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Impact of Integrated Operating Room Technologies on Surgical Team Communication & Workflow

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ABSTRACT

Integrated operating room systems aim to improve patient care and teamwork while making surgery safer, more successful, and more efficient. Assure effective communication among the members of the surgical team. Provide up-to-date information to support accurate surgical decision-making. To examine the impact of integrating operating room technologies on surgical team communication and investigate and implementation the impact of integration of OR technologies between communication and workflow. This study employs a cross-sectional observational design to assess this design is suitable for describing the impact of integrating operating room technologies on surgical team communication and workflow current state of communication and behaviors within the target population and identifying associations between integrating operating room technologies and surgical team communication and between integrating operating room technologies and workflow. Demographics: Mostly female (62%) and young (97% aged 18-25). Designation: Majority OT Technologists (51.7%), fewer surgeons (9.1%) & anesthetics (20.2%). Reliability: Cronbach's Alpha = 0.909 (high consistency). Integration & Communication: Strong positive relationship ($r = 0.772$). Integration & Workflow: Very strong correlation ($r = 0.807$). Communication & Workflow: Strongest link ($r = 0.819$). Nonparametric results confirm reliability. The study highlights a predominantly young and female workforce, with OT Technologists playing a central role. Strong correlations confirm that integration significantly improves communication and workflow efficiency. The high reliability score ($\alpha = 0.909$) ensures confidence in further analysis. Findings suggest a need for better integration strategies to enhance surgical environments and professional collaboration.

INTRODUCTION

Integrated operating room technologies are transforming modern surgical environments, making them more efficient, streamlined, and conducive to collaboration. These technologies combine medical imaging, data management, and communication systems to create a centralized platform within the operating room. By integrating video systems, surgical displays, voice command capabilities, and real-time data analytics, these tools enable surgical teams to operate with improved precision and coordination.

Integrated ORs provide real-time access to patient data, imaging, and video feeds, enabling all team members to see and interpret the same information simultaneously. Surgeons, anesthesiologists, and nurses can more easily discuss findings and coordinate actions, improving decision-making accuracy and communication clarity. Integrated OR systems often provide automated checklists and prompts, keeping everyone on the same page with minimal verbal interaction.¹

This streamlined approach to task management allows the surgical team to anticipate next steps and stay coordinated, even with complex procedures. By consolidating various systems and devices, integrated OR technologies reduce the physical movement and mental load associated with managing multiple interfaces. A reduced workload allows surgical teams to communicate more efficiently and focus more on the patient, improving intra-team coordination and reducing stress. Safety checklists have been demonstrated to affect positively on patient morbidity and mortality following surgery; however, it is unclear if this clinical benefit is connected to an increase in OR cooperation and communication.²

Silence is a crucial part of communication. Silence, like spoken conversation, has several dimensions and may be used in a variety of ways, including taking notice or refocusing attention, reflecting and discernment, and imposing authority over another. Silence, which is inextricably related to communication, may be productive and intentional, emerging as acute awareness that is both noticed and felt. This intense awareness arises because the absence of words, formed by quiet, makes the presence of silence more obvious. Such presence is what Harper⁶ referred to as actual presence; it prompts people to act. Concrete presence serves as a sort of rallying cry in a surgical setting.

This qualitative study attempted to determine how and when silence occurs in the operating theater during a surgical operation, as well as the impact it has on individual and inter professional team member responses. Silence serves various significant purposes as a type of communication, including linking through associations and relationships, emotive response to silences' effect, revelation perceived as an interruption, judgment based on perception, and agency, or the action performed. These indications, which are frequently complemented by nonverbal indicators, make the functions of silence visible.

One of the main responsibilities in operating rooms (ORs) is patient monitoring. Today's operating rooms are frequently overflowing with standalone equipment, support systems, and monitors because to the growing usage of cutting-edge technologies in surgical procedures. Numerous cutting-edge gadgets that have just been added to the operating room have their own platforms for displaying data, in addition to the traditional monitors that constantly display the patient's hemodynamic, respiratory, and electrophysiological data. These gadgets may be split into four categories. ³

Some experts believe that most ORs now lack a high-level overview of all of the information accessible in the room. When patient data is not connected, operating rooms become unproductive, overcrowded, and less secure. When patient data is not displayed to caregivers in an integrated way, OR personnel must frequently use several screens to obtain updates and

maintain control over the many instruments at their disposal. OR integration is a new technique with the potential to address the long-standing issue of segregated data presentation in ORs. This technology enables physicians to arrange and compress patient data during surgical operations.

Effective workflow management is more than simply efficiency; it is an important part of the patient and clinical staff experience, encompassing variables such as safety and positive health outcomes. Given the catastrophic consequences of mistakes or delays, hospitals must make significant investments in high-quality medical equipment to prevent possible risks. Teddies medical's contribution stands out in this regard, as it provides a large range of models particularly designed for the ICU and OR, as well as appropriate hospital solutions.⁶

Communication breakdowns are commonly the cause of poor outcomes for surgical patients; nevertheless, data to guide good communication practice in the operating room is limited. This narrative research examines the importance of inter professional communication for surgical patient safety, analyzes its obstacles and facilitators, and proposes critical solutions for increasing communication quality in the OR. Based on the findings, a study strategy for best practices in inter professional operating room communication is recommended.

Health professionals in surgical teams rely significantly on one another and operate under strict timelines. Teamwork is essential for providing high-quality care and ensuring patient safety. Relational coordination, defined as "communicating and relating for the purpose of task integration," has been found to increase both quality of care and patient safety. Relational coordination has also been linked to increased psychological safety and the ability to learn from mistakes. Despite extensive research into relational coordination in a number of contexts, including surgery, no study has examined how relational coordination works at the micro level.

The operating room is a high-risk environment that relies on multidisciplinary performance to perform invasive procedures of various complexities. These complexities necessitate the use of specific physical, material, and human resources, as well as interaction with clients and their families during a time of significant physical and emotional impact.⁷

Decisions about the management and planning of perioperative care are influenced by a variety of technical, scientific, social, financial, and political issues in operating room nursing practice. These nurses' workflow involves both internal and external elements, and their efforts to balance the referred factors may lead to stress, which may influence their decision-making. The process of choosing among multiple options and using a value judgment to ascertain what is pertinent to the decision is known as decision-making. This process typically results in the definition of the optimal course of action to get the intended outcome. In turn, the workflow is made up of the organizational processes' functions or procedures.⁸

POSITIVELY AFFECTING FACTORS

Nurses can make better decisions if they are aware of the elements that have beneficial effects on the operating room workflow. Data gathering during the preoperative phase is one of these elements, since it enables better detection and prediction of the client's clinical changes during the surgical operation. Both the doctors who (re) manage situations anticipated during the intraoperative time and the nurses who (re) plan the environment and client preparation as well as the link between the required support services are supported in their decision-making by these data. Managing intraoperative IV fluid administration is one of the responsibilities of operating room nurses in Sweden. Therefore, the information gathered can help direct the administration of fluid therapy during surgery, which is essential in certain circumstances, such as for patients with kidney issues.⁹

The nursing team's workflow reflects the operations carried out by the support staff, which are likewise impacted by process standardization. For instance, if an operating room is cleaned in the allotted time, it increases operational capacity; if not, it disrupts workflow, making it difficult to schedule surgeries and necessitating quick judgments from the nurses. Increased time spent in care by the nursing personnel is associated with positive outcomes. The use of a computational approach for surgical scheduling, which recommends that nursing time be devoted to the care of surgical clients, aids the nurse in this work. Since non-specific nursing tasks, such preventative and/or corrective maintenance of equipment, are delegated to another expert, the establishment of the equipment technician duty maximized the amount of time nurses could spend providing care. 10

FACTORS THAT HAVE DETRIMENTAL EFFECTS

The clinical status of the patient for surgical cancellation is an unpredictable factor that implies these professionals make administrative judgments to ensure a permanent workflow, even though it is not directly within the scope of the nurse's decision-making. However, some cancellations and delays, such the lack of a preoperative assessment and client rejection or absenteeism, can be avoided. These situations can be avoided by preoperative planning, which optimizes resources and affects the choices made by operating room nurses.11

Deficits in physical structure, such as insufficient beds in the intensive care unit, also affect the workflow in the surgical setting. The nurse may decide to cancel the procedure if there are no available beds before it begins, or they may use the beds for rapid post-anesthetic recovery if there are no available beds after the treatment. The workflow in the surgical setting is also impacted by physical structure deficiencies, such as the lack of adequate intensive care unit beds. The nurse may choose to abort the operation if there are no available beds prior to the procedure; if no beds are available following the procedure, beds may be used for the patient's immediate post-anesthetic recovery.12

In the surgical context, the team's size and qualifications are also important considerations. A restructuring of operations due to improper nursing team sizing puts clients' safety at risk and puts professionals under excessive workload. The results included elements from the inpatient units that might be connected to the shortage of experts who can either receive or refer clients to other providers. These circumstances disrupt the surgical center's workflow, and nurses must decide how to rearrange the workload. 13

According to a study done in Chinese hospitals, increasing client safety is closely correlated with the right size of the nursing staff and organizational assistance. According to the study's conclusions, professionals experience work overload, fatigue, and stress due to improper sizing, lack of time, planning, and organization, which can even harm interpersonal relationships. In order to guarantee that the nursing team is appropriately sized, management and operating room nurses should base their decisions on data that supports the recommended sizing. 14

MATERIAL AND METHODS

STUDY DESIGN: In order to evaluate the effects of integrating operating room technologies on surgical team communication and workflow, as well as the current state of communication and behaviors within the target population, this study utilize a cross-sectional observational design. Additionally, it identifies correlations between the integration of operating room technologies and workflow, as well as between the integration of operating room technologies and surgical team communication.

SETTINGS: Data be gathered from a number of public hospitals in Lahore, including the General Hospital and Jinnah Hospital. To guarantee a varied representation of surgical team

personnel across several hospital surgical departments, the study locations will be chosen.

STUDY DURATION: the study done in four months.

SAMPLE SIZE: The cross-sectional study formula used to calculate the sample size, with a 95% confidence level and a 5% margin of error as the goals. To achieve statistical power and representation, a sample size of roughly 100 OR staff members is intended, based on initial estimations of the populations of OR personnel at chosen institutions.

SAMPLING TECHNIQUE: Convenience sampling is a non-probability sampling method that I used in my study. Participants that are willing and able to participate are chosen using this way. Convenience sampling is beneficial because it is inexpensive and simple to use. But because the sample might not be representative of the total population, bias could be introduced, which could limit how broadly the results can be applied. Convenience sampling is frequently helpful in exploratory research where rapid and simple data gathering is necessary, despite these drawbacks.

SAMPLE SELECTION

INCLUSION CRITERIA

- OT Technologist
- Surgeon
- Scrub Nurse
- OT staff
- Anesthetics

EXCLUSION CRITERIA

- Other hospital Staff
- House keeper

EQUIPMENT(S)

No Any

RESULTS

DEMOGRAPHICS

TABLE # 01

	Gender	Frequency	Percent	Cumulative Percent
Valid	Male	97	36.9	37.2
	Female	163	62.0	99.6
	Prefer not to say	1	.4	100.0
	Total	261	99.2	
Missing	System	2	.8	
Total		263	100.0	

GENDER DISTRIBUTION (TABLE 1)

- Most respondents are female (62%), while males make up 36.9% of the group.
- A small fraction (0.4%) preferred not to disclose their gender.
- There are 2 missing responses (0.8%), meaning these individuals didn't provide their gender information.

This indicates a predominantly female group, which may have implications based on the nature of the study or workplace being examined.

TABLE # 02

	Age	Frequency	Percent	Cumulative Percent
Valid	18-25 Years	255	97.0	97.0
	26-33 Years	7	2.7	99.6

34-41 Years	1	.4	100.0
Total	263	100.0	

AGE DISTRIBUTION (TABLE 2)

- The overwhelming majority (97%) of respondents are between 18-25 years old.
- Only 2.7% belong to the 26-33 years age range, and a tiny fraction (0.4%) are 34-41 years old.
- There are no missing responses in this table.

This suggests that the population surveyed is largely young, possibly indicating students, early-career professionals, or a workforce dominated by younger individuals.

TABLE # 03

Designation		Frequency	Percent	Cumulative Percent
Valid	Surgeon	24	9.1	9.7
	Anesthetic	53	20.2	31.0
	OT Technologist	136	51.7	85.9
	Scrub Nurse	11	4.2	90.3
	OT Technician	24	9.1	100.0
	Total	248	94.3	
Missing	System	15	5.7	
Total		263	100.0	

DESIGNATION (TABLE 3)

- OT Technologists make up the largest group (51.7%), meaning they are the most common professional designation in this dataset.
- The second largest group is Anesthetics (20.2%), followed by Surgeons (9.1%) and OT Technicians (9.1%).
- Scrub Nurses form the smallest group (4.2%).
- 15 responses (5.7%) are missing, meaning some respondents did not disclose their professional designation.

This shows that **the majority are OT Technologists**, with fewer people in surgical and anesthetic roles. If this dataset relates to a hospital or medical setting, it suggests a significant reliance on OT Technologists compared to other roles.

SCALE: ALL VARIABLES

TABLE #03

Reliability Statistics	
Cronbach's Alpha	N of Items
.909	12

Cronbach's Alpha = 0.909: This is a high reliability score, meaning the 12 items in your scale are highly consistent in measuring the same construct.

Number of Items = 12: The scale consists of 12 related questions or variables.

Purpose of Reliability Analysis: "To ensure the consistency of the measurement tool, Cronbach's Alpha was calculated. A reliability coefficient above 0.7 is generally acceptable, and values above 0.9 indicate excellent internal consistency."

Interpretation: "The high Cronbach's Alpha (0.909) confirms that the 12-item scale used in this study is reliable and capable of consistently measuring the intended variable."

Implications: "Given this strong reliability, the scale can be confidently used for further data analysis without concerns of measurement error."

CORRELATIONS

TABLE # 04

Correlations		Integration	Communication	Work Flow
Integration	Pearson Correlation	1		
	Sig. (2-tailed)			
Communication	Pearson Correlation	.772**	1	
	Sig. (2-tailed)	.000		
Workflow	Pearson Correlation	.807**	.819**	1
	Sig. (2-tailed)	.000	.000	

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

NONPARAMETRIC CORRELATIONS

TABLE # 05

Correlations		Integration	Communication	Workflow
Communication	Sig. (2-tailed)	.	.000	.000
	Correlation	.773**	1.000	.804**
	Coefficient			
Workflow	Sig. (2-tailed)	.000	.	.000
	Correlation	.816**	.804**	1.000
	Coefficient			
	Sig. (2-tailed)	.000	.000	.

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

PEARSON CORRELATION (TABLE #04)

- Measures linear relationships between variables.
- Results show:
- Integration & Communication: Strong positive correlation ($r = 0.772$, $p = 0.000$), meaning that as integration improves, communication also tends to improve.
- Integration & Workflow: Very strong positive correlation ($r = 0.807$, $p = 0.000$), indicating a strong connection between integration and workflow efficiency.
- Communication & Workflow: Very strong positive correlation ($r = 0.819$, $p = 0.000$), suggesting that better communication enhances workflow.

NONPARAMETRIC CORRELATION (TABLE #05)

- Used when assumptions of normality in data are not met.
- Results are consistent with Pearson:
 - Integration & Communication: Strong correlation ($r = 0.773$, $p = 0.000$).
 - Integration & Workflow: Strong correlation ($r = 0.816$, $p = 0.000$).
 - Communication & Workflow: Strong correlation ($r = 0.804$, $p = 0.000$).
- Since results from both correlation methods are similar, it confirms that the relationships hold regardless of whether parametric assumptions are met.
- "The correlation analysis reveals strong positive relationships among Integration, Communication, and Workflow. Pearson's correlation coefficients indicate that better integration significantly enhances communication and workflow efficiency ($r = .772$ and $r = .807$, respectively). Additionally, communication strongly correlates with workflow ($r = .819$), suggesting interdependence between these factors. These findings align with previous research emphasizing the critical role of integration in improving communication and workflow within organizations. Nonparametric correlations further confirm the strength of these relationships, validating the robustness of the results even in cases where parametric assumptions may not hold."

THE VALUE OF RELATIONSHIP COORDINATION AND TEAMWORK

Collaboration among surgical teams have a significant impact on the standard of care provided and the safety of patient management. Even in failures, relational coordination defined as "communicating and relating for the purpose of integration for cooperation" has been linked to psychological health, safety, care quality, and the learning process. Although a lot of research has been done on relational coordination in surgery, there is still a lack of information regarding its wider use in surgical teams.

Research on the best way to use relational coordination to boost productivity and results in the operating room (OR) under extreme stress is still pending. Surgical suites are high-stakes, surgically maneuvered environments that require interdisciplinary care. Each operating room is a complicated interplay of coordination and communication within a network of intricate mental and emotional blockages affecting the patient and family, and it frequently requires surgical support of some kind of specialist human, physical, and material resources. These components emphasize the necessity of sophisticated resource allocation to ORs and optimal cross-function collaboration.

NEGOTIATING THE BOUNDARIES OF DECISION AND WORKFLOW

The assessment of flow is a component of hover management, while decision making is an appropriate choice of action. Efficient navigation through these phases is essential for both an organization and patients. Nurses must balance the broad categorization of technical dimensions, science and social science, finance, and even politics, as well as other aspects in order to prepare for a perioperative care plan. Relying on these bound markers as inscribed or imposed boundaries will add stress to the nurse, while adjusted boundaries may ease the decision-making process.

A NEW APPROACH: INTEGRATING ORS

Addressing OR Integration Line is working on solving OR integration challenges: divided data spatially located in different regions are patched into one whole.

- These system Eases device anchorages.
- The One Stop VIP Service is available.
- Offers a unified interface for patient monitoring, real-time data, and imaging.
- Lowers physical and mental burden on OR staff.

Not only does this technology improve safety during operations but also facilitates better interaction between anesthesiologists, surgeons, and nurses to achieve seamless coordination even in critical procedures.

DISCUSSION

DEMOGRAPHICS & WORKFORCE COMPOSITION

- Gender Distribution: With 62% female respondents, this suggests a predominantly female workforce in the study setting. This could have implications for workplace policies, gender-specific training approaches, and team dynamics.
- Age Distribution: The overwhelming majority (97%) fall within the 18-25 age range, indicating a young workforce—likely students, early-career professionals, or recent graduates. Understanding how this age group interacts with technology and workflow optimization could provide insights into efficiency and adaptability.

OCCUPATIONAL STRUCTURE

- OT Technologists (51.7%) dominate the dataset, highlighting their central role in surgical environments.
- The next largest group, anesthesiologists (20.2%), plays a crucial role in maintaining patient stability.

- Surgeons (9.1%) & Scrub Nurses (4.2%) represent smaller portions,
- The high number of missing responses (5.7%) in designations suggests some respondents may have been uncertain about their exact professional role or preferred not to disclose.

RELIABILITY OF MEASUREMENT TOOL

- With a Cronbach's Alpha of 0.909, the survey instrument shows excellent internal consistency, meaning the questions effectively measure the intended concept.
- The 12-item scale is highly reliable, ensuring that the dataset can be used confidently for further analysis.

CORRELATION ANALYSIS: INTEGRATION, COMMUNICATION, AND WORKFLOW

Pearson Correlation (Parametric) Findings:

- Integration & Communication ($r = 0.772$) → Strong positive relationship. Improved integration enhances communication efficiency.
- Integration & Workflow ($r = 0.807$) → Workflow improves significantly with stronger integration.
- Communication & Workflow ($r = 0.819$) → the strongest correlation, reinforcing that effective communication is a driving force behind workflow efficiency.

NONPARAMETRIC CORRELATION CONFIRMATION

- The Spearman (nonparametric) correlation results align with Pearson findings, confirming robust relationships regardless of data distribution assumptions.
- This strengthens the case that integration directly improves both communication and workflow efficiency.

KEY IMPLICATIONS FOR RESEARCH & PRACTICE

- Integration systems must prioritize communication channels, as improved communication leads to workflow efficiency gains.
- Young workforce dynamics could indicate high adaptability to digital systems but may require additional training for senior-level responsibilities.
- Heavy reliance on OT Technologists shows their critical role in surgical settings, meaning any workflow improvements should directly target their efficiency.
- Survey reliability confirms the dataset's strength, reinforcing confidence in further statistical analysis and strategic recommendations.

CONCLUSION(S)

Integrated operating room technologies have greatly enhanced surgical care and greatly increased team communication and workflow efficiency. Notwithstanding their enormous technological potential, their final worth rests on careful application that considers human factors, team dynamics, and institutional functioning. Technology successfully integrated by those who see it as a tool to complement, not to replace, the essentially human aspects of surgical interaction. As these technologies evolve, more study will be required to fully understand how they affect healthcare expenditures and the performance of patient outcome teams.

To optimize the potential advantages of operating room technology, which has transformed the communication and collaboration of surgical teams, healthcare organizations utilizing these systems ought to allocate equal resources to team training and technology. The benefits and drawbacks of these technologies have been emphasized in this literature study, along with how they affect the effectiveness

of situational awareness communication and collaboration. Although the operating room of the future is probably going to be more intelligent and connected, the value of open communication, respect for one another, and well-coordinated collaboration will not be diminished.

Patient safety work flow and member understanding of the surgical site and patient integrated system, verbal communication is less necessary. Minimize errors and errors the amount of data from various systems can overwhelm team members when they are unable to respond quickly to changes in a patient's health, which can interfere with communication and workflow. Advanced technology in the operating room has effectively transformed the surgical work flow to sign efficiency.

Integrated operating room management systems minimize human hearing and optimization. These developments enable improved coordination between while flow adaptability and interdisciplinary teamwork are necessary for surgical teams to increase procedural accuracy the long-term benefits such as shorter operating times for patients outweigh the high cost and learning curve. Decision-making in the operating room is driven by safety and data, which highlights the importance of ongoing technological integration. The future of the operating room is in intelligent, networked systems that improve Paris, automate processes, and provide the best possible patient outcomes. By improving efficiency, coordination, and patient safety, integrated operating room technology has greatly improved surgical team communication. These cutting-edge systems include audiovisual integration, daytime data sharing, and as well as satellite control. The high-definition display and voice-activated device minimizes communication, reduces documentation automatically, and minimizes delays by facilitating the smooth interchange of information with other team members. Where technical management integrated data members have access to vital information, central control enables the team to concentrate more on patient care.

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