relaxation in 30 minutes, allowing the ORT to anticipate closure and prepare accordingly. Conversely, the ORT informing the AT that the surgeon is about to remove a large tumor adherent to a major vessel enables the anesthesia team to prepare for potential rapid blood loss. This proactive communication prevents surprises and allows for smooth, prepared transitions between surgical phases. Studies of surgical safety checklists have shown that involving all team members, including technicians, in time-outs and sign-outs improves information sharing and reduces communication failures [19]. When ORTs and ATs actively participate, they contribute unique information—about equipment status, specific supply availability, or observations from their unique vantage points—that enriches the team's collective understanding.

#### 6. Cultivation of Shared Situational Awareness

Situational awareness (SA) is the perception of environmental elements, comprehension of their meaning, and projection of their status in the near future. In the OR, SA is distributed across the team. The ORT maintains a high-fidelity SA of the surgical field and instrument needs, while the AT maintains SA of the patient's physiological parameters and anesthesia equipment status. Their coordination acts as a force-multiplier for the team's overall SA. By sharing their unique perspectives, they create a more complete and accurate picture of the operative environment. A

lapse in one domain can be caught by the other. For instance, if an ORT is deeply focused on a complex anastomosis, they may not notice a kinked intravenous line. The AT, whose SA includes the IV drip chamber and monitor waveforms, can identify and rectify the issue. This cross-checking is a form of cognitive redundancy that makes the system more robust against individual error or fixation [20]. Their mutual updates (“Blood loss is picking up,” “Patient’s pressure is trending down with traction”) keep the entire team aligned on the dynamic state of the procedure.

## 7. Error Prevention, Trapping, and Mitigation

The OR is a error-prone environment due to complexity, time pressure, and fatigue. Coordination between ORTs and ATs creates multiple barriers to error. In the preparation phase, they perform independent but overlapping checks. The AT’s machine checkout verifies the integrity of the gas delivery system, while the ORT’s preparation includes ensuring suction is working—a shared resource. This redundancy catches failures that a single check might miss. During the procedure, they serve as real-time auditors for one another. An AT may notice an incorrect sponge count being announced and question it before the incision is closed. An ORT may see a medication vial being drawn up that doesn’t match the typical sequence for the current surgical stage and ask for verification [21]. This culture of mutual vigilance, rooted in respect for each other’s expertise, is a powerful error-trapping mechanism. When errors do occur, their coordinated response is critical for mitigation. In the event of a massive hemorrhage, the ORT’s rapid procurement of vascular clamps and hemostatic agents works in tandem with the AT’s swift preparation of blood products and rapid infusion devices. This synchronized response can be the difference between a controlled crisis and a catastrophic outcome.

## 8. Fostering Team Morale and a Culture of Safety

The relational dynamic between ORTs and ATs significantly influences the overall team climate. When they work together with mutual respect, efficiency, and quiet competence, it sets a positive, collaborative tone for the entire room. This professional rapport reduces interpersonal friction and cognitive load for surgeons and anesthesiologists, who can trust that the support system is functioning smoothly. Conversely, tension, miscommunication, or disrespect between technicians creates a toxic undercurrent of stress

that can impair everyone’s performance [22]. A team where the ORT and AT seamlessly assist each other—the AT helping to reposition a light when the ORT’s hands are full, the ORT reminding the AT of an upcoming need for a specific drug—models the kind of situational teamwork that defines high-performing units. This fosters psychological safety, where all members feel empowered to speak up about concerns, knowing they will be heard respectfully by their colleagues across disciplinary lines. This culture is foundational for continuous learning and improvement, moving beyond blame to systemic problem-solving [23].

## 9. Impact on Operating Room Efficiency

Beyond team performance, the practical, operational efficiency of the OR suite is heavily dependent on the synchronized work of ORTs and ATs. Efficiency metrics, which are closely monitored by hospital administration, are directly influenced by their coordination in the preoperative, intraoperative, and postoperative phases.

## 10. Optimizing Preoperative Preparation and On-Time Starts

Delays in first-case starts are a major source of OR inefficiency, causing cascading disruptions throughout the day’s schedule. A significant proportion of these delays are attributed to inadequate preoperative preparation [24]. The parallel preparatory work of the ORT and AT is critical. The ORT must open sterile supplies, set up tables, and ensure all necessary instruments are present and functional. The AT must complete the anesthesia machine check, prepare drugs, and set up monitoring lines and airway equipment. If either technician is delayed, lacks necessary supplies, or encounters malfunctioning equipment, the entire case is delayed. Effective coordination means they communicate about the patient’s arrival, any special requirements, and potential problems. For instance, if the AT discovers a faulty ventilator during the check, informing the ORT immediately allows both to adjust their workflow—the AT to find a replacement machine, the ORT to potentially delay opening expensive sterile items until the issue is resolved—minimizing wasted time and resources. Their joint readiness is the prerequisite for the patient’s timely entry into the room.

## 11. Streamlining Intraoperative Workflow and Minimizing Case Duration

During surgery, non-value-added time—periods

where no productive surgical or anesthetic activity occurs—erodes efficiency. Poor coordination between ORTs and ATs is a primary generator of such downtime. Examples include waiting for a specialized instrument that wasn't communicated in advance, pausing for anesthesia to troubleshoot a monitor, or halting for patient repositioning that was not coordinated with line and tube management. Seamless coordination eliminates these hiccups. The AT anticipating the need for a blood warmer and having it ready before major blood loss begins prevents a frantic search later. The ORT preparing the next phase of instruments before the surgeon asks for them maintains surgical momentum. This anticipatory, coordinated support keeps the procedure flowing at its optimal pace. Research indicates that teams with higher levels of coordination and implicit coordination (unspoken understanding) experience shorter operative times for similar procedures, as fewer interruptions and delays accumulate [25].

## 12. Accelerating Turnover Time Between Cases

Turnover time (the interval between one patient leaving the OR and the next entering) is a key determinant of daily OR throughput. This interval is a symphony of parallel processing where ORTs and ATs are the principal actors. The ORT is responsible for clearing the sterile field, disposing of sharps and biohazard waste, and cleaning and restocking the room for the next case. The AT is responsible for cleaning the anesthesia machine, discarding used drugs, restocking the anesthesia cart, and preparing for the next patient. If these processes are uncoordinated, they create bottlenecks. For example, if the AT is still cleaning equipment in the middle of the room, it impedes the environmental services staff or the ORT from cleaning surfaces. Structured, coordinated turnover protocols, where tasks are sequenced and spaces are shared efficiently, can dramatically reduce turnover times [26]. Some institutions employ parallel processing rooms or “anesthesia workstations” where the AT can prepare the next machine outside the main OR, eliminating congestion. Effective communication about the specifics of the upcoming case (e.g., “Next case is a laparoscopic cholecystectomy, no special needs”) allows both technicians to tailor their setup for speed.

## 13. Improving Resource Utilization and Cost-Effectiveness

Efficient coordination leads to more judicious use of expensive resources. When ORTs and ATs communicate effectively about case progression,

they can avoid opening redundant or unnecessary disposable supplies, reducing waste [27]. Accurate anticipation of case needs minimizes the frequency of “stat” requests to central supply or the pharmacy, which are costly and disruptive. Furthermore, by preventing delays and reducing overtime, efficient coordination directly saves on labor costs, which constitute the largest portion of OR expenditure. The ability to complete more cases within allocated OR block time improves the utilization of the OR suite itself, a fixed and extremely expensive asset. From a managerial perspective, the return on investment from training and fostering this coordination is significant, as it enhances the productivity of the entire surgical enterprise [28].

## 14. Barriers and Challenges to Effective Coordination

Despite its clear benefits, achieving optimal ORT-AT coordination is often hampered by systemic, cultural, and educational barriers. Recognizing these challenges is the first step toward addressing them.

The traditional OR hierarchy, with surgeons at the apex, can inadvertently suppress the voices and contributions of support staff. This hierarchy can also create vertical “silos” where communication flows up and down within professional groups (nursing, anesthesia, surgery) but not horizontally across them [29]. An ORT may report to nursing leadership, while an AT reports to the anesthesia department. This separate reporting can lead to conflicting priorities, different training cultures, and a lack of shared accountability for overall team performance. In such environments, technicians may be reluctant to cross perceived professional boundaries to assist or correct each other, fearing overstep or reprimand from their own supervisors.

## 15. Variability in Education, Training, and Scope of Practice

The educational pathways and certification requirements for ORTs and ATs can vary significantly by region and institution. This variability leads to differences in foundational knowledge, understanding of each other's roles, and even terminology [30]. An AT trained in one hospital may have a vastly different scope of practice (e.g., whether they can draw up medications, assist with arterial lines) than an AT in another. This lack of standardization can create uncertainty and friction during coordination. Furthermore, interdisciplinary training is rare; ORTs and ATs are typically educated in separate programs with little to no formal curriculum on

how to work together effectively in the dynamic OR environment. Chronic understaffing and high workload are pervasive issues in healthcare. When technicians are stretched thin, covering multiple rooms or rushing between tasks, the cognitive bandwidth for proactive coordination diminishes. Fatigue impairs communication, situational awareness, and the willingness to engage in collaborative problem-solving [31]. In crisis situations, a shortage of personnel means the ORT and AT may be unable to provide each other with the mutual support that defines effective coordination, as each is overwhelmed with their own critical tasks. While the surgical safety checklist has standardized some communication, the myriad of micro-interactions between ORTs and ATs often lack protocol. The method for handing off a non-sterile item to the field, the process for alerting about a pending anesthesia event, or the system for coordinating room cleanup may be based on local, unwritten norms that vary between teams and individuals. This inconsistency breeds errors and inefficiency. The absence of shared, rehearsed communication tools like SBAR (Situation, Background, Assessment, Recommendation) for technician-level interactions is a missed opportunity [32].

## 16. Technological and Physical Environment Constraints

The OR's physical layout can either facilitate or hinder coordination. Poorly designed workspaces where the anesthesia zone encroaches on the sterile field or where supply carts block pathways create physical barriers to interaction. Likewise, incompatible or poorly integrated technology—such as anesthesia monitors that cannot be easily seen by the surgical team or separate, non-communicating inventory systems for surgical and anesthesia supplies—forces technicians to rely on verbal updates for information that should be readily visible, increasing cognitive load and the risk of miscommunication [33].

Overcoming these barriers requires deliberate, multi-faceted interventions aimed at cultural change, education, process redesign, and leadership support. Evidence from quality improvement initiatives points to several effective strategies. Moving beyond profession-specific training, high-fidelity simulation that includes ORTs, ATs, surgeons, and anesthesiologists is one of the most powerful tools for improvement. Simulation scenarios can be designed to force coordination at the technician interface, such as managing a sudden cardiac arrest, a massive hemorrhage, or a fire in

the OR [34]. Debriefing these simulations focuses not on clinical knowledge, but on communication, role clarity, and mutual support. This shared experience builds trust, familiarizes each professional with the other's challenges and language, and reinforces CRM principles in a safe, low-stakes environment. Regular, mandatory interdisciplinary training sessions signal institutional commitment to teamwork.

## 17. Implementation of Structured Communication Tools

Adopting and rigorously using standardized communication frameworks for all interactions can reduce ambiguity. This includes enforcing closed-loop communication during critical steps, utilizing read-backs for medication and blood product verification, and employing structured handoff tools (like I-PASS) during staff shift changes or patient transfers [35]. Briefings and debriefings should be explicitly designed to solicit input from ORTs and ATs. A preoperative huddle should include questions directed at them: "ORT, are there any special instruments or implants we need to be aware of?" "AT, are there any anesthesia equipment or drug concerns for this case?" [36]. This formalizes their role as essential sources of information.

Some progressive institutions are breaking down silos by creating blended "perioperative technician" roles or teams where staff cross-train in both sterile processing/anesthesia support functions, providing maximum flexibility [37]. A less radical but effective approach is the adoption of shared leadership models for specific processes, like turnover. Designating an ORT and an AT as co-leads for turnover in a given room, with joint accountability for the time and quality of the process, fosters direct collaboration and problem-solving between them. Creating physically co-located workstations for preoperative planning can also facilitate informal communication and relationship-building.

## 18. Standardization of Processes and Workspace Design

Applying Lean and other quality improvement methodologies to OR processes can identify and eliminate waste in the coordination between technicians. Standardizing setup trays, creating clearly marked zones in the OR (sterile, anesthesia, circulation), and implementing visual management systems (e.g., kanban boards for supply status) reduce variability and the need for verbal clarification [38]. Involving ORTs and ATs in the

design of new OR suites or the redesign of workflows ensures the physical environment supports, rather than hinders, their coordinated work.

### 19. Fostering a Culture of Psychological Safety and Mutual Respect

Ultimately, all tools and protocols are ineffective without the right culture. Leadership must actively cultivate an environment where every team member's input is valued. This involves leaders—surgeons, anesthesiologists, nurse managers—explicitly modeling respectful communication, thanking technicians for their vigilance, and publicly reinforcing instances of excellent coordination [39]. Recognizing and rewarding teams, not just individuals, for efficiency and safety achievements reinforces the value of collaboration. Addressing disruptive behavior and hierarchies that silence support staff is non-negotiable for creating psychological safety [40].

### 20. Conclusion

The operating room is a crucible where technical skill, advanced technology, and human collaboration are tested under pressure. Within this environment, the coordination between the Operating Room Technician and the Anesthesia Technician emerges not as a minor operational detail, but as a fundamental driver of system performance.

Effective ORT-AT coordination enhances team performance by creating robust channels of communication, cultivating a rich, shared situational awareness, establishing redundant barriers against error, and fostering a climate of psychological safety and mutual respect. This creates a resilient team capable of adapting to both routine procedures and unforeseen crises. Simultaneously, this coordination is a powerful engine for efficiency. It optimizes preoperative preparation to secure on-time starts, streamlines intraoperative workflow to minimize non-productive time, accelerates turnover between cases to maximize throughput, and promotes the cost-effective use of materials and personnel.

The barriers to this ideal state are significant, rooted in traditional hierarchies, educational silos, resource constraints, and a lack of standardized processes. However, these challenges are not insurmountable. Evidence-based strategies, including interdisciplinary simulation training, the implementation of structured communication protocols, process standardization, workspace redesign, and most importantly, the deliberate

cultivation of a culture that values every team member's contribution, provide a clear pathway forward.

Investing in the coordination between ORTs and ATs is an investment in the core functioning of the surgical suite. It is a recognition that in the modern, high-stakes OR, excellence is a team sport. The surgeon's skill and the anesthesiologist's judgment are amplified and safeguarded by the seamless, anticipatory support of a technically proficient and harmoniously coordinated support team. By strengthening this specific partnership, healthcare institutions can build more reliable, efficient, and safe operating rooms, ultimately fulfilling the paramount goal of achieving the best possible outcomes for every patient who passes through their doors.

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### References

- [1] Macki M, Fakhri M, Kandagatla P, et al. The Impact of Different Postgraduate Year Training in Neurosurgery Residency on 30-Day Return to Operating Room: A National Surgical Quality Improvement Program Study. *World Neurosurgery*. 2018;114:e70–e76. doi: 10.1016/j.wneu.2018.02.068.
- [2] Bath MF, Awopetu AI, Stather PW, et al. The Impact of Operating Surgeon Experience, Supervised Trainee vs. Trained Surgeon, in Vascular Surgery Procedures: A Systematic Review and Meta-Analysis. *Eur J Vasc Endovasc Surg*. 2019;58:292–298. doi: 10.1016/j.ejvs.2019.03.029.
- [3] Nasri B, Saxe J. Impact of Residents on Safety Outcomes in Laparoscopic Cholecystectomy.

- World J Surg. 2019;43:3013–3018. doi: 10.1007/s00268-019-05141-5.
- [4] Lear R, Godfrey AD, Riga C, et al. The Impact of System Factors on Quality and Safety in Arterial Surgery: A Systematic Review. *Eur J Vasc Endovasc Surg.* 2017;54:79–93. doi: 10.1016/j.ejvs.2017.03.014.
- [5] Cooper WO, Spain DA, Guillaumondegui O, et al. Association of Coworker Reports About Unprofessional Behavior by Surgeons With Surgical Complications in Their Patients. *JAMA Surg.* 2019;154:828–834. doi: 10.1001/jamasurg.2019.1738.
- [6] Tricco AC, Lillie E, Zarin W, et al. PRISMA Extension for Scoping Reviews (PRISMA-ScR): Checklist and Explanation. *Ann Intern Med.* 2018;169:467–473. doi: 10.7326/M18-0850.
- [7] Xu R, Carty MJ, Orgill DP, et al. The teaming curve: a longitudinal study of the influence of surgical team familiarity on operative time. *Ann Surg.* 2013;258:953–957. doi: 10.1097/SLA.0b013e3182864ffe.
- [8] Kazaure HS, Roman SA, Sosa JA. The resident as surgeon: an analysis of ACS-NSQIP. *J Surg Res.* 2012;178:126–132. doi: 10.1016/j.jss.2011.12.033.
- [9] Levac D, Colquhoun H, O’Brien KK. Scoping studies: advancing the methodology. *Implement Sci.* 2010;5:69. doi: 10.1186/1748-5908-5-69.
- [10] Vincent C, Moorthy K, Sarker SK, et al. Systems approaches to surgical quality and safety: from concept to measurement. *Ann Surg.* 2004;239:475–482. doi: 10.1097/01.sla.0000118753.22830.41.
- [11] Carter JM, Riley C, Ananth A, et al. Improving outcomes in a high-output pediatric otolaryngology practice. *Int J Pediatr Otorhinolaryngol.* 2014;78:2229–2233. doi: 10.1016/j.ijporl.2014.10.018.
- [12] Kurmann A, Keller S, Tschan-Semmer F, et al. Impact of team familiarity in the operating room on surgical complications. *World J Surg.* 2014;38:3047–3052. doi: 10.1007/s00268-014-2680-2.
- [13] Moris DN, Linos D. Music meets surgery: two sides to the art of “healing”. *Surg Endosc.* 2013;27:719–723. doi: 10.1007/s00464-012-2525-8.
- [14] Maruthappu M, Duclos A, Zhou CD, et al. The impact of team familiarity and surgical experience on operative efficiency: a retrospective analysis. *J R Soc Med.* 2016;109:147–153. doi: 10.1177/0141076816634317.
- [15] Wu J-M, Yen H-H, Ho T-W, et al. The effect of performing two pancreatoduodenectomies by a single surgical team in one day on surgeons and patient outcomes. *HPB (Oxford)* 2020;22:1185–1190. doi: 10.1016/j.hpb.2019.11.004.
- [16] Gillespie BM, Gillespie J, Boorman RJ, et al. The Impact of Robotic-Assisted Surgery on Team Performance: A Systematic Mixed Studies Review. *Hum Factors.* 2020;18720820928624.
- [17] Sacks GD, Shannon EM, Dawes AJ, et al. Teamwork, communication and safety climate: a systematic review of interventions to improve surgical culture. *BMJ Qual Saf.* 2015;24:458–467. doi: 10.1136/bmjqs-2014-003764.
- [18] Yamaguchi JT, Garcia RM, Cloney MB, et al. Impact of resident participation on outcomes following lumbar fusion: An analysis of 5655 patients from the ACS-NSQIP database. *J Clin Neurosci.* 2018;56:131–136. doi: 10.1016/j.jocn.2018.06.030.
- [19] Healey AN, Olsen S, Davis R, et al. A method for measuring work interference in surgical teams. *Cogn Tech Work.* 2008;10:305–312.
- [20] Ebadi A, Tighe PJ, Zhang L, et al. DisTeam: A decision support tool for surgical team selection. *Artif Intell Med.* 2017;76:16–26. doi: 10.1016/j.artmed.2017.02.002.
- [21] Nyanchoka L, Tudur-Smith C, Thu VN, et al. A scoping review describes methods used to identify, prioritize and display gaps in health research. *J Clin Epidemiol.* 2019;109:99–110. doi: 10.1016/j.jclinepi.2019.01.005.
- [22] Nurok M, Sundt TM, Frankel A. Teamwork and communication in the operating room: relationship to discrete outcomes and research challenges. *Anesthesiol Clin.* 2011;29:1–11. doi: 10.1016/j.anclin.2010.11.012.
- [23] Vashdi DR, Bamberger PA, Erez M. Can Surgical Teams Ever Learn? The Role of Coordination, Complexity, and Transitivity in Action Team Learning. *AMJ.* 2013;56:945–971. doi: 10.5465/amj.2010.0501.
- [24] Bougie O, Zuckerman SL, Switzer N, et al. Influence of Resident Involvement in Obstetrics and Gynaecology Surgery on Surgical Outcomes: Systematic Review and Meta-Analysis. *J Obstet Gynaecol Can.* 2018;40:1170–1177. doi: 10.1016/j.jogc.2017.10.035.
- [25] Elbardissi AW, Duclos A, Rawn JD, et al. Cumulative team experience matters more than individual surgeon experience in cardiac surgery. *J Thorac Cardiovasc Surg.* 2013;145:328–333. doi: 10.1016/j.jtcvs.2012.09.022.
- [26] Engelmann CR, Neis JP, Kirschbaum C, et al. A noise-reduction program in a pediatric operation theatre is associated with surgeon’s benefits and a reduced rate of complications: a prospective controlled clinical trial. *Ann Surg.* 2014;259:1025–1033. doi: 10.1097/SLA.0000000000000253.
- [27] El Boghdady M, Ewalds-Kvist BM. The influence of music on the surgical task performance: A systematic review. *Int J Surg.* 2020;73:101–112. doi: 10.1016/j.ijss.2019.11.012.
- [28] Zheng B, Panton ONM, Al-Tayeb TA. Operative length independently affected by surgical team size: data from 2 Canadian hospitals. *Can J Surg.* 2012;55:371–376. doi: 10.1503/cjs.011311.
- [29] Arksey H, O’Malley L. Scoping studies: towards a methodological framework. *Int J Soc Res Methodol.* 2005;8:19–32. doi: 10.1080/1364557032000119616.
- [30] Sevdalis N, Undre S, McDermott J, et al. Impact of intraoperative distractions on patient safety: a prospective descriptive study using validated

- instruments. *World J Surg.* 2014;38:751–758. doi: 10.1007/s00268-013-2315-z.
- [31] Panagiotti M, Khan K, Keers RN, et al. Prevalence, severity, and nature of preventable patient harm across medical care settings: systematic review and meta-analysis. *BMJ.* 2019;366:l4185. doi: 10.1136/bmj.l4185.
- [32] Gross CE, Chang D, Adams SB, et al. Surgical resident involvement in foot and ankle surgery. *Foot Ankle Surg.* 2017;23:261–267. doi: 10.1016/j.fas.2016.08.001.
- [33] Stepaniak PS, Heij C, Buise MP, et al. Bariatric surgery with operating room teams that stayed fixed during the day: a multicenter study analyzing the effects on patient outcomes, teamwork and safety climate, and procedure duration. *Anesth Analg.* 2012;115:1384–1392. doi: 10.1213/ANE.0b013e31826c7fa6.
- [34] Koch A, Burns J, Catchpole K, et al. Associations of workflow disruptions in the operating room with surgical outcomes: a systematic review and narrative synthesis. *BMJ Qual Saf.* 2020;29:1033–1045. doi: 10.1136/bmjqs-2019-010639.
- [35] Etherington N, Larrigan S, Liu H, et al. Measuring the teamwork performance of operating room teams: a systematic review of assessment tools and their measurement properties. *J Interprof Care.* 2021;35(1):37–4.
- [36] Murji A, Luketic L, Sobel ML, et al. Evaluating the effect of distractions in the operating room on clinical decision-making and patient safety. *Surg Endosc.* 2016;30:4499–4504. doi: 10.1007/s00464-016-4782-4.
- [37] Wu WW, Medin C, Bucknor A, et al. Evaluating the Impact of Resident Participation and the July Effect on Outcomes in Autologous Breast Reconstruction. *Ann Plast Surg.* 2018;81:156–162. doi: 10.1097/SAP.0000000000001518.
- [38] Gjeraa K, Spanager L, Konge L, et al. Non-technical skills in minimally invasive surgery teams: a systematic review. *Surg Endosc.* 2016;30:5185–5199. doi: 10.1007/s00464-016-4890-1.
- [39] Schrand KV, Hussain LR, Dunki-Jacobs EM, et al. Outcomes associated with resident involvement in ventral hernia repair: A population based study using the NSQIP database. *Am J Surg.* 2018;216:923–925. doi: 10.1016/j.amjsurg.2018.03.014.
- [40] Salm L, Chapalley D, Perrodin SF, et al. Impact of changing the surgical team for wound closure on surgical site infection: A matched case-control study. *PLoS ONE.* 2020;15:e0241712. doi: 10.1371/journal.pone.0241712.